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International Telecommunication Union
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Recommendation ITU-R BS.2076-3

(02/2025)

BS Series: Broadcasting service (sound)

Audio definition model

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Note: *This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.*

Electronic Publication
Geneva, 2025

RECOMMENDATION ITU-R BS.2076-3

Audio definition model

(2015-2017-2019-2025)

Scope

This Recommendation describes the structure of a metadata model that allows the format and content of audio files to be reliably described. This model, called the Audio Definition Model (ADM), specifies how XML metadata can be generated to provide the definitions of tracks in an audio file.

Keywords

ADM, Audio Definition Model, BW64, Metadata, Wave-file, WAVE, object-based, channel-based, scene-based, renderer, XML, XSD, format, immersive

The ITU Radiocommunication Assembly,

considering

a) that Recommendation ITU-R BS.2051 – Advanced sound system for programme production, highlights the need for a file format that is capable of dealing with the requirements for future audio systems;

b) that Recommendation ITU-R BS.1909 – Performance requirements for an advanced multichannel stereophonic sound system for use with or without accompanying picture, outlines the requirements for an advanced multichannel stereophonic sound system;

c) that it is desirable that there is a single standard for a metadata model for defining audio content that file and streaming formats could adopt,

recommends[1]

that the Audio Definition Model described in Annex 1 should be used for the following cases in programme production and international exchange:

– applications requiring a generic metadata model for, and a formalized description of, custom/proprietary audio formats and content (including codecs);

– generating and parsing audio metadata with general-purpose tools, such as text editors;

– an organization’s internal production developments, where multi-purpose metadata needs to be added;

– a human-readable and hand-editable file for describing audio configurations (such as describing a mixing studio channel configuration) in a consistent and translatable format is needed.

[1] The informative Annex 2 provides examples of ADM usage. The informative Annex 3 gives an overview of the changes in this edition compared to the previous edition.

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Annex 1

Audio Definition Model

1 Introduction

Audio for broadcasting and cinema is evolving towards an immersive and interactive experience, which requires the use of more flexible audio formats. A fixed channel-based approach is not sufficient to encompass these developments and so combinations of channel, object and scene-based formats have been developed. Report ITU-R BS.2266 [1] and Recommendations ITU-R BS.1909 [2] and ITU-R BS.2051 [3] highlight these developments and the need for the production chain to accommodate them.

The requirement for allowing different types of audio to be distributed, whether by file or by streaming, is that whatever file/stream format is used, metadata should co-exist to fully describe the audio. Each individual track within a file or stream should be able to be correctly rendered, processed or distributed according to the accompanying metadata. To ensure compatibility across all systems, the Audio Definition Model is a Recommendation that will make this possible.

2 Background

The purpose of this model is to formalise the description of audio. It is not a format for carrying audio. This distinction will help in the understanding of the model.

2.1 Cooking analogy

To help explain what the ADM actually does, it may be useful to consider a cooking analogy. The recipe for a cake will contain a list of ingredients, instructions on how to combine those ingredients and how to bake the cake.

The ADM is like a set of rules for writing the list of ingredients; it gives a clear description of each item, for example: 2 eggs, 400g flour, 200g butter, 200g sugar.

The ADM provides the instructions for combining ingredients but does not tell you how to do the mixing or baking; in the audio world that is the role of the renderer.

The ADM is compatible with wave-file based formats such as the BW64 format specified in Recommendation ITU-R BS.2088 [7] and the BWF as defined by the ITU in Recommendation ITU-R BS.1352 [4].

When Recommendation ITU-R BS.2088 is used, the <*chna*> chunk of the BW64 file is like the bar code on the packet of each of the ingredients; this code allows us to look up the model's description of each item. The bag containing the actual ingredients is like the 'data' chunk of the BW64 file that contains the audio samples.

From the BW64 file point of view, one would look at the bar codes on each ingredient in the bag, and use that to look up the description of each item in the bag. Each description follows the structure of the model. There might be ingredients such as breadcrumbs, which could be divided into its own components (flour, yeast, etc.); which is like having an audio object containing multiple channels (e.g. 'stereo' containing 'left' and 'right').

See Report ITU-R BS.2388 – Usage guidelines for audio definition model and multichannel audio files [10] that describes in detail the use of ADM.

2.2 Brief overview

This model uses XML as its specification language. When used with BW64 files [7], the XML may be embedded in specific chunks, for example the <axml> chunk, of the file.

The model is divided into two sections, the **content** part, and the **format** part. The content part will describe the language of dialogue, the loudness, etc.

The format part describes the technical nature of the audio so it can be decoded or rendered correctly. Format elements may be defined before having any audio signals, whereas the content parts can usually only be completed after the signals have been generated.

3 Overview description of the ADM

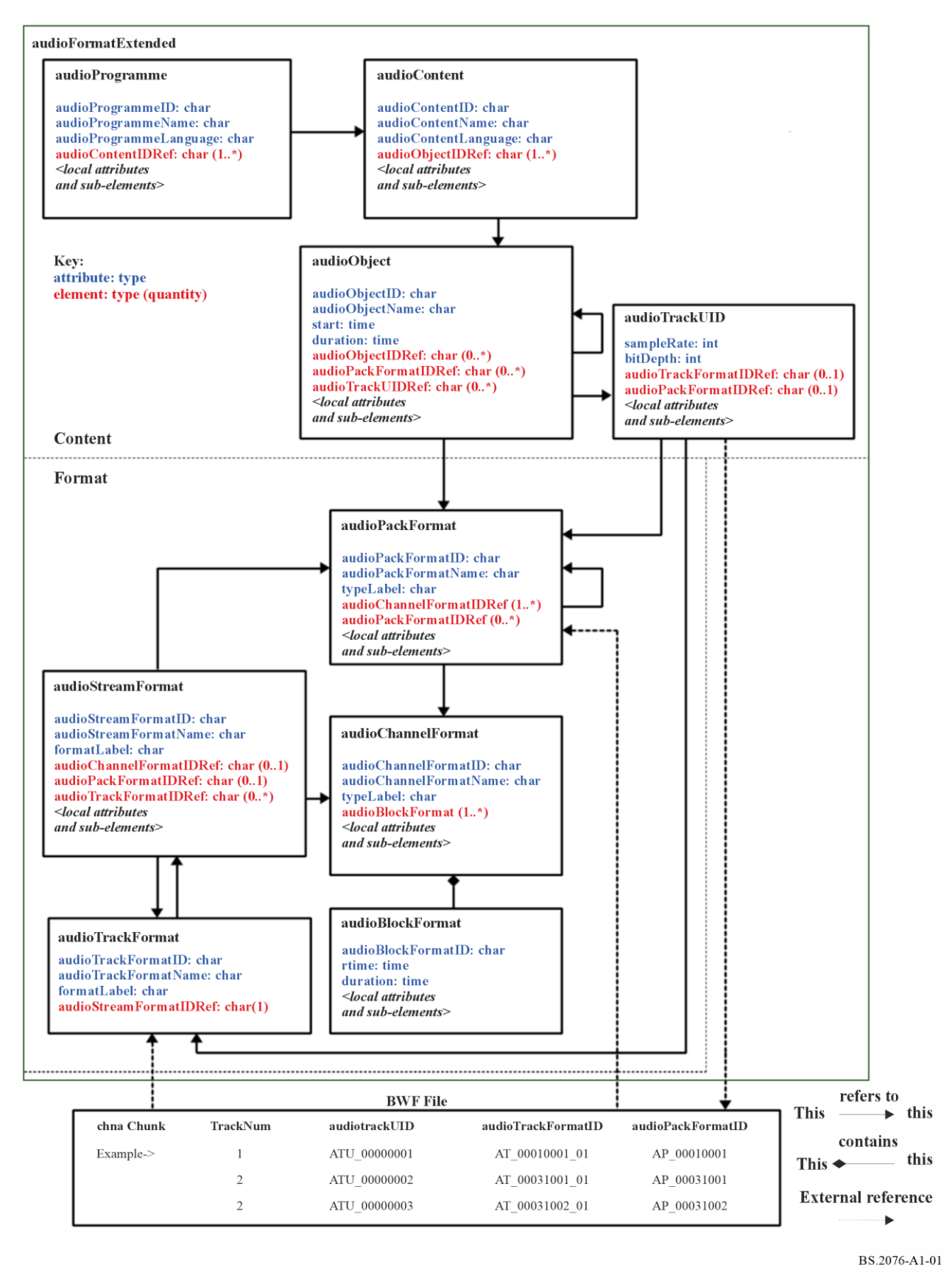
The overall diagram of the UML model for the ADM is shown in Fig. A1-1. This shows how the elements relate to each other and illustrates the split between the content and format parts. It also shows the <*chna*> chunk of a BW64 file and how it connects the tracks in the file to the model.

Where a BW64 file contains a number of audio tracks, it is necessary to know what each track is. The <*chna*> chunk contains a list of numbers corresponding to each track in the file. Hence, for a 6-track file, the list is at least 6 long. For each track there is an audioTrackFormatID number and an audioTrackUID number (notice the additional 'U' which stands for 'unique'). The reason the list could be longer than the number of tracks is that a single track may have different definitions at different times so will require multiple audioTrackUIDs and references.

The audioTrackFormatID is used to look up the definition of the format of that particular track. The audioTrackFormatIDs are not unique; for example, if a file contains five stereo pairs, there will be five identical audioTrackFormatIDs to describe the 'left' channel, and five to describe the 'right' channel. Thus, only two different audioTrackFormatIDs will need to be defined. However, audioTrackUIDs are unique (hence the 'U'), and they are there to uniquely identify the track. This use of IDs means that the tracks can be ordered in any way in the file; their IDs reveal what those tracks are.

FIGURE A1-1

Overall UML Model



3.1 Format

The audioTrackFormatID identifies the format of the track. The audioTrackFormat shall also contain a reference to an audioStreamFormatID, which allows identification of the combination of the audioTrackFormat and audioStreamFormat. An audioStreamFormat describes a decodable signal.

The audioStreamFormat references one or more audioTrackFormats. The combination of audioStreamFormat and audioTrackFormat reveals whether the signal has to be decoded or not.

The next stage is to determine what type of audio the stream is; for example, it may be a conventional channel (e.g. 'front left'), an audio object (e.g. something named 'guitar' positioned at the front), a HOA (Higher Order Ambisonics) component (e.g. 'X') or a group of channels. Inside audioStreamFormat there shall be a reference to either an audioChannelFormat or audioPackFormat that will describe the audio stream. There shall only be one of these references.

If audioStreamFormat contains an audioChannelFormat reference (i.e. audioChannelFormatIDRef) then audioStreamFormat is one of several different types of audioChannelFormat. An audioChannelFormat is a description of a single waveform of audio. In audioChannelFormat, the typeDefinition attribute shall be set such that it identifies the channel type.

The typeDefinition attribute can be set to 'DirectSpeakers', 'HOA', 'Matrix' 'Objects' or 'Binaural'. For each of those types, there is a different set of sub-elements to specify the static parameters associated with that type of audioChannelFormat. For example, the 'DirectSpeakers' type of channel has the sub-element 'speakerLabel' for allocating a loudspeaker to the channel.

To allow audioChannelFormat to describe dynamic channels (i.e. channels that may change over time), audioBlockFormat is used to divide the channel along the time axis. The audioBlockFormat element may contain a start time (relative to the start time of the parent audioObject) and duration. Within audioBlockFormat the time-dependent parameters that describe the channel depend upon the audioChannelFormat type.

For example, the 'Objects' type of channel has the sub-elements 'azimuth', 'elevation' and 'distance' to describe the location of the sound. The number and duration of audioBlockFormats is not limited, there could be an audioBlockFormat for every sample if something moves rapidly, though that might be a bit excessive! At least one audioBlockFormat shall be required, static channels shall have one audioBlockFormat containing the channel's parameters.

When an audioStreamFormat is representing a single channel of audio (such as for PCM), the audioStreamFormat shall contain a single reference to an audioChannelFormat, and it shall not contain any references to audioPackFormats.

When an audioStreamFormat is representing multiple audio channels that are combined in a coded bitstream (e.g. an MPEG-1 Layer II bitstream), the audioStreamFormat shall reference a single audioPackFormat, and not reference any audioChannelFormats.

For example, 'stereo', '5.1', '1st order Ambisonics' would all be examples of an audioPackFormat. Note that audioPackFormat just describes the format of the audio. For example, a file containing 5 stereo pairs will contain only one audioPackFormat to describe 'stereo'. It is possible to nest audioPackFormats; a '2nd order HOA' could contain a '1st order HOA' audioPackFormat alongside audioChannelFormats for the R, S, T, U & V components.

3.2 Content

Using an audio scene with five stereo pairs as an example, the audioTrackFormat defines which audio tracks are left and right, not which ones belong together, nor what is represented in them. AudioObject is used to determine which tracks belong together and where they are in the file. This element links the actual audio data with the format, and this is where audioTrackUID comes in.

For example, for a stereo pair in PCM, an audioObject contains references to two audioTrackUIDs; therefore, those two tracks will contain the associated essence. The audioObject contains a reference to an audioPackFormat, which defines the format of those two tracks as a stereo pair.

As there are five stereo pairs in this example, 5 audioObject elements are needed. Each one shall contain the same reference to a stereo audioPackFormat, but shall contain different audioTrackUID references, as each stereo pair is carrying different audio. The order of audioTrackUIDRefs is not important in an audioObject, as the format definition through audioTrack, audioStreamFormat, audioChannelFormat and audioPackFormat determines which track is which.

The audioObject element may also contain start and duration attributes. This start time is the time when the signal for the object starts in a file or recording. Thus, if start is "00:00:10.00000", the signal for the object shall start 10 seconds into the track in the audio file.

As audioPackFormat can be nested, it follows that audioObjects can be nested. Therefore, the audioObject shall contain not only references to the two audioTrackUIDs carrying the stream, but also references to two audioObjects, one for the 5.1 and one for the 2.0.

AudioObject is referred to by audioContent, which gives a description of the content of the audio; it has parameters such as language (if there is dialogue) and the loudness parameters. Some of the values for these parameters can only be calculated after the audio has been generated, so they are not in the format part.

AudioProgramme brings all the audioContent together; it combines them to make the complete 'mix'.

For example:

– an audioProgramme may contain audioContent for 'narrator' and another one for 'background music';
– an audioProgramme for France may contain audioContents called 'dialogue-fr' and 'backgroundMusic', and another audioProgramme for the UK which contains audioContents called 'dialogue-en' and the same 'backgroundMusic'.

Multiple audioProgramme elements can be defined in one ADM XML tree representation. This facilitates the description of a presentation that represents a predefined number of meaningful mixes that users can choose from. Each audioProgramme element may reference just a subset of audioContent elements of the ADM XML tree. This is one method to enable the ADM to describe personalised audio.

For example:

– Following the previous example for audioProgramme, a single ADM XML tree can contain both French and English audioProgramme elements.
– An ADM XML tree describing a sports programme can contain audioProgramme elements for a home team and an away team. The home team audioProgamme may contain audioContent elements for a 'home team biased commentary', and another one for 'ambience'. The away team audioProgramme may contain audioContent for an 'away team biased commentary' and the same 'ambience'.

TABLE A1-1

Alternative mixes

	Ambience	Neutral commentary	Home team biased commentary	Away team biased commentary
Default mix	•	•		
Home team	•		•	
Away team	•			•

Another approach to this example is to use a single audioProgramme containing the four audioContent elements (‘ambience’, ‘neutral commentary’, ‘home team biased commentary’ and ‘away team biased commentary’) and associated four audioObject elements, and allow user interaction to be used to select the audioObject elements for commentary.

4 Common definitions

For many situations, particularly in channel and scene-based work, many of the required formats will be common. For example, mono, stereo and 5.1 all have common definitions and it would be inefficient to generate and carry a mass of XML every time one of these formats needs to be described. Common definitions are specified in Recommendation ITU-R BS.2094 [8].

This set is defined in Recommendation ITU-R BS.2094 [8] and is also available as an attached XML file. This reference file does not have to be included in a file using the ADM but can be externally referred to. Therefore, a file should not need to carry the XML of the format if only common definitions are used. When audioProgramme, audioContent and audioObject are used, or custom definitions are required, then the file shall carry ADM XML code.

5 ADM elements

Each of the elements within the ADM is described in the following subsections.

5.1 audioTrackFormat

The audioTrackFormat element describes the format of a single set of samples or data in a single track in a storage medium. It is used to describe what format the data is in, allowing a renderer to decode the signal correctly. It is referred from the audioStreamFormat element, which is used to identify the combination of tracks required to decode the track data successfully.

For PCM audio an audioStreamFormat will refer to a single audioTrackFormat and so the two elements are effectively describing the same thing. In this case, the audioTrackFormat and the audioStreamFormat should be omitted. Then the audioTrackUID shall refer to the corresponding audioChannelFormat. For coded audio, multiple audioTrackFormats will have to be combined in a single audioStreamFormat to generate decodable data.

Software that parses the model can start from either audioTrackFormat or audioStreamFormat. To allow for this flexibility audioTrackFormat can also refer back to the audioStreamFormat.

If the audioStreamFormat references an audioTrackFormat then the audioTrackFormat shall refer back to the same audioStreamFormat.

5.1.1 Attributes

TABLE A1-2

AudioTrackFormat attributes

Attribute	Description	Example	Required
audioTrackFormatID	ID for track, see § 6. The yyyy digits of AT_yyyyxxxx_zz represent the type of audio contained in the track. The yyyyxxxx digits shall match the audioStreamFormat yyyyxxxx digits	AT_00010001_01	Yes
audioTrackFormatName	Name for track	PCM_FrontLeft	Yes
formatLabel	Descriptor of the format	0001	Optional
formatDefinition	Description of the format	PCM	Optional

5.1.2 Sub-elements

TABLE A1-3

audioTrackFormat sub-elements

Sub-element	Description	Example	Quantity
audioStreamFormatIDRef	Reference to an audioStreamFormat	AS_00010001	1 (see Note below)

NOTE – Earlier versions (Recommendations ITU-R BS.2076-0 and ITU-R BS.2076-1) of this Recommendation specified the above quantity as “0 or 1”, but this was an error. As some existing ADM files (based on Recommendations ITU-R BS.2076-0 or ITU-R BS.2076-1) may lack this sub-element, any software that reads ADM files should tolerate audioStreamFormatIDRef being absent.

5.1.3 Sample code

```
<audioTrackFormat audioTrackFormatID="AT_00010001_01"
audioTrackFormatName="PCM_FrontLeft" formatDefinition="PCM" formatLabel="0001">
  <audioStreamFormatIDRef>AS_00010001</audioStreamFormatIDRef>
</audioTrackFormat>
```

5.2 audioStreamFormat

An audioStreamFormat is a combination of one or more track formats required to render a channel, object, HOA component or pack. The audioStreamFormat establishes a relationship between audioTrackFormats and the audioChannelFormats or audioPackFormat. Its main use is to allow non-PCM encoded tracks, where one or more audioTrackFormats must be combined to represent a decodable signal that covers several audioChannelFormats (by referencing an audioPackFormat). For PCM audio, the audioStreamFormat and the audioTrackFormat should be omitted (see § 5.1). If they are not omitted, the audioStreamFormat may refer to a single audioTrackFormat and shall refer to a single audioChannelFormat.

Software that reads ADM files should be aware that existing ADM files (based on Recommendation ITU-R BS.2076-2 and earlier) for PCM audio may contain a single audioStreamFormat elements that reference a single audioTrackFormat and a single audioChannelFormat element. If so, then the yyyyxxxx parts of AT_yyyyxxxx_zz, AS_yyyyxxxx, and AC_yyyyxxxx should be identical.

5.2.1 Attributes

TABLE A1-4

audioStreamFormat attributes

Attribute	Description	Example	Required
audioStreamFormatID	ID for the stream, see § 6. The yyyy digits of AS_yyyyxxxx represent the type of audio contained in the stream. The xxxx digits shall match the audioChannelFormat xxxx digits, if an audioChannelFormat is being referenced.	AS_00010001	Yes
audioStreamFormatName	Name of the stream	PCM_FrontLeft	Yes
formatLabel	Descriptor of the format	0001	Optional
formatDefinition	Description of the format	PCM	Optional

5.2.2 Sub-elements

TABLE A1-5

audioStreamFormat sub-elements

Sub-element	Description	Example	Quantity
audioChannelFormatIDRef	Reference to audioChannelFormat	AC_00010001	0 or 1
audioPackFormatIDRef	Reference to audioPackFormat	AP_00010003	0 or 1
audioTrackFormatIDRef	Reference to audioTrackFormat	AT_00010001_01	0…* (see Note below)

NOTE – Earlier versions (Recommendations ITU-R BS.2076-0 and ITU-R BS.2076-1) of this Recommendation specified this quantity as “1”. Software that reads ADM files should be aware that some existing ADM files (based on Recommendations ITU-R BS.2076-0 or ITU-R BS.2076-1) may only have the audioTrackFormatIDRef sub-element within audioStreamFormat, but may lack the audioStreamFormatIDRef sub-element within audioTrackFormat (see § 5.1.2).

Only one of audioPackFormatIDRef or audioChannelFormatIDRef can be used, not both in the same element.

5.2.3 Sample code

```
<audioStreamFormat audioStreamFormatID="AS_00010001"
audioStreamFormatName="PCM_FrontLeft" formatDefinition="PCM"
formatLabel="0001">
  <audioTrackFormatIDRef>AT_00010001_01</audioTrackFormatIDRef>
  <audioChannelFormatIDRef>AC_00010001</audioChannelFormatIDRef>
</audioStreamFormat>
```

5.3 audioChannelFormat

An audioChannelFormat represents the format of a single sequence of audio samples on which some action may be performed, such as movement of an object, which is rendered in a scene. It is sub-divided in the time domain into one or more audioBlockFormats.

5.3.1 Attributes

TABLE A1-6

audioChannelFormat attributes

Attribute	Description	Example	Required
audioChannelFormatName	Name of the channel format	FrontLeft	Yes
audioChannelFormatID	ID of the channel format, see § 6 for the use of the audioChannelFormatID in typical channel configurations. The yyyy digits of AC_yyyyxxxx represent the type of audio contained in the channel.	AC_00010001	Yes
typeLabel	Descriptor of the type of channel	0001	Optional (1)
typeDefinition	Description of the type of channel	DirectSpeakers	Optional (1)

(1) At least one of typeLabel or typeDefinition is required.

The typeDefinition of the audioChannelFormat specifies the type of audio it is describing, and also determines which parameters are used within its audioBlockFormat children.
Currently, there are five different typeDefinitions:

TABLE A1-7

typeDefinitions

typeDefinition	typeLabel	Description
DirectSpeakers	0001	For channel-based audio, where each channel feeds a speaker directly
Matrix	0002	For all other typeDefinitions, where signals are matrixed together, such as Mid-Side, Lt/Rt
Objects	0003	For object-based audio where channels represent audio objects (or parts of objects), so include positional information
HOA	0004	For scene-based audio where Ambisonics and HOA are used
Binaural	0005	For binaural audio, where playback is over headphones
User Custom	1yyy to Fyyy	For user custom types.

5.3.2 Sub-elements

TABLE A1-8

audioChannelFormat sub-elements

Sub-element	Description	Attributes	Quantity
audioBlockFormat	Time division of channel containing dynamic metadata	See § 5.4	1...*
frequency	Describes the high and/or low cut-off frequency for the audio in Hz	typeDefinition = “lowPass" or “highPass"	0...2

The optional frequency parameter allows a frequency range of the audio to be described. This can be either low-pass or high-pass, or by combining both to achieve band-pass and band-stop. One use of this is for LFE channels where a low-pass frequency limit (e.g. 120 Hz) can be described.

5.3.3 Sample code

```
<audioChannelFormat audioChannelFormatID="AC_00010001"
audioChannelFormatName="FrontLeft" typeDefinition="DirectSpeakers">
  <audioBlockFormat ...>
    ...
  </audioBlockFormat>
</audioChannelFormat>
```

5.4 audioBlockFormat

An audioBlockFormat represents the format of a time-limited range of samples within an audioChannelFormat.

5.4.1 Attributes

TABLE A1-9

audioBlockFormat attributes

Attribute	Description	Example	Required
audioBlockFormatID	ID for block, see § 6.	AB_00010001_00000001	Yes
rtime	Start time of block (relative to the start time of the parent audioObject) The start time is in the time format as described in § 5.13.	00:00:00.00000 or 00:00:00.00000S48000	Optional Default when not present: 00:00:00.00000
duration	Duration of block. The duration is in the time format as described in § 5.13.	00:00:05.00000 or 00:00:05.00000S48000	Optional Default when not present: Unbounded duration

The last eight hexadecimal digits in the audioBlockFormatID shall contain the index for the block within the channel, starting at 00000001 for the first block.

If *rtime* is not used then the block starts at 00:00:00.00000. If *duration* is not used then the block lasts for the whole duration of the channel.

If there is only one audioBlockFormat within an audioChannelFormat, the characteristics of the parent audioChannelFormat are considered to be static over time, therefore *rtime* and *duration* may be omitted. When there is more than one audioBlockFormat within an audioChannelFormat, the characteristics of the parent audioChannelFormat are intended to be dynamic over time, therefore both *rtime* and *duration* shall be present.

Most of the sub-elements within audioBlockFormat are dependent upon the typeDefinition or typeLabel, as shown in Table A1-10, of the parent audioChannelFormat element.

Time restrictions imposed by the audioObject element shall apply to both dynamic and static metadata regardless of typeDefinitions. Currently, there are five different defined typeDefinitions:

TABLE A1-10

typeDefinitions

typeDefinition	typeLabel	Description
DirectSpeakers	0001	For channel-based audio, where each channel feeds a speaker directly
Matrix	0002	For all other typeDefinitions, where signals are matrixed together, such as Mid-Side, Lt/Rt
Objects	0003	For object-based audio where channels represent audio objects (or parts of objects) and so include positional information
HOA	0004	For scene-based audio where Ambisonics and HOA are used
Binaural	0005	For binaural audio, where playback is over headphones
User Custom	1yyy to Fyyy	For user custom types.

5.4.2 Sample code

```
<audioBlockFormat audioBlockFormatID="AB_00010001_00000001" rtime="00:00:00.00000"
duration="00:00:05.00000">
  ...
</audioBlockFormat>
```

5.4.3 Sub-elements

TABLE A1-11

Common audioBlockFormat sub-elements for all typeDefinitions

Sub-element	Attribute	Description	Units	Example	Quantity	Default
gain	gainUnit	Definition of a gain value in the audioBlockFormat. An optional gainUnit attribute (either ‘linear’ or ‘dB’) can be used to define the unit of the gain value. The default unit is ‘linear’. For a detailed description of the application of this gain value see § 12.	gain value, default is linear value	0.5 (linear), −6 (dB)	0 or 1	1.0
importance		Importance of the audioChannelFormat, defined for the duration of the current audioBlockFormat.	0 to 10	10	0 or 1	10

TABLE A1-11 (*end*)

Sub-element	Attribute	Description	Units	Example	Quantity	Default
jumpPosition		If jumpPosition is set to 0, then interpolation of the time-variant parameters will take the entire duration of the block. If jumpPosition is set to 1 and the interpolationLength attribute is not present, then the time-variant parameters will change instantly from the previous block's time-variant parameters. If the interpolationLength attribute is used and the jumpPosition value is 1, then the interpolation will take as long as the specified value. The sub-element jumpPosition and its interpolationLength attribute affect the interpolated parameters as defined in § 9.3.	1/0 flag	1	0 or 1	0
	interpolationLength	If the interpolationLength attribute is used, and the jumpPosition value is 1, then the interpolation will take as long as the specified value. The interpolation length shall be no longer than the block's duration. The time format is described in § 5.13.	ss.zzzzz or zzzzzSfffff	0.05125 or 2460S48000	0 or 1	0 (only applies with jumpPosition=1)

TABLE A1-12

Common audioBlockFormat sub-elements for typeDefinitions excluding "Binaural" and "Matrix"

Sub-element	Attribute	Description	Units	Example	Quantity	Default
headLocked		Indicates if the perceived location of the audio element is locked to the head (flag = 1) or not locked (flag = 0) See § 9.4	0/1 flag	1	0 or 1	0
headphoneVirtualise	bypass	Specifies whether the object should be virtualised using a headphone virtualiser or not (1=renderer to stereo, 0=renderer with headphone virtualiser) See § 9.5	1/0 flag	1	0 or 1	0
	DRR	Direct to Reverberant Ratio in dB. See § 9.5	dB	100	0 or 1	130 (anechoic-all direct)

5.4.3.1 If audioChannelFormat.typeDefinition == "DirectSpeakers"

For channel-based systems, this is the metadata used to describe the channel. If the channel is intended to be played out through a specific loudspeaker, then use *speakerLabel* to indicate the label of that loudspeaker.

While both the maximum and minimum values for the three position elements are available (using the bound attribute), they should be avoided, as the exact position should normally be specified by omitting the *bound* attribute.

TABLE A1-13

audioBlockFormat sub-elements for DirectSpeakers (polar)

Sub-element	Attribute	Bound attribute	Description	Units/ Values	Example	Quantity
speakerLabel		N/A	The label of the loudspeaker that the DirectSpeaker (channel) is intended to be played back on	–	M-030	0...*
position	coordinate="azimuth"		Exact azimuth location of sound	Degrees	−30.0	1
position	coordinate="azimuth"	max	Max. azimuth location of sound	Degrees	−22.5	0 or 1
position	coordinate="azimuth"	min	Min. azimuth location of sound	Degrees	−30.0	0 or 1
position	coordinate="elevation"		Exact elevation location of sound	Degrees	0.0	1
position	coordinate="elevation"	max	Max. elevation location of sound	Degrees	5.0	0 or 1
position	coordinate="elevation"	min	Min. elevation location of sound	Degrees	0.0	0 or 1
position	coordinate="distance"		Exact normalized distance from origin	Normalized to 1	1.0	0 or 1
position	coordinate="distance"	max	Max. normalized distance from origin	Normalized to 1	0.8	0 or 1
position	coordinate="distance"	min	Min. normalized distance from origin	Normalized to 1	0.9	0 or 1
position	screenEdgeLock		Defines a speaker position at a screen edge	Left, right, top, bottom	Left	0 … 2

TABLE A1-14

audioBlockFormat sub-elements for DirectSpeakers (Cartesian)

Sub-element	Attribute	Bound attribute	Description	Units/ Values	Example	Quantity
speakerLabel		N/A	The label of the loudspeaker that the DirectSpeaker (channel) is intended to be played back on or virtual loudspeaker in the Cartesian cube, see Rec. ITU-R BS.2094.	–	M_FL	0...*
cartesian		N/A	Specifies coordinate system, if the flag is set to 1 the Cartesian coordinate system is used, otherwise spherical coordinates are used.	1/0 flag	1	1
position	coordinate="X"		Exact X location of sound	Relative units	−0.2	1
position	coordinate="X"	max	Max. X location of sound	Relative units	0.5	0 or 1
position	coordinate="X"	min	Min. X location of sound	Relative units	−0.5	0 or 1
position	coordinate="Y"		Exact Y location of sound	Relative units	1.0	1
position	coordinate="Y"	max	Max. Y location of sound	Relative units	1.0	0 or 1
position	coordinate="Y"	min	Min. Y location of sound	Relative units	−1.0	0 or 1
position	coordinate="Z"		Exact Z location of sound	Relative units	0.0	0 or 1
position	coordinate="Z"	max	Max. Z location of sound	Relative units	0.8	0 or 1
position	coordinate="Z"	min	Min. Z location of sound	Relative units	0.9	0 or 1
position	screenEdgeLock		Defines a speaker position at a screen edge	Left, right, top, bottom	Left	0 … 2

The **screenEdgeLock** attribute allows a speaker to be positioned on the edge of the screen. For classical frontal display, the attribute can be used in combination with the coordinate="elevation"

and/or the coordinate="azimuth" attribute (for polar coordinates); or with the coordinate="X" and/or the coordinate="Z" (for Cartesian coordinates). It is set to a string stating at which edge of the screen to the speaker position should be assumed to be (if screen-size information is available), so it is either "left", "right", "top", "bottom". The coordinate attribute must still be included so it is clear which dimension is being set, and to provide an alternative position should the screen not exist or no screen-size information be available.

The example XML code below illustrates how a speaker positioned on the right edge of the screen can be defined (with an alternative position of −29.0 degrees should the screen not exist).

```
<audioBlockFormat ...>
  <speakerLabel>M-SC</speakerLabel>
  <position coordinate="azimuth" screenEdgeLock="right">-29.0</position>
  <position coordinate="elevation">0.0</position>
  <position coordinate="distance">1.0</position>
</audioBlockFormat>
```

If two screenEdgeLock positions are required (for corners of the screen) then the two position ADM elements shall be used as shown in the example below. This is because XML does not allow multiple attributes of the same name within the same element.

```
  <position coordinate="azimuth" screenEdgeLock="right">-29.0</position>
  <position coordinate="elevation" screenEdgeLock="top">15.0</position>
```

The distance measure is normalized, but an absolute reference distance is available in audioPackFormat. These coordinates are based on the polar system, as this is the common way of describing channel and speaker locations. However, it is also possible to use the Cartesian coordinate system by using different coordinate attributes ('X', 'Y' and 'Z'); and this system is described in more detail in § 8.

5.4.3.1.1 Sample code

```
<audioBlockFormat ...>
  <speakerLabel>M-30</speakerLabel>
  <position coordinate="azimuth">-30.0</position>
  <position coordinate="elevation">0.0</position>
  <position coordinate="distance">1.0</position>
</audioBlockFormat>
```

5.4.3.2 If audioChannelFormat.typeDefinition == "Matrix"

This is for matrix channels, such as mid-side and Lt/Rt. The matrix element contains a list of coefficient sub-elements which each refer to other channels and a multiplication factor. All the matrix coefficients in this list should be added together to generate the matrix equation.

There are three types of matrix that can be defined: encoding, decoding and direct:

– An encoding matrix will be typically used to describe how the audio signals have been encoded to generate matrixed audio signals.

– A decoding matrix will be typically used to describe how the audio signals can be converted from matrixed audio signals to another type of output (typically, but not restricted to the "DirectSpeakers" typeDefinition). This could be the reverse process of the encoding matrix. The encoding matrix can reference a decoding matrix to connect related matrices.

– A direct matrix can convert between the same typeDefinition channels (e.g. channel-based to channel-based) directly (such as channel-based downmixing).

The audioPackFormat (see § 5.5.4) contains sub-elements that group Matrix channels and allow cross-referencing between encoding and decoding matrices:

– For example, the encoding matrix element of a ‘Side’ channel will contain two matrix coefficient sub-elements, one with the value 0.5 referring to "Left" and the other with a value of −0.5 referring to ‘Right’; this gives Side=0.5*Left-0.5*Right.

– An example of a decoding matrix would be Left=0.5*Mid+0.5*Side, where ‘Left’ becomes a channel-based output.

– A direct matrix example would be a 5.1->LoRo downmix where Lo=Left+0.7071*Centre+0.7071*LeftSurround & Ro=Right+0.7071*Centre+0.7071*RightSurround.

– The values for gain and phase shift can either be constants (using gain and phase) or they may be variables (using gainVar and phaseVar) that allow the renderer to decide the value, maybe via another source of metadata.

TABLE A1-15

audioBlockFormat sub-elements for Matrix

Sub-element	Attribute	Description	Quantity	Default
outputChannelFormatIDRef (1)	–	For defining a decoding or direct matrix, this is the output audioChannelFormat that defines the channel being decoded to.	0 or 1	
matrix	–	See Table A1-16.	1	

(1) This element name has been editorially changed from *outputChannelIDRef*. Therefore, ADM parsing software should be aware that *outputChannelIDRef* might occur in some files instead of *outputChannelFormatIDRef* and should be able to read both.

TABLE A1-16

matrix sub-elements

Sub-element	Attribute	Description	Units	Example	Quantity	Default
coefficient	gainUnit	Unit for attribute of ‘gain’. If gainUnit is not used, ‘linear’ unit is assumed.		linear / dB	0 or 1	‘linear’
coefficient	gain	Multiplication factor of another channel. Constant value. Type: float	Linear or logarithmic gain value(1)	−0.5	0...* Note: no more than one use of each attribute can be specified.	1.0
coefficient	gainVar	Multiplication factor of another channel. Variable. Type: string (reference to float)	A variable representing a linear gain value(1)	clev		-

TABLE A1-16 (*end*)

Sub-element	Attribute	Description	Units	Example	Quantity	Default
coefficient	phase	Phase shift of another channel. Constant value. Type: float	degrees	90		0
coefficient	phaseVar	Phase shift of another channel. Variable. Type: string (reference to float)	A variable representing a value in degrees	ph		-
coefficient	delay	Time delay of another channel. Constant value Type: float	ms (float)	10.5		0.0
coefficient	delayVar	Time delay of another channel. Variable Type: string (reference to float)	A variable representing a time in ms	del		-
coefficient		Reference to another audioChannelFormat ID		AC_00010001	1...*	

(1) A negative linear gain value implies an inversion of the signal.

5.4.3.2.1 Sample code

```
<audioBlockFormat ...>
  <outputChannelIDRef>AC_00010001</outputChannelIDRef>
  <jumpPosition interpolationLength="0.50000">1</jumpPosition>
  <matrix>
    <coefficient gain="0.5">AC_00021001</coefficient>
    <coefficient gain="0.5">AC_00021002</coefficient>
  </matrix>
</audioBlockFormat>
```

5.4.3.3 If audioChannelFormat.typeDefinition == “Objects”

For object-based audio where the position of the audio object may change dynamically. As well as the coordinates of the object, there are parameters for the object’s size, and whether it is a diffuse or coherent sound.

The channelLock parameter informs a renderer to send the object’s audio to the nearest speaker or channel, rather than the usual panning, interpolation, etc. The jumpPosition parameter will ensure the renderer can control the temporal interpolation of the position values, so the object will move in space in the time specified by the interpolationLength attribute, rather than move smoothly to the next position over the whole duration of the block.

The position elements use the coordinate attribute to specify which axis is used. The primary coordinate system is the polar coordinate system, which uses azimuth, elevation and distance axes. However, it is possible to specify other axes for other coordinates such as X, Y and Z for the Cartesian coordinate system. This is described in more detail in § 8.

Several parameter definitions depend upon the coordinate system used, so they are each described in Tables A1-17 and A1-18.

For a polar/spherical coordinate system:

TABLE A1-17

audioBlockFormat sub-elements for Objects (polar)

Sub-element	Attribute	Description	Units	Example	Quantity	Default
position	coordinate= “azimuth”	azimuth “theta” of sound location	degrees (−180 ≤ theta ≤ 180)	−22.5	1	
position	coordinate= “elevation”	elevation “phi” of sound location	degrees (−90 ≤ phi ≤ 90)	5.0	1	
position	coordinate= “distance”	distance “r” from origin, where 1 is on the unit sphere surface	relative distance value	0.9	0 or 1	1.0
width		horizontal extent	degrees (0 to 360)	45	0 or 1	0.0
height		vertical extent	degrees (0 to 360)	20	0 or 1	0.0
depth		distance extent	Ratio (0 to 1)	0.2	0 or 1	0.0
objectDivergence	azimuthRange	Adjusts the balance between the object’s specified position and two other positions specified by the azimuthRange value (symmetrical on both sides of the object at the object’s position +/– azimuthRange). A value of 0 for the objectDivergence means no divergence. The positionRange attribute shall not be used.	0 to 1.0 for objectDivergence, 0.0 to 180.0 (angle) for azimuthRange	0.5, 60.0	0 or 1	0.0, 0.0
zoneExclusion (“zone” sub-elements)		Indicates which speaker/room zones the object should not be rendered through.	see “zone” sub-elements		0 or 1	
zone (sub-element of zoneExclusion)	minElevation maxElevation minAzimuth maxAzimuth	Specifies the circular projection onto the sphere for spherical coordinates. Multiple zone elements can be used to specify more complex exclusion shapes.	−180 to 180 float for the spherical azimuth attribute and −90 to 90 float for the spherical elevation attribute. String for a label to describe the exclusion zone	maxElevation = 30 minElevation = −30 minAzimuth = −30 maxAzimuth = 30 “Centre front”	1…*	

For a Cartesian coordinate system, where the position and size values are relative to the cube, where 1 or −1 are on the surface of the unit cube:

TABLE A1-18

audioBlockFormat sub-elements for Objects (Cartesian)

Sub-element	Attribute	Description	Units	Example	Quantity	Default
position	coordinate="X"	left/right dimension	Relative units	−0.2	1	
position	coordinate="Y"	back/front dimension	Relative units	0.1	1	
position	coordinate="Z"	bottom/top dimension	Relative units	−0.5	0 or 1	0.0
width		X-width	Relative units (0 to 1)	0.03	0 or 1	0.0
depth		Y-width	Relative units (0 to 1)	0.05	0 or 1	0.0
height		Z-width	Relative units (0 to 1)	0.07	0 or 1	0.0
objectDivergence	positionRange	Adjusts the balance between the object's specified position and two other positions specified by the positionRange value (symmetrical on both sides of the object at the object's position +/– positionRange along the X-axis). A value of 0 for the objectDivergence means no divergence. The azimuthRange sub-element shall not be present.	0 to 1.0 for objectDivergence, 0.0 to 1.0 for positionRange	0.5, 0.25	0 or 1	0.0, 0.0
zoneExclusion ("zone" sub-elements)		Indicates which speaker/room zones the object should not be rendered through.	see "zone" sub-elements		0 or 1	
zone (sub-element of zoneExclusion)	minX maxX minY maxY minZ maxZ	Specifies the corner points of a cuboid in the 3D space that will be excluded from rendering for Cartesian coordinates. Multiple zone elements can be used to specify more complex exclusion shapes.	−1.0 to 1.0 float for each Cartesian attribute. String for a label to describe the exclusion zone	minX=–1.0 maxX=1.0 minY=–1.0 maxY=0.0 minZ=–1.0 maxZ=1.0 "Rear half"	1…*	

The **screenEdgeLock** attribute also exists with the **position** element, which is described in § 5.4.3.1.

The following parameters are independent of the coordinates system used:

TABLE A1-19

audioBlockFormat sub-elements for Objects

Sub-element	Attribute	Description	Units	Example	Quantity	Default
cartesian		Shall be set to 0 to indicate that spherical coordinates are used. Shall be set to 1 to indicate that Cartesian coordinates are used.	1/0 flag	1	0 or 1	0
diffuse		Describes the diffuseness of an audioObject (if it is diffuse or direct sound)	0.0 to 1.0	0.5	0 or 1	0
channelLock	maxDistance	If set to 1 a renderer can lock the object to the nearest channel or speaker, rather than normal rendering. The optional maxDistance attribute defines the radius of a sphere around the object's position. If one or more speakers exist in the defined sphere or on its surface, the object snaps to the nearest speaker. If maxDistance is undefined, a default value of infinity is assumed, meaning that the object should snap to the nearest of all speakers (unconditioned channelLock). § 10.2	1/0 flag for channelLock, float value for maxDistance in the range from 0.0 to $2\sqrt{3}$	1, 1.0	0 or 1	0 (channel Lock), infinity (maxDistance)
screenRef		Indicates whether the object is screen-related (flag is equal to 1) or not (flag is equal to 0)	1/0 flag	0	0 or 1	0

5.4.3.3.1 Sample code

```
<audioBlockFormat ...>
  <position coordinate="azimuth">-22.5</position>
  <position coordinate="elevation">5.0</position>
  <position coordinate="distance">0.9</position>
  <depth>0.2</depth>
</audioBlockFormat>
```

5.4.3.4 If audioChannelFormat.typeDefinition == “HOA”

In scene-based audio, a sound scene is represented by a set of coefficient signals. These coefficient signals are the linear weights of spatial orthogonal basis functions (such as spherical or circular harmonics functions). The scene can then be reproduced by rendering these coefficient signals to a target loudspeaker layout or headphones. The program production is decoupled from the reproduction and allows the creation of mixed program material while being agnostic to the number and position of the target loudspeakers. An example of scene-based audio is Higher-Order Ambisonics (HOA).

The definition of audioChannelFormat.typeDefinition == “HOA” is used for scene-based coefficient signals (or components) that use (higher-order) Ambisonics (HOA). Each component can be described by either a combination of degree, order values, and normalization, or an equation.

The HOA components are defined by the degree, order, and normalization values. Degree, order, and normalization are specified in § 11.

If the optional equation sub-element is used, it is recommended that C-style mathematical notation be used for the equation element (e.g. ‘cos(A)*sin(E)’). Its purpose is to allow an informative description of customized or experimental HOA components that cannot be described by the order, degree, and normalization parameters alone.

The normalization, nfcRefDist and screenRef parameters occur in both the audioPackFormat (see § 5.5.5.1) and audioBlockFormat. Therefore, the values of these parameters should be matched in both elements if they are referenced to each other. However, when the parameters are specified within an audioBlockFormat differ from those in the audioPackFormat, the audioBlockFormat values shall take priority over those given in the audioPackFormat.

TABLE A1-20

audioBlockFormat sub-elements for HOA

Sub-element	Description	Units	Example	Quantity	Default	Required
equation	An equation to describe the HOA component		cos(A)*sin(E)	0 or 1		Optional, used only for descriptive/informative purposes.
order	Order of the HOA component		1	0 or 1		Yes
degree	Degree of the HOA component		−1	0 or 1		Yes
normalization	Indicates the normalization scheme of the HOA component (N3D, SN3D, FuMa).		N3D	0 or 1	SN3D	Optional

TABLE A1-20 (*end*)

Sub-element	Description	Units	Example	Quantity	Default	Required
nfcRefDist	Indicates the reference distance of the loudspeaker setup for near-field compensation (NFC). If no nfcRefDist is defined or the value is 0, NFC is not necessary.	metre	2	0 or 1	0	Optional
screenRef	Indicates whether the component is screen-related (flag is equal to 1) or not (flag is equal to 0)	1/0 flag	0	0 or 1	0	Optional

5.4.3.4.1 Sample code

```
<audioBlockFormat ...>
  <degree>1</degree>
  <order>1</order>
  <normalization>N3D</normalization>
</audioBlockFormat>
```

5.4.3.5 If audioChannelFormat.typeDefinition == “Binaural”

Given that binaural consists of two channels, the left and right ear, the attribute audioChannelFormatName shall be set to either “LeftEar” or “RightEar”.

NOTE – Previous versions of this Recommendation, up to and including Recommendation ITU-R BS.2076-2, specified that audioChannelFormatName shall be set to either “leftEar” or “rightEar”. Software that reads ADM files should tolerate these previously specified values.

For “Binaural”, only the common audioBlockFormat sub-elements specified for all typeDefinitions, as indicated in Table A1-11, are available.

5.4.3.5.1 Sample code

```
<audioBlockFormat .../>
```

5.5 audioPackFormat

The audioPackFormat groups together one or more audioChannelFormats that belong together.

Examples of audioPackFormats are ‘stereo’ and ‘5.1’ for channel-based formats. It can also contain references to other packs to allow nesting. The typeDefinition is used to define the type of channels described within the pack. The typeDefinition/typeLabel shall match those in the referred audioChannelFormats. The sub-elements within audioPackFormat are dependent upon the typeDefinition or typeLabel of the audioPackFormat element.

5.5.1 Attributes

TABLE A1-21

audioPackFormat attributes

Attribute	Description	Example	Required
audioPackFormatID	ID for the pack, see § 6 for the use of the audioPackFormatID in typical channel configurations. The yyyy digits of AP_yyyyxxxx represent the type of audio contained in the pack.	AP_00010001	Yes
audioPackFormatName	Name for the pack	stereo	Yes
typeLabel	Descriptor of the type of channel	0001	Optional (1)
typeDefinition	Description of the type of channel	DirectSpeakers	Optional (1)
importance	Importance of a pack. Allows a renderer to discard a pack below a certain level of importance. 10 is the most important, 0 is the least.	10	Optional

(1) At least one of typeLabel or typeDefinition is required.

There are five different defined typeDefinitions:

TABLE A1-22

typeDefinitions

typeDefinition	typeLabel	Description
DirectSpeakers	0001	For channel-based audio, where each channel feeds a speaker directly
Matrix	0002	For channel-based audio where channels are matrixed together, such as Mid-Side, Lt/Rt
Objects	0003	For object-based audio where channels represent audio objects (or parts of objects), so include positional information
HOA	0004	For scene-based audio where Ambisonics and HOA are used
Binaural	0005	For binaural audio, where playback is over headphones
User Custom	1yyy to Fyyy	For user custom types.

5.5.2 Sub-elements

TABLE A1-23

audioPackFormat sub-elements

Sub-element	Description	Example	Quantity
audioChannelFormatIDRef	Reference to an audioChannelFormat	AC_00010001	0...*
audioPackFormatIDRef	Reference to an audioPackFormat	AP_00010002	0...*
absoluteDistance	Absolute distance in metres	4.5	0 or 1

There is an overall absolute distance parameter, which can be used with the normalized distance parameters specified with the audioBlockFormats, to give absolute distances to each block.

One example of the usage of the absoluteDistance parameter may be to indicate the assumed reference decoding distance (in metres) of a scene-based audio stream. This reference distance may be used in binaural rendering of the rendered soundfield.

If absoluteDistance is negative or undefined, distance based binaural rendering is not intended.

5.5.3 Sample code

```
<audioPackFormat audioPackFormatID="AP_000010002" audioPackFormatName="stereo"
typeLabel="0001">
  <audioChannelFormatIDRef>AC_00010001</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00010002</audioChannelFormatIDRef>
</audioPackFormat>
```

5.5.4 If audioPackFormat.typeDefinition == “Matrix”

If the typeDefinition of the audioPackFormat is set to Matrix, then there are extra sub-elements available to allow the definition of encoding (e.g. Left/Right to Mid/Side), decoding (e.g. Mid/Side to Left/Right) and direct (e.g. Lo/Ro) matrices.

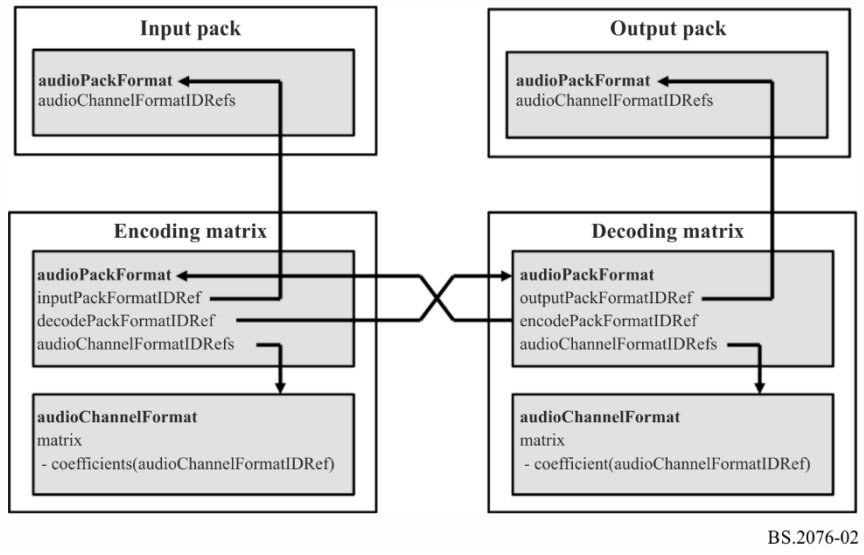
The matrix can either be an encoding, a decoding matrix or a direct matrix. An encoding matrix converts an input audioPackFormat of any type into a matrix-encoded audioPackFormat. A decoding matrix takes matrix-encoded audioPackFormat and converts into a channel-based output audioPackFormat. Related encoding and decoding matrices can be cross-referenced.

“DirectSpeakers” would be the most commonly used for the case of channel-based matrix encoding/decoding and downmixing. For example, Stereo to Mid/Side would be the encoding matrix, and Mid/Side to Stereo would be the decoding matrix.

The diagram in Fig. A1-2 shows how encoder and decoder matrix audioPackFormats relate to each other, as well in the input and output audioPackFormats and audioChannelFormats.

FIGURE A1-2

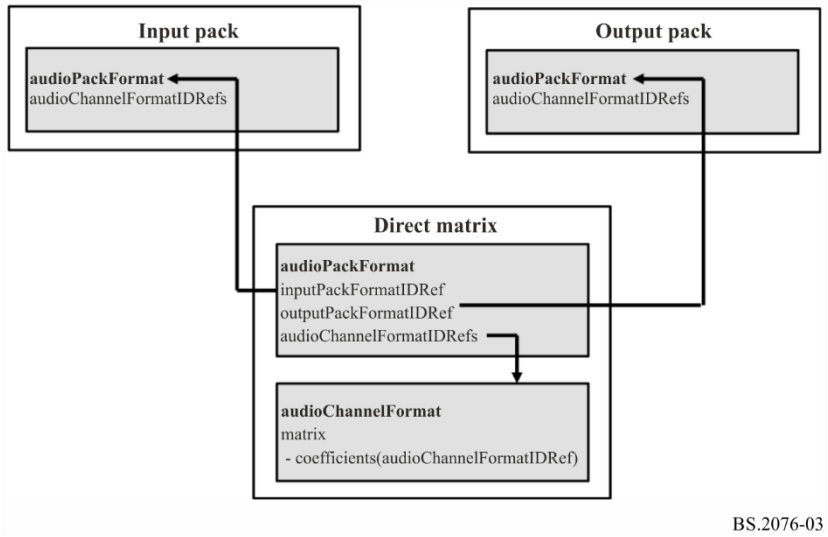
Encode/Decode Matrix relationships



The diagram in Fig. A1-3 shows how a direct matrix audioPackFormat relates to input and output audioPackFormats and audioChannelFormats.

FIGURE A1-3

Direct matrix relationships



5.5.4.1 Matrix Sub-elements

The encoding matrix contains an inputPackFormatIDRef, which references a channel-based input pack. It can also contain a list of decodePackFormatIDRefs, which are references to corresponding decoding matrices.

The decoding matrix contains an outputPackFormatIDRef, which reference a channel-based output pack. It can also contain a list of encodePackFormatIDRefs, which are references to corresponding encoding matrices.

The direct matrix contains an inputPackFormatIDRef, which references a channel-based input pack and an outputPackFormatIDRef, which reference a channel-based output pack.

TABLE A1-24

audioPackFormat sub-elements for Matrix

Sub-element	Description	Example	Quantity
encodePackFormatIDRef	Reference to an encoding matrix audioPackFormat from a decoding matrix.	AP_00020001	0…*
decodePackFormatIDRef	Reference to a decoding matrix audioPackFormat from an encoding matrix.	AP_00020101	0 …*
inputPackFormatIDRef	Reference to a channel-based (DirectSpeakers) input audioPackFormat.	AP_00010002	0 or 1
outputPackFormatIDRef	Reference to a channel-based (DirectSpeakers) matrix decoded audioPackFormat.	AP_00010002	0 or 1

5.5.4.2 Sample code

```
<audioPackFormat audioPackFormatID="AP_00021001"
audioPackFormatName="MidSide_Encode" typeLabel="0002"
typeDefinition="Matrix">
  <decodePackFormatIDRef>AP_00021101</decodePackFormatIDRef>
  <inputPackFormatIDRef>AP_00010002</inputPackFormatIDRef>
  <audioChannelFormatIDRef>AC_00021001</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00021002</audioChannelFormatIDRef>
</audioPackFormat>

<audioPackFormat audioPackFormatID="AP_00021101"
audioPackFormatName="MidSide_Decode" typeLabel="0002"
typeDefinition="Matrix">
  <encodePackFormatIDRef>AP_00021001</encodePackFormatIDRef>
  <outputPackFormatIDRef>AP_00010002</outputPackFormatIDRef>
  <audioChannelFormatIDRef>AC_00021101</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00021102</audioChannelFormatIDRef>
</audioPackFormat>
```

5.5.5 If audioPackFormat.typeDefinition == “HOA”

If the audioPackFormat element is of HOA type then the following sub-elements can be defined. These parameters provide defaults for the audioBlockFormat parameters corresponding to the HOA-type audioChannelFormat definitions within this audioPackFormat. The normalization, nfcRefDist and screenRef parameters occur in both the audioPackFormat and audioBlockFormat (see § 5.4.3.4). Therefore, the values of these parameters should be matched in both elements if they are referenced to each other. However, when the parameters are specified within an audioBlockFormat differ from those in the audioPackFormat, the audioBlockFormat values shall take priority over those given in the audioPackFormat.

5.5.5.1 HOA Sub-elements

TABLE A1-25

audioPackFormat sub-elements for HOA

Sub-element	Description	Units	Example	Quantity	Default	Required
normalization	Indicates the normalization scheme of the HOA content (N3D, SN3D, FuMa).		N3D	0 or 1	SN3D	Optional
nfcRefDist	Indicates the reference distance of the loudspeaker setup for near-field compensation (NFC). If no nfcRefDist is defined or the value is 0, NFC is not necessary.	metre	2	0 or 1	0	Optional
screenRef	Indicates whether the content is screen-related (flag is equal to 1) or not (flag is equal to 0)	1/0 flag	0	0 or 1	0	Optional

5.6 audioObject

An audioObject establishes the relationship between the content, the format via audio packs, and the assets using the track UIDs. AudioObjects can be nested and so they can refer to other audioObjects.

5.6.1 Attributes

TABLE A1-26

audioObject attributes

Attribute	Description	Example	Required	Default
audioObjectID	ID of the object, see § 6.	AO_1001	Yes	-
audioObjectName	Name of the object	dialogue_stereo	Yes	-
start	Start time for the object, relative to the start of the audioProgramme. The start time is in the time format as described in § 5.13.	00:00:00.00000 or 00:00:00.00000S48000	Optional	00:00:00.00000
duration	Duration of object. The duration is in the time format as described in § 5.13.	00:02:00.00000 or 00:02:00.00000S48000	Optional	duration of audioProgramme
dialogue	If the audio is not dialogue set a value of 0; if it contains only dialogue a value of 1; if it contains both then a value of 2.	0	Optional	2
importance	Importance of an object. Allows a renderer to discard an object below a certain level of importance. 10 is most important, 0 least.	10	Optional	10
interact	Set to 1 if a user can interact with the object, 0 if not.	1	Optional	0
disableDucking	Set to 1 to disallow automatic ducking of object, 0 to allow ducking	0	Optional	0

5.6.2 Sub-elements

TABLE A1-27

audioObject sub-elements

Sub-element	Attribute	Description	Units/Type	Example	Quantity
audioPackFormatIDRef		Reference to an audioPackFormat for format description	ID String	AP_00010001	0…*
audioObjectIDRef		Reference to another audioObject	ID String	AO_1002	0…*
audioObjectLabel	language	The object description in the language specified by the language attribute. The language attribute can be used for definition of multiple audioObject labels in different languages. See Table 1-28.	String	“Dialogue” language=”en”	0…*

TABLE A1-27 *(end)*

Sub-element	Attribute	Description	Units/Type	Example	Quantity
audioComplementary ObjectGroupLabel	language	The complementary object group description in the language specified by the language attribute. The language attribute can be used for definition of multiple audioComplementaryObjectGroup labels in different languages. See Table A1-29.	String	“主音声” language=“jp”	0…*
audioComplementary ObjectIDRef		Reference to another audioObject that is complementary to the object, e.g. to describe mutually exclusive languages.	ID String	AO_1003	0…*
audioTrackUIDRef		Reference to an audioTrackUID (when using a BW64 file according to [7] this is listed in the <*chna*> chunk)	ID String	ATU_00000001	0…*
audioObjectInteraction		Specification of possible user interaction with the object.	-	-	0 or 1
gain	gainUnit	Definition of a gain value to be applied to all audio samples referenced by the audioObject. The default value is 1.0. An optional gainUnit attribute (either ‘linear’ or ‘dB’) can be used to define the unit of the gain value. The default unit is ‘linear’. For a detailed description of the application of this gain value see § 12.	Linear or logarithmic gain value	0.5 (linear), −6.0 (dB)	0 or 1
headLocked		Indicates if the perceived location of the audio element is locked to the head (flag = 1) or not locked (flag = 0) See § 9.4 Default Value is 0	0/1 flag	1	0 or 1
positionOffset *(when polar coordinates are used*	coordinate= “azimuth”	Apply an offset to the “azimuth” angle to all elements in the audioObjects.	Degrees	30.0	0 or 1
	coordinate= “elevation”	Apply an offset to the “elevation” angle to all elements in the audioObjects.	Degrees	15.0	0 or 1
	coordinate= “distance”	Apply an offset of “distance” to all elements in the audioObjects.	Normalised distance	0.9	0 or 1
positionOffset *(when Cartesian coordinates are used)*	coordinate= “X”	Apply an offset of “X” axis to all elements in the audioObjects.	Normalised value	−0.2	0 or 1
	coordinate= “Y”	Apply an offset of “Y” axis to all elements in the audioObjects.	Normalised value	0.1	0 or 1
	coordinate= “Z”	Apply an offset of “Z” axis to all elements in the audioObjects.	Normalised value	−0.5	0 or 1
mute		Status of the audioObject to play back or not. Set to 0 if the object is played back (default). Set to 1 if the object is muted.		1	0 or 1
alternativeValueSet	alternativeValue SetID	An alternative set of parameters that will be used if the alternativeValueSetID is referenced by an audioProgramme or audioContent element. See § 5.6.5 for sub-elements.			0…*

If the value of audioTrackUIDRef is set to ATU_00000000 then it shall not refer to a track in the file, but refers to a silent or empty track. For multichannel formats where some of the channels are not being used, instead of storing zero value samples in the file, this silent track should be used to save space in the file.

TABLE A1-28

audioObjectLabel attributes

Attribute	Description	Example	Required
language	The language attribute can be used for definition of multiple audioObject labels in different languages. The language code is given as a 2- or 3-character code as specified by ISO 639-1 or ISO 639-2. Both ISO 639-2/B and ISO 639-2/T may be used.	eng	No

The audioComplementaryObjectGroupLabel element contains a textual label for a set of mutually exclusive audioObjects, e.g. language tracks that contain the same dialogue in different dub versions.

The audioComplementaryObjectGroupLabel element when present shall only be included in one corresponding parent audioObject for each set of mutually exclusive contents. It shall be included in the same parent audioObject that also contains the audioComplementaryObjectIDRef sub-elements.

TABLE A1-29

audioComplementaryObjectGroupLabel attributes

Attribute	Description	Example	Required
language	Attribute defining the language of the parent audioComplementaryObjectGroupLabel. The language code is given as a 2- or 3-character code as specified by ISO 639-1 or ISO 639-2. Both ISO 639-2/B and ISO 639-2/T may be used.	eng	No

5.6.3 audioComplementaryObjectIDRef

The audioComplementaryObjectIDRef element contains a reference to another audioObject that is complementary to the parent audioObject. A list of audioComplementaryObjectIDRefs can therefore be used to describe mutually exclusive content, e.g. language tracks that contain the same dialogue in different dub versions (“XOR” relationship).

To avoid cross-references between audioComplementaryObjectIDRefs of several audioObjects, the audioComplementaryObjectIDRef sub-element shall only be included in one corresponding parent audioObject for each set of mutually exclusive contents. The parent audioObject with the audioComplementaryObjectIDRefs shall be the one that contains the default version of the set of mutually exclusive contents.

5.6.4 audioObjectInteraction sub-element

An audioObjectInteraction sub-element describes possible user interaction with the corresponding parent audioObject element. If the interact attribute of the parent audioObject element is not present or is set to 0, the audioObjectInteraction sub-element shall not be present. If the interact attribute of the parent audioObject element is present and set to 1, there is no requirement on whether the audioObjectInteraction sub-element shall be present or not. If the interact attribute is set to 1 and the audioObjectInteraction sub-element is not present, this shall indicate that on-off interaction, unlimited

gain interaction and unlimited position interaction are enabled for the audioObject element (see also §§ 12 and 13).

Previous versions of this Recommendation, up to and including Recommendation BS.2076-2, did not explicitly prohibit the presence of an audioObjectInteraction element when the interact attribute of the audioObject element is not set to 1. When it is known that the metadata adheres to versions up to and including Recommendation BS.2076-2, any audioObjectInteraction sub-element shall be ignored when the interact attribute of the parent audioObject element is not present or not set to 1.

These restrictions also apply analogously for the audioObjectInteraction sub-element of alternativeValueSet sub-elements (see § 5.6.5).

The audioObjectInteraction element has the following attributes and sub-elements.

TABLE A1-30

audioObjectInteraction attributes

Attribute	Description	Example	Required
onOffInteract	Set to 1 if a user can switch the object on or off, 0 if not.	1	Yes
gainInteract	Set to 1 if a user can change the gain of the object, 0 if not.	1	Optional
positionInteract	Set to 1 if a user can change the position of the object, 0 if not.	0	Optional

TABLE A1-31

audioObjectInteraction sub-elements

Sub-element	Attribute	Bound attribute	Description	Units	Example
gainInteractionRange	N/A	min	Minimum linear gain factor or logarithmic gain offset of a possible user gain interaction. For a detailed description of the application of this gain-related parameter see § 12. (NOTE: The earlier versions of this Recommendation contained the following formulae to describe the application of the minimum bound of the gain interaction range “Linear gain: gainMin = gain (or 1.0 if not defined) * gainInteractionRangeMin”. This formula was not correct as it was undefined to what ADM element or parameter “gain” in the formula was referring. In the current version (Rec. ITU-R BS.2076-2), this erroneous formula was removed. The gainInteractionRange boundaries should be interpreted as described in § 12.)	Linear or logarithmic (dB) gain value	0.5

TABLE A1-31 *(end)*

Sub-element	Attribute	Bound attribute	Description	Units	Example
	N/A	max	Maximum linear gain factor or logarithmic gain offset of possible user gain interaction. For a detailed description of the application of this gain-related parameter see § 12. (NOTE: The earlier versions of this Recommedation contained the following formulae to describe the application of the maximum bound of the gain interaction range (Linear gain: gainMax = gain (or 1.0 if not defined) * gainInteractionRangeMax". This formula was not correct as it was undefined to what ADM element or parameter "gain" was referring in the formula. In the current version (Rec. ITU-R BS.2076-2), this erroneous formula was removed. The gainInteractionRange boundaries should be interpreted as described in § 12.	Linear of logarithmic (dB) gain value	1.2
	gainUnit		Unit for attribute of 'gain'. If gainUnit is not used, 'linear' unit is used.		linear / dB
positionInteractionRange *(when polar coordinates are used)*	coordinate= "azimuth"	min	Minimum azimuth offset value of possible user position interaction	Degrees	–30.0
	coordinate= "azimuth"	max	Maximum azimuth offset value of possible user position interaction	Degrees	+30.0
	coordinate= "elevation"	min	Minimum elevation offset value of possible user position interaction	Degrees	–15.0
	coordinate= "elevation"	max	Maximum elevation offset value of possible user position interaction	Degrees	+15.0
	coordinate= "distance"	min	Minimum normalized distance of possible user position interaction	0 to 1	0.5
	coordinate= "distance"	max	Maximum normalized distance of possible user position interaction	0 to 1	0.5
positionInteractionRange *(when Cartesian coordinates are used)*	coordinate= "X"	min	Minimum X-axis offset value of possible user position interaction	Normalized Units	–0.5
	coordinate= "X"	max	Maximum X-axis offset value of possible user position interaction	Normalized Units	+0.5
	coordinate= "Y"	min	Minimum Y-axis offset value of possible user position interaction	Normalized Units	–0.2
	coordinate= "Y"	max	Maximum Y-axis offset value of possible user position interaction	Normalized Units	0.0
	coordinate= "Z"	min	Minimum Z-axis offset value of possible user position interaction	Normalized Units	0.1
	coordinate= "Z"	max	Maximum Z-axis offset value of possible user position interaction	Normalized Units	0.4

5.6.4.1 Sample code

```
<audioObjectInteraction onOffInteract="1" gainInteract="1" positionInteract="1">
  <positionInteractionRange coordinate="elevation" bound="min">
     -10.0
  </positionInteractionRange>
  <positionInteractionRange coordinate="elevation" bound="max">
     +10.0
  </positionInteractionRange>
  <positionInteractionRange coordinate="azimuth" bound="min">
     -30.0
  </positionInteractionRange>
  <positionInteractionRange coordinate="azimuth" bound="max">
     +30.0
  </positionInteractionRange>
</audioObjectInteraction>
```

If an *audioObject* allows interaction, the result of a user-imposed change to an attribute that can be set by the user shall be within the limits of the interaction range of that *audioObject*. In this context, a "change" is the difference between a condition before and after the interaction.

The resultant overall playback gain of a sound source is the combination of the attributes of the gain sub-elements of the *audioBlockFormat* and all changes caused by interaction in the hierarchy of *audioObjects* that refer to the *audioBlockFormat* (see § 12).

5.6.5 alternativeValueSet sub-element

The alternativeValueSet sub-element allows an alternative set of parameters for the audioObject to be defined. The parameters defined in this sub-element shall take precedence over the same parameters in the parent audioObject element. The parameters defined in the parent audioObject that have not been defined in the alternativeValueSet shall be used in that alternativeValueSet. Multiple alternativeValueSets can be defined in an audioObject to allow multiple variations to be defined. Table A1-32 lists the sub-elements that are contained within alternativeValueSet, and each has the same specification of the same sub-elements in the parent audioObject as listed in Table A1-27.

TABLE A1-32

alternativeValueSet sub-elements

Sub-element	Note
audioObjectLabel	See Tables A1-27, A1-30 and A1-31 for attributes, descriptions, examples, units and quantities.
audioObjectInteraction	
gain	
headLocked	
positionOffset	
mute	

The restrictions on the presence of the audioObjectInteraction sub-element in the alternativeValueSet element depend on the interact attribute of the parent audioObject element. If the interact attribute of the parent audioObject element is not present or is set to 0, the audioObjectInteraction sub-element in the alternativeValueSet element shall not be present. If the interact attribute of the parent audioObject element is present and set to 1, there is no requirement on whether the audioObjectInteraction sub-element in the alternativeValueSet element shall be present or not. If the

interact attribute of the parent audioObject element is set to 1 and the audioObjectInteraction sub-element in the alternativeValueSet element is not present, the audioObjectInteraction sub-element in the parent audioObject element shall be used. In this case, if the audioObjectInteraction sub-element in the parent audioObject element is also not present, this shall indicate that on-off interaction, unlimited gain interaction and unlimited position interaction are enabled for the audioObject element when the alternativeValueSet element is active (see also §§ 12 and 13).

Previous versions of this Recommendation, up to and including Recommendation ITU-R BS.2076-2, did not explicitly prohibit the presence of an audioObjectInteraction sub-element in the alternativeValueSet element when the interact attribute of the parent audioObject element is not set to 1. When it is known that the metadata adheres to versions up to and including Recommendation ITU-R BS.2076-2, any audioObjectInteraction sub-element shall be ignored when the interact attribute of the parent audioObject element is not present or not set to 1.

5.6.5.1 alternativeValueSetID attribute

The alternativeValueSet sub-element shall use an alternativeValueSetID attribute and the ID shall be in this format: AVS_wwww_zzzz, where ‘w’ and ‘z’ are hexadecimal digits. The ‘wwww’ shall match the ‘wwww’ of the parent audioObjectID, and the ‘zzzz’ shall be a unique value for each alternativeValueSet sub-element used within the parent audioObject.

The alternativeValueSetID may be referenced from either audioProgramme or audioContent.

5.6.5.2 Sample code

```
<audioObject audioObjectID="AO_1001" audioObjectName="Effects">
  <gain>1.0</gain>
  <alternativeValueSet alternativeValueSetID=”AVS_1001_0001”>
    <gain>1.5</gain>
  </alternativeValueSet>
  <alternativeValueSet alternativeValueSetID=”AVS_1001_0002”>
    <gain>0.5</gain>
  </alternativeValueSet>
  …
</audioObject>
```

5.6.6 Sample code

```
<audioObject audioObjectID="AO_1001" audioObjectName="Dialogue_stereo">
  <audioPackFormatIDRef>AP_00010001</audioPackFormatIDRef>
  <audioTrackUIDRef>ATU_00000001</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000002</audioTrackUIDRef>
</audioObject>
```

5.6.7 Nested audioObjects and timing parameters

When audioObject elements are nested the start time of the audioObject is still relative to the start of the programme, not the relative to the audioObject that refers to it. To ensure that any audioObject that is referred from another audioObject shall not have a start time earlier than the referent, nor does it have an end time (i.e. start + duration) after the referent.

An audioObject element shall not reference itself, nor can a loop of references be used (e.g. AO_1001 -> AO_1002 -> AO_1003 -> AO_1001 would be a loop and therefore illegal).

5.7 audioContent

An audioContent element describes the content of one component of a programme (e.g. background music), and refers to audioObjects to tie the content to its format. This element includes loudness metadata.

5.7.1 Attributes

TABLE A1-33

audioContent attributes

Attribute	Description	Example	Required
audioContentID	ID of the content, see § 6.	ACO_1001	Yes
audioContentName	Name of the content	Music	Yes
audioContentLanguage	Language of the content (as a String). It is recommended to use a language code to identify the language. The language code should be given as a 2- or 3-character code as specified by ISO 639-1 or ISO 639-2. Both ISO 639-2/B and ISO 639-2/T may be used.	en	Optional

5.7.2 Sub-elements

TABLE A1-34

audioContent sub-elements

Sub-element	Attribute	Description	Example	Quantity
audioContentLabel	language	The content description in the language specified by the language attribute. The language attribute can be used for definition of multiple audioContent labels in different languages. It is recommended to use a language code to identify the language. The language code should be given as a 2- or 3-character code as specified by ISO 639-1 or ISO 639-2. Both ISO 639-2/B and ISO 639-2/T may be used.	“News” language=”en”	0…*
audioObjectIDRef		Reference to audioObject	AO_1001	1…*
loudnessMetadata		See § 5.7.4		0…*
dialogue		If the audio is not dialogue set a value of 0; if it contains only dialogue set a value of 1; if it contains both then set a value of 2.	0	0 or 1
alternativeValueSetIDRef		Reference to an alternativeValueSet within an audioObject.	AVS_1001_0001	0…*

As it is possible to include multiple alternativeValueSetIDRef sub-elements within an audioContent element, it shall be ensured that the alternativeValueSetIDRef only references one alternativeValueSet within the same audioObject. This should be done by inspecting the alternativeValueSet ID digits. The ID has the format: AVS_wwww_zzzz, where wwww matches the digits in the audioObject ID. Therefore, to ensure an audioObject is not referenced multiple times, each alternativeValueSetIDRef in an audioContent shall have unique wwww digits.

5.7.3 dialogue

This optional element specifies the kind of content that is included in the parent audioContent. The Dialogue sub-element can take the values 0 (no dialogue), 1 (pure dialogue) or 2 (mixed). It has an attribute that specifies the type of content using defined lists (enumerators) of content kinds.

The attribute is dependent on the value of the Dialogue element.

TABLE A1-35

dialogue attributes

Value of dialogue	Attribute	Description	Example
0	nonDialogueContentKind	ID of the contained content kind (enumerator, see specification below)	0
1	dialogueContentKind	ID of the contained content kind (enumerator, see specification below)	0
2	mixedContentKind	ID of the contained content kind (enumerator, see specification below)	0

TABLE A1-36

dialogue types

nonDialogueContentKind	Description
0	Undefined
1	Music
2	Effects
3	Music and Effects
dialogueContentKind	**Description**
0	Undefined
1	(storyline) Dialogue
2	Voiceover
3	Spoken subtitle

TABLE A1-36 *(end)*

dialogueContentKind	Description
4	Audio description/visually impaired
5	Commentary
6	Emergency
mixedContentKind	**Description**
0	Undefined
1	Complete main
2	Mixed
3	Hearing impaired
4	Complete main with audio description/visually impaired

5.7.4 loudnessMetadata attributes and sub-elements

TABLE A1-37

loudnessMetadata attributes

Attribute	Description	Example
loudnessMethod	The method used to determine the loudness.	“ITU-R BS.1770”
loudnessRecType	The loudnessRecType indicates which regional recommended practice was followed in the loudness correction of the audio	“EBU R128”
loudnessCorrectionType	The correction type is used to indicate what correction has been applied to the audio, for example, file-based or real-time.	“File-based”

The audio could be corrected or normalized by numerous means, relating to loudness algorithm, regional recommended practice followed, and by what correction type. The loudnessMethod indicates the method used to determine the loudness (e.g. a value based on Recommendation ITU-R BS.1770). The loudnessRecType indicates the regional recommended practice that was followed as a character string, such as “EBU R128”, “ATSC A/85”, “ARIB TR B32” or “FreeTV OP59”. The loudnessCorrectionType specifies how the audio has been correlated: in an off-line file-based or a real-time process.

TABLE A1-38

loudnessMetadata sub-elements

Sub-element	Description	Units/Type	Example	Quantity
integratedLoudness	Integrated loudness value	LKFS/LUFS	−23.0	0 or 1
loudnessRange	Loudness range	LU	10.0	0 or 1
maxTruePeak	Maximum true-peak	dBTP	−2.3	0 or 1
maxMomentary	Maximum momentary loudness	LKFS/LUFS	−19.0	0 or 1
maxShortTerm	Maximum short- term loudness	LKFS/LUFS	−21.2	0 or 1
dialogueLoudness	Loudness of the average dialogue	LKFS/LUFS	−24.0	0 or 1
renderer	This sub-element defines the renderer configuration that has been used for the measurement of the other sub-elements in the parent loudnessMetadata element. See Tables A1-39 and A1-40.	–	–	0 or 1

NOTE – Recommendation ITU-R BS.1770 uses LKFS for loudness units, and the EBU uses LUFS. Both units are identical, and the model does not require the units to be expressed in the metadata.

TABLE A1-39

renderer attributes

Attributes	Description	Example	Required
uri	Renderer uri used for loudness measurement.	urn:itu:bs:2127:0:itu_adm_renderer	Optional
name	Renderer name used for loudness measurement.	“Rec. ITU-R BS.2127"	Optional
version	Version number of the renderer.	“1.0.0”	Optional
coordinateMode	Specifies the coordinate system path used during rendering, irrespective of the underlying composition coordinate system. Allowable values are “polar” or “cartesian”.	“polar”	Optional

TABLE A1-40

renderer sub-elements

Sub-element	Description	Example	Quantity
audioPackFormatIDRef	Reference to an audioPackFormat element of type ‘0001’ (DirectSpeakers). This sub-element defines the loudspeaker layout that has been used for rendering.	AP_00010002	0 or 1
audioObjectIDRef	Reference to audioObject elements. This sub-element can be used to define audioObject elements that have been used for rendering.	AO_1001	0 … *

5.7.5 Sample code

```
<audioContent audioContentID="ACO_1001" audioContentName="Music">
  <audioContentLabel language="eng">Music</audioContentLabel>
  <audioContentLabel language="deu">Musik</audioContentLabel>
  <audioObjectIDRef>AO_1001</audioObjectIDRef>
  <loudnessMetadata>
    <integratedLoudness>-23.0</integratedLoudness>
    <maxTruePeak>-2.3</maxTruePeak>
  </loudnessMetadata>
</audioContent>
```

5.8 audioProgramme

An audioProgramme element refers to a set of one or more audioContents that are combined to create a full audio programme. It contains start and end times for the programme, which can be used for alignment with video times. Loudness metadata is also included to allow the programme's loudness to be recorded.

When more than one audioProgramme is included in a file, and there is no other information to decide which one to choose for playback, then the default audioProgramme shall be the one with the lowest ID value.

5.8.1 Attributes

TABLE A1-41

audioProgramme attributes

Attribute	Description	Example	Required
audioProgrammeID	ID of the programme, see § 6.	APR_1001	Yes
audioProgrammeName	Name of the programme		Yes
audioProgrammeLanguage	Language of the dialogue content contained in this programme (as a String). It is recommended to use a language code to identify the language. The language code should be given as a 2- or 3-character code as specified by ISO 639-1 or ISO 639-2. Both ISO 639-2/B and ISO 639-2/T may be used.	fr	Optional
start	Start time for the programme. The start time is in the time format as described in § 5.13.	00:00:10.00000 or 00:00:10.00000S48000	Optional If start is not present, it shall be assumed the start is 00:00:0.00000
end	End time for the programme. The end time is in the time format as described in § 5.13.	00:10:00.00000 or 00:10:00.00000S48000	Optional If end is not present, it shall be assumed it is the end of file
maxDuckingDepth	Indicates the maximum amount of automatic ducking allowed for every audioObject in the programme. Range is 0 to −62 dB		Optional

5.8.2 Sub-elements

TABLE A1-42

audioProgramme sub-elements

Sub-element	Attribute	Description	Example	Quantity
audioProgrammeLabel	language	The programme description in the language specified by the language attribute. The language attribute can be used for definition of multiple audioProgramme labels in different languages. The language code should be given as a 2- or 3-character code as specified by ISO 639-1 or ISO 639-2. Both ISO 639-2/B and ISO 639-2/T may be used.	“Venue” language=”en”	0…*
audioContentIDRef		Reference to content	ACO_1001	1…*
loudnessMetadata	-	See § 5.8.4		0 … *
audioProgrammeReferenceScreen	-	Specification of a reference/ production/monitoring screen size for the audioProgramme, see § 5.8.3. If the reference screen-size is not given, a default screen-size is implicitly defined (see § 10.5).		0 or 1
authoringInformation		See § 5.8.6		0 or 1
alternativeValueSetIDRef		Reference to an alternativeValueSet within an audioObject.	AVS_1001_0001	0…*

As it is possible to include multiple alternativeValueSetIDRef sub-elements within an audioProgramme element, only one alternativeValueSet shall be referenced within the same audioObject. This should be done by inspecting the alternativeValueSet ID digits. The ID has the format: AVS_wwww_zzzz, where wwww matches the digits in the audioObject ID. Therefore, to ensure an audioObject is not referenced multiple times, each alternativeValueSetIDRef in an audioProgramme shall have unique wwww digits.

5.8.3 audioProgrammeReferenceScreen

An audioProgrammeReferenceScreen element describes a reference/production/monitoring screen that was used by the content creator during the production of the content of this audioObject. The screen can be described using either polar coordinates or Cartesian coordinates, but not both (see Fig. A1-4).

TABLE A1-43

audioProgrammeReferenceScreen attributes

Attribute	Description	Example
aspectRatio	Aspect ratio of the screen (proportional relationship between its width and its height (with respect to the image dimensions))	1.78, 1.6

For when polar coordinates are used:

TABLE A1-44

audioProgrammeReferenceScreen sub-elements

Sub-element	Coordinate Attribute	Description	Units	Example
screenCentrePosition	azimuth	Azimuth angle of the centre of the screen	degrees	+30.0
	elevation	Elevation angle of the centre of the screen	degrees	−15.0
	distance	Normalized distance to the centre of the screen. Default is 1.0	Normalized units (0.0 to 1.0)	1.0
screenWidth	azimuth	Width of the screen in polar coordinates (azimuth opening angle theta)	degrees ($0 < \text{theta} \leq 180$)	+58.0 or +96.0

For when Cartesian coordinates are used:

TABLE A1-45

Sub-element	Coordinate Attribute	Description	Units	Example
screenCentrePosition	X	X-coordinate of the centre of the screen	Normalized units ($\text{abs}(X) \leq 1$)	−0.3
	Y	Y-coordinate of the centre of the screen	Normalized units ($\text{abs}(Y) \leq 1$)	−0.2
	Z	Z-coordinate of the centre of the screen	Normalized units ($\text{abs}(Z) \leq 1$)	1.0
screenWidth	X	Width of the screen in Cartesian coordinates (width of the screen on the X-axis)	$0 < X \leq 2$	0.8

5.8.4 loudnessMetadata attributes and sub-elements

TABLE A1-46

loudnessMetadata attributes

Attribute	Description	Example
loudnessMethod	The method used to determine the loudness.	“ITU-R BS.1770”
loudnessRecType	The loudnessRecType indicates which regional recommended practice was followed in the loudness correction of the audio	“EBU R128”
loudnessCorrectionType	The correction type is used to indicate what correction has been applied to the audio, for example, file-based or real-time.	“File-based”

The audio could be corrected or normalized by numerous means, relating to loudness algorithm, regional recommended practice followed, and by what correction type. The loudnessMethod indicates the method used to determine the loudness (e.g. a value based on Recommendation ITU-R BS.1770). The loudnessRecType indicates the regional recommended practice that was followed as a character string, such as “EBU R128”, “ATSC A/85”, “ARIB TR B32” or “FreeTV OP59”. The loudnessCorrectionType specifies how the audio has been correlated: in an off-line file-based or a real-time process.

TABLE A1-47

loudnessMetadata sub-elements

Sub-element	Description	Units/Type	Example	Quantity
integratedLoudness	Integrated loudness value	LKFS/LUFS	−23.0	0 or 1
loudnessRange	Loudness range	LU	10.0	0 or 1
maxTruePeak	Maximum true-peak	dBTP	−2.3	0 or 1
maxMomentary	Maximum momentary loudness	LKFS/LUFS	−19.0	0 or 1
maxShortTerm	Maximum short- term loudness	LKFS/LUFS	−21.2	0 or 1
dialogueLoudness	Loudness of the average dialogue	LKFS/LUFS	−24.0	0 or 1
renderer	This sub-element defines the renderer configuration that has been used for the measurement of the other sub-elements in the parent loudnessMetadata element. See Tables A1-48 and A1-49.	–	–	0 or 1

NOTE – Recommendation ITU-R BS.1770 uses LKFS for loudness units, and the EBU uses LUFS. Both units are identical, and the model does not require the units to be expressed in the metadata.

TABLE A1-48

renderer attributes

Attributes	Description	Example	Required
uri	Renderer uri used for loudness measurement.	urn:itu:bs:2127:0:itu_adm_renderer	Optional
name	Renderer name used for loudness measurement.	“Rec, ITU-R BS.2127”	Optional
version	Version number of the renderer.	“1.0.0”	Optional
coordinateMode	Specifies the coordinate system path used during rendering, irrespective of the underlying composition coordinate system. Allowable values are “polar” or “cartesian”.	“polar”	Optional

TABLE A1-49

renderer sub-elements

Sub-element	Description	Example	Quantity
audioPackFormatIDRef	Reference to an audioPackFormat element of type ‘0001’ (DirectSpeakers). This sub-element defines the loudspeaker layout that has been used for rendering.	AP_00010002	0 or 1
audioObjectIDRef	Reference to audioObject elements. This sub-element can be used to define audioObject elements that have been used for rendering.	AO_1001	0 … *

5.8.5 Sample code

```
<audioProgramme audioProgrammeID="APR_1001" audioProgrammeName="Documentary">
  <audioProgrammeLabel language="eng">Default Mix</audioProgrammeLabel>
  <audioProgrammeLabel language="deu">Standard Mix</audioProgrammeLabel>
  <audioContentIDRef>ACO_1001</audioContentIDRef>
  <audioContentIDRef>ACO_1002</audioContentIDRef>
</audioProgramme>
```

5.8.6 authoringInformation

TABLE A1-50

authoringInformation sub-elements

Sub-element	Description	Quantity
referenceLayout	The reference layout describes the loudspeaker layout for which the content of the audioProgramme was originally produced for. In that sense it represents the optimal loudspeaker layouts from the content creator's point of view. See Table A1-51.	0 …*
renderer	See Tables A1-52 and A1-53.	0 … *

TABLE A1-51

referenceLayout sub-elements

Sub-element	Description	Example	Quantity
audioPackFormatIDRef	Reference to an audioPackFormat used as the reference layout during production. The referenced layout can either be part of the Common Definitions in Recommendation ITU-R BS.2094 or contained in the local ADM code itself. In case a reproduction technique is used during production that makes use of a virtual loudspeaker setup (e.g. binaural rendering or soundbar rendering), the referenceLayout should reference the virtual loudspeaker layout.	AP_00010003	1

TABLE A1-52

renderer attributes

Attributes	Description	Example	Required
uri	Renderer uri used in production and monitoring.	urn:itu:bs:2127:0:itu_adm_renderer	Yes
name	Renderer name used in production and monitoring.	“Rec, ITU-R BS.2127”	Optional
version	Version number of the renderer.	“1.0.0”	Optional
coordinateMode	Specifies the coordinate system path used during rendering, irrespective of the underlying composition coordinate system. Allowable values are “polar” or “cartesian”.	“polar”	Optional

TABLE A1-53

renderer sub-elements

Sub-element	Description	Example	Quantity
audioPackFormatIDRef	Reference to an audioPackFormat used in production and monitoring.	AP_00010003	1…*

5.8.7 Sample code

```
<audioFormatExtended version= "ITU-R_BS.2076-3">
  <audioProgramme audioProgrammeID="APR_1001" audioProgrammeName="MyProgramme">
    <authoringInformation>
      <renderer uri="urn:itu:bs:2127:0:itu_adm_renderer">
        <audioPackFormatIDRef>AP_00010003</audioPackFormatIDRef>
        <audioPackFormatIDRef>AP_00010017</audioPackFormatIDRef>
       </renderer>
    </authoringInformation>
  </audioProgramme>
</audioFormatExtended>
```

5.9 audioTrackUID

The audioTrackUID uniquely identifies a track or asset within a file or recording of an audio scene. This element contains information about the bit-depth and sample-rate of the track. For PCM audio, the audioStreamFormat and the audioTrackFormat should be omitted; then the audioTrackUID shall refer to the corresponding audioChannelFormat. The audioTrackUID element also contains sub-elements that allow the model to be used for non-BW64 applications by performing the job of the *<chna>* chunk.

5.9.1 Attributes

TABLE A1-54

audioTrackUID attributes

Attribute	Description	Example	Required
UID	The actual UID value, see § 6.	ATU_00000001	Yes
sampleRate	Sample rate of track in Hz	48000	Optional
bitDepth	Bit-depth of track in bits	24	Optional

5.9.2 Sub-elements

TABLE A1-55

audioTrackUID sub-elements

Sub-element	Description	Example	Quantity
audioMXFLookUp (Deprecated)	This sub-element was deprecated in Rec. ITU-R BS.2076-3 and therefore shall not be used. Other methods to package ADM into MXF exist and shall be used.		0
audioTrackFormatIDRef	Reference to an audioTrackFormat description	AT_00010001_01	0 or 1
audioChannelFormatIDRef	Reference to an audioChannelFormat description. This element is used only if an audioTrackFormat is omitted for PCM audio.	AC_00010001	0 or 1
audioPackFormatIDRef	Reference to an audioPackFormat description	AP_00010002	0 or 1

NOTE – The sub-element audioMXFLookUp was deprecated in Recommendation ITU-R BS.2076-3 and therefore shall not be used. Other methods to package ADM into MXF exist and shall be used.

5.9.3 Sample code

When a composition contains related audioTrackFormat, audioStreamFormat, and audioChannelFormat elements, audioTrackUID references audioTrackFormat.

```
<audioTrackUID UID="ATU_00000001" sampleRate="48000" bitDepth="24">
  <audioTrackFormatIDRef>AT_00031001_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00031001</audioPackFormatIDRef>
</audioTrackUID>
```

For PCM only applications where audioTrackFormat and audioStreamFormat elements are not present in the composition, audioTrackUID references audioChannelFormat.

```
<audioTrackUID UID="ATU_00000001" sampleRate="48000" bitDepth="24">
  <audioChannelFormatIDRef>AC_00031001</audioChannelFormatIDRef>
  <audioPackFormatIDRef>AP_00031001</audioPackFormatIDRef>
</audioTrackUID>
```

5.10 profileList

The profileList shall represent which constraint specifications the ADM is compliant with.

5.10.1 Sub-elements

TABLE A1-56

profileList sub-elements

Sub-element	Description	Example	Quantity
profile	Each profile specification shall specify how the profile string shall be set for the respective profile. It shall indicate a reference (e.g., a document reference) to the respective profile to which the ADM metadata is compliant.	"ITU-R BS.XXXX"	1 … *

NOTE – If multiple profile elements are present, then the ADM is constrained by the most constrained parts of each profile.

TABLE A1-57

profile attributes

Attribute	Description	Example	Required
profileName	The profileName attribute string shall be set for the respective profile. It shall indicate the name of the respective profile to which the ADM metadata is compliant.	"Production Profile"	Yes
profileVersion	The profileVersion attribute string shall be set for the respective profile. It shall indicate the version of the respective profile to which the ADM metadata is compliant.	"1.0.0"	Yes
profileLevel	The profileLevel attribute string shall be set for the respective profile. It shall indicate the level of the respective profile to which the ADM metadata is compliant.	"1"	Yes

5.11 tagList

The tagList element contains one or more tagGroup sub-elements. Each tagGroup sub-element defines a group of one or more tags which are associated with one or more ADM elements.

TABLE A1-58

tagList sub-elements

Sub-element	Description	Example	Quantity
tagGroup	A group of tag elements and any associated ADM elements.	See Table A1-59	1 … *

The tag sub-element can be used to attach descriptive text, keywords and short names to selected ADM elements. Application standards and profiles may define a restricted controlled vocabulary for tag values. Applications may use tag values for automatic selection, discarding, and searching of ADM elements. For example, tag values for an audioProgramme element can be used to define a

target platform and/or playback environment for the audioProgramme. Tag values can be also used to indicate features of ADM elements.

The values of the tag sub-elements and their class attributes provide additional information and shall not influence the way ADM elements are parsed or interpreted. Additionally, the contents of the tag elements shall not be used to duplicate or replace any other existing ADM elements.

TABLE A1-59

tagGroup sub-elements

Sub-element	Attribute	Description	Example	Quantity
tag	–	The tag value.	“Legacy 2.0”, “AdvSS/NGA”, “mobile”, “Event X”, “unfinished”, “Effects”, “Music”, “Team Y”, “final”, etc.	1 … *
	class	The class attribute can be used to assign the tag to a category	“platform”, “format”, “genre”	0 or 1
audioProgrammeIDRef	–	Reference to an audioProgramme element associated with the tag sub-elements.	“APR_1001”	0 … *
audioContentIDRef	–	Reference to an audioContent element associated with the tag sub-elements.	“ACO_1001”	0 … *
audioObjectIDRef	–	Reference to an audioObject element associated with the tag sub-element.	“AO_1001”	0 … *

In each tagGroup element, there shall be at least one audioProgrammeIDRef sub-element or at least one audioContentIDRef sub-element or at least one audioObjectIDRef sub-element.

5.11.1 Sample code

```
<tagList>
  <tagGroup>
    <tag class="format">Stereo</tag>
    <tag class="program genre">Sport</tag>
    <audioProgrammeIDRef>APR_1001</audioProgrammeIDRef>
  </tagGroup>
  <tagGroup>
    <tag class="format">NGA 5.1+2dialogues</tag>
    <tag class="program genre">News</tag>
    <audioProgrammeIDRef>APR_1002</audioProgrammeIDRef>
    <audioProgrammeIDRef>APR_1003</audioProgrammeIDRef>
  </tagGroup>
  <tagGroup>
    <tag class="format">NGA 5.1+2dialogues</tag>
    <tag class="program genre">News</tag>
    <audioProgrammeIDRef>APR_1004</audioProgrammeIDRef>
    <audioProgrammeIDRef>APR_1005</audioProgrammeIDRef>
  </tagGroup>
  <tagGroup>
    <tag class="dialogue type">boosted dialogue</tag>
    <audioObjectIDRef>AO_1012</audioObjectIDRef>
    <audioObjectIDRef>AO_1013</audioObjectIDRef>
  </tagGroup>
</tagList>
```

5.12 audioFormatExtended

audioFormatExtended is the parent element, containing all the ADM elements.

5.12.1 Sub-elements

TABLE A1-60

audioFormatExtended sub-elements

Sub-element	Description	Quantity
audioProgramme	Description of the whole audio programme.	0…*
audioContent	Description of the content of some audio within the programme.	0…*
audioObject	The link between the actual audio tracks and their format.	0…*
audioPackFormat	A description of a pack of channels that relate together.	0…*
audioChannelFormat	A description of an audio channel.	0…*
audioStreamFormat	A description of an audio stream.	0…*
audioTrackFormat	A description of an audio track.	0…*
audioTrackUID	The unique identifier for an actual audio track.	0…*
profileList	Description of profile compliance.	0 or 1
tagList	Descriptive text, keywords and shortnames for ADM elements	0 or 1

None of elements in Table A1-60 are mandatory within an ADM file. For example, a file that only consists of Common Definition tracks would not contain any audioTrackFormat, audioStreamFormat, audioChannelFormat and audioPackFormat elements. While it is preferable for ADM files to contain at least one audioProgramme and audioContent element, it is still valid for them to be omitted (for example in temporary or test files).

5.12.2 Attributes

TABLE A1-61

audioFormatExtended attributes

Attribute	Description	Example	Required
version	ADM Recommendation name and revision number	"ITU-R_BS.2076-3"	Yes

The version name is used to indicate which version of the ADM is used. If the version attribute is missing then the ADM is assumed to be Recommendation ITU-R BS.2076-0, as this version of the ADM did not contain this version attribute. For any later version of the ADM, then the version attribute should be included with the relevant name.

The version name for this particular update of the Recommendation is "ITU-R_BS.2076-3".

5.12.3 Sample code

```
<audioFormatExtended version="ITU-R_BS.2076-3">
  ...
</audioFormatExtended>
```

5.13 Time parameters format

The time-based time formats in this document show five decimal places for the seconds (either 'ss.zzzzz' or 'hh:mm:ss.zzzzz'), but this is a minimum number of decimal places, for example 01:34:16.25000. It is acceptable to use more decimal places, and this is advised when sampling rates over 48 kHz are being used. Nine decimal places (i.e. hh:mm:ss.zzzzzzzzz) gives nanosecond precision.

For the longer form fractional sample-based time format (hh:mm:ss.zzzzzSfffff), the 'z' digits represent the numerator of a fraction, and the fffff digits represent the denominator. The number of 'z's must match the number of 'f's. (i.e. 'hh:mm:ss.zzzzzS48000', 'hh:mm:ss.zzzzzzS192000'). The value of 'zzzzz' should be less than the value of 'fffff' to ensure a fraction less than one. Both values shall not be negative, and fffff shall be greater than zero. For example, 01:34:16.12000S48000 is the same as 01:34:16.25000.

For the shorter sample-based format 'zzzzzSfffff', the number of digits may be variable (i.e. '0S48000' or '500000S48000'). The value of 'zzzzz' can be more than the value of 'fffff' if the time being represented is greater than a second. Both values shall not be negative, and fffff shall be greater than zero.

6 Use of IDs

The ID attributes in each of the elements have three main purposes: to allow the elements to reference each other, to provide a unique identification for each defined element, and to provide a logical numerical representation of the contents of the element. The IDs for each element follows the following format:

TABLE A1-62

Element ID formats

Element	ID format
audioPackFormat	AP_yyyyxxxx
audioChannelFormat	AC_yyyyxxxx
audioBlockFormat	AB_yyyyxxxx_zzzzzzzz
audioStreamFormat	AS_yyyyxxxx
audioTrackFormat	AT_yyyyxxxx_zz
audioProgramme	APR_wwww
audioContent	ACO_wwww
audioObject	AO_wwww
alternativeValueSet	AVS_wwww_zzzz
audioTrackUID	ATU_vvvvvvvv

The yyyy part is a four-digit hexadecimal number that represents the type of element it is, by using the typeLabel values. There are five defined type label values and the possibility to define user custom types:

TABLE A1-63

typeDefinitions

typeDefinition	typeLabel	Description
DirectSpeakers	0001	For channel-based audio, where each channel feeds a speaker directly
Matrix	0002	For channel-based audio where channels are matrixed together, such as Mid-Side, Lt/Rt
Objects	0003	For object-based audio where channels represent audio objects (or parts of objects), so include positional information
HOA	0004	For scene-based audio where Ambisonics and HOA are used
Binaural	0005	For binaural audio, where playback is over headphones
User Custom	1yyy to Fyyy	For user custom types.

The xxxx part is a four-digit hexadecimal number, which shall identify the description within a particular type. Values in the range 0001-0FFF are reserved for common definition such as ‘FrontLeft’ or ‘Stereo’. Common definitions are specified in Recommendation ITU-R BS.2094 [8]. Values in the range 1000-FFFF are for custom definitions, which will be particularly used in object-based audio where all the objects will be custom definitions.

The audioChannelFormatID values in the range 0001-0FFF specify the channel with respect to the channel label and channel configuration. The set of defined common definitions for audioChannelFormatIDs for typical speaker positions is found in Recommendation ITU-R BS.2094 [8]. Some examples of these common definitions are shown in Table A1-64.

TABLE A1-64

Examples of common definition channel labels

Sub-element	ID of channel	Name of channel	speakerLabel
audioChannelFormatID	AC_00010001	FrontLeft	M+030
audioChannelFormatID	AC_00010002	FrontRight	M-030
audioChannelFormatID	AC_00010003	FrontCentre	M+000
audioChannelFormatID	AC_00010004	LowFrequencyEffects	LFE
audioChannelFormatID	AC_00010005	SurroundLeft	M+110
audioChannelFormatID	AC_00010006	SurroundRight	M-110

The audioPackFormatID specifies the channel configuration. The set of defined common definitions for audioPackFormatIDs for typical speaker configurations is found in Recommendation ITU-R BS.2094 [8]. Some examples of the common definitions are shown in Table A1-65.

TABLE A1-65

Examples of common definition for audioPackFormat

Sub-element	ID of pack	Name of pack
audioPackFormatID	AP_00010002	Stereo_(0+2+0)
audioPackFormatID	AP_00010003	5.1_(0+5+0)

In audioBlockFormat the zzzzzzzz part is an 8-digit hexadecimal number that acts as an index/counter for the blocks within the channel. This index shall start at 1 for the first block. The yyyyxxxx values shall match those of the parent audioChannelFormat ID.

In audioTrackFormat the zz part is a 2-digit hexadecimal number that acts as an index/counter for the tracks within the stream. This index shall start at 1 for the first track. The yyyyxxxx values shall match those of the reference audioStreamFormat ID.

In audioTrackUID the vvvvvvvv part is a unique 8-digit hexadecimal number that acts as a counter.

The audioProgramme, audioContent, audioObject and alternativeValueSet do not have a type and so have no yyyy values. As there is initially no intention to have common definitions for these elements the values for wwww will be in the hexadecimal range 1000-FFFF because they will always be custom values. However, keeping the common range of values (0001-0FFF) set aside for now may be useful in future; for example, EBU R 123 configurations may use them.

IDs with a zero value shall not be used for any definitions, as they are reserved for elements that should be ignored and are undefined. For example, AT_00000000_00 is for an audioTrackFormat that has no definition and should be ignored. This can be useful for audio files that contain unused tracks (e.g. an 8-track file containing 5-channel audio), so the <chna> chunk can reference AT_00000000_00 in the audioTrackFormat fields for those unused tracks.

Both upper and lower-case hex digits (a-f and A-F) must be supported when reading IDs. Therefore, IDs with the same digits, but with a different case are treated to be identical. For example, AC_0001000a and AC_0001000A are the same ID.

7 <chna> Chunk

While the ADM is designed to be a general model, its relationship with the BW64 file specified in Recommendation ITU-R BS.2088 is important. The following describes how a BW64 file access's the ADM metadata via a new RIFF chunk called <*chna*>. An overview of this new chunk is given here.

The ADM is linked to the BW64 file using the audioTrackFormat, audioPackFormat and audioObject (via audioTrackUID) elements. The BW64 file defines a new chunk called <*chna*> (short for 'channel allocation'), which contains a set of IDs for each track in the file. These IDs either refer to elements, or be referred to from an element.

Each track in the chunk contains the following IDs:

- **audioTrackFormatID** – the ID of the description of a particular audioTrackFormat element. As audioTrackFormat also refers to audioStreamFormat and either audioPackFormat or audioChannelFormat, this ID is enough to describe the format for a particular track. For PCM audio, the audioTrackFormat and the audioStreamFormat should be omitted. In this case, the audioChannelFormatID is referenced by the <chna> chunk in the BW64 file and uses the format AC_yyyyxxxx_00, (the "00" suffix pads out the string to match the required number of bytes in the <chna> chunk's "trackRef" field (see Clause 8.2 in Recommendation ITU-R BS.2088-1).
- **audioPackFormatID** – the ID of the description of a particular audioPackFormat. As most audioChannelFormats need to be assigned to an audioPackFormat (e.g. 'FrontLeft' channel in '5.1' pack), it must be specified in the <*chna*> chunk with this ID.
- **audioTrackUID** – the unique ID that identifies the track. The content descriptor audioObject requires knowledge of which tracks in the file are being described, so contains a list of audioTrackUID references which correspond to audio tracks in the file.

The typeDefinition that audioPackFormatID references does not have to match the typeDefinition that the audioTrackFormatID references for each track. A situation where they may differ is when an encoding matrix definition is being used, where the audioTrackFormatIDs will refer to the 'DirectSpeakers' input channels to the matrix, and the audioPackFormatID will refer to 'Matrix' type encoding matrix pack.

To enable tracks to contain more than one audioTrackFormatID, in order to allow different formats in the track at different times, the track number can be allocated multiple IDs. An example of such as allocation is below:

TABLE A1-66

<chna> chunk example

Track No	audioTrackUID	audioTrackFormatID	audioPackFormatID
1	00000001	00010001_01	00010002
1	00000002	00031001_01	00031001
2	00000003	00010002_01	00010002
2	00000004	00031002_01	00031002

Here, track number two has two audioTrackUIDs as the audioTrackFormats and audioPackFormats assigned to it are used at different times in the file. The times of allocation would have to be found be inspecting the audioObject elements that cover those audioTrackUIDs. An example of this is a programme where tracks 1 and 2 contain the theme tune which lasts for the first minute of the file.

These tracks are free after this first minute, so some audio objects from the main body of the programme are stored in them subsequently. As the theme tune and the audio objects have completely different formats and contents they require different audioTrackUIDs.

8 Coordinate system

The position elements in audioBlockFormat, for both the 'DirectSpeakers' and 'Objects' typeDefinitions, allow different axes to be specified in the coordinate attribute. A polar coordinate system, which uses azimuth, elevation and distance is used. The azimuth and elevation angle may also be used for the equation sub-element for scene-based audio (c.f. § 5.4.3.4). To ensure consistency when specifying positions each of the polar axes should be based on these guidelines:

– The origin is in the centre, where the sweet-spot would be (although some systems do not have a sweet-spot, so the centre of the space should be assumed).

– Azimuth – angle in the horizontal plane with 0 degrees as straight ahead, and positive angles to the left (or anti-clockwise) when viewed from above.

– Elevation – angle in the vertical plane with 0 degrees horizontally ahead, and positive angles going up.

– Distance – a normalized distance, where 1.0 is assumed to be the default radius of the sphere.

Cartesian coordinates, which is also used for object-based audio, and is supported by using X, Y and Z as the coordinate attributes. It is recommended that normalized values be used here, where the values 1.0 and −1.0 are on the surface of the cube, with the origin being the centre of the cube.

The direction of each axis should be:

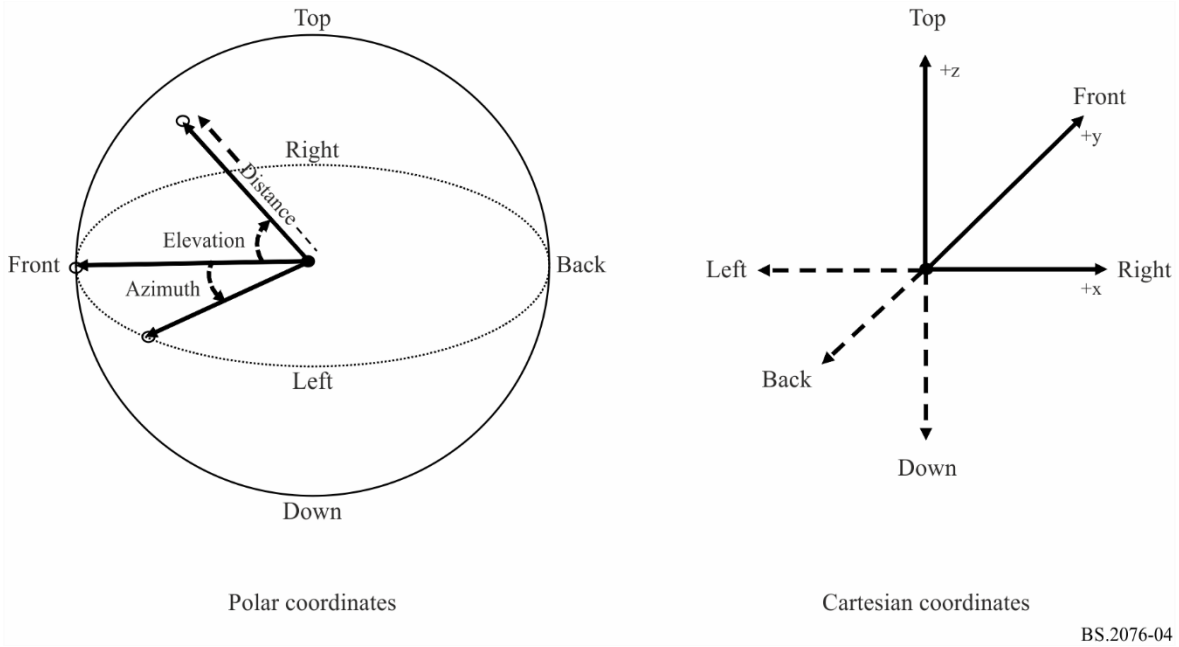
– **X** – left to right, with positive values to the right.

– **Y** – front to back, with positive values to the front.

– **Z** – top to bottom, with positive values to the top.

FIGURE A1-4

Coordinate systems used for Objects



If normalized distances are used in the coordinate system they can be scaled to an absolute distance by multiplying by the absoluteDistance parameter in the audioPackFormat.

For scene-based audio, the coordinate system is also Cartesian based, but the axes are different. The reason for the different axes for scene-based audio is a legacy of the development of Ambisonics, which has always used these axes. In this case the direction of each axis is:

– **X** – front to back, with positive values to the front.

– **Y** – left to right, with positive values to the left.

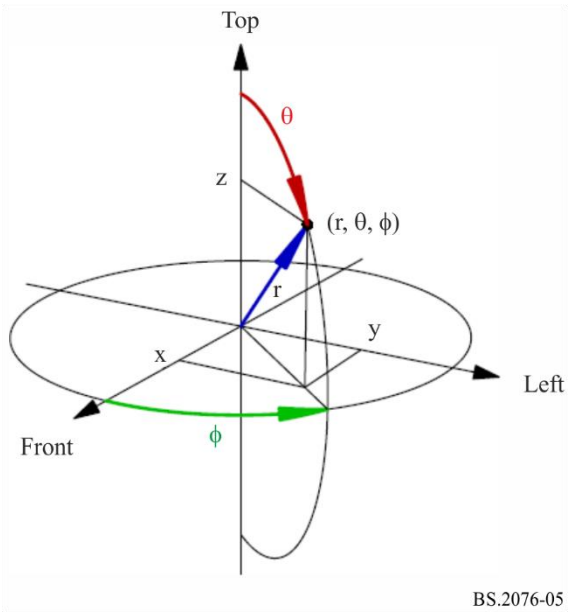
– **Z** – top to bottom, with positive values to the top.

To avoid confusion with the other Cartesian system, it is recommended the axes be labelled 'X_HOA', 'Y_HOA' and 'Z_HOA'. However, the HOA component definitions are unlikely to include coordinate information and so this information is primarily to ensure the rendering is correctly done.

The spherical coordinate system for scene-based audio is used according to Fig. A1-5.

FIGURE A1-5

Spherical and Cartesian coordinate system as used for HOA



9 Common parameter descriptions for all typeDefinitions

There are three parameters that are common to all the typeDefinitions:

– **importance** defined in audioBlockFormat, audioPackFormat and audioObject;

– **gain** occurs in both audioBlockFormat and audioObject;

– **jumpPosition** and **interpolationLength** occurs in audioBlockFormat.

There are two parameters that are common to typeDefinitions excluding "Binaural" and "Matrix":

– **headLocked** occurs in both audioBlockFormat and audioObject;

– **headphoneVirtualise** occurs in audioBlockFormat.

9.1 gain

The **gain** parameter is a linear or logarithmic gain and controls the level of the referenced audio signal. At rendering/playback the level of signal will be multiplied by the gain value. If the gain parameter is not set, a value of 1.0 is assumed, so the audio signal's level is not adjusted.

Ideally, the waveform that is being described should be at the desired level, so the gain parameter is not required (or set to 1.0), rather than relying on the gain parameter to adjust levels.

For a detailed description of the relationship and application of gain parameters in the ADM, see § 12.

9.2 importance

The **importance** parameter allows a processor to compromise audio tracks below a certain level of importance, with 10 being the most important, and 0 the least. This parameter for example may be useful when the size of the ADM metadata needs to be reduced and allow prioritisation to be made on what compromises can be made.

When the importance parameter is used in audioObject it can be used to remove less important sounds when the number of objects or tracks needs to be reduced. For example, some background sound effects can be discarded to ensure main dialogue objects are retained.

When the importance parameter is used in audioPackFormat it can be used to compromise on spatial audio quality. Nested audioPackFormats can be used to exploit this feature. For example, an audio object with a main direct sound (in a parent audioPackFormat with high importance) and additional reverb sounds (in a child audioPackFormat with low importance), could have the reverb sound discarded which retains the main sound, but compromises quality.

The importance parameter in audioBlockFormat can be used in a similar way to audioPackFormat to allow spatial quality to be compromised, but care must be taken that the sound is not adversely repositioned as a result of discarding channels.

9.3 jumpPosition and interpolationLength

If the **jumpPosition** flag is set to 0 then the renderer will interpolate a moving object between positions over the full duration of the block. If it is set to 1 it will jump to the new position instantly. If the **interpolationLength** attribute is used when **jumpPosition** is 1, then the interpolation period is set to the **interpolationLength** value. The **interpolationLength** shall be no longer than the block's duration.

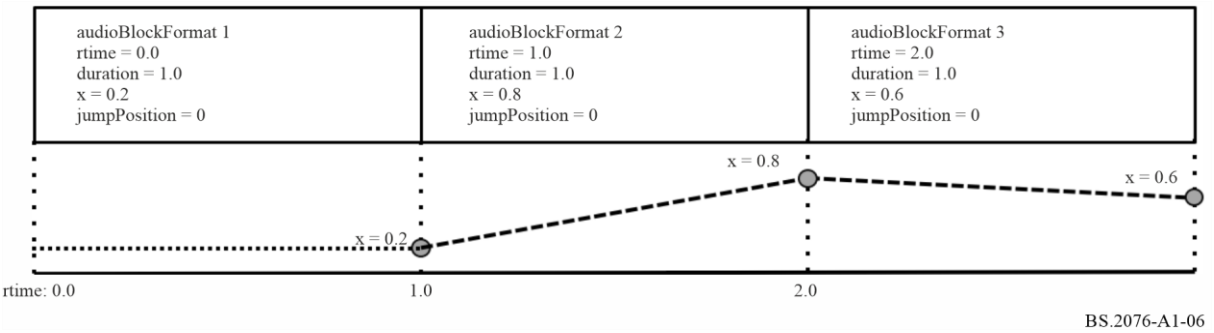
The **interpolationLength** parameter allows the interpolation of a moving object to be done over a shorter time period than the next update time. This allows the control of the crossfading of objects that may be desirable due to processing done to objects. If the value is set to zero then the object will jump position without interpolation. If this attribute is not included when jumpPosition is set to 1, then the interpolation length will be set to 0.

It is recommended that audioBlockFormat sizes are chosen to be small enough to avoid the use of the **interpolationLength** parameter for smoothly moving objects.

To help illustrate how jumpPosition and interpolationLength are interpreted, the following diagrams show a sequence of audioBlockFormats and how a dynamic parameter's value varies over time. The first example, in Fig. A1-6, shows when jumpPosition is set to zero (or not used), so the parameter (arbitrary parameter 'x' in this case) is interpolated over the duration of the entire audioBlockFormats. As the first block has a jumpPosition of zero and is not proceeded by another block the x value is only known at the end of the block, therefore the position at the start of the first block is effectively undefined. If this situation occurs, then the position at the start of the first block is made the same as the end of the block.

FIGURE A1-6

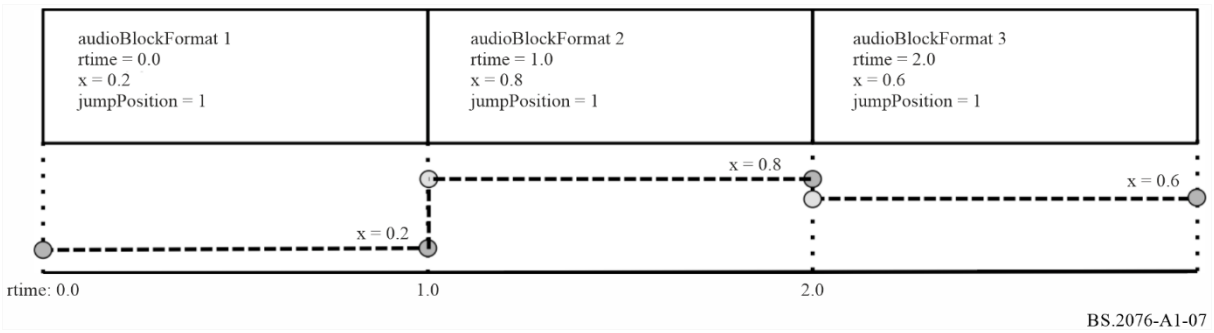
Interpolation with no jumpPosition



The second example, in Fig. A1-7, shows how the value of x varies when jumpPosition is set to 1 and no interpolationLength is set. The value of x is set at the beginning of the block and maintains that value throughout its duration. This also shows that the first block has a defined position from the beginning, and thus illustrates that it is recommended to set jumpPosition to 1 for the first block in a sequence.

FIGURE A1-7

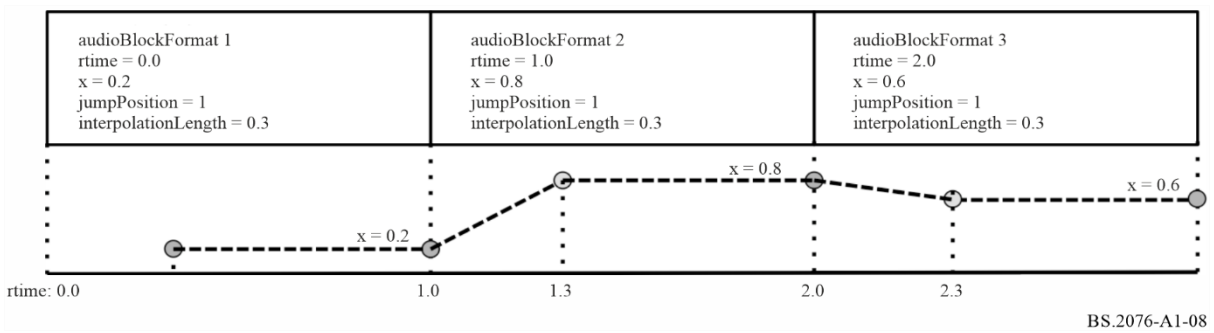
Interpolation with jumpPosition set



The third example, in Fig. A1-8, shows how the use of the interpolationLength attribute varies the value of x over the sequence of blocks. In this example, each interpolationLength is set to 0.3, so the value of x is interpolated over the first 0.3 seconds of the block, and then is locked to the defined value for the remainder of the block. The first block has an undefined value of x for the first 0.3 seconds.

FIGURE A1-8

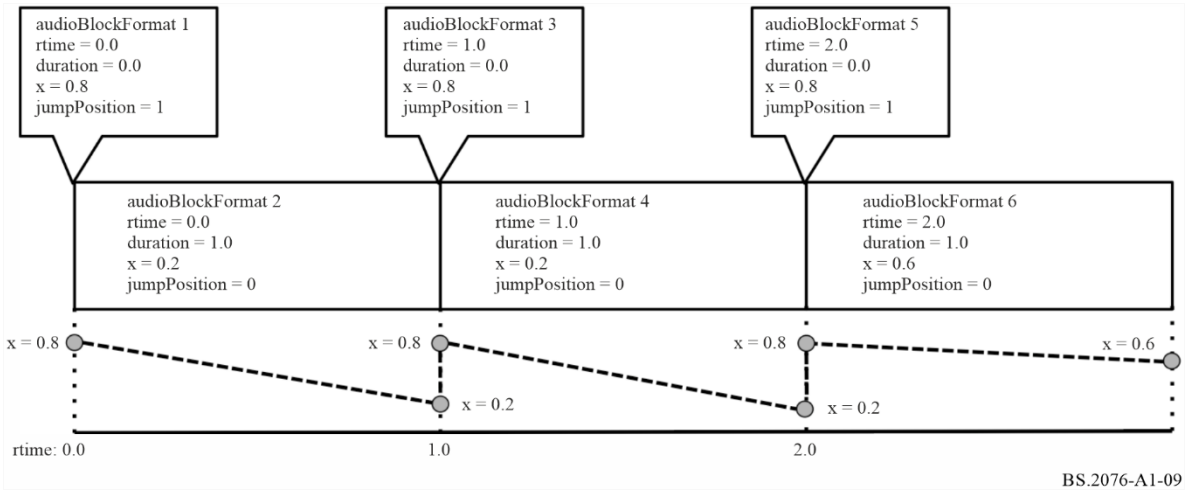
Interpolation with interpolationLength used with jumpPosition



The fourth example, in Fig. A1-9, shows how zero length blocks can be used to make a position jump, but also allow for interpolation to follow immediately. By having a first block of zero length it can ensure an initial position is always present.

FIGURE A1-9

Interpolation using zero length blocks



To ensure undefined behaviour of the first block is avoided, then the position specified in the first block covers the entire length of the block (regardless of the jumpPosition and interpolationLength properties).

The following parameters can be interpolated: position, width, height, depth, diffuse, and objectDivergence (including azimuthRange and positionRange) for typeDefinition of "Objects", gain attribute of coefficient sub-element of matrix sub-element for typeDefinition of "Matrix", gain for all typeDefinitions.

The other parameters in audioBlockFormat should not be interpolated and should remain constant for the duration of the block.

9.4 headLocked

The **headLocked** flag indicates that an audio object should lock to the listener's head when the head is moved (yaw/pitch/roll). Therefore, a headphone renderer which uses head tracking should not track the object if headLocked is set to "1". Figure A1-10 depicts the concept of enabled and disabled head-locked audio elements.

The default state (when headLocked is not present) is for head-locking to be off, so the scene of objects remains fixed relative to the moving head (the middle diagram in Fig. A1-10).

If **headLocked** is present in the audioOject and the audioBlockFormat, the value defined in the **audioBlockFormat** shall take precedence over the audioObject value.

9.5 headphoneVirtualise

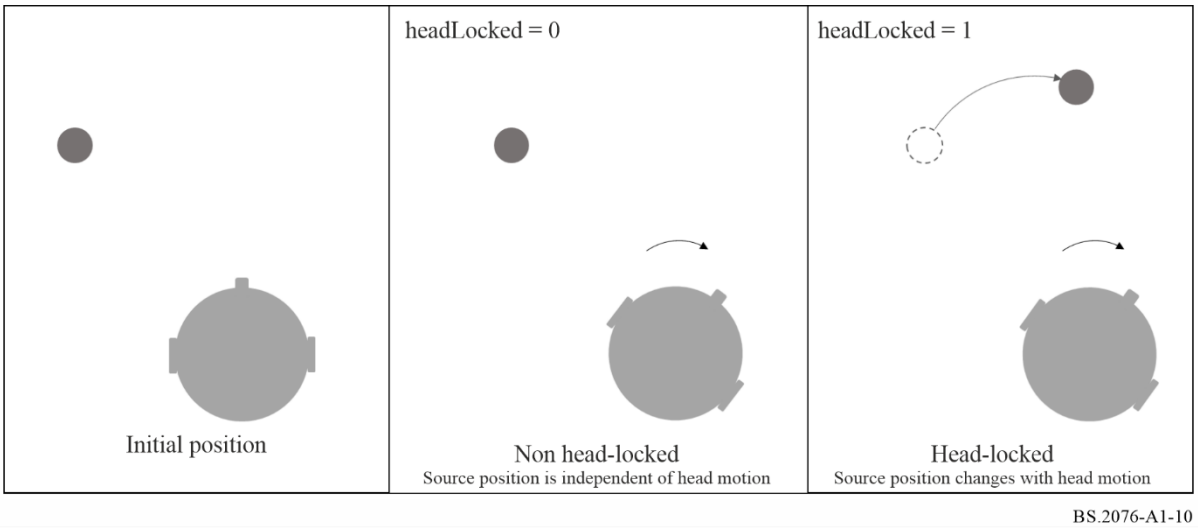
The **headphoneVirtualise** element specifies whether the content of the audioChannelFormat should be rendered with headphone virtualisation. The element consists of two attributes: "**bypass**" and "**DRR**" (Direct-to-Reverberant ratio).

The **bypass** attribute is a 1/0 flag that signals whether the content should be rendered using a headphone virtualiser (value of 0) or renderer to stereo (value of 1).

The **DRR** attribute defines the Direct-to-Reverberant-Ratio (DRR) in dB. This can be given in the range of −130 dB to 130 dB with 130 dB meaning anechoic (all direct sound).

FIGURE A1-10

Intended behaviour for head-locked audio elements



10 Parameter descriptions for typeDefinition of ‘Objects’

These parameters are found in the audioBlockFormat when the typeDefinition is ‘Objects’.

10.1 diffuse

The **diffuse** value between 0.0 and 1.0 describes the diffuseness of a sound, where 0.0 (the default) is a direct non-diffuse sound, and 1.0 a completely diffuse sound.

10.2 channelLock

If the **channelLock** flag is set to 1 then the renderer will send the audio signal to the nearest (in terms of 3D position) channel or speaker position. A typical application for this is where the exact location of the object is not critical, but the need for un-processed reproduction of that signal takes priority.

The optional maxDistance attribute defines the radius r, $0 \leq r \leq 2$, of a sphere around the object’s position. If one or more speakers exist in the defined sphere or on its surface, the object snaps to the nearest speaker. If maxDistance is undefined, a default value of infinity is assumed, meaning that the object should snap to the nearest of all speakers (unconditioned channelLock).

10.3 zoneExclusion

The **zoneExclusion** parameter is used to dynamically reconfigure the object renderer to “mask out” certain speaker zones during playback. This guarantees that no loudspeaker belonging to the masked zones will be used for rendering the applicable object. Typical zone masks used in production today include sides and rear. Multiple **zone** sub-elements within **zoneExclusion** can be set simultaneously to mask out more than one zone. The default is that all zones are enabled and when zoneExclusion is set to one or more of the indicated zones, those are “masked out” during playback. The sub-element **zone** is used to define the coordinates of the zone in the unit-cuboid.

Zones are defined in the Cartesian coordinate system using the sub-element **zone** by specifying the corner points of a unit-cuboid in 3D space by: minX, maxX, minY, maxY, minZ, maxZ. In the

spherical coordinate system the zone is defined by: minAzimuth, maxAzimuth, minElevation, maxElevation.

For example: minX= −1.0, maxX=1.0, minY= −1.0, maxY= –1.0, minZ= −1.0, maxZ=1.0 specifies the *rear* wall.

10.4 objectDivergence

The **objectDivergence** parameter (0.0 to 1.0) indicates the amount an object is split symmetrically into a pair of virtual objects, so that a phantom object is created in the position of the original object. The spread of the signal between the virtual objects should not create an image shift from the original object position and should be power preserving across virtual objects and the original. The **azimuthRange** and **positionRange** attributes allow the relative positions of virtual objects to be specified. This can either be an angle where spherical coordinates are being used, or a distance value where Cartesian coordinates are being used. When spherical coordinates are used, a value of 45 degrees would place virtual objects 45 degrees to the left and right of the specified object. The default angle is 0 degrees if this attribute is not used. When Cartesian coordinates are used, a value of 0.5 would place the virtual objects at x-0.5,y,z and x+0.5,y,z if x,y,z is the location of the specified object. The default distance is 0.0.

The values of **objectDivergence** should be interpreted as:

TABLE A1-67

objectDivergence values

Value	Description
0	No divergence with only the original object being present.
1	Maximum divergence where this would represent virtual objects being created azimuthRange degrees on either side of the original position.

Example: With an LCR loudspeaker layout and the object positioned directly at the C position, and the LR virtual objects specified by using an **azimuthRange** of 30 degrees. An **objectDivergence** value of 0 indicating no divergence, only the centre speaker would be firing. A value of 0.5 would have all three (LCR) loudspeakers firing equally, and a value of 1 would have the L and R loudspeakers firing equally.

10.5 screenRef and audioProgrammeReferenceScreen

The **screenRef** flag is used to indicate whether the corresponding audio signal (e.g. object or HOA signal) is screen-related or not. The screenRef flag can be used by a renderer for special processing of all screen-related objects taking into account the size of a local reproduction screen compared to the production screen-size.

If a renderer uses the screenRef flag to enable a special processing, it should use the reference/monitoring/production screen-size of the currently rendered audioProgramme as the reference screen.

If the flag is set and no audioProgrammeReferenceScreen element is included in the corresponding currently rendered audioProgramme, the reference production/monitoring screen is implicitly defined on the basis of Recommendation ITU-R BT.1845 – Guidelines on metrics to be used when tailoring television programmes to broadcasting applications at various image quality levels, display sizes and aspect ratios [6].

TABLE A1-68

Default screen size

Azimuth of left bottom corner of screen	29.0°
Elevation of the left bottom corner of screen	−17.3°
Aspect ratio	1.78 (16:9)
Polar angular width of the screen	58° (as defined by image system 3840 × 2160)

These spherical values can be transferred to Cartesian coordinates assuming a reference distance of 1.0 by first transferring the values above to the "standard" azimuth/elevation convention (0° azimuth is in front of the right ear, positive values are counted counter-clockwise; 0° elevation is directly above the head, positive values are counted downwards to the front) and then using the trigonometric functions to gain the Cartesian coordinates. The screen is assumed to have its centre touching the unit sphere. This results in the following values (orientation of the Cartesian coordinate axes as in § 8):

TABLE A1-69

Default screen size in Cartesian coordinates

X-coordinate of the centre of the screen	0.0
Y-coordinate of the centre of the screen	1.0
Z-coordinate of the centre of the screen	0.0
Aspect ratio	1.78
Width of the screen	1.1086

NOTE – The maths to convert from the polar coordinate screen to Cartesian coordinates is:

$$d = \frac{1}{\sqrt{\left(\frac{1}{a^2}\right)\tan^2\left(\frac{w}{2}\right)+1}}$$

where:

d : Y-coordinate of the centre of the screen

a : aspect ratio

w : polar angle of the screen width.

$$x = 2d\tan\left(\frac{w}{2}\right)$$

where:

x : Cartesian screen width

w : polar angle of the screen width.

11 Parameter descriptions for typeDefinition of 'HOA'

These parameters are found in the audioBlockFormat when the typeDefinition is 'HOA'.

11.1 order and degree

The meaning of **order** and **degree** values is based on the following definition of real-valued spherical harmonics:

$$Y_n^m(\theta,\phi) = N_n^{|m|} P_n^{|m|}(\cos(\theta)) \begin{cases} \sqrt{2}\cos(m\phi), & \text{for } m > 0 \\ 1, & \text{for } m = 0 \\ -\sqrt{2}\sin(m\phi), & \text{for } m < 0 \end{cases}$$

where:

n : order value

m : degree value

ϕ : azimuth

θ : elevation

$N_n^{|m|}$: normalization parameter for the given order and degree

$P_n^{|m|}$: associated Legendre function for the given order and degree.

The associated Legendre functions $P_n^m(x)$ are defined as:

$$P_n^m(x) = (1-x^2)^{\frac{m}{2}} \frac{\mathrm{d}^m}{\mathrm{dx}^m} P_n(x),\ m \geq 0$$

with the Legendre polynomial $P_n(x)$ and without the Condon-Shortley phase term $(-1)^m$.

11.2 normalization

When the **normalization** is specified as N3D, the following equation is given:

$$N_{\mathrm{N3D}}{}_n^{|m|} = \sqrt{(2n+1)\frac{(n-|m|)!}{(n+|m|)!}}.$$

N3D normalization yields a set of orthonormal basis functions. With N3D normalization the higher-order components ($n \geq 0$) can have an energy greater than that of the $n = 0$ component, which risks causing clipping distortions when audio data is stored in integer sample formats.

When the **normalization** is specified as SN3D, the following equation is given:

$$N_{\mathrm{SN3D}}{}_n^{|m|} = \sqrt{\frac{(n-|m|)!}{(n+|m|)!}}.$$

SN3D normalization applies a weighting to the HOA components according to the order such that the energy does not exceed that of the $n = 0$ component.

When the **normalization** is specified as FuMa, the signal was stored with the Furse-Malham (FuMa) weighting. This system of weighting is designed for coefficients not to exceed an absolute value of 1 in panning. It also has a −3 dB weighting of the n = 0 component. It is only defined up to order 3.

TABLE A1-70

HOA FuMa normalization

Order (n)	**Degree ($\|m\|$)**	$N_{\mathrm{FuMa}_n}^{\|m\|}$ ***Normalization (relative to*** $N_{\mathrm{SN3D}_n}^{\|m\|}$***)***
0	0	$\frac{1}{\sqrt{2}} N_{\mathrm{SN3D}_n}^{\|m\|}$
1	0	$N_{\mathrm{SN3D}_n}^{\|m\|}$
1	1	$N_{\mathrm{SN3D}_n}^{\|m\|}$
2	0	$N_{\mathrm{SN3D}_n}^{\|m\|}$
2	1	$\frac{2}{\sqrt{3}} N_{\mathrm{SN3D}_n}^{\|m\|}$
2	2	$\frac{2}{\sqrt{3}} N_{\mathrm{SN3D}_n}^{\|m\|}$
3	0	$N_{\mathrm{SN3D}_n}^{\|m\|}$
3	1	$\sqrt{\frac{45}{32}} N_{\mathrm{SN3D}_n}^{\|m\|}$
3	2	$\frac{3}{\sqrt{5}} N_{\mathrm{SN3D}_n}^{\|m\|}$
3	3	$\sqrt{\frac{8}{5}} N_{\mathrm{SN3D}_n}^{\|m\|}$

To reduce the risk of clipping with integer sample formats the SN3D normalization is the default option. Due to its greater dynamic range, N3D normalization is recommended for floating-point sample formats where there is practically no risk of clipping.

11.3 nfcRefDist

The **nfcRefDist** indicates the reference distance (in metre) that has been used during the scene-based audio production. This reference distance may be used for the audio rendering for nearfield compensation (NFC) [9].

If the **nfcRefDist** is not defined or set to zero, nearfield-compensated rendering is not intended.

11.4 screenRef

The **screenRef** flag is used to indicate whether the scene-based programme is screen-related or not.

The screenRef flag can be used by a renderer for special adaptation of the scene-based content taking into account the size of a local reproduction screen in relation to the production screen-size.

See § 10.5 for additional information regarding the production screen-size parameter.

11.5 Ambisonics Channel Numbering

An often-used convention for channel ordering based on order and degree components is the so-called Ambisonics Channel Number (ACN):

$$\mathrm{ACN} = n^2 + n + m.$$

The order and degree components can be easily retrieved from the ACN number:

$$n = \lfloor \sqrt{\mathrm{ACN}} \rfloor,$$
$$m = \mathrm{ACN} - n^2 - n.$$

12 Relationship and application of gain parameters in the ADM

The following elements of the ADM are relevant to calculate the final gain of a specific audio sample:

– **gain sub-element of audioBlockFormat**: Defines a gain value (either linear or logarithmic) that should be applied to all audio samples corresponding to the parent audioBlockFormat. If the gain parameter is not set, a linear value of 1.0 is assumed. Ideally the waveform (represented e.g. by PCM samples) should be at the desired level, so the gain parameter is not required (or set to 1.0). The gain parameter in audioBlockFormat is useful when a single audio track is being used by multiple audioChannelFormat definitions, each requiring different levels.

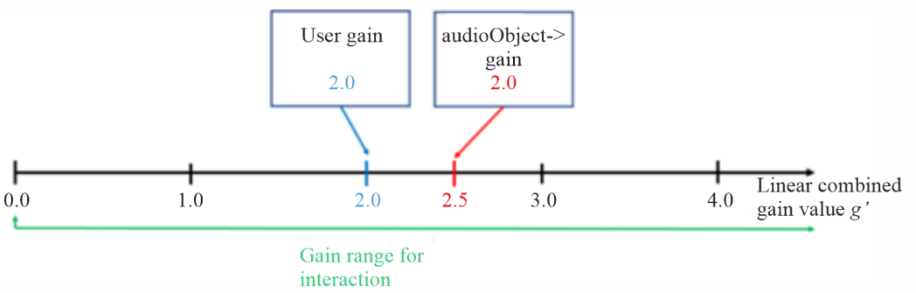
– **gain sub-element of audioObject**: Defines a gain value (either linear or logarithmic) that should be applied to all audio samples corresponding to the parent audioObject. The gain parameter in audioObject can for instance be used for user interactivity. Then it describes the initial playback gain of the audioObject during rendering. For example, it might be required that a particular audioObject is usually muted, so it will be given a gain of zero (-inf dB). It can also be used to ensure that different audioProgrammes using a different combination of audioObjects maintain a desired loudness level. If the gain parameter is not set, a linear value of 1.0 (0 dB) is assumed.

– **gainInteractionRange sub-element of audioObjectInteraction**: The audioObjectInteraction sub-element of audioObject can be used to define in which boundaries a user can interactively influence the audioObject. With relation to gain, it is possible to allow or forbid any gain interaction at all. If gain interaction is allowed, the gainInteractionRange sub-element of audioObjectInteraction defines minimum and maximum boundaries for the gain interaction (either as linear or logarithmic values). Any change to an attribute that can be set by the user should be within the limits of the interaction range.

During rendering/playback, all the different gain parameters and related ADM metadata have to be combined in a specific way to ensure the correct playback level is chosen for specific set of audio samples or an audio source.

FIGURE A1-11

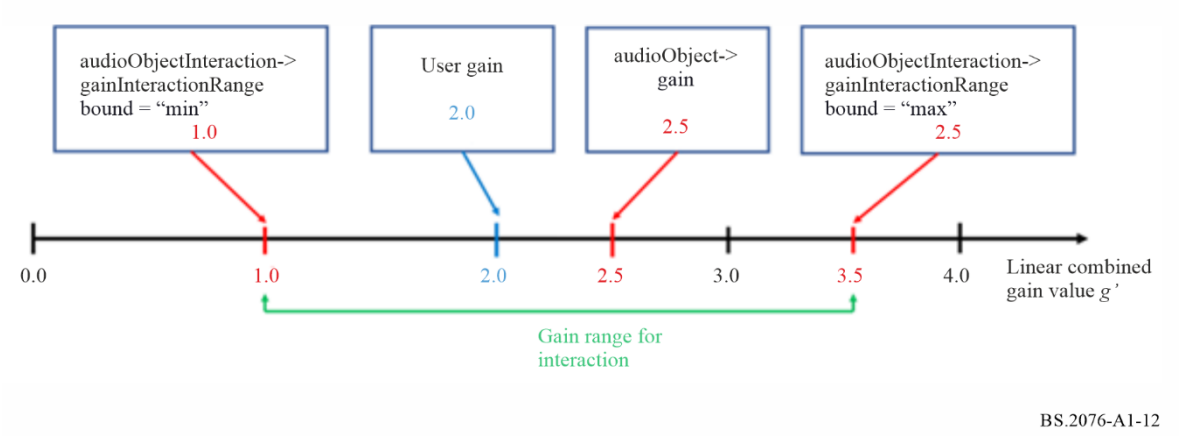
User gain can take any values without gain range set



BS.2076-A1-11

FIGURE A1-12

User gain within the values set by gainInteractionRange bounds



The following defines how the total gain value g_{total} is determined for each audio sample.

First it is determined whether gain interactivity is enabled:

1 If the interact attribute of the audioObject element is not present or is present and set to 0, then gain interactivity is disabled.

2 If the interact attribute of the audioObject element is present and set to 1:

2.1 If the audioObjectInteraction sub-element of the audioObject element is not present, then gain interactivity is enabled.

2.2 If the audioObjectInteraction sub-element of the audioObject element is present:

2.2.1 If the gainInteract attribute of the audioObjectInteraction element is not present or is present and set to 0, then gain interactivity is disabled.

2.2.2 If the gainInteract attribute of the audioObjectInteraction element is present and set to 1, then gain interactivity is enabled.

If gain interactivity is disabled, gain value g' as used below is set to the value of the gain sub-element of the audioObject element, or to 1.0 (0 dB) if the gain sub-element is not present.

If gain interactivity is enabled, the following variables are defined:

g_{min} …value of the audioObjectInteraction->gainInteractionRange sub-element with attribute bound="min"; if no audioObjectInteraction element is present or no gainInteractionRange sub-element with attribute bound="min" is present, then g_{min} is set to 0.0 (-inf dB)

g_{max} …value of the audioObjectInteraction->gainInteractionRange sub-element with attribute bound="max"; if no audioObjectInteraction element is present or no positionInteractionRange sub-element with attribute bound="max" is present, then g_{max} is set to inf (inf dB)

g_{User} …gain value imposed by user interaction; if the user did not set a gain value, the value of the gain sub-element of the audioObject element is used as a default; if the gain sub-element is not present, the default value for g_{User} is 1.0 (0 dB)

With these variables, gain value g' is calculated as follows:

$$g' = \min\left(g_{max}, \max(g_{min}, g_{User})\right)$$

If an alternativeValueSet sub-element is active for an audioObject element, the applicable values to be used in the procedure above depend on the precedence and inheritance of gain and

audioObjectInteraction sub-elements between the parent audioObject element and its active alternativeValueSet sub-element (see § 5.6.5).

Summary of common scenarios with gain interactivity:

– If gain interactivity is disabled, the gain sub-element can be used to assign any static gain level to the audioObject.

– If gain interactivity is enabled, g_{User} is set to the value of the gain sub-element which serves as a default until the user changes the gain value.

– If gain interactivity is enabled and no gainInteractionRange sub-elements are present, the user can adjust the gain without any constraints. This is illustrated in Fig. A1-11. In this case, the combined gain value is simply $g' = g_{User}$.

– If gain interactivity is enabled and any gainInteractionRange sub-elements are present, the user can adjust the gain value g' within the limits imposed by the gainInteractionRange sub-elements. This is illustrated in Fig. A1-12.

The resulting overall playback gain value then is

$$g_{total} = g_{block} \cdot g'$$

with g_{block} being the audioBlockFormat->gain value. This is illustrated in Fig. A1-13.

All gain values referred to in the calculations in this section are considered as linear gain values.

Linear and logarithmic gain values can be translated as follows:

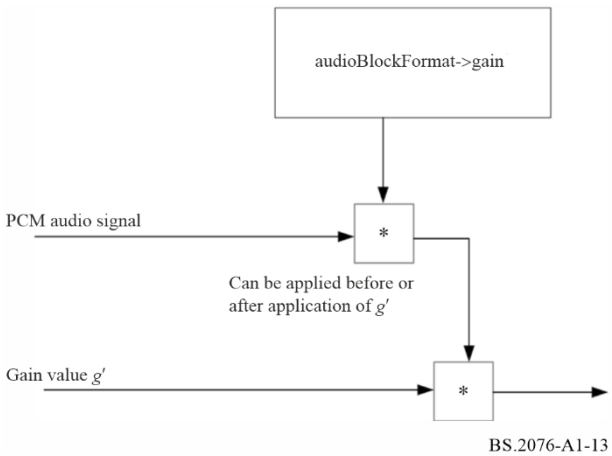
$$g_{log}[dB] = 20 \cdot \log_{10}(g_{lin})$$

$$g_{lin} = 10^{(\frac{g_{log}[dB]}{20})}$$

A linear value of 0.0 is equivalent to a logarithmic value of negative infinity ("-inf").

FIGURE A1-13

Application of audioBlockFormat gain and gain value g'



13 Application of position-related parameters in the ADM

The following elements of the ADM are relevant to calculate the final position to which a specific audio sample should be rendered:

– **position sub-element of audioBlockFormat** (for typeDefinition="DirectSpeakers" and typeDefinition="Objects"): This element defines the position of either a loudspeaker (typeDefinition="DirectSpeakers") or a single sequence of audioChannelFormat samples

representing an object. The position can be given either by azimuth, elevation and normalised distance (polar/spherical coordinates) or normalised X, Y, Z values (Cartesian coordinates).

– **positionOffset sub-element of audioObject**: This defines position offset values that should be applied to the position metadata of all audio corresponding to the parent audioObject. It describes the initial playback position offset of the audioObject during rendering.

– **positionInteractionRange sub-element of audioObjectInteraction**: This element defines the bounds in which a user-side position interaction is possible. It gives minimum and maximum values for a possible user interaction with respect to azimuth, elevation and distance (spherical coordinates) or X, Y, Z (Cartesian coordinates).

During rendering/playback, all the different position-related parameters and related ADM metadata shall be combined in a specific way to ensure the correct rendering position is chosen for specific set of audio samples or an audio source.

FIGURE A1-14

Application of audioObject position offset values (polar coordinates) without positionInteractionRange sub-elements set

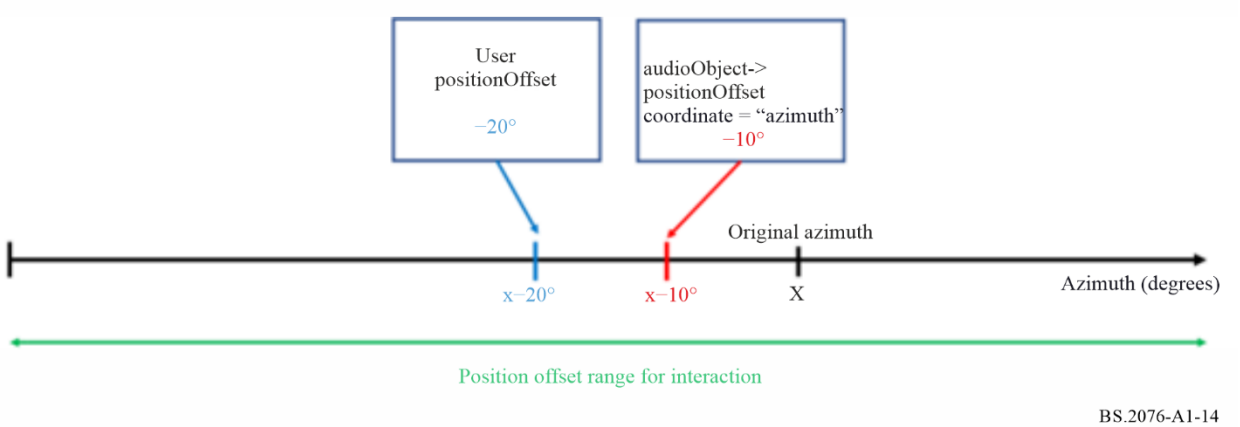
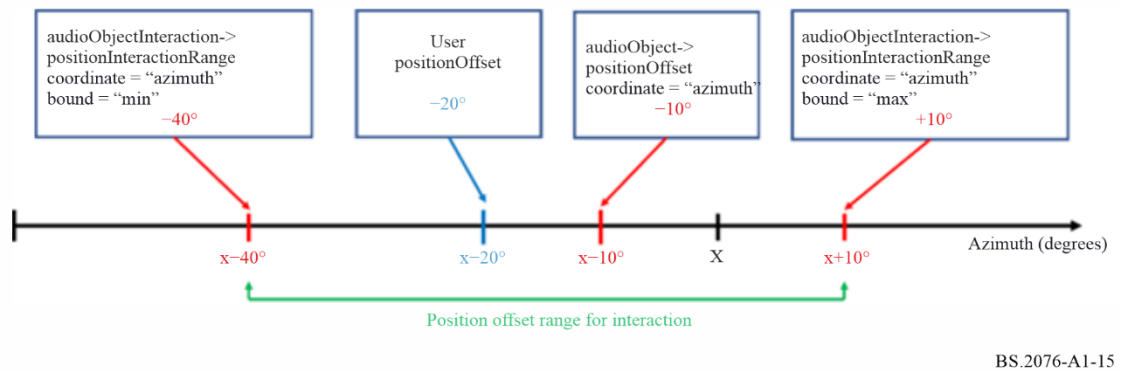


FIGURE A1-15

Application of audioObject position offset values (polar coordinates) with positionInteractionRange sub-elements set



The following specifies how the total position value p_{total} for any single selected coordinate (azimuth, elevation, distance, or X,Y,Z) is determined for each audioBlockFormat.

First, it is determined whether position interactivity is enabled for the selected coordinate:

1 If the interact attribute of the audioObject element is not present or is present and set to 0, then position interactivity is disabled for the selected coordinate.

2 If the interact attribute of the audioObject element is present and set to 1:

2.1 If the audioObjectInteraction sub-element of the audioObject element is not present, then position interactivity is enabled for the selected coordinate.

2.2 If the audioObjectInteraction sub-element of the audioObject element is present:

2.2.1 If the positionInteract attribute of the audioObjectInteraction element is not present or is present and set to 0, then position interactivity is disabled for the selected coordinate.

2.2.2 If the positionInteract attribute of the audioObjectInteraction element is present and set to 1:

2.2.2.1 If the audioObjectInteraction element does not include positionInteractionRange sub-elements for any coordinate, then position interactivity is enabled for the selected coordinate.

2.2.2.2 If the audioObjectInteraction element includes positionInteractionRange sub-elements with bound=”min” and bound=”max” for the selected coordinate, then position interactivity is enabled for the selected coordinate.

2.2.2.3 Otherwise, position interactivity is disabled for the selected coordinate

If position interactivity is disabled for a selected coordinate, then variable p' as used below is set to the value of the positionOffset sub-element for the selected coordinate (or to 0.0 if the positionOffset sub-element is not present for that coordinate).

If position interactivity is enabled for a selected coordinate, the following variables are defined:

p_{min} …value of the audioObjectInteraction->positionInteractionRange sub-element with attribute bound=”min” for the selected coordinate; if no audioObjectInteraction element is present or no positionInteractionRange sub-elements are present, then $p_{min}$is set to -inf

p_{max} …value of the audioObjectInteraction->positionInteractionRange sub-element with attribute bound=”max” for the selected coordinate; if no audioObjectInteraction element is present or no positionInteractionRange sub-elements are present, then $p_{max}$is set to inf

p_{User} …positionOffset value imposed by user interaction; if the user did not set a positionOffset value, the value of the positionOffset sub-element for the selected coordinate is used as a default; if the positionOffset sub-element is not present for that coordinate, the default value for p_{User} is 0.0.

With these variables, the combined positionOffset value *p'* is calculated as follows:

$$p' = \min\left(p_{max}, \max(p_{min}, p_{User})\right)$$

If an alternativeValueSet sub-element is active for an audioObject element, the applicable values to be used in the procedure above depend on the precedence and inheritance of positionOffset and audioObjectInteraction sub-elements between the parent audioObject element and its active alternativeValueSet sub-element (see § 5.6.5).

Summary of common scenarios with position offset interaction:

– Position interactivity is enabled for all coordinates without any constraints, if the interact attribute of the audioObject element is present and set to 1 and there is no audioObjectInteraction sub-element, or if the audioObjectInteraction sub-element is present with the positionInteract attribute set to ‘1’ and without positionInteractionRange sub-

elements for any coordinate. In this case, the user can adjust the position offset value along all coordinate directions without any constraints. This is illustrated exemplarily for the azimuth coordinate in Fig. A1-14.

– Position interactivity is enabled for only one or more selected coordinates if the interact attribute of the audioObject element is present and set to 1 and the audioObjectInteraction sub-element is present with the positionInteract attribute is set to '1' and positionInteractionRange sub-elements present only for the selected coordinates. In this case, the user can adjust the position along the selected coordinates according to the limits imposed by the positionInteractionRange sub-elements but cannot adjust the position along any other coordinate. This is illustrated exemplarily for the azimuth coordinate in Fig. A1-15.

– If position interactivity is disabled for a coordinate, the corresponding positionOffset sub-element can be used to assign any static positionOffset to the audioObject along that coordinate.

– If position interactivity is enabled for a coordinate, p_{User} is set to the value of the corresponding positionOffset sub-element which serves as a default until the user changes the positionOffset value.

The resulting overall position value then is

$$p_{total} = p_{block} + p'$$

with p_{block} being the corresponding audioBlockFormat->position value.

For the distance coordinate, the following additional operation is performed:

$$p'_{total} = \max(0, p_{total})$$

14 References

[1] Report ITU-R BS.2266 – Framework of future audio broadcasting systems

[2] Recommendation ITU-R BS.1909 – Performance requirements for an advanced multichannel stereophonic sound system for use with or without accompanying picture

[3] Recommendation ITU-R BS.2051 – Advanced sound system for programme production

[4] Recommendation ITU-R BS.1352 – File format for the exchange of audio programme materials with metadata on information technology media

[5] Recommendation ITU-R BS.1770 – Algorithms to measure audio programme loudness and true-peak audio level

[6] Recommendation ITU-R BT.1845 – Guidelines on metrics to be used when tailoring television programmes to broadcasting applications at various image quality levels, display sizes and aspect ratios

[7] Recommendation ITU-R BS.2088 – Long-form file format for the international exchange of audio programme materials with metadata

[8] Recommendation ITU-R BS.2094 – Common definitions for the Audio Definition Model

[9] Daniel J. Spatial sound encoding including near field effect: Introducing distance coding filters and a viable, new ambisonic format. In 23rd International AES Conference: Signal Processing in Audio Recording and Reproduction 2003

[10] Report ITU-R BS.2388 – Usage guidelines for audio definition model and multichannel audio files

Annex 2
(informative)

Examples of ADM usage

This Annex 2 contains a selection of examples of metadata that uses the ADM. These are to help illustrate how the ADM is used, but not be considered as references for audio definitions.

1 Channel-based example

The most common use of audio is still channel-based, where tracks within a file each represent a static audio channel. This example demonstrates how to define two tracks, streams and channels; and a pack for stereo. The track and stream definitions are for PCM audio. Two objects are defined, both stereo, but containing different content so there are 4 tracks used. This example uses a programme called ‘Documentary’ containing ‘Music’ and ‘Speech’ each defined as separate stereo objects.

The format-related elements in this example represent a tiny subset of the common reference set of definitions. In practice, this XML code would be part of the common reference file and would not have to be included in the BWF file. All that would be required is a <*chna*> chunk with the references to the audioTrackFormats and audioPackFormats and any extra XML required for audioObject, audioContent and audioProgramme.

1.1 Summary of elements

These are the elements in the format part of the description:

TABLE A2-1

Channel-based example format elements

Element	ID	Name	Description
audioTrackFormat	AT_00010001_01	PCM_FrontLeft	Defines track as PCM
audioTrackFormat	AT_00010002_01	PCM_FrontRight	Defines track as PCM
audioStreamFormat	AS_00010001	PCM_FrontLeft	Defines stream as PCM
audioStreamFormat	AS_00010002	PCM_FrontRight	Defines stream as PCM
audioChannelFormat and audioBlockFormat	AC_00010001 AB_00010001_00000001	FrontLeft	Describes channel as front left with a position and speaker reference
audioChannelFormat and audioBlockFormat	AC_00010002 AB_00010002_00000001	FrontRight	Describes channel as front right with a position and speaker reference
audioPackFormat	AP_00010002	Stereo	Defines a stereo pack referring to two channels.

These are the elements in the content part of the description:

TABLE A2-2

Channel-based example content elements

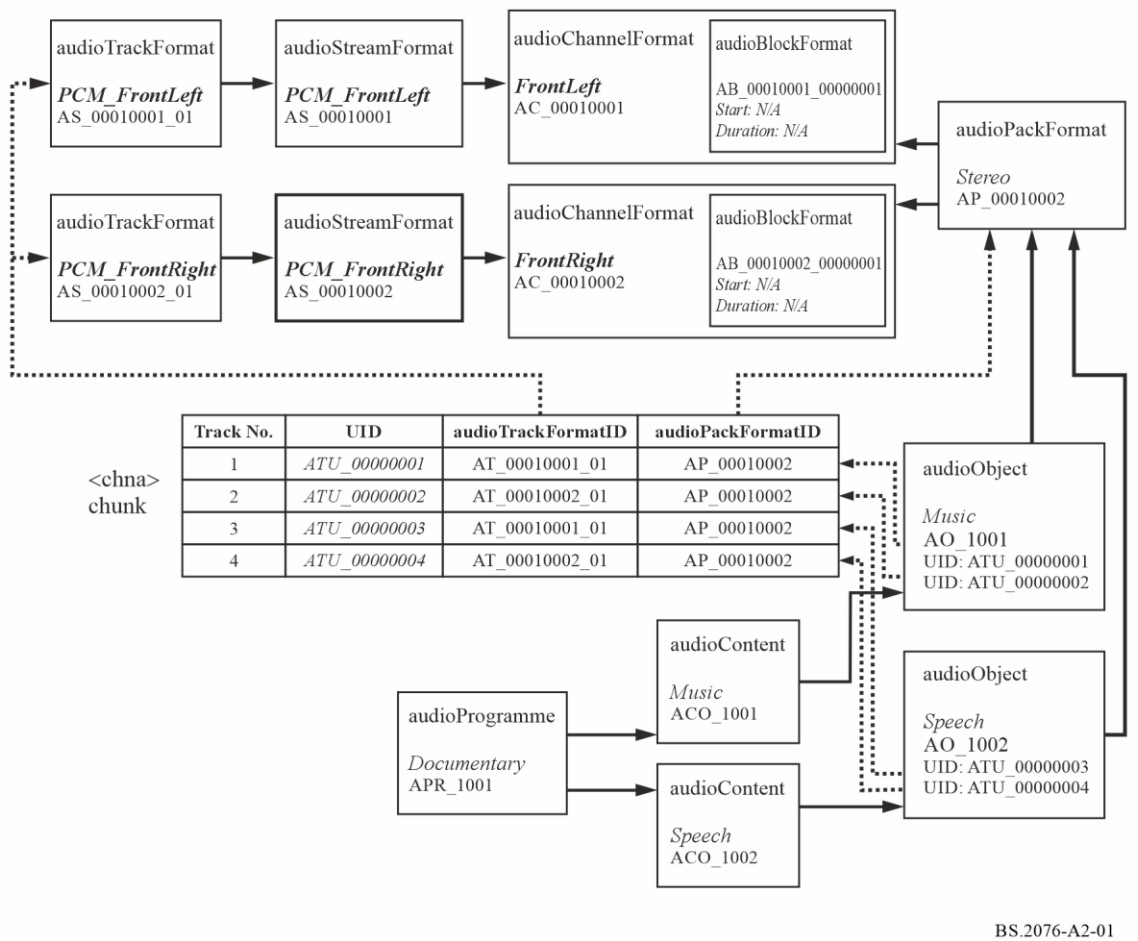
Element	ID	Name	Description
audioObject	AO_1001	Music	Object for ‘Music’, stereo format
audioObject	AO_1002	Speech	Object for ‘Speech’, stereo format
audioContent	ACO_1001	Music	Music content
audioContent	ACO_1002	Speech	Speech content
audioProgramme	APR_1001	Documentary	Programme ‘Documentary’ containing ‘Music’ and ‘Speech’ content

1.2 Element Relationships

The diagram in Fig. A2-1 shows how the defined elements relate to each other. The top half of the diagram covers the elements that describe the two-channel stereo format. The <*chna*> chunk in the middle shows how the four tracks are connected to the format definitions. The content definition elements are at the bottom of the diagram, with the audioObject elements containing the track UID references to the UIDs in the <*chna*> chunk.

FIGURE A2-1

Channel-based example diagram



1.3 Sample code

This XML sample code does not include the audioFormatExtended parent element and the XML header for clarity.

The first excerpt of code covers the format elements, which could be contained within the common definitions reference file:

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

<audioPackFormat audioPackFormatID="AP_00010002" audioPackFormatName="Stereo"
typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioChannelFormatIDRef>AC_00010001</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00010002</audioChannelFormatIDRef>
</audioPackFormat>

<!-- ############ -->
<!-- CHANNELS -->
<!-- ############ -->

<audioChannelFormat audioChannelFormatID="AC_00010001"
audioChannelFormatName="FrontLeft" typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_00010001_00000001">
    <speakerLabel>M+030</speakerLabel>
    <position coordinate="azimuth">30.0</position>
    <position coordinate="elevation">0.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00010002"
audioChannelFormatName="FrontRight" typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_00010002_00000001">
    <speakerLabel>M-030</speakerLabel>
    <position coordinate="azimuth">-30.0</position>
    <position coordinate="elevation">0.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<!-- ############ -->
<!-- STREAMS -->
<!-- ############ -->

<audioStreamFormat audioStreamFormatID="AS_00010001"
audioStreamFormatName="PCM_FrontLeft" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00010001</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00010001_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00010002"
audioStreamFormatName="PCM_FrontRight" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00010002</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00010002_01</audioTrackFormatIDRef>
</audioStreamFormat>
```

```
<!-- ############ -->
<!-- AUDIO TRACKS -->
<!-- ############ -->

<audioTrackFormat audioTrackFormatID="AT_00010001_01"
audioTrackFormatName="PCM_FrontLeft" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00010001</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00010002_01"
audioTrackFormatName="PCM_FrontRight" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00010002</audioStreamFormatIDRef>
</audioTrackFormat>
```

The second excerpt covers the content part, which would have to be included in the <*axml*> chunk of the BWF file:

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

<audioProgramme audioProgrammeID="APR_1001" audioProgrammeName="Documentary">
  <audioContentIDRef>ACO_1001</audioContentIDRef>
  <audioContentIDRef>ACO_1002</audioContentIDRef>
</audioProgramme>

<!-- ############ -->
<!-- CONTENTS -->
<!-- ############ -->

<audioContent audioContentID="ACO_1001" audioContentName="Music">
  <audioObjectIDRef>AO_1001</audioObjectIDRef>
  <loudnessMetadata>
    <integratedLoudness>-28.0</integratedLoudness>
  </loudnessMetadata>
</audioContent>

<audioContent audioContentID="ACO_1002" audioContentName="Speech">
  <audioObjectIDRef>AO_1002</audioObjectIDRef>
  <loudnessMetadata>
    <integratedLoudness>-23.0</integratedLoudness>
  </loudnessMetadata>
</audioContent>

<!-- ############ -->
<!-- OBJECTS -->
<!-- ############ -->

<audioObject audioObjectID="AO_1001" audioObjectName="Music" start="00:00:00.00000">
  <audioPackFormatIDRef>AP_00010002</audioPackFormatIDRef>
  <audioTrackUIDRef>ATU_00000001</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000002</audioTrackUIDRef>
</audioObject>

<audioObject audioObjectID="AO_1002" audioObjectName="Speech" start="00:00:00.00000">
  <audioPackFormatIDRef>AP_00010002</audioPackFormatIDRef>
  <audioTrackUIDRef>ATU_00000003</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000004</audioTrackUIDRef>
</audioObject>

<!-- ############ -->
<!-- AUDIO TRACK UIDs -->
<!-- ############ -->

<audioTrackUID UID="ATU_00000001">
```

```
  <audioTrackFormatIDRef>AT_00010001_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010002</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000002">
  <audioTrackFormatIDRef>AT_00010002_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010002</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000003">
  <audioTrackFormatIDRef>AT_00010001_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010002</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000004">
  <audioTrackFormatIDRef>AT_00010002_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010002</audioPackFormatIDRef>
</audioTrackUID>
```

2 Channel-based example optimized for PCM

The structure of this example results in the same rendered audio output as that described in § 1, however this version omits the use of both audioTrackFormat and audioStreamFormat elements as described in Annex 1, § 5.1.

This example demonstrates how to define two channels and a pack for stereo. As the essence is PCM, the track and stream definitions can be omitted. Two objects are defined, both stereo, but containing different content so there are 4 tracks used. This example uses a programme called ‘Documentary’ containing ‘Music’ and ‘Speech’ each defined as separate stereo objects.

The format-related elements in this example represent a tiny subset of the common reference set of definitions. In practice, this XML code would be part of the common reference file and would not have to be included in the BWF file. All that would be required is a <*chna*> chunk with the references to the audioChannelFormats and audioPackFormats and any extra XML required for audioObject, audioContent and audioProgramme.

2.1 Summary of elements

These are the elements in the format part of the description:

TABLE A2-3

Channel-based example format elements

Element	ID	Name	Description
audioChannelFormat & audioBlockFormat	AC_00010001 AB_00010001_00000001	FrontLeft	Describes channel as front left with a position and speaker reference
audioChannelFormat & audioBlockFormat	AC_00010002 AB_00010002_00000001	FrontRight	Describes channel as front right with a position and speaker reference
audioPackFormat	AP_00010002	Stereo	Defines a stereo pack referring to two channels.

These are the elements in the content part of the description:

TABLE A2-4

Channel-based example content elements

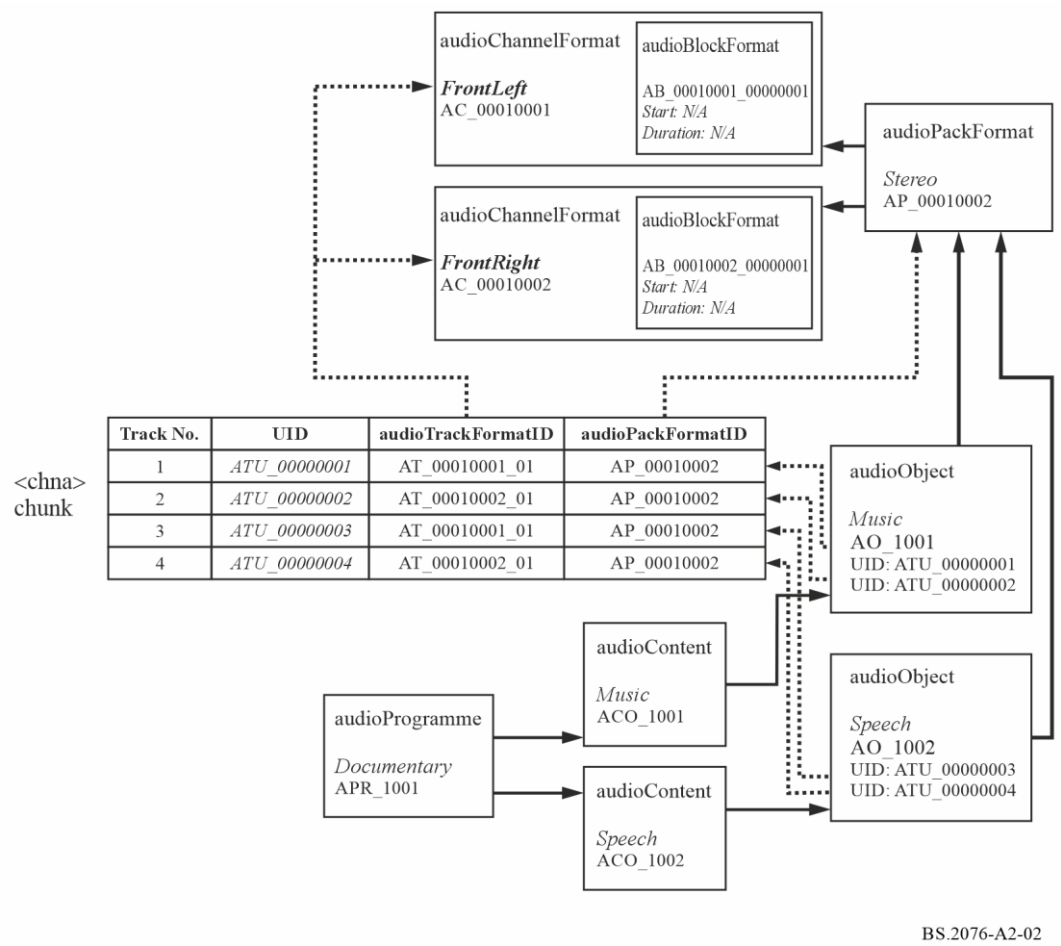
Element	ID	Name	Description
audioObject	AO_1001	Music	Object for ‘Music’, stereo format
audioObject	AO_1002	Speech	Object for ‘Speech’, stereo format
audioContent	ACO_1001	Music	Music content
audioContent	ACO_1002	Speech	Speech content
audioProgramme	APR_1001	Documentary	Programme ‘Documentary’ containing ‘Music’ and ‘Speech’ content

2.2 Element Relationships

The diagram in Fig. A2-2 shows how the defined elements relate to each other. The top half of the diagram covers the elements that describe the two-channel stereo format. The <*chna*> chunk in the middle shows how the four tracks are connected to the format definitions. The content definition elements are at the bottom of the diagram, with the audioObject elements containing the track UID references to the UIDs in the <*chna*> chunk.

FIGURE A2-2

Channel-based example diagram



2.3 Sample code

This XML sample code does not include the audioFormatExtended parent element and the XML header for clarity.

The first excerpt of code covers the format elements, which could be contained within the common definitions reference file:

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

<audioPackFormat audioPackFormatID="AP_00010002" audioPackFormatName="Stereo"
typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioChannelFormatIDRef>AC_00010001</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00010002</audioChannelFormatIDRef>
</audioPackFormat>

<!-- ############ -->
<!-- CHANNELS -->
<!-- ############ -->

<audioChannelFormat audioChannelFormatID="AC_00010001"
audioChannelFormatName="FrontLeft" typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_00010001_00000001">
    <speakerLabel>M+030</speakerLabel>
    <position coordinate="azimuth">30.0</position>
    <position coordinate="elevation">0.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00010002"
audioChannelFormatName="FrontRight" typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_00010002_00000001">
    <speakerLabel>M-030</speakerLabel>
    <position coordinate="azimuth">-30.0</position>
    <position coordinate="elevation">0.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>
```

The second excerpt covers the content part, which would have to be included in the <*axml*> chunk of the BWF file:

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

<audioProgramme audioProgrammeID="APR_1001" audioProgrammeName="Documentary">
  <audioContentIDRef>ACO_1001</audioContentIDRef>
  <audioContentIDRef>ACO_1002</audioContentIDRef>
</audioProgramme>

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

```
<audioContent audioContentID="ACO_1001" audioContentName="Music">
  <audioObjectIDRef>AO_1001</audioObjectIDRef>
  <loudnessMetadata>
    <integratedLoudness>-28.0</integratedLoudness>
  </loudnessMetadata>
</audioContent>

<audioContent audioContentID="ACO_1002" audioContentName="Speech">
  <audioObjectIDRef>AO_1002</audioObjectIDRef>
  <loudnessMetadata>
    <integratedLoudness>-23.0</integratedLoudness>
  </loudnessMetadata>
</audioContent>

<!-- ############ -->
<!-- OBJECTS -->
<!-- ############ -->

<audioObject audioObjectID="AO_1001" audioObjectName="Music" start="00:00:00.00000">
  <audioPackFormatIDRef>AP_00010002</audioPackFormatIDRef>
  <audioTrackUIDRef>ATU_00000001</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000002</audioTrackUIDRef>
</audioObject>

<audioObject audioObjectID="AO_1002" audioObjectName="Speech" start="00:00:00.00000">
  <audioPackFormatIDRef>AP_00010002</audioPackFormatIDRef>
  <audioTrackUIDRef>ATU_00000003</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000004</audioTrackUIDRef>
</audioObject>

<!-- ############ -->
<!-- AUDIO TRACK UIDs -->
<!-- ############ -->

<audioTrackUID UID="ATU_00000001">
  <audioChannelFormatIDRef>AC_00010001</audioChannelFormatIDRef>
  <audioPackFormatIDRef>AP_00010002</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000002">
  <audioChannelFormatIDRef>AC_00010002</audioChannelFormatIDRef>
  <audioPackFormatIDRef>AP_00010002</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000003">
  <audioChannelFormatIDRef>AC_00010001</audioChannelFormatIDRef>
  <audioPackFormatIDRef>AP_00010002</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000004">
  <audioChannelFormatIDRef>AC_00010002</audioChannelFormatIDRef>
  <audioPackFormatIDRef>AP_00010002</audioPackFormatIDRef>
</audioTrackUID>
```

3 Object-based example

To demonstrate how the ADM can be used in object-based audio here is a simple example using a single object. This example uses multiple audioBlockFormats within an audioChannelFormat to describe the dynamic properties of an object called ‘Car’. The audioBlockFormats uses the start and duration attributes to frame the time dependent metadata, thus allowing the object’s position to move in space.

3.1 Summary of elements

These are the elements in the format part of the description:

TABLE A2-5

Object-based example format elements

Element	ID	Name	Description
audioTrackFormat	AT_00031001_01	PCM_Car1	Defines track as PCM
audioStreamFormat	AS_00031001	PCM_Car1	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00031001 AB_00031001_00000001 AB_00031001_00000002 AB_00031001_00000003	Car1	Describes channel as an object type containing three blocks with different positional metadata in each.
audioPackFormat	AP_00031001	Car	Defines a pack referring to one channel.

These are the elements in the content part of the description:

TABLE A2-6

Object-based exmaple content elements

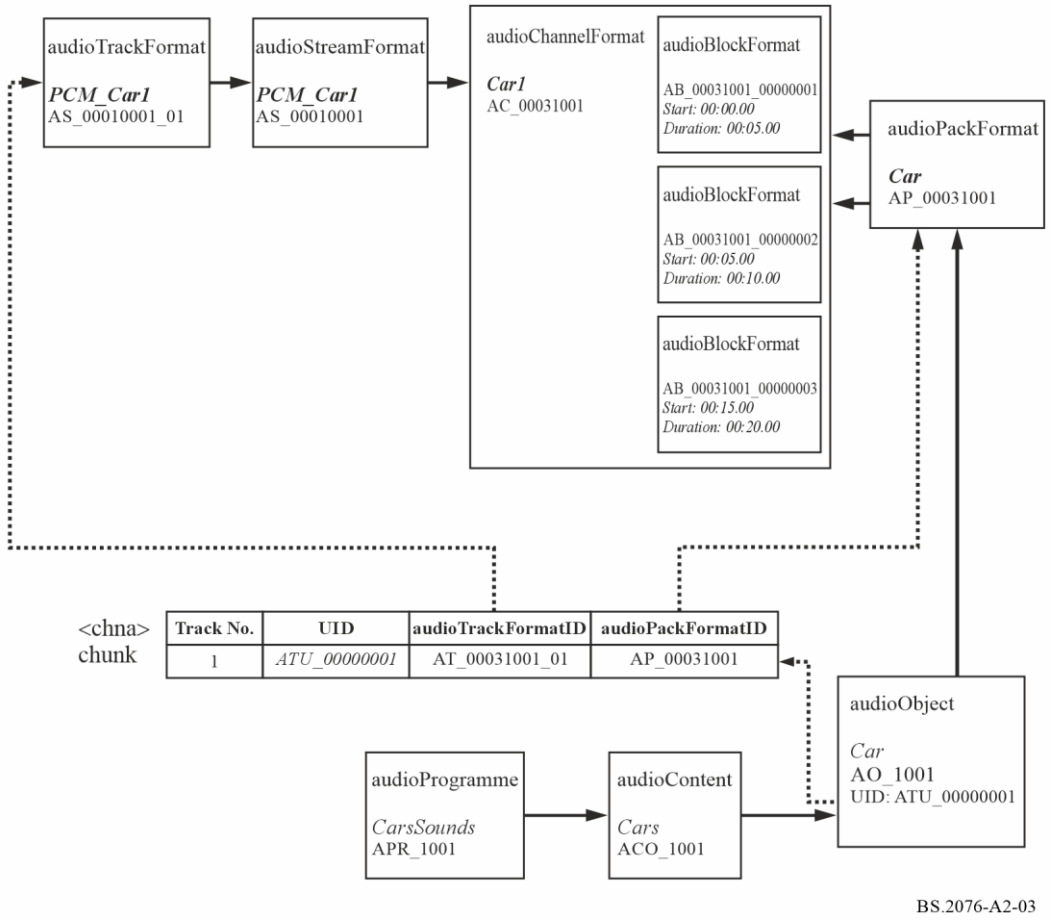
Element	ID	Name	Description
audioObject	AO_1001	Car	Object for ‘Car, stereo format
audioContent	ACO_1001	Cars	‘Cars’ content
audioProgramme	APR_1001	CarsSounds	Programme ‘CarsSounds’ containing ‘Cars’ content

3.2 Element Relationships

The diagram in Fig. A2-3 shows how the defined elements relate to each other. The top half of the diagram covers the elements that describe the single channel object containing three blocks. The <*chna*> chunk in the middle shows how the single track is connected to the format definitions. The content definition elements are at the bottom of the diagram, with the audioObject element containing the track UID references to the UID in the <*chna*> chunk.

FIGURE A2-3

Object-based example diagram



3.3 Sample code

This XML sample code does not include the audioFormatExtended parent element and the XML header for clarity. The excerpt of code covers both the format and content elements:

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

<audioProgramme audioProgrammeID="APR_1001" audioProgrammeName="CarsSounds">
  <audioContentIDRef>ACO_1001</audioContentIDRef>
</audioProgramme>

<!-- ############ -->
<!-- CONTENTS -->
<!-- ############ -->

<audioContent audioContentID="ACO_1001" audioContentName="Cars">
  <audioObjectIDRef>AO_1001</audioObjectIDRef>
  <loudnessMetadata>
    <integratedLoudness>-23.0</integratedLoudness>
  </loudnessMetadata>
</audioContent>

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

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

<audioObject audioObjectID="AO_1001" audioObjectName="Car" start="00:00:00.00000">
  <audioPackFormatIDRef>AP_00031001</audioPackFormatIDRef>
  <audioTrackUIDRef>ATU_00000001</audioTrackUIDRef>
</audioObject>

<!-- ############ -->
<!-- PACKS -->
<!-- ############ -->

<audioPackFormat audioPackFormatID="AP_00031001" audioPackFormatName="Car"
typeLabel="0003" typeDefinition="Objects">
  <audioChannelFormatIDRef>AC_00031001</audioChannelFormatIDRef>
</audioPackFormat>

<!-- ############ -->
<!-- CHANNELS -->
<!-- ############ -->

<audioChannelFormat audioChannelFormatID="AC_00031001" audioChannelFormatName="Car1"
typeLabel="0003" typeDefinition="Objects">
  <audioBlockFormat audioBlockFormatID="AB_00031001_00000001" rtime="00:00:00.00000"
duration="00:00:05.00000">
    <position coordinate="azimuth">-22.5</position>
    <position coordinate="elevation">5.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
  <audioBlockFormat audioBlockFormatID="AB_00031001_00000002" rtime="00:00:05.00000"
duration="00:00:10.00000">
    <position coordinate="azimuth">-24.5</position>
    <position coordinate="elevation">6.0</position>
    <position coordinate="distance">0.9</position>
  </audioBlockFormat>
  <audioBlockFormat audioBlockFormatID="AB_00031001_00000003" rtime="00:00:15.00000"
duration="00:00:20.00000">
    <position coordinate="azimuth">-26.5</position>
    <position coordinate="elevation">7.0</position>
    <position coordinate="distance">0.8</position>
  </audioBlockFormat>
</audioChannelFormat>


<!-- ############ -->
<!-- STREAMS -->
<!-- ############ -->

<audioStreamFormat audioStreamFormatID="AS_00031001" audioStreamFormatName="PCM_Car1"
formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00031001</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00031001_01</audioTrackFormatIDRef>
</audioStreamFormat>

<!-- ############ -->
<!-- AUDIO TRACKS -->
<!-- ############ -->
```

```
<audioTrackFormat audioTrackFormatID="AT_00031001_01" audioTrackFormatName="PCM_Car1"
formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00031001</audioStreamFormatIDRef>
</audioTrackFormat>
```

4 Scene-based example

The other main type of audio is scene-based where the audio channels are representing Ambisonics/HOA components. Their use is very similar to that of the channel-based approach with the main difference being the parameters used within audioBlockFormat. This example shows a simple 1st order Ambisonics (using the N3D normalization) configuration using four channels mapped onto four tracks. Like the channel-based approach, the format elements would be defined in a common reference file so in practice would not need to be included in the BWF file itself.

4.1 Summary of elements

These are the elements in the format part of the description:

TABLE A2-7

Scene-based example format elements

Element	ID	Name	Description
audioTrackFormat	AT_00040101_01	PCM_N3D_ACN_0	Defines track as PCM
audioTrackFormat	AT_00040102_01	PCM_N3D_ACN_1	Defines track as PCM
audioTrackFormat	AT_00040103_01	PCM_N3D_ACN_2	Defines track as PCM
audioTrackFormat	AT_00040104_01	PCM_N3D_ACN_3	Defines track as PCM
audioStreamFormat	AS_00040101	PCM_N3D_ACN_0	Defines stream as PCM
audioStreamFormat	AS_00040102	PCM_N3D_ACN_1	Defines stream as PCM

TABLE A2-7 (*end*)

Element	ID	Name	Description
audioStreamFormat	AS_00040103	PCM_N3D_ACN_2	Defines stream as PCM
audioStreamFormat	AS_00040104	PCM_N3D_ACN_3	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00040101 AB_00040101_00000001	N3D_ACN_0	Describes channel as ACN0 HOA component
audioChannelFormat & audioBlockFormat	AC_00040102 AB_00040102_00000001	N3D_ACN_1	Describes channel as ACN1 HOA component
audioChannelFormat & audioBlockFormat	AC_00040103 AB_00040103_00000001	N3D_ACN_2	Describes channel as ACN2 HOA component
audioChannelFormat & audioBlockFormat	AC_00040104 AB_00040104_00000001	N3D_ACN_3	Describes channel as ACN3 HOA component
audioPackFormat	AP_00040011	3D_order1_N3D_ACN	Defines a 1st order HOA pack referring to four ACN channels.

These are the elements in the content part of the description:

TABLE A2-8

Scene-based example content elements

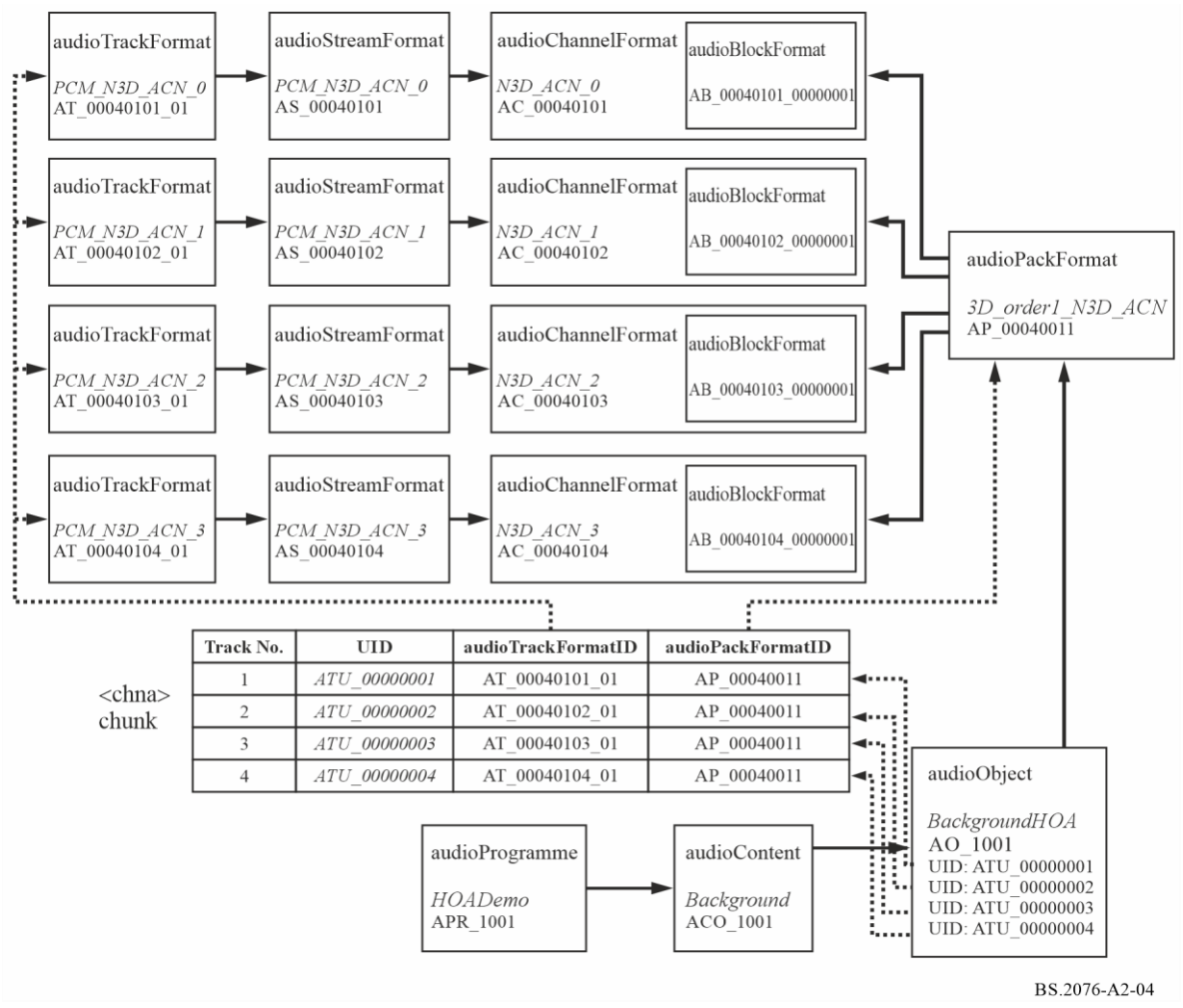
Element	ID	Name	Description
audioObject	AO_1001	BackgroundHOA	Object for 'BackgroundHOA', 1st order HOA format
audioContent	ACO_1001	Background	'Background' content
audioProgramme	APR_1001	HOADemo	'HOADemo' containing a 'Background'content

4.2 Element Relationships

The diagram in Fig. A2-4 shows how the defined elements relate to each other. The top half of the diagram covers the elements that describe the four channels of the first order HOA (N3D method). The <*chna*> chunk in the middle shows how the four tracks are connected to the format definitions. The content definition elements are at the bottom of the diagram, with the audioObject element containing the track UID references to the UIDs in the <*chna*> chunk.

FIGURE A2-4

Scene-based example diagram



4.3 Sample code

This XML sample code does not include the audioFormatExtended parent element and the XML header for clarity. The first excerpt of code covers the format elements, which could be contained within the common reference file:

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

<audioPackFormat audioPackFormatID="AP_00040011"
audioPackFormatName="3D_order1_N3D_ACN" typeLabel="0004" typeDefinition="HOA">
  <normalization>N3D</normalization>
  <audioChannelFormatIDRef>AC_00040101</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00040102</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00040103</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00040104</audioChannelFormatIDRef>
</audioPackFormat>

<!-- ############ -->
<!-- CHANNELS -->
<!-- ############ -->

<audioChannelFormat audioChannelFormatID="AC_00040101"
audioChannelFormatName="N3D_ACN_0" typeDefinition="HOA">
  <audioBlockFormat audioBlockFormatID="AB_00040101_00000001">
    <degree>0</degree>
    <order>0</order>
    <normalization>N3D</normalization>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00040102"
audioChannelFormatName="N3D_ACN_1" typeDefinition="HOA">
  <audioBlockFormat audioBlockFormatID="AB_00040102_00000001">
    <degree>1</degree>
    <order>-1</order>
    <normalization>N3D</normalization>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00040103"
audioChannelFormatName="N3D_ACN_2" typeDefinition="HOA">
  <audioBlockFormat audioBlockFormatID="AB_00040103_00000001">
    <degree>1</degree>
    <order>0</order>
    <normalization>N3D</normalization>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00040104"
audioChannelFormatName="N3D_ACN_3" typeDefinition="HOA">
  <audioBlockFormat audioBlockFormatID="AB_00040104_00000001">
    <degree>1</degree>
    <order>1</order>
    <normalization>N3D</normalization>
  </audioBlockFormat>
</audioChannelFormat>
```

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

<audioStreamFormat audioStreamFormatID="AS_00040101"
audioStreamFormatName="PCM_N3D_ACN_0" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00040101</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00040101_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00040102"
audioStreamFormatName="PCM_N3D_ACN_1" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00040102</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00040102_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00040103"
audioStreamFormatName="PCM_N3D_ACN_2" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00040103</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00040103_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00040104"
audioStreamFormatName="PCM_N3D_ACN_3" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00040104</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00040104_01</audioTrackFormatIDRef>
</audioStreamFormat>

<!-- ############ -->
<!-- AUDIO TRACKS -->
<!-- ############ -->

<audioTrackFormat audioTrackFormatID="AT_00040101_01"
audioTrackFormatName="PCM_N3D_ACN_0" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00040101</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00040102_01"
audioTrackFormatName="PCM_N3D_ACN_1" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00040102</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00040103_01"
audioTrackFormatName="PCM_N3D_ACN_2" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00040103</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00040104_01"
audioTrackFormatName="PCM_N3D_ACN_3" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00040104</audioStreamFormatIDRef>
</audioTrackFormat>
```

The second excerpt covers the content part, which would have to be included in the <*axml*> chunk of the BWF file:

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

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

<audioProgramme audioProgrammeID="APR_1001" audioProgrammeName="HOADemo">
  <audioContentIDRef>ACO_1001</audioContentIDRef>
</audioProgramme>

<!-- ############ -->
<!-- CONTENTS -->
<!-- ############ -->

<audioContent audioContentID="ACO_1001" audioContentName="Background">
  <audioObjectIDRef>AO_1001</audioObjectIDRef>
</audioContent>

<!-- ############ -->
<!-- OBJECTS -->
<!-- ############ -->

<audioObject audioObjectID="AO_1001" audioObjectName="BackgroundHOA">
  <audioPackFormatIDRef>AP_00040011</audioPackFormatIDRef>
  <audioTrackUIDRef>ATU_00000001</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000002</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000003</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000004</audioTrackUIDRef>
</audioObject>

<!-- ############ -->
<!-- AUDIO TRACK UIDs -->
<!-- ############ -->

<audioTrackUID UID="ATU_00000001">
  <audioTrackFormatIDRef>AT_00040101_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00040011</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000002">
  <audioTrackFormatIDRef>AT_00040102_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00040011</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000003">
  <audioTrackFormatIDRef>AT_00040103_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00040011</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000004">
  <audioTrackFormatIDRef>AT_00040104_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00040011</audioPackFormatIDRef>
</audioTrackUID>
```

5 Personalized audio example

To demonstrate how the ADM can be used to describe personalized audio, here is an example using a combination of channel-based audio for the ambience/bed and object-based audio for the commentator objects. This example uses multiple audioProgramme elements that represent five different preset mixes

for a sports programme: default mix, just the action, clear commentary, home team, and away team. The corresponding ADM XML tree contains four different audioContent elements to choose from: ambience, main commentary, home team biased commentary, and away team biased commentary.

TABLE A2-9

Personalized audio example mixes

	Ambience	Main commentary 1	Main commentary 2	Home team biased commentary	Away team biased commentary
Default mix	•	•	•		
Just the action	•				
Clear commentary		•	•		
Home team	•			•	
Away team	•				•

5.1 Summary of elements

These are the elements in the format part of the description:

TABLE A2-10

Personalized example format elements

Element	ID	Name	Description
audioTrackFormat	AT_00010001_01	PCM_FrontLeft	Defines track as PCM
audioStreamFormat	AS_00010001	PCM_FrontLeft	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00010001 AB_00010001_00000001	FrontLeft	Describes channel as front left with a position and speaker reference
audioTrackFormat	AT_00010002_01	PCM_FrontRight	Defines track as PCM
audioStreamFormat	AS_00010002	PCM_FrontRight	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00010002 AB_00010002_00000001	FrontRight	Describes channel as front right with a position and speaker reference
audioTrackFormat	AT_00010003_01	PCM_FrontCentre	Defines track as PCM
audioStreamFormat	AS_00010003	PCM_FrontCentre	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00010003 AB_00010003_00000001	FrontCentre	Describes channel as front centre with a position and speaker reference
audioTrackFormat	AT_00010004_01	PCM_LFE	Defines track as PCM
audioStreamFormat	AS_00010004	PCM_LFE	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00010004 AB_00010004_00000001	LFE	Describes channel as LFE with a position and speaker reference
audioTrackFormat	AT_00010005_01	PCM_SurroundLeft	Defines track as PCM
audioStreamFormat	AS_00010005	PCM_SurroundLeft	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00010005 AB_00010005_00000001	SurroundLeft	Describes channel as surround left with a position and speaker reference

TABLE A2-10 (*end*)

Element	ID	Name	Description
audioTrackFormat	AT_00010006_01	PCM_SurroundRight	Defines track as PCM
audioStreamFormat	AS_00010006	PCM_SurroundRight	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00010006 AB_00010006_00000001	SurroundRight	Describes channel as surround right with a position and speaker reference
audioPackFormat	AP_00010003	5.1	Defines a 5.1 pack referring to six channels.
audioTrackFormat	AT_00031001_01	PCM_Main_Comm1	Defines track as PCM
audioStreamFormat	AS_00031001	PCM_Main_Comm1	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00031001 AB_00031001_00000001	Main_Comm1	Describes channel as an object type containing a single block with positional metadata.
audioTrackFormat	AT_00031002_01	PCM_Main_Comm2	Defines track as PCM
audioStreamFormat	AS_00031002	PCM_Main_Comm2	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00031002 AB_00031002_00000001	Main_Comm2	Describes channel as an object type containing a single block with positional metadata.
audioTrackFormat	AT_00031003_01	PCM_Home_Comm	Defines track as PCM
audioStreamFormat	AS_00031003	PCM_Home_Comm	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00031003 AB_00031003_00000001	Home_Comm	Describes channel as an object type containing a single block with positional metadata.
audioTrackFormat	AT_00031004_01	PCM_Away_Comm	Defines track as PCM
audioStreamFormat	AS_00031004	PCM_Away_Comm	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00031004 AB_00031004_00000001	Away_Comm	Describes channel as an object type containing a single block with positional metadata.
audioPackFormat	AP_00031001	MainComm1	Defines a pack referring to one channel.
audioPackFormat	AP_00031002	MainComm2	Defines a pack referring to one channel.
audioPackFormat	AP_00031003	HomeComm	Defines a pack referring to one channel.
audioPackFormat	AP_00031004	AwayComm	Defines a pack referring to one channel.

TABLE A2-11

Personlized example content elements

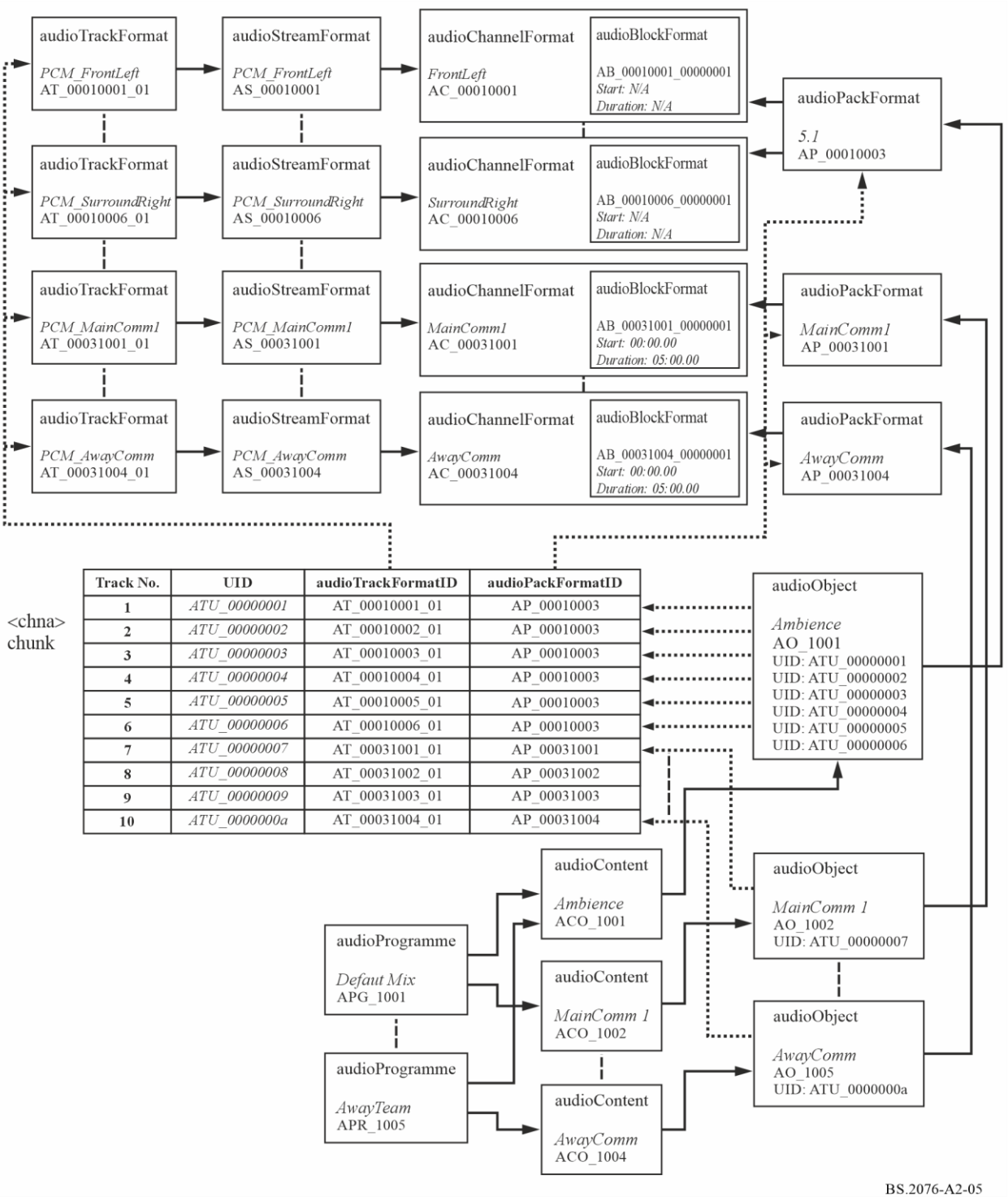
Element	ID	Name	Description
audioObject	AO_1001	Ambience	Object for ‘Ambience’, 5.1 format
audioContent	ACO_1001	Ambience	‘Ambience’ content
audioObject	AO_1002	Main_Comm1	Object for ‘Main_Comm1’, mono format
audioObject	AO_1003	Main_Comm2	Object for ‘Main_Comm2’, mono format
audioContent	ACO_1002	Main_Comm	‘Main_Comm’ content
audioObject	AO_1004	Home_Comm	Object for ‘Home_Comm’, mono format
audioContent	ACO_1003	Home_Comm	‘Home_Comm’ content
audioObject	AO_1005	Away_Comm	Object for ‘Away_Comm’, mono format
audioContent	ACO_1004	Away_Comm	‘Away_Comm’ content
audioProgramme	APR_1001	DefaultMix	Programme ‘DefaultMix’ containing ‘Ambience’ and ‘Main_Comm” content
audioProgramme	APR_1002	JustTheAction	Programme ‘JustTheAction’ containing only ‘Ambience’ content
audioProgramme	APR_1003	ClearCommentary	Programme ‘ClearCommentary’ containing only ‘Main_Comm’ content
audioProgramme	APR_1004	HomeTeam	Programme ‘HomeTeam’ containing ‘Ambience’ and ‘Home_Comm’ content
audioProgramme	APR_1005	AwayTeam	Programme ‘AwayTeam’ containing ‘Ambience’ and ‘Away_Comm’ content

5.2 Element Relationships

The diagram in Fig. A2-5 shows how the defined elements relate to each other. The top half of the diagram covers the elements that describe the 5.1 channel ambience/bed and the 4 mono objects. The <*chna*> chunk in the middle shows how the tracks are connected to the format definitions. The content definition elements are at the bottom of the diagram, with the audioObject element containing the track UID references to the UID in the <*chna*> chunk.

FIGURE A2-5

Personalised audio example diagram



5.3 Sample code

This XML sample code does not include the audioFormatExtended parent element and the XML header for clarity. The excerpt of code covers both the format and content elements:

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

<audioProgramme audioProgrammeID="APR_1001" audioProgrammeName="DefaultMix">
```

```
  <audioContentIDRef>ACO_1001</audioContentIDRef>
  <audioContentIDRef>ACO_1002</audioContentIDRef>
</audioProgramme>

<audioProgramme audioProgrammeID="APR_1002" audioProgrammeName="JustTheAction">
  <audioContentIDRef>ACO_1001</audioContentIDRef>
</audioProgramme>

<audioProgramme audioProgrammeID="APR_1003" audioProgrammeName="ClearCommentary">
  <audioContentIDRef>ACO_1002</audioContentIDRef>
</audioProgramme>

<audioProgramme audioProgrammeID="APR_1004" audioProgrammeName="HomeTeam">
  <audioContentIDRef>ACO_1001</audioContentIDRef>
  <audioContentIDRef>ACO_1003</audioContentIDRef>
</audioProgramme>

<audioProgramme audioProgrammeID="APR_1005" audioProgrammeName="AwayTeam">
  <audioContentIDRef>ACO_1001</audioContentIDRef>
  <audioContentIDRef>ACO_1004</audioContentIDRef>
</audioProgramme>

<!-- ############ -->
<!-- CONTENTS -->
<!-- ############ -->

<audioContent audioContentID="ACO_1001" audioContentName="Ambience">
  <audioObjectIDRef>AO_1001</audioObjectIDRef>
  <loudnessMetadata>
    <integratedLoudness>-23.0</integratedLoudness>
  </loudnessMetadata>
</audioContent>

<audioContent audioContentID="ACO_1002" audioContentName="Main_Comm">
  <audioObjectIDRef>AO_1002</audioObjectIDRef>
  <audioObjectIDRef>AO_1003</audioObjectIDRef>
  <loudnessMetadata>
    <integratedLoudness>-23.0</integratedLoudness>
  </loudnessMetadata>
</audioContent>

<audioContent audioContentID="ACO_1003" audioContentName="Home_Comm">
  <audioObjectIDRef>AO_1004</audioObjectIDRef>
  <loudnessMetadata>
    <integratedLoudness>-23.0</integratedLoudness>
  </loudnessMetadata>
</audioContent>

<audioContent audioContentID="ACO_1004" audioContentName="AwayComm">
  <audioObjectIDRef>AO_1005</audioObjectIDRef>
  <loudnessMetadata>
    <integratedLoudness>-23.0</integratedLoudness>
  </loudnessMetadata>
</audioContent>

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

```
<audioObject audioObjectID="AO_1001" audioObjectName="Ambience">
  <audioPackFormatIDRef>AP_00010003</audioPackFormatIDRef>
  <audioTrackUIDRef>ATU_00000001</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000002</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000003</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000004</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000005</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000006</audioTrackUIDRef>
</audioObject>

<audioObject audioObjectID="AO_1002" audioObjectName="Main_Comm1"
start="00:00:00.00000">
  <audioPackFormatIDRef>AP_00031001</audioPackFormatIDRef>
  <audioTrackUIDRef>ATU_00000007</audioTrackUIDRef>
</audioObject>

<audioObject audioObjectID="AO_1003" audioObjectName="Main_Comm2"
start="00:00:00.00000">
  <audioPackFormatIDRef>AP_00031002</audioPackFormatIDRef>
  <audioTrackUIDRef>ATU_00000008</audioTrackUIDRef>
</audioObject>

<audioObject audioObjectID="AO_1004" audioObjectName="Home_Comm"
start="00:00:00.00000">
  <audioPackFormatIDRef>AP_00031003</audioPackFormatIDRef>
  <audioTrackUIDRef>ATU_00000009</audioTrackUIDRef>
</audioObject>

<audioObject audioObjectID="AO_1005" audioObjectName="Away_Comm"
start="00:00:00.00000">
  <audioPackFormatIDRef>AP_00031004</audioPackFormatIDRef>
  <audioTrackUIDRef>ATU_0000000a</audioTrackUIDRef>
</audioObject>

<!-- ############ -->
<!-- PACKS -->
<!-- ############ -->

<audioPackFormat audioPackFormatID="AP_00010003" audioPackFormatName="5.1"
typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioChannelFormatIDRef>AC_00010001</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00010002</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00010003</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00010004</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00010005</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00010006</audioChannelFormatIDRef>
</audioPackFormat>

<audioPackFormat audioPackFormatID="AP_00031001" audioPackFormatName="MainComm1"
typeLabel="0003" typeDefinition="Objects">
  <audioChannelFormatIDRef>AC_00031001</audioChannelFormatIDRef>
</audioPackFormat>

<audioPackFormat audioPackFormatID="AP_00031002" audioPackFormatName="MainComm2"
typeLabel="0003" typeDefinition="Objects">
  <audioChannelFormatIDRef>AC_00031002</audioChannelFormatIDRef>
</audioPackFormat>
```

```
<audioPackFormat audioPackFormatID="AP_00031003" audioPackFormatName="HomeComm"
typeLabel="0003" typeDefinition="Objects">
  <audioChannelFormatIDRef>AC_00031003</audioChannelFormatIDRef>
</audioPackFormat>

<audioPackFormat audioPackFormatID="AP_00031004" audioPackFormatName="AwayComm"
typeLabel="0003" typeDefinition="Objects">
  <audioChannelFormatIDRef>AC_00031004</audioChannelFormatIDRef>
</audioPackFormat>

<!-- ############ -->
<!-- CHANNELS -->
<!-- ############ -->

<audioChannelFormat audioChannelFormatID="AC_00010001"
audioChannelFormatName="FrontLeft" typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_00010001_00000001">
    <speakerLabel>M+030</speakerLabel>
    <position coordinate="azimuth">30.0</position>
    <position coordinate="elevation">0.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00010002"
audioChannelFormatName="FrontRight" typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_00010002_00000001">
    <speakerLabel>M-030</speakerLabel>
    <position coordinate="azimuth">-30.0</position>
    <position coordinate="elevation">0.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00010003"
audioChannelFormatName="FrontCentre" typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_00010003_00000001">
    <speakerLabel>M+000</speakerLabel>
    <position coordinate="azimuth">0.0</position>
    <position coordinate="elevation">0.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00010004" audioChannelFormatName="LFE"
typeLabel="0001" typeDefinition="DirectSpeakers">
  <frequency typeDefinition="lowPass">120</frequency>
  <audioBlockFormat audioBlockFormatID="AB_00010004_00000001">
    <speakerLabel>LFE</speakerLabel>
    <position coordinate="azimuth">0.0</position>
    <position coordinate="elevation">-20.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00010005"
audioChannelFormatName="SurroundLeft" typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_00010005_00000001">
    <speakerLabel>M+110</speakerLabel>
```

```
    <position coordinate="azimuth">110.0</position>
    <position coordinate="elevation">0.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00010006"
audioChannelFormatName="SurroundRight" typeLabel="0001"
typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_00010006_00000001">
    <speakerLabel>M-110</speakerLabel>
    <position coordinate="azimuth">-110.0</position>
    <position coordinate="elevation">0.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00031001"
audioChannelFormatName="MainComm1" typeLabel="0003" typeDefinition="Objects">
  <audioBlockFormat audioBlockFormatID="AB_00031001_00000001" rtime="00:00:00.00000"
duration="00:05:00.00000">
    <position coordinate="X">-1.0</position>
    <position coordinate="Y">1.0</position>
    <position coordinate="Z">0.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00031002"
audioChannelFormatName="MainComm2" typeLabel="0003" typeDefinition="Objects">
  <audioBlockFormat audioBlockFormatID="AB_00031002_00000001" rtime="00:00:00.00000"
duration="00:05:00.00000">
    <position coordinate="X">1.0</position>
    <position coordinate="Y">1.0</position>
    <position coordinate="Z">0.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00031003"
audioChannelFormatName="HomeComm" typeLabel="0003" typeDefinition="Objects">
  <audioBlockFormat audioBlockFormatID="AB_00031003_00000001" rtime="00:00:00.00000"
duration="00:05:00.00000">
    <position coordinate="X">0.0</position>
    <position coordinate="Y">1.0</position>
    <position coordinate="Z">0.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00031004"
audioChannelFormatName="AwayComm" typeLabel="0003" typeDefinition="Objects">
  <audioBlockFormat audioBlockFormatID="AB_00031004_00000001" rtime="00:00:00.00000"
duration="00:05:00.00000">
    <position coordinate="X">0.0</position>
    <position coordinate="Y">1.0</position>
    <position coordinate="Z">0.0</position>
  </audioBlockFormat>
</audioChannelFormat>


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

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

<audioStreamFormat audioStreamFormatID="AS_00010001"
audioStreamFormatName="PCM_FrontLeft" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00010001</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00010001_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00010002"
audioStreamFormatName="PCM_FrontRight" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00010002</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00010002_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00010003"
audioStreamFormatName="PCM_FrontCentre" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00010003</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00010003_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00010004" audioStreamFormatName="PCM_LFE"
formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00010004</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00010004_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00010005"
audioStreamFormatName="PCM_SurroundLeft" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00010005</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00010005_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00010006"
audioStreamFormatName="PCM_SurroundRight" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00010006</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00010006_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00031001"
audioStreamFormatName="PCM_MainComm1" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00031001</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00031001_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00031002"
audioStreamFormatName="PCM_MainComm2" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00031002</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00031002_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00031003"
audioStreamFormatName="PCM_HomeComm" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00031003</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00031003_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00031004"
audioStreamFormatName="PCM_AwayComm" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00031004</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00031004_01</audioTrackFormatIDRef>
```

```
</audioStreamFormat>

<!-- ############ -->
<!-- AUDIO TRACKS -->
<!-- ############ -->

<audioTrackFormat audioTrackFormatID="AT_00010001_01"
audioTrackFormatName="PCM_FrontLeft" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00010001</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00010002_01"
audioTrackFormatName="PCM_FrontRight" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00010002</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00010003_01"
audioTrackFormatName="PCM_FrontCentre" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00010003</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00010004_01" audioTrackFormatName="PCM_LFE"
formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00010004</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00010005_01"
audioTrackFormatName="PCM_SurroundLeft" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00010005</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00010006_01"
audioTrackFormatName="PCM_SurroundRight" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00010006</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00031001_01"
audioTrackFormatName="PCM_MainComm1" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00031001</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00031002_01"
audioTrackFormatName="PCM_MainComm2" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00031002</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00031003_01"
audioTrackFormatName="PCM_HomeComm" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00031003</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00031004_01"
audioTrackFormatName="PCM_AwayComm" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00031004</audioStreamFormatIDRef>
</audioTrackFormat>

<!-- ############ -->
<!-- AUDIO TRACK UIDs -->
<!-- ############ -->
```

```
<audioTrackUID UID="ATU_00000001">
  <audioTrackFormatIDRef>AT_00010001_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010003</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000002">
  <audioTrackFormatIDRef>AT_00010002_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010003</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000003">
  <audioTrackFormatIDRef>AT_00010003_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010003</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000004">
  <audioTrackFormatIDRef>AT_00010004_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010003</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000005">
  <audioTrackFormatIDRef>AT_00010005_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010003</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000006">
  <audioTrackFormatIDRef>AT_00010006_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010003</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000007">
  <audioTrackFormatIDRef>AT_00031001_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00031001</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000008">
  <audioTrackFormatIDRef>AT_00031002_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00031002</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000009">
  <audioTrackFormatIDRef>AT_00031003_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00031003</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_0000000a">
  <audioTrackFormatIDRef>AT_00031004_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00031004</audioPackFormatIDRef>
</audioTrackUID>
```

6 22.2 multichannel programme with an alternative dialogue example

6.1 Summary of elements

These are the elements in the format part of the description:

TABLE A2-12

22.2 example format elements

Element	ID	Name	Description
audioTrackFormat	AT_00010018_01	PCM_FrontLeftWide	Defines track as PCM
audioStreamFormat	AS_00010018	PCM_FrontLeftWide	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00010018 AB_00010018_00000001	FrontLeftWide	Describes channel as front left with a position and speaker reference
audioTrackFormat	AT_00010019_01	PCM_FrontRightWide	Defines track as PCM
audioStreamFormat	AS_00010019	PCM_FrontRightWide	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00010019 AB_00010019_00000001	FrontRightWide	Describes channel as front right with a position and speaker reference
audioTrackFormat	AT_00010003_01	PCM_FrontCentre	Defines track as PCM
audioStreamFormat	AS_00010003	PCM_FrontCentre	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00010003 AB_00010003_00000001	FrontCentre	Describes channel as front centre with a position and speaker reference
audioTrackFormat	AT_00010020_01	PCM_LFE1	Defines track as PCM
audioStreamFormat	AS_00010020	PCM_LFE1	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00010020 AB_00010020_00000001	LFE1	Describes channel as LFE1 with a position and speaker reference
audioTrackFormat	AT_0001001c_01	PCM_BackLeftMid	Defines track as PCM
audioStreamFormat	AS_0001001c	PCM_BackLeftMid	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_0001001c AB_0001001c_00000001	BackLeftMid	Describes channel as surround left with a position and speaker reference
audioTrackFormat	AT_0001001d_01	PCM_BackRightMid	Defines track as PCM
audioStreamFormat	AS_0001001d	PCM_BackRightMid	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_0001001d AB_0001001d_00000001	BackRightMid	Describes channel as surround right with a position and speaker reference
audioTrackFormat	AT_00010001_01	PCM_FrontLeft	Defines track as PCM
audioStreamFormat	AS_00010001	PCM_FrontLeft	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00010001 AB_00010001_00000001	FrontLeft	Describes channel as front left centre with a position and speaker reference
audioTrackFormat	AT_00010002_01	PCM_FrontRight	Defines track as PCM
audioStreamFormat	AS_00010002	PCM_FrontRight	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00010002 AB_00010002_00000001	FrontRight	Describes channel as front right centre with a position and speaker reference
audioTrackFormat	AT_00010009_01	PCM_BackCentre	Defines track as PCM
audioStreamFormat	AS_00010009	PCM_BackCentre	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00010009 AB_00010009_00000001	BackCentre	Describes channel as back centre with a position and speaker reference
audioTrackFormat	AT_00010021_01	PCM_LFE2	Defines track as PCM

TABLE A2-12 (*continued*)

Element	ID	Name	Description
audioStreamFormat	AS_00010021	PCM_LFE2	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00010021 AB_00010021_00000001	LFE2	Describes channel as LFE2 with a position and speaker reference
audioTrackFormat	AT_0001000a_01	PCM_SideLeft	Defines track as PCM
audioStreamFormat	AS_0001000a	PCM_SideLeft	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_0001000a AB_0001000a_00000001	SideLeft	Describes channel as surround right with a position and speaker reference
audioTrackFormat	AT_0001000b_01	PCM_SideRight	Defines track as PCM
audioStreamFormat	AS_0001000b	PCM_SideRight	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_0001000b AB_0001000b_00000001	SideRight	Describes channel as side right with a position and speaker reference
audioTrackFormat	AT_00010022_01	PCM_TopFrontLeftMid	Defines track as PCM
audioStreamFormat	AS_00010022	PCM_TopFrontLeftMid	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00010022 AB_00010022_00000001	TopFrontLeftMid	Describes channel as top front left with a position and speaker reference
audioTrackFormat	AT_00010023_01	PCM_TopFrontRightMid	Defines track as PCM
audioStreamFormat	AS_00010023	PCM_TopFrontRightMid	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00010023 AB_00010023_00000001	TopFrontRightMid	Describes channel as top front right with a position and speaker reference
audioTrackFormat	AT_0001000e_01	PCM_TopFrontCentre	Defines track as PCM
audioStreamFormat	AS_0001000e	PCM_TopFrontCentre	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_0001000e AB_0001000e_00000001	TopFrontCentre	Describes channel as top front centre with a position and speaker reference
audioTrackFormat	AT_0001000c_01	PCM_TopCentre	Defines track as PCM
audioStreamFormat	AS_0001000c	PCM_TopCentre	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_0001000c AB_0001000c_00000001	TopCentre	Describes channel as top centre with a position and speaker reference
audioTrackFormat	AT_0001001e_01	PCM_TopBackLeftMid	Defines track as PCM
audioStreamFormat	AS_0001001e	PCM_TopBackLeftMid	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_0001001e AB_0001001e_00000001	TopBackLeftMid	Describes channel as top back left with a position and speaker reference
audioTrackFormat	AT_0001001f_01	PCM_TopBackRightMid	Defines track as PCM
audioStreamFormat	AS_0001001f	PCM_TopBackRightMid	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_0001001f AB_0001001f_00000001	TopBackRightMid	Describes channel as top back right with a position and speaker reference
audioTrackFormat	AT_00010013_01	PCM_TopSideLeft	Defines track as PCM
audioStreamFormat	AS_00010013	PCM_TopSideLeft	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00010013 AB_00010013_00000001	TopSideLeft	Describes channel as top side left with a position and speaker reference
audioTrackFormat	AT_00010014_01	PCM_TopSideRight	Defines track as PCM
audioStreamFormat	AS_00010014	PCM_TopSideRight	Defines stream as PCM

TABLE A2-12 (*end*)

Element	ID	Name	Description
audioChannelFormat & audioBlockFormat	AC_00010014 AB_00010014_00000001	TopSideRight	Describes channel as top side right with a position and speaker reference
audioTrackFormat	AT_00010011_01	PCM_TopBackCentre	Defines track as PCM
audioStreamFormat	AS_00010011	PCM_TopBackCentre	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00010011 AB_00010011_00000001	TopBackCentre	Describes channel as top back centre with a position and speaker reference
audioTrackFormat	AT_00010015_01	PCM_BottomFrontCentre	Defines track as PCM
audioStreamFormat	AS_00010015	PCM_BottomFrontCentre	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00010015 AB_00010015_00000001	BottomFrontCentre	Describes channel as bottom front centre with a position and speaker reference
audioTrackFormat	AT_00010016_01	PCM_BottomFrontLeftMid	Defines track as PCM
audioStreamFormat	AS_00010016	PCM_BottomFrontLeftMid	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00010016 AB_00010016_00000001	BottomFrontLeftMid	Describes channel as bottom front left with a position and speaker reference
audioTrackFormat	AT_00010017_01	PCM_BottomFrontRightMid	Defines track as PCM
audioStreamFormat	AS_00010017	PCM_BottomFrontRightMid	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00010017 AB_00010017_00000001	BottomFrontRightMid	Describes channel as bottom front right with a position and speaker reference
audioPackFormat	AP_00010009	22.2	Defines a 22.2 pack referring to 24 channels.

TABLE A2-13

22.2 example content elements

audioObject	AO_1001	MainLanguage	Object for 'MainLanguage', 22.2 format
audioObject	AO_1002	AlternativeLanguage	Object for 'AlternativeLanguage', 22.2 format
audioContent	ACO_1001	MainLanguage	'MainLanguage' content
audioContent	ACO_1002	AlternativeLanguage	'AlternativeLanguage' content
audioProgramme	APR_1001	MainLanguage	Programme 'MainLanguage' containing 'MainLanguage' content
audioProgramme	APR_1002	AlternativeLanguage	Programme 'AlternativeLanguage' containing 'AlternativeLanguage' content

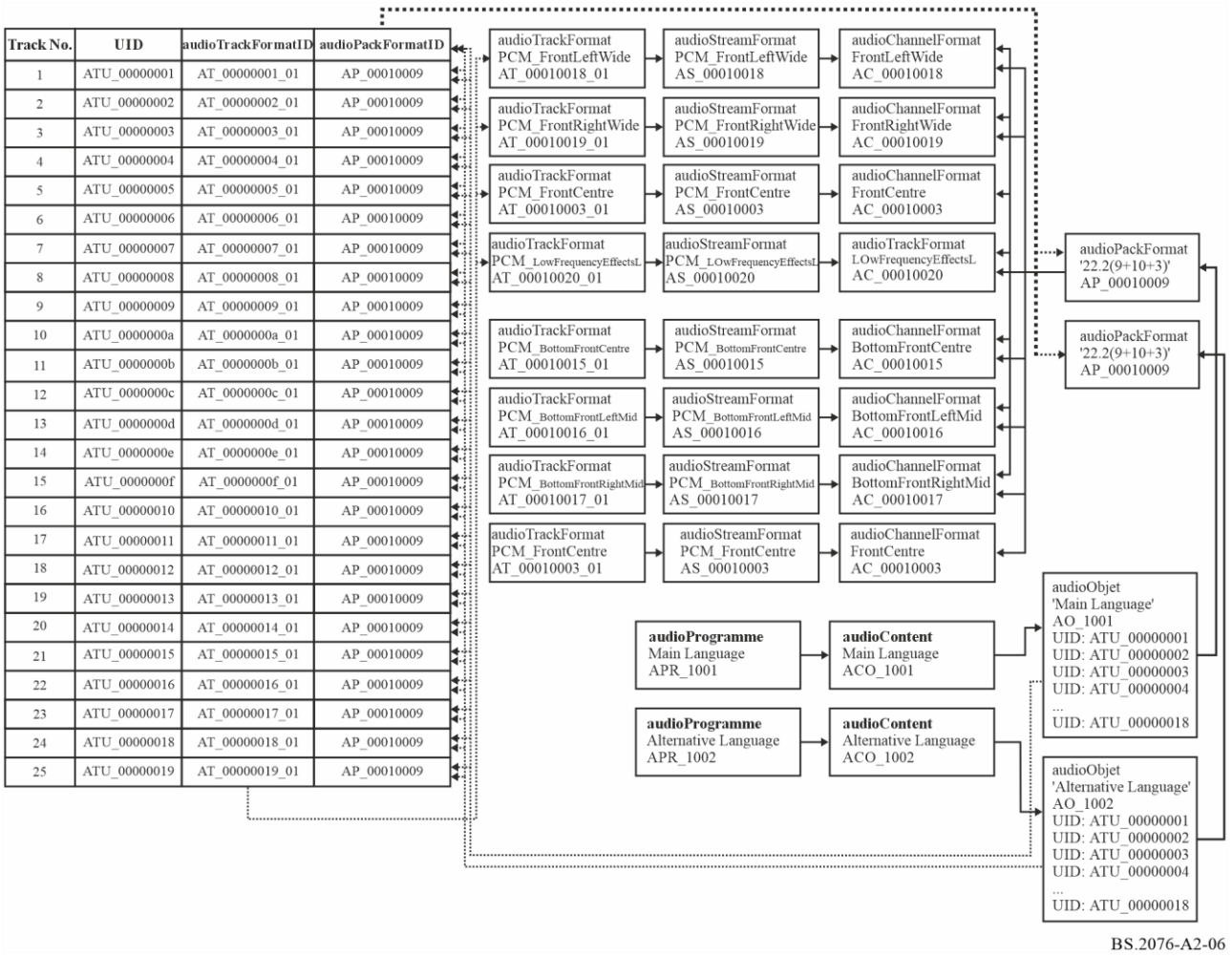
6.2 Element relationships

The diagram in Fig. A2-6 shows how the defined elements relate to each other. The top half of the diagram covers the elements that describe the 22.2 channel and the one alternative dialogue object. The <*chna*> chunk in the middle shows how the tracks are connected to the format definitions.

The content definition elements are at the bottom of the diagram, with the audioObject element containing the track UID references to the UID in the <*chna*> chunk.

FIGURE A2-6

22-channel example diagram



6.3 Sample code

This XML sample code does not include the audioFormatExtended parent element and the XML header for clarity. The excerpt of code covers both the format and content elements:

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

<audioProgramme audioProgrammeID="APR_1001" audioProgrammeName="Main_Language">
  <audioContentIDRef>ACO_1001</audioContentIDRef>
</audioProgramme>

<audioProgramme audioProgrammeID="APR_1002" audioProgrammeName="Alternative_Language">
  <audioContentIDRef>ACO_1002</audioContentIDRef>
</audioProgramme>
```

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

<audioContent audioContentID="ACO_1001" audioContentName="Main_Language">
  <audioObjectIDRef>AO_1001</audioObjectIDRef>
  <loudnessMetadata>
    <integratedLoudness>-24.0</integratedLoudness>
  </loudnessMetadata>
</audioContent>

<audioContent audioContentID="ACO_1002" audioContentName="Alternative_Language">
  <audioObjectIDRef>AO_1002</audioObjectIDRef>
  <loudnessMetadata>
    <integratedLoudness>-24.0</integratedLoudness>
  </loudnessMetadata>
</audioContent>

<!-- ############ -->
<!-- OBJECTS -->
<!-- ############ -->

<audioObject audioObjectID="AO_1001" audioObjectName="Main_Language">
  <audioPackFormatIDRef>AP_00010009</audioPackFormatIDRef>
  <audioTrackUIDRef>ATU_00000001</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000002</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000003</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000004</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000005</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000006</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000007</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000008</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000009</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_0000000a</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_0000000b</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_0000000c</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_0000000d</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_0000000e</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_0000000f</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000010</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000011</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000012</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000013</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000014</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000015</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000016</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000017</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000018</audioTrackUIDRef>
</audioObject>

<audioObject audioObjectID="AO_1002" audioObjectName="Alternative_Language">
  <audioPackFormatIDRef>AP_00010009</audioPackFormatIDRef>
  <audioTrackUIDRef>ATU_00000001</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000002</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000019</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000004</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000005</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000006</audioTrackUIDRef>
```

```
  <audioTrackUIDRef>ATU_00000007</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000008</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000009</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_0000000a</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_0000000b</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_0000000c</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_0000000d</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_0000000e</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_0000000f</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000010</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000011</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000012</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000013</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000014</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000015</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000016</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000017</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000018</audioTrackUIDRef>
</audioObject>

<!-- ############ -->
<!-- PACKS -->
<!-- ############ -->

<audioPackFormat audioPackFormatID="AP_00010009" audioPackFormatName="22.2"
typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioChannelFormatIDRef>AC_00010018</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00010019</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00010003</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00010020</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_0001001c</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_0001001d</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00010001</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00010002</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00010009</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00010021</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_0001000a</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_0001000b</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00010022</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00010023</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_0001000e</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_0001000c</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_0001001e</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_0001001f</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00010013</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00010014</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00010011</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00010015</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00010016</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00010017</audioChannelFormatIDRef>
</audioPackFormat>



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

```
<audioChannelFormat audioChannelFormatID="AC_00010018"
audioChannelFormatName="FrontLeftWide" typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_00010018_00000001">
    <speakerLabel>M+060</speakerLabel>
    <position coordinate="azimuth">60.0</position>
    <position coordinate="elevation">0.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00010019"
audioChannelFormatName="FrontRightWide" typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_00010019_00000001">
    <speakerLabel>M-060</speakerLabel>
    <position coordinate="azimuth">-60.0</position>
    <position coordinate="elevation">0.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00010003"
audioChannelFormatName="FrontCentre" typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_00010003_00000001">
    <speakerLabel>M+000</speakerLabel>
    <position coordinate="azimuth">0.0</position>
    <position coordinate="elevation">0.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00010020" audioChannelFormatName="LFE1"
typeLabel="0001" typeDefinition="DirectSpeakers">
  <frequency typeDefinition="lowPass">120</frequency>
  <audioBlockFormat audioBlockFormatID="AB_00010020_00000001">
    <speakerLabel>LFE1</speakerLabel>
    <position coordinate="azimuth">45.0</position>
    <position coordinate="elevation">-30.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_0001001c"
audioChannelFormatName="BackLeftMid" typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_0001001c_00000001">
    <speakerLabel>M+135</speakerLabel>
    <position coordinate="azimuth">135.0</position>
    <position coordinate="elevation">0.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_0001001d"
audioChannelFormatName="BackRightMid" typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_0001001d_00000001">
    <speakerLabel>M-135</speakerLabel>
    <position coordinate="azimuth">-135.0</position>
    <position coordinate="elevation">0.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
```

```
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00010001" audioChannelFormatName="FrontLeft"
typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_00010001_00000001">
    <speakerLabel>M+030</speakerLabel>
    <position coordinate="azimuth">30.0</position>
    <position coordinate="elevation">0.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00010002"
audioChannelFormatName="FrontRight" typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_00010002_00000001">
    <speakerLabel>M-030</speakerLabel>
    <position coordinate="azimuth">-30.0</position>
    <position coordinate="elevation">0.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00010009"
audioChannelFormatName="BackCentre" typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_00010009_00000001">
    <speakerLabel>M+180</speakerLabel>
    <position coordinate="azimuth">180.0</position>
    <position coordinate="elevation">0.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00010021" audioChannelFormatName="LFE2"
typeLabel="0001" typeDefinition="DirectSpeakers">
  <frequency typeDefinition="lowPass">120</frequency>
  <audioBlockFormat audioBlockFormatID="AB_00010021_00000001">
    <speakerLabel>LFE2</speakerLabel>
    <position coordinate="azimuth">-45.0</position>
    <position coordinate="elevation">-30.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_0001000a" audioChannelFormatName="SideLeft"
typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_0001000a_00000001">
    <speakerLabel>M+090</speakerLabel>
    <position coordinate="azimuth">90.0</position>
    <position coordinate="elevation">0.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_0001000b" audioChannelFormatName="SideRight"
typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_0001000b_00000001">
    <speakerLabel>M-090</speakerLabel>
    <position coordinate="azimuth">-90.0</position>
    <position coordinate="elevation">0.0</position>
```

```
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00010022"
audioChannelFormatName="TopFrontLeftMid" typeLabel="0001"
typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_00010022_00000001">
    <speakerLabel>U+045</speakerLabel>
    <position coordinate="azimuth">45.0</position>
    <position coordinate="elevation">30.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00010023"
audioChannelFormatName="TopFrontRightMid" typeLabel="0001"
typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_00010023_00000001">
    <speakerLabel>U-045</speakerLabel>
    <position coordinate="azimuth">-45.0</position>
    <position coordinate="elevation">30.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_0001000e"
audioChannelFormatName="TopFrontCentre" typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_0001000e_00000001">
    <speakerLabel>U+000</speakerLabel>
    <position coordinate="azimuth">0.0</position>
    <position coordinate="elevation">45.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_0001000c" audioChannelFormatName="TopCentre"
typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_0001000c_00000001">
    <speakerLabel>T+000</speakerLabel>
    <position coordinate="azimuth">0.0</position>
    <position coordinate="elevation">90.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_0001001e"
audioChannelFormatName="TopBackLeftMid" typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_0001001e_00000001">
    <speakerLabel>U+135</speakerLabel>
    <position coordinate="azimuth">135.0</position>
    <position coordinate="elevation">30.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_0001001f"
audioChannelFormatName="TopBackRightMid" typeLabel="0001"
typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_0001001f_00000001">
```

```
    <speakerLabel>U-135</speakerLabel>
    <position coordinate="azimuth">-135.0</position>
    <position coordinate="elevation">30.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00010013"
audioChannelFormatName="TopSideLeft" typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_00010013_00000001">
    <speakerLabel>U+090</speakerLabel>
    <position coordinate="azimuth">90.0</position>
    <position coordinate="elevation">30.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00010014"
audioChannelFormatName="TopSideRight" typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_00010014_00000001">
    <speakerLabel>U-090</speakerLabel>
    <position coordinate="azimuth">-90.0</position>
    <position coordinate="elevation">30.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00010011"
audioChannelFormatName="TopBackCentre" typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_00010011_00000001">
    <speakerLabel>U+180</speakerLabel>
    <position coordinate="azimuth">180.0</position>
    <position coordinate="elevation">45.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00010015"
audioChannelFormatName="BottomFrontCentre" typeLabel="0001"
typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_00010015_00000001">
    <speakerLabel>B+000</speakerLabel>
    <position coordinate="azimuth">0.0</position>
    <position coordinate="elevation">-30.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00010016"
audioChannelFormatName="BottomFrontLeftMid" typeLabel="0001"
typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_00010016_00000001">
    <speakerLabel>B+045</speakerLabel>
    <position coordinate="azimuth">45.0</position>
    <position coordinate="elevation">-30.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>
```

```
<audioChannelFormat audioChannelFormatID="AC_00010017"
audioChannelFormatName="BottomFrontRightMid" typeLabel="0001"
typeDefinition="DirectSpeakers">
  <audioBlockFormat audioBlockFormatID="AB_00010017_00000001">
    <speakerLabel>B-045</speakerLabel>
    <position coordinate="azimuth">-45.0</position>
    <position coordinate="elevation">-30.0</position>
    <position coordinate="distance">1.0</position>
  </audioBlockFormat>
</audioChannelFormat>

<!-- ############ -->
<!-- STREAMS -->
<!-- ############ -->

<audioStreamFormat audioStreamFormatID="AS_00010018"
audioStreamFormatName="PCM_FrontLeftWide" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00010018</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00010018_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00010019"
audioStreamFormatName="PCM_FrontRightWide" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00010019</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00010019_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00010003"
audioStreamFormatName="PCM_FrontCentre" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00010003</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00010003_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00010020" audioStreamFormatName="PCM_LFE1"
formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00010020</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00010020_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_0001001c"
audioStreamFormatName="PCM_BackLeftMid" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_0001001c</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_0001001c_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_0001001d"
audioStreamFormatName="PCM_BackRightMid" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_0001001d</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_0001001d_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00010001"
audioStreamFormatName="PCM_FrontLeft" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00010001</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00010001_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00010002"
audioStreamFormatName="PCM_FrontRight" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00010002</audioChannelFormatIDRef>
```

```
  <audioTrackFormatIDRef>AT_00010002_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00010009"
audioStreamFormatName="PCM_BackCentre" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00010009</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00010009_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00010021" audioStreamFormatName="PCM_LFE2"
formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00010021</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00010021_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_0001000a" audioStreamFormatName="PCM_SideLeft"
formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_0001000a</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_0001000a_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_0001000b"
audioStreamFormatName="PCM_SideRight" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_0001000b</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_0001000b_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00010022"
audioStreamFormatName="PCM_TopFrontLeftMid" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00010022</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00010022_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00010023"
audioStreamFormatName="PCM_TopFrontRightMid" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00010023</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00010023_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_0001000e"
audioStreamFormatName="PCM_TopFrontCentre" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_0001000e</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_0001000e_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_0001000c"
audioStreamFormatName="PCM_TopCentre" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_0001000c</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_0001000c_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_0001001e"
audioStreamFormatName="PCM_TopBackLeftMid" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_0001001e</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_0001001e_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_0001001f"
audioStreamFormatName="PCM_TopBackRightMid" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_0001001f</audioChannelFormatIDRef>
```

```
  <audioTrackFormatIDRef>AT_0001001f_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00010013"
audioStreamFormatName="PCM_TopSideLeft" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00010013</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00010013_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00010014"
audioStreamFormatName="PCM_TopSideRight" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00010014</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00010014_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00010011"
audioStreamFormatName="PCM_TopBackCentre" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00010011</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00010011_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00010015"
audioStreamFormatName="PCM_BottomFrontCentre" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00010015</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00010015_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00010016"
audioStreamFormatName="PCM_BottomFrontLeftMid" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00010016</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00010016_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00010017"
audioStreamFormatName="PCM_BottomFrontRightMid" formatLabel="0001"
formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00010017</audioChannelFormatIDRef>
  <audioTrackFormatIDRef>AT_00010017_01</audioTrackFormatIDRef>
</audioStreamFormat>

<!-- ############ -->
<!-- AUDIO TRACKS -->
<!-- ############ -->

<audioTrackFormat audioTrackFormatID="AT_00010018_01"
audioTrackFormatName="PCM_FrontLeftWide" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00010018</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00010019_01"
audioTrackFormatName="PCM_FrontRightWide" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00010019</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00010003_01"
audioTrackFormatName="PCM_FrontCentre" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00010003</audioStreamFormatIDRef>
</audioTrackFormat>
```

```
<audioTrackFormat audioTrackFormatID="AT_00010020_01" audioTrackFormatName="PCM_LFE1"
formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00010020</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_0001001c_01"
audioTrackFormatName="PCM_BackLeftMid" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_0001001c</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_0001001d_01"
audioTrackFormatName="PCM_BackRightMid" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_0001001d</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00010001_01"
audioTrackFormatName="PCM_FrontLeft" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00010001</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00010002_01"
audioTrackFormatName="PCM_FrontRight" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00010002</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00010009_01"
audioTrackFormatName="PCM_BackCentre" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00010009</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00010021_01" audioTrackFormatName="PCM_LFE2"
formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00010021</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_0001000a_01" audioTrackFormatName="PCM_SideLeft"
formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_0001000a</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_0001000b_01"
audioTrackFormatName="PCM_SideRight" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_0001000b</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00010022_01"
audioTrackFormatName="PCM_TopFrontLeftMid" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00010022</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00010023_01"
audioTrackFormatName="PCM_TopFrontRightMid" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00010023</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_0001000e_01"
audioTrackFormatName="PCM_TopFrontCentre" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_0001000e</audioStreamFormatIDRef>
</audioTrackFormat>
```

```
<audioTrackFormat audioTrackFormatID="AT_0001000c_01"
audioTrackFormatName="PCM_TopCentre" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_0001000c</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_0001001e_01"
audioTrackFormatName="PCM_TopBackLeftMid" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_0001001e</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_0001001f_01"
audioTrackFormatName="PCM_TopBackRightMid" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_0001001f</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00010013_01"
audioTrackFormatName="PCM_TopSideLeft" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00010013</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00010014_01"
audioTrackFormatName="PCM_TopSideRight" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00010014</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00010011_01"
audioTrackFormatName="PCM_TopBackCentre" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00010011</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00010015_01"
audioTrackFormatName="PCM_BottomFrontCentre" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00010015</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00010016_01"
audioTrackFormatName="PCM_BottomFrontLeftMid" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00010016</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00010017_01"
audioTrackFormatName="PCM_BottomFrontRightMid" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00010017</audioStreamFormatIDRef>
</audioTrackFormat>


<!-- ############ -->
<!-- AUDIO TRACK UIDs -->
<!-- ############ -->

<audioTrackUID UID="ATU_00000001">
  <audioTrackFormatIDRef>AT_00010018_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010009</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000002">
  <audioTrackFormatIDRef>AT_00010019_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010009</audioPackFormatIDRef>
</audioTrackUID>
```

```
<audioTrackUID UID="ATU_00000003">
  <audioTrackFormatIDRef>AT_00010003_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010009</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000004">
  <audioTrackFormatIDRef>AT_00010020_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010009</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000005">
  <audioTrackFormatIDRef>AT_0001001c_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010009</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000006">
  <audioTrackFormatIDRef>AT_0001001d_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010009</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000007">
  <audioTrackFormatIDRef>AT_00010001_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010009</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000008">
  <audioTrackFormatIDRef>AT_00010002_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010009</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000009">
  <audioTrackFormatIDRef>AT_00010009_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010009</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_0000000a">
  <audioTrackFormatIDRef>AT_00010021_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010009</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_0000000b">
  <audioTrackFormatIDRef>AT_0001000a_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010009</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_0000000c">
  <audioTrackFormatIDRef>AT_0001000b_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010009</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_0000000d">
  <audioTrackFormatIDRef>AT_00010022_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010009</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_0000000e">
  <audioTrackFormatIDRef>AT_00010023_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010009</audioPackFormatIDRef>
```

```
</audioTrackUID>

<audioTrackUID UID="ATU_0000000f">
  <audioTrackFormatIDRef>AT_0001000e_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010009</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000010">
  <audioTrackFormatIDRef>AT_0001000c_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010009</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000011">
  <audioTrackFormatIDRef>AT_0001001e_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010009</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000012">
  <audioTrackFormatIDRef>AT_0001001f_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010009</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000013">
  <audioTrackFormatIDRef>AT_00010013_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010009</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000014">
  <audioTrackFormatIDRef>AT_00010014_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010009</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000015">
  <audioTrackFormatIDRef>AT_00010011_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010009</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000016">
  <audioTrackFormatIDRef>AT_00010015_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010009</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000017">
  <audioTrackFormatIDRef>AT_00010016_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010009</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000018">
  <audioTrackFormatIDRef>AT_00010017_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010009</audioPackFormatIDRef>
</audioTrackUID>
```

```
<audioTrackUID UID="ATU_00000019">
  <audioTrackFormatIDRef>AT_00010003_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010009</audioPackFormatIDRef>
</audioTrackUID>
```

7 Example of the use of the Matrix type

The example illustrates both an encoding and decoding matrices that are associated with each other, in this case the 5.1 to Lo/Ro downmix matrix. The audio tracks are the Lo/Ro channels, so the decoding matrix describes how these are converted back to channel-based channels (trivially in this case), and the encoding matrix that was used to produce these tracks.

In reality, an Lo/Ro downmix would more likely be specified using a single direct matrix, as the Lo/Ro channels are effectively channel-based. This example is used to illustrate the concept of an encoding and decoding matrix pair, where the decoding matrix is just a trivial identity matrix.

7.1 Summary of elements

These are the elements in the format part of the description:

TABLE A2-14

Matrix example format elements

Element	ID	Name	Description
audioTrackFormat	AT_00021103_01	PCM_Lo/Ro_Decode_Left	Defines track as PCM
audioTrackFormat	AT_00021104_01	PCM_Lo/Ro_Decode_Right	Defines track as PCM
audioStreamFormat	AS_00021103	PCM_Lo/Ro_Decode_Left	Defines stream as PCM
audioStreamFormat	AS_00021104	PCM_Lo/Ro_Decode_Right	Defines stream as PCM
audioChannelFormat & audioBlockFormat	AC_00021003 AB_00021003_00000001	Lo/Ro_Left	Describes channel as Lo matrix encoding
audioChannelFormat & audioBlockFormat	AC_00021004 AB_00021004_00000001	Lo/Ro_Right	Describes channel as Ro matrix encoding
audioChannelFormat & audioBlockFormat	AC_00021103 AB_00021103_00000001	Lo/Ro_Decode_Left	Describes channel as Lo matrix decoding
audioChannelFormat & audioBlockFormat	AC_00021104 AB_00021104_00000001	Lo/Ro_Decode_Right	Describes channel as Ro matrix decoding
audioPackFormat	AP_00021002	Lo/Ro	Defines a Lo/Ro pack encoding matrix (from 5.1 channels).
audioPackFormat	AP_00021102	Lo/Ro_Decode	Defines a Lo/Ro pack decoding matrix (to 2 channels).

These are the elements in the content part of the description:

TABLE A2-15

Matrix example content elements

Element	ID	Name	Description
audioObject	AO_1001	Lo/Ro_Downmix	Object for Lo/Ro encoded channels

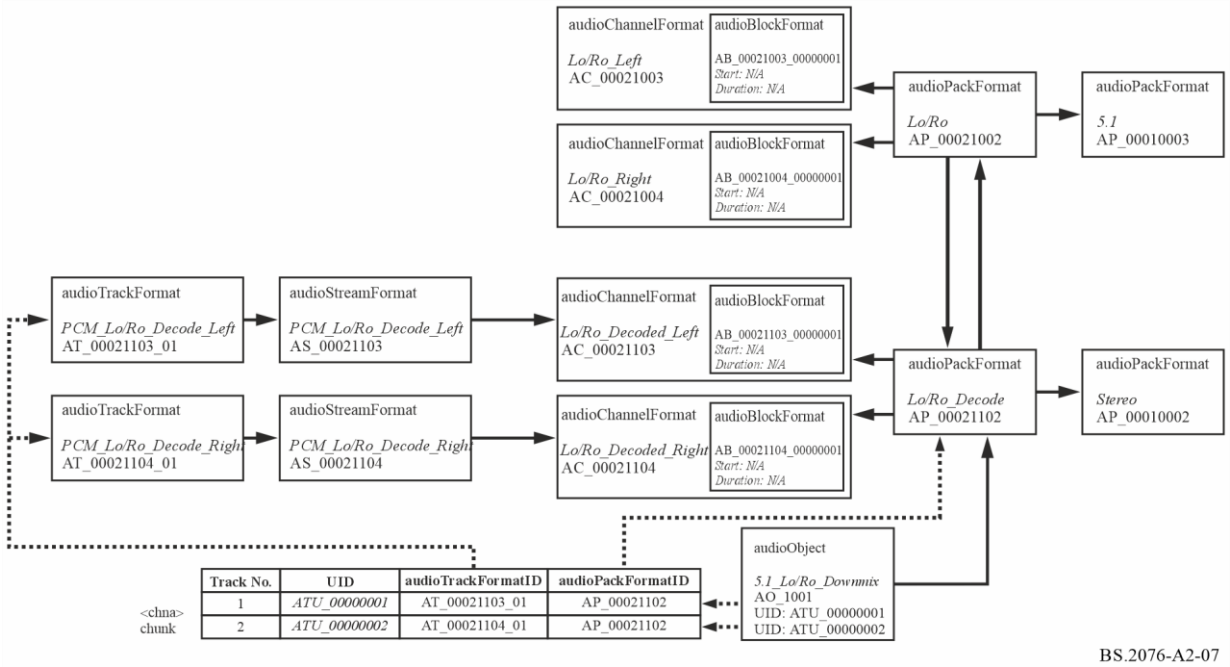
7.2 Element Relationships

The diagram in Fig. A2-7 shows how the defined elements relate to each other. The two audioTrackFormat and audioStreamFormat elements refer to audioChannelFormats that describe a decoding matrix. These are refered from an audioPackFormat element that describes the while decoding matrix. This audioPackFormat element also references another audioPackFormat element that describes an associated encoding matrix (which in turn references two encoding matrix audioChannelFormat elements). Each of the matrix audioPackFormat elements also reference 'DirectSpeakers' audioPackFormat elements, which are not included in the XML as they are common definitions (hence greyed out in the diagram).

The <*chna*> chunk at the bottom shows how the tracks are connected to the format definitions. The audioObject element containing the track UID references to the UID in the <*chna*> chunk, and references the decoding matrix audioPackFormat element.

FIGURE A2-7

Matrix example diagram



7.3 Sample code

This XML sample code does not include the audioFormatExtended parent element and the XML header for clarity. The elements that are in the common definitions (Recommendation ITU-R BS.2094) have also been removed for clarity. The code contains both the content and format parts, but omits the common definition elements that are referenced:

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

<audioObject audioObjectID="AO_1001" audioObjectName="Lo/Ro_Downmix">
    <audioPackFormatIDRef>AP_00021102</audioPackFormatIDRef>
    <audioTrackUIDRef>ATU_00000001</audioTrackUIDRef>
    <audioTrackUIDRef>ATU_00000002</audioTrackUIDRef>
</audioObject>
```

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

<audioPackFormat audioPackFormatID="AP_00021002" audioPackFormatName="Lo/Ro"
typeLabel="0002" typeDefinition="Matrix">
  <decodePackFormatIDRef>AP_00021102</decodePackFormatIDRef>
  <inputPackFormatIDRef>AP_00010003</inputPackFormatIDRef>
  <audioChannelFormatIDRef>AC_00021003</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00021004</audioChannelFormatIDRef>
</audioPackFormat>

<audioPackFormat audioPackFormatID="AP_00021102" audioPackFormatName="Lo/Ro_Decode"
typeLabel="0002" typeDefinition="Matrix">
  <encodePackFormatIDRef>AP_00021002</encodePackFormatIDRef>
  <outputPackFormatIDRef>AP_00010002</outputPackFormatIDRef>
  <audioChannelFormatIDRef>AC_00021103</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00021104</audioChannelFormatIDRef>
</audioPackFormat>

<!-- ############ -->
<!-- CHANNELS -->
<!-- ############ -->

<audioChannelFormat audioChannelFormatID="AC_00021003"
audioChannelFormatName="Lo/Ro_Left" typeLabel="0002" typeDefinition="Matrix">
  <audioBlockFormat audioBlockFormatID="AB_00021003_00000001">
    <matrix>
      <coefficient gain="1.0">AC_00010001</coefficient>
      <coefficient gain="cvar">AC_00010003</coefficient>
      <coefficient gain="svar">AC_00010005</coefficient>
    </matrix>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00021004"
audioChannelFormatName="Lo/Ro_Right" typeLabel="0002" typeDefinition="Matrix">
  <audioBlockFormat audioBlockFormatID="AB_00021004_00000001">
    <matrix>
      <coefficient gain="1.0">AC_00010002</coefficient>
      <coefficient gain="cvar">AC_00010003</coefficient>
      <coefficient gain="svar">AC_00010006</coefficient>
    </matrix>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00021103"
audioChannelFormatName="Lo/Ro_Decode_Left" typeLabel="0002" typeDefinition="Matrix">
  <audioBlockFormat audioBlockFormatID="AB_00021103_00000001">
    <outputChannelFormatIDRef>AC_00010001</outputChannelFormatIDRef>
    <matrix>
      <coefficient gain="1.0">AC_00021003</coefficient>
    </matrix>
  </audioBlockFormat>
</audioChannelFormat>

<audioChannelFormat audioChannelFormatID="AC_00021104"
audioChannelFormatName="Lo/Ro_Decode_Right" typeLabel="0002" typeDefinition="Matrix">
```

```
  <audioBlockFormat audioBlockFormatID="AB_00021104_00000001">
    <outputChannelFormatIDRef>AC_00010002</outputChannelFormatIDRef>
    <matrix>
      <coefficient gain="1.0">AC_00021004</coefficient>
    </matrix>
  </audioBlockFormat>
</audioChannelFormat>

<!-- ############ -->
<!-- STREAMS -->
<!-- ############ -->

<audioStreamFormat audioStreamFormatID="AS_00021103"
audioStreamFormatName="PCM_Lo/Ro_Deocde_Left" formatLabel="0001"
formatDefinition="PCM">
    <audioChannelFormatIDRef>AC_00021103</audioChannelFormatIDRef>
    <audioTrackFormatIDRef>AT_00021103_01</audioTrackFormatIDRef>
</audioStreamFormat>

<audioStreamFormat audioStreamFormatID="AS_00021104"
audioStreamFormatName="PCM_Lo/Ro_Decode_Right" formatLabel="0001"
formatDefinition="PCM">
    <audioChannelFormatIDRef>AC_00021104</audioChannelFormatIDRef>
    <audioTrackFormatIDRef>AT_00021104_01</audioTrackFormatIDRef>
</audioStreamFormat>

<!-- ############ -->
<!-- AUDIO TRACKS -->
<!-- ############ -->

<audioTrackFormat audioTrackFormatID="AT_00021103_01"
audioTrackFormatName="PCM_Lo/Ro_Decode_Left" formatLabel="0001" formatDefinition="PCM">
    <audioStreamFormatIDRef>AS_00021103</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_00021104_01"
audioTrackFormatName="PCM_Lo/Ro_Decode_Right" formatLabel="0001"
formatDefinition="PCM">
    <audioStreamFormatIDRef>AS_00021104</audioStreamFormatIDRef>
</audioTrackFormat>
```

Annex 3
(informative)

Overview of changes in this edition (Recommendation ITU-R BS.2076-3)

This overview provides a list of updates and changes to this Recommendation from previous version(s).

i) Editorial changes and additional clarifying text / examples to ensure clear understanding, describing existing features in Recommendation ITU-R BS.2076-2:

Item	Description	Section(s)
1	Expanded sample code to clearly illustrate use of *audioTrackFormat*, *audioStreamFormat* and *audioChannelFormat* elements, including the case for PCM when *audioTrackFormat* and *audioStreamFormat* are not present.	5.9.3
2	Added statement about format of vvvvvvvv part in *audioTrackUID*.	6
3	Clarification of what interaction is enabled when audioObject->interact is set to 1 but audioObject->audioObjectInteraction is not present	12 and 13
4	Reorganized common audioBlockFormat sub-elements for all typeDefintions into tables	5.4.3
5	Added an example of ADM usage for PCM that does not include elements *audioTrackFormat* and *audioStreamFormat*	Annex 2 2
6	Moved "Overview of changes" from the beginning of the document to an Annex at the end of the document.	

ii) Technical corrections and additional clarification text:

Item	Description	Section(s)
7	Frequency element (200 changed to 120) used for LFE for alignment with other documents.	5.3.2, Annex 2 5.3 and 6.3
8	Added missing definition of *shortform* time formats and incorporated further time format refinements from other ADM related documents.	5.13
9	Corrected element *audioChannelFormatIDRef* to *outputChannelFormatIDRef* in final sentence.	5.4.3.2

iii) Further technical changes including the definition of new elements and attributes:

Item	Description	Section(s)
10	Addition of profileList	5.10
11	Interpolation time unit, added support for fractional representation to align with how other time units may use.	5.13
12	Addition of tagList.	5.11
13	Addition of Cartesian positions for *DirectSpeakers* and add Cartesian flag similar to Objects	5.4.3.1
14	Addition of coordinateMode in authoringInformation	5.8.6
15	Addition of new elements for definition of loudness measurement configuration.	5.7.4 and 5.8.4