International Telecommunication Union

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Radiocommunication Sector of ITU

Recommendation ITU-R BS.2076-1

(06/2017)

Audio Definition Model

BS Series

Broadcasting service (sound)

International Telecommunication Union

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

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RECOMMENDATION ITU-R BS.2076-1*

Audio Definition Model

(2015-2017)

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 open standard for a metadata model for defining audio content that file and streaming formats could either adopt or become compatible with by means of suitable interfacing,

recommends

for the following use cases:

- 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,

to use the Audio Definition Model (ADM) described in Annex 1 for metadata to describe audio formats used in programme production and international exchange.

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* Radiocommunication Study Group 6 made editorial amendments to this Recommendation in October 2017 in accordance with Resolution ITU-R 1.

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 are being 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 central requirement for allowing all the 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 an open standard 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 what the renderer does.

The ADM is in general compatible with wave-file based formats such as the BW64 format specified in Recommendation ITU-R BS.2088 [7], the BWF as defined by the ITU in [4] and other wave based formats that support the usage of the needed additional chunks.

When used in the context of Recommendation ITU-R BS.2088 file, the <*chna*> chunk of the BS.2088 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 BS.2088 file that contains the audio samples.

From a Recommendation ITU-R BS.2088 file point of view, we would look at our bar codes on each ingredient in our 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').

2.2 Brief overview

This model will initially use XML as its specification language, though it could be mapped to other languages such as JSON (JavaScript Object Notation) if required. When it is used with Recommendation ITU-R BS.2088 files, the XML can be embedded in the <*axml*> chunk of the file.

The model is divided into two sections, the **content** part, and the **format** part. The content part describes what is contained in the audio, so will describe things like the language of any dialogue, the loudness and so on.

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

While this model is based around a wave-file based format, it is a more general model. However, examples are given using Recommendation ITU-R BS.2088 according to the definition in [7] as this explains more clearly how the model works. It is also expected that the model's parameters are added to in subsequent versions of this specification to reflect the progress in audio technology.

3 Description of the model

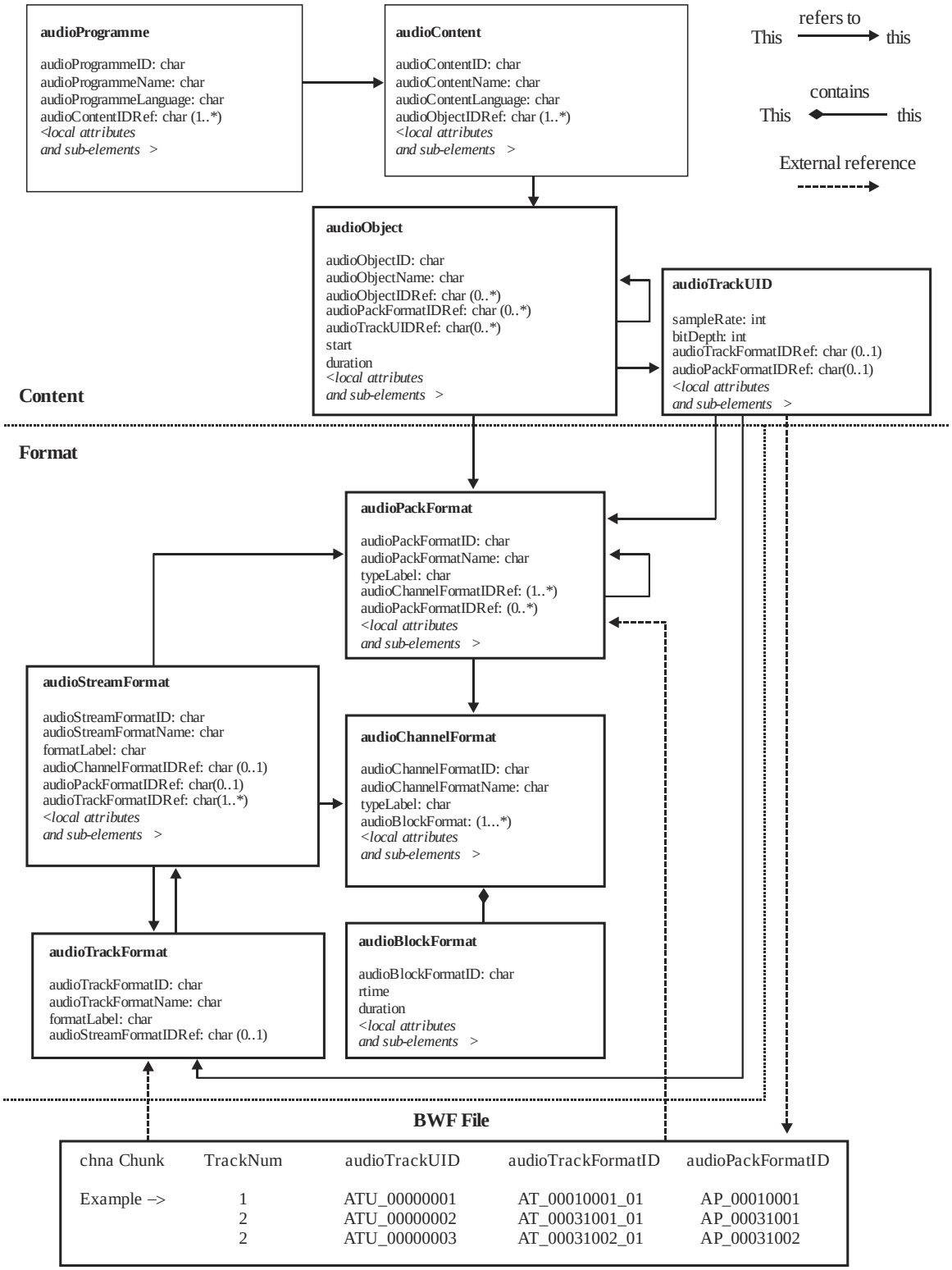
The overall diagram of the model is given in Fig. 1. This shows how the elements relate to each other and illustrates the split between the content and format parts. It also shows the <*chna*> chunk of a BS.2088 file and how it connects the tracks in the file to the model.

Where a BS.2088 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 5 stereo pairs, there will be 5 identical audioTrackFormatIDs to describe the 'left' channel, and 5 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 1

Overall UML Model



BS.2076-01

3.1 Format

The audioTrackFormatID answers the question “What is the format of this track?” The audioTrackFormat will also contain an audioStreamFormatID, which allows identification of the

combination of the audioTrackFormat and audioStreamFormat. An audioStreamFormat describes a decodable signal.

The audioStreamFormat is made up of one or more audioTrackFormats. Hence, the combination of audioStreamFormat and audioTrackFormat reveals whether the signal has to be decoded or not.

The next stage is to find out 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 will be a reference to either an audioChannelFormat or audioPackFormat that will describe the audio stream. There will 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 there is a typeDefinition attribute, which is used to define what the type of channel is.

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 change in some way over time), it uses audioBlockFormat to divide the channel along the time axis. The audioBlockFormat element will contain a start time (relative to the start time of the parent audioObject) and duration. Within audioBlockFormat there are time-dependent parameters that describe the channel which 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 is required and so static channels will have one audioBlockFormat containing the channel's parameters.

If audioStreamFormat refers to an audioPackFormat, it describes a group of channels. An audioPackFormat element groups together one or more audioChannelFormats that belong together (e.g. a stereo pair). This is important when rendering the audio, as channels within the group may need to interact with each other.

The reference to an audioPackFormat containing multiple audioChannelFormats from an audioStreamFormat usually occurs when the audioStreamFormat contains non-PCM audio which carries several channels encoded together. AudioPackFormat would usually not be referred from audioStreamFormat for most channel and scene-based formats with PCM audio. Where this reference does exist, the function of audioPackFormat is to combine audioChannelFormats that belong together for rendering purposes.

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 5 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 a stereo pair (in PCM), audioObject will contain references to two audioTrackUIDs; therefore, those two tracks will contain stereo audio. It will also contain a reference to audioPackFormat, which defines the format of those two tracks as a stereo pair.

As there are 5 stereo pairs in this example, 5 audioObject elements will be needed. Each one will contain the same reference to a stereo audioPackFormat, but will contain different reference to audioTrackUIDs, 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 also contains 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 will 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 will 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, and this is why 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 personalized 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 program 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 1

Alternative mixes

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

4 Common formats

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 available in Recommendation ITU-R BS.2094 [8] as an attached XML file. This reference file will not have to be included in a file using the ADM but can be externally referred to. Therefore a file will not need to carry the XML of the format if only common formats are used. The occasions any ADM XML code will need to be carried in a file is when audioProgramme, audioContent and audioObject are used, or custom definitions are required.

5 ADM elements

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

5.1 audioTrackFormat

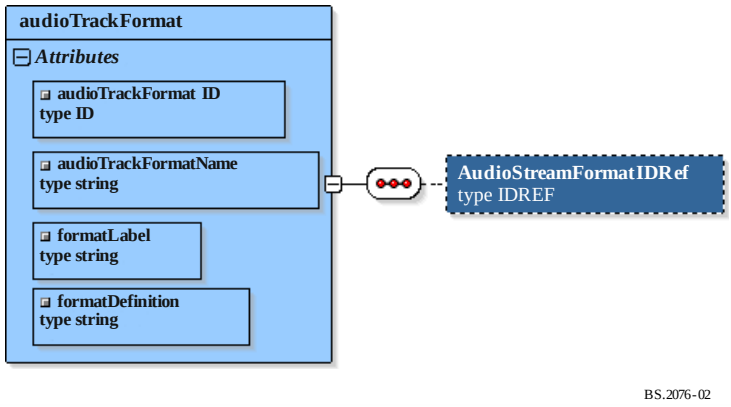
The audioTrackFormat element corresponds to a single set of samples or data in a single track in a storage medium. It is used to describe what format the data is in, allowing a renderer to decode the signal correctly. It is referred from the audioStreamFormat element, which is used to identify the combination 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. 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. However, it is a strict requirement that if this reference is used, the audioTrackFormat must refer to the same audioStreamFormat that is referring back to it.

FIGURE 2

audioTrackFormat



5.1.1 Attributes

TABLE 2

audioTrackFormat attributes

Attribute	Description	Example	Required
audioTrackFormatID	ID for track, see § 6. The yyyy digits of AT_yyyyxxxx_nn_represent the type of audio contained in the track. The yyyyxxxx digits should match the audioStreamFormat yyyyxxxx digits	AT_00010001_01	Yes
audioTrackFormat Name	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 3

audioTrackFormat sub-elements

Element	Description	Example	Quantity
audioStreamFormatIDRef	Reference to an audioStreamFormat	AS_00010001	0 or 1

5.1.3 Sample code

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

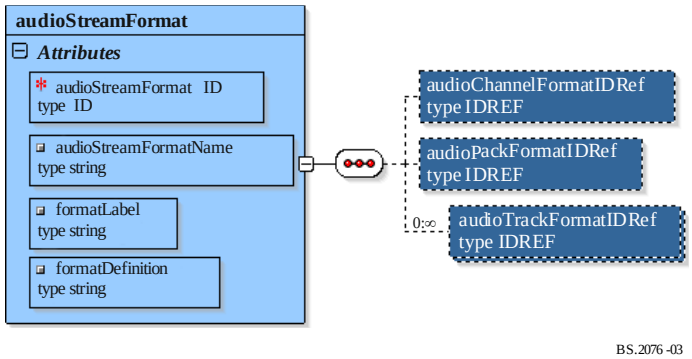
5.2 audioStreamFormat

A stream is a combination of tracks (or one track) 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 deal with 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).

FIGURE 3

audioStreamFormat



5.2.1 Attributes

TABLE 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 should match the audioChannelFormat xxxx digits.	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 5

audioStreamFormat sub-elements

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	1…*

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

5.2.3 Sample code

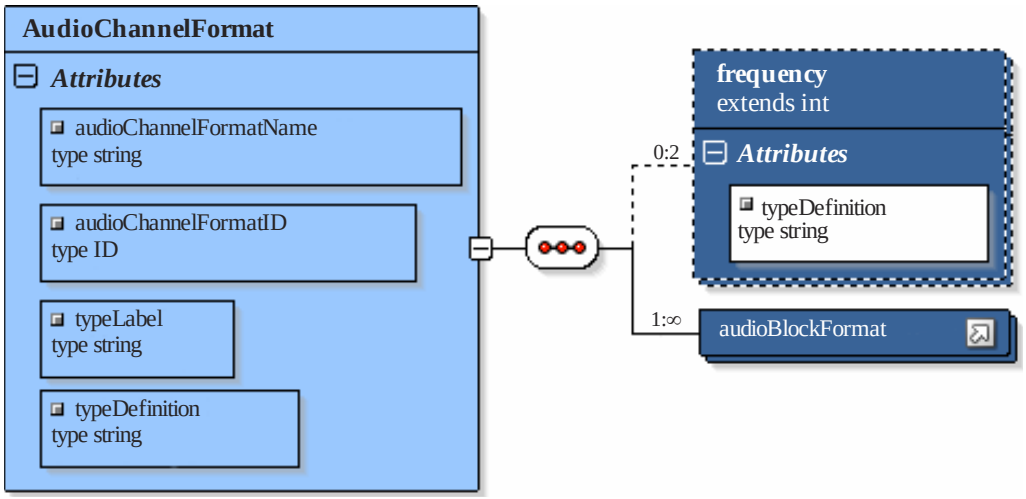
```
<audioStreamFormat audioStreamFormatID="AT_00010001"
audioStreamFormatName="PCM_FrontLeft" formatDefinition="PCM"
formatLabel="0001">
  <audioTrackFormatIDRef>AT_00010001_01</audioTrackFormatIDRef>
  <audioChannelFormatIDRef>AC_00010001</audioChannelFormatIDRef>
</audioStreamFormat>
```

5.3 audioChannelFormat

An audioChannelFormat represents 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.

FIGURE 4

audioChannelFormat



5.3.1 Attributes

TABLE 6

audioChannelFormat attributes

Attribute	Description	Example	Required
audioChannelFormatName	Name of the channel	FrontLeft	Yes
audioChannelFormatID	ID of the channel, 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. The xxxx digits should match the audioStreamFormat xxxx digits.	AC_00010001	Yes
typeLabel	Descriptor of the type of channel	0001	Optional
typeDefinition	Description of the type of channel	DirectSpeakers	Optional

The typeDefinition of the audioChannel Format 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 7

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	1xxx to Fxxx	For user custom types.

5.3.2 Sub-elements

TABLE 8

audioChannelFormat sub-elements

Element	Description	Attributes	Quantity
audioBlockFormat	Time division of channel containing dynamic metadata	See § 5.4	1...*
frequency	Sets a high 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 specified. This can be either low-pass or high-pass, or by combining both to achieve band-pass and band-stop. The mostly common use of this is for LFE channels where a low-pass frequency (e.g. 200 Hz) can be specified.

5.3.3 Sample code

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

5.4 audioBlockFormat

An audioBlockFormat represents a single sequence of audioChannelFormat samples with fixed parameters, including position, within a specified time interval.

5.4.1 Attributes

TABLE 9

audioBlockFormat attributes

Attribute	Description	Example	Required
audioBlockFormatID	ID for block	AB_00010001_00000001	Yes
rtime	Start time of block (relative to the start time of the parent audioObject)	00:00:00.00000	Optional
duration	Duration of block	00:00:05.00000	Optional

The last 8 hexadecimal digits in the audioBlockFormatID contain the index for the block within the channel, starting at 00000001 for the first block.

If *rtime* and *duration* are not used then the block lasts for the whole duration of the channel.

The sub-elements within audioBlockFormat are dependent upon the typeDefinition or typeLabel of the parent audioChannelFormat element.

Currently, there are five different defined typeDefinitions:

TABLE 10

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) 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

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

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 speaker. 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.

FIGURE 5

audioBlockFormat (DirectSpeakers)

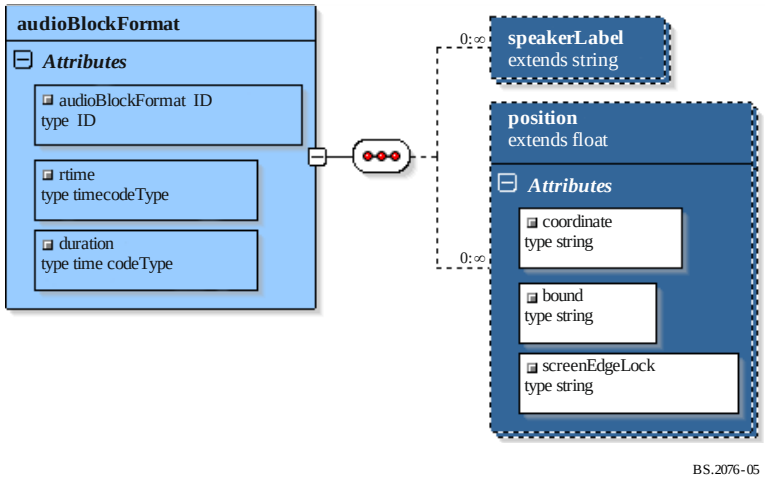


TABLE 11

audioBlockFormat sub-elements for DirectSpeakers

Element	Attribute	Bound attribute	Description	Units	Example	Quantity
speakerLabel		N/A	A reference to the label of the speaker position	–	M-30	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

The **screenEdgeLock** attribute allows a speaker to be positioned on the edge of the screen. The attribute can be used in combination with the coordinate="elevation" and/or the coordinate="azimuth" attribute and 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 must 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, as absolute speaker distances from the origin are rarely used, 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 channel-based 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 coefficients in this list should be added together to generate the matrix equation.

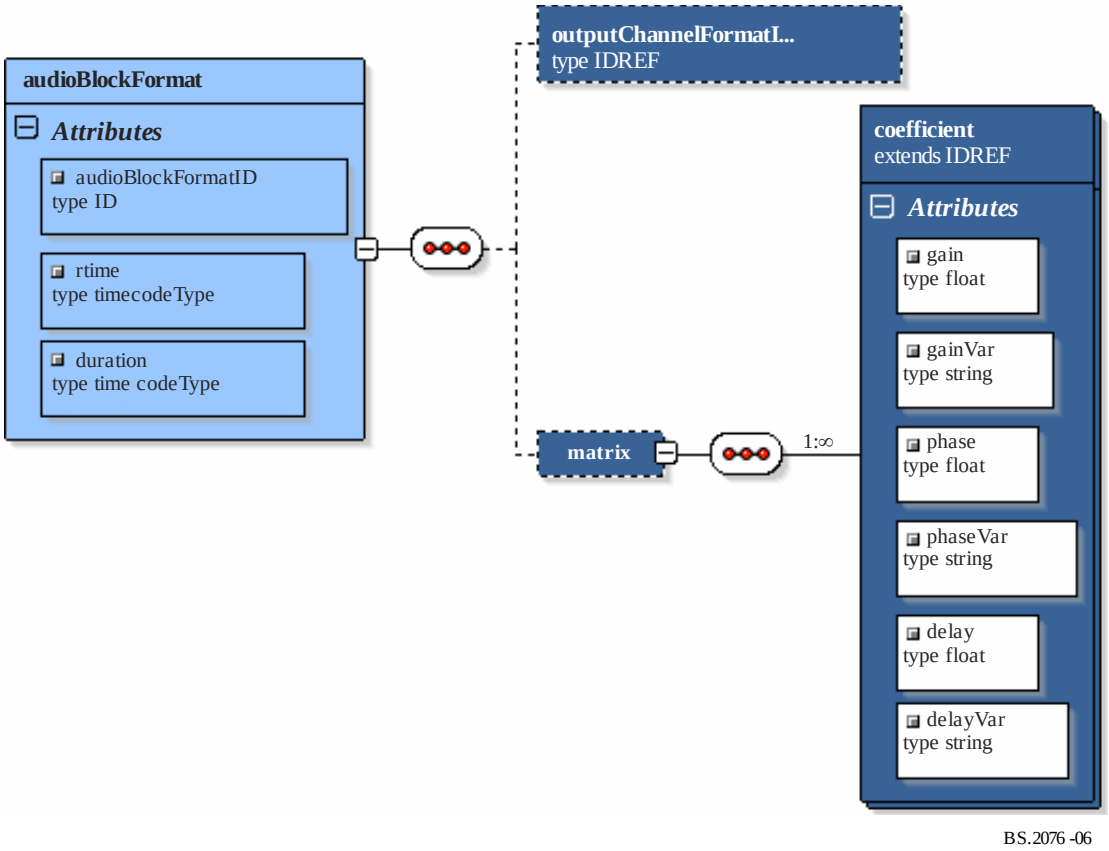
There are three types of matrix that can be defined: encoding, decoding and direct:

- 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 a channel-based (i.e. “DirectSpeakers”) output. 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 from channel-based to channel-based directly (such as downmixing).

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

FIGURE 6

AudioBlockFormat (Matrix)



For example, the encoding matrix element of a ‘Side’ channel will contain two 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 12

audioBlockFormat sub-elements for Matrix

Element	Sub-elements	Description	Quantity
outputChannel FormatIDRef*	–	For defining a decoding or direct matrix, this is the DirectSpeakers type output audioChannelFormat that defines the channel being decoded to.	0 or 1
matrix	coefficient	Contains the coefficients for combining other channels	1

*This element name has been editorially changed from *outputChannelIDRef*, which was the incorrect name used in the original version of BS.2076-1. Therefore ADM parsing software should be aware that *outputChannelIDRef* might occur in some files instead of *audioChannelFormatIDRef* and should be able to read both.

TABLE 13

matrix sub-elements

Sub-element	Attribute	Description	Units	Example	Quantity
coefficient	gain	Multiplication factor of another channel. Constant value.	Ratio	−0.5	0...*
coefficient	gainVar	Multiplication factor of another channel. Variable.	Ratio	clev	0...*
coefficient	phase	Phase shift of another channel. Constant value.	Degrees	90	0...*
coefficient	phaseVar	Phase shift of another channel. Variable.	Degrees	ph	0...*
coefficient	delay	Time delay of another channel. Constant value	ms (float)	10.5	0…*
coefficient	delayVar	Time delay of another channel. Variable	ms (float)	del	0…*
coefficient		Reference to other channel definition		AC_00010001	1...*

5.4.3.2.1 Sample code

```
<audioBlockFormat ...>
  <outputChannelIDRef>AC_00010001</outputChannelIDRef>
  <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”

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

The channelLock parameter will inform 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 does not perform any temporal interpolation of the position values, so the object will jump in space rather than move smoothly to the next position.

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.

The position and object size parameters definitions depend upon the coordinate system used, so they are each described in Tables 14 and 15.

For a polar/spherical coordinate system:

TABLE 14

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	abs(r)	0.9	0 or 1	1.0
width		horizontal extent	Degrees	45	0 or 1	0.0
height		vertical extent	Degrees	20	0 or 1	0.0
depth		distance extent	Ratio	0.2	0 or 1	0.0

For a Cartesian coordinate system, where the position and size values are normalized to the cube:

TABLE 15

audioBlockFormat sub-elements for Objects (Cartesian)

Sub-element	Attribute	Description	Units	Example	Quantity	Default
position	coordinate="X"	left/right dimension	Normalized Units	−0.2	1	
position	coordinate="Y"	back/front dimension	Normalized Units	0.1	1	
position	coordinate="Z"	bottom/top dimension	Normalized Units	−0.5	0 or 1	0.0
width		X-width	Normalized Units	0.03	0 or 1	0.0
depth		Y-width	Normalized Units	0.05	0 or 1	0.0
height		Z-width	Normalized Units	0.07	0 or 1	0.0

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 16

audioBlockFormat sub-elements for Objects

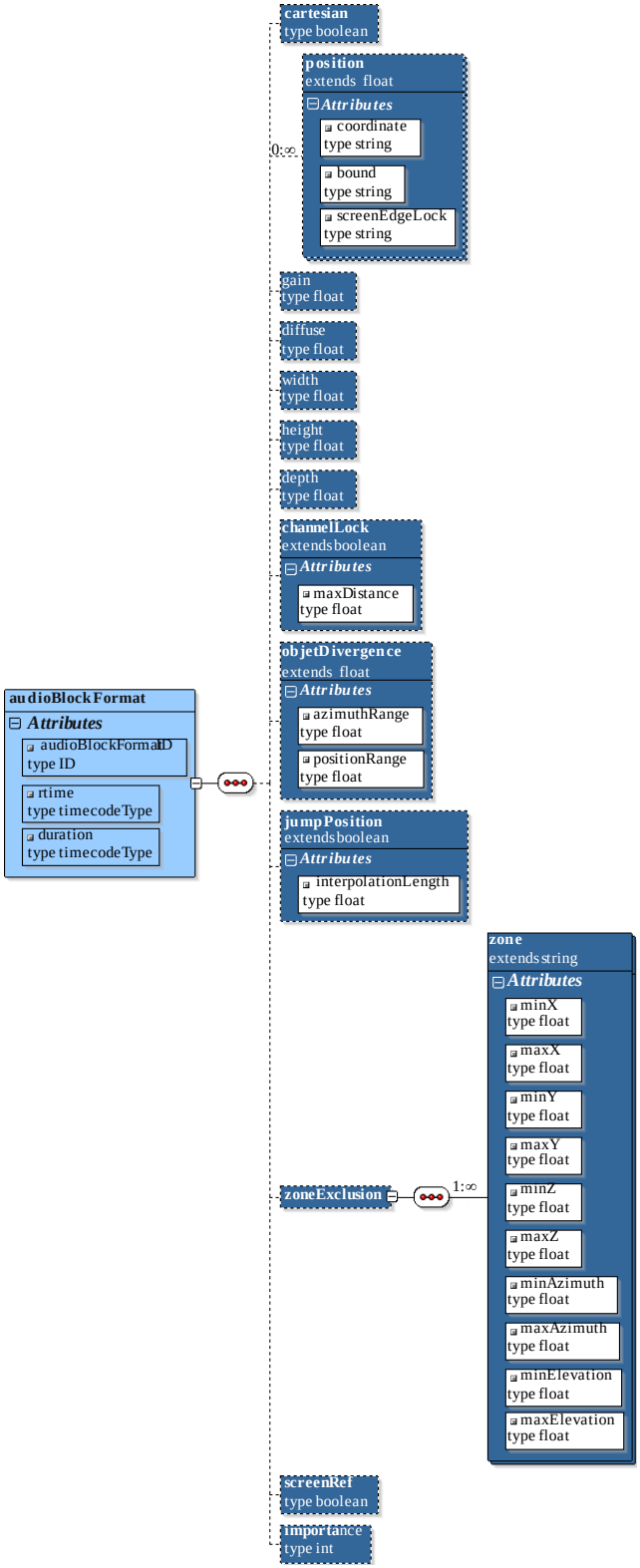
Sub-element	Attribute	Description	Units	Example	Quantity	Default
cartesian		Specifies coordinate system, if the flag is set to 1 the Cartesian coordinate system is used, otherwise spherical coordinates are used.	1/0 flag	1	0 or 1	0
gain		Apply a gain to the audio in the object	linear gain value	0.5	0 or 1	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).	1/0 flag for channelLock, float value for maxDistance in the range from 0.0 to 2.0	1, 1.0	0 or 1	0 (chanel Lock), infinity (maxDistance)
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.	0 to 1.0 for objectDivergence, 0.0 to 180.0 (angle) for azimuthRange	0.5, 60.0	0 or 1	0.0, 45.0
	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.	0 to 1.0 for objectDivergence, 0.0 to 1.0 for positionRange	0.5, 0.25	0 or 1	0.0, 0.0

TABLE 16 (*end*)

Sub-element	Attribute	Description	Units	Example	Quantity	Default
jumpPosition	interpolation Length	If jumpPosition is set to 1 the position will change instantly from the previous block's position. If set to 0 then interpolation of the position will take the entire length of the block. 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 should be shorter or equal than the block's duration.	1/0 flag for jumpPosition seconds (5d.p) for interpolation Length	1, 0.05125	0 or 1 for jumpPosition	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..*	
	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 attribite. String for a label to describe the exclusion zone	maxElevation =30 minElevation =-30 minAzimuth= -30 maxAzimuth =30 "Centre front"	1..*	
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
importance		Importance of an object. Similar to definition for audioPack, except specifically for an object.	0 to 10	10	0 or 1	10

FIGURE 7

audioBlockFormat (Objects)



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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.

When no equation is given, the HOA components are defined by the degree, order, and normalization values. Degree, order, and normalization are specified in § 10.

The equation field takes priority over the fields order, degree, normalization when present. 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 the description of customized or experimental HOA components that cannot be described by the order, degree, and normalization parameters alone.

FIGURE 8

AudioBlockFormat (HOA)

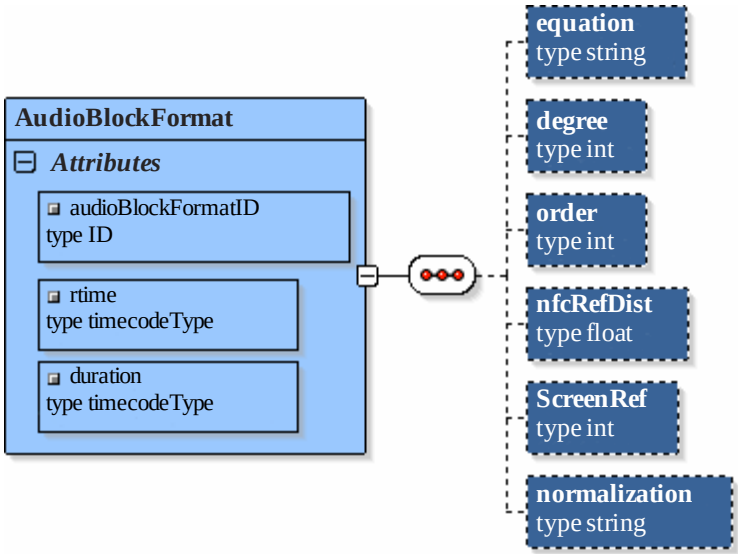

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TABLE 17

audioBlockFormat sub-elements for HOA

Element	Description	Units	Example	Quantity	Default	Required
equation	An equation to describe the HOA component		cos(A)*sin(E)	0 or 1		Optional, has priority over order, degree, normalization
order	Order of the HOA component		1	0 or 1		Optional
degree	Degree of the HOA component		−1	0 or 1		Optional
normalization	Indicates the normalization scheme of the HOA component (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 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

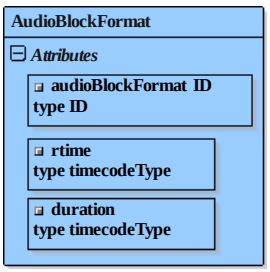
```
<audioBlockFormat ...>
  <degree>1</degree>
  <order>1</order>
  <normalization>N3D</normalization>
</audioBlockFormat>
```

5.4.3.5 If audioChannelFormat.typeDefinition == “Binaural”

This is for binaural representation of audio. Given that binaural consists of two channels, the left and right ear, this is rather simple. As the name of the audioChannelFormat will be either “leftEar” or “rightEar” there is no other metadata required in audioBlockFormat.

FIGURE 9

audioBlockFormat (Binaural)



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5.4.3.6 Sample code

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

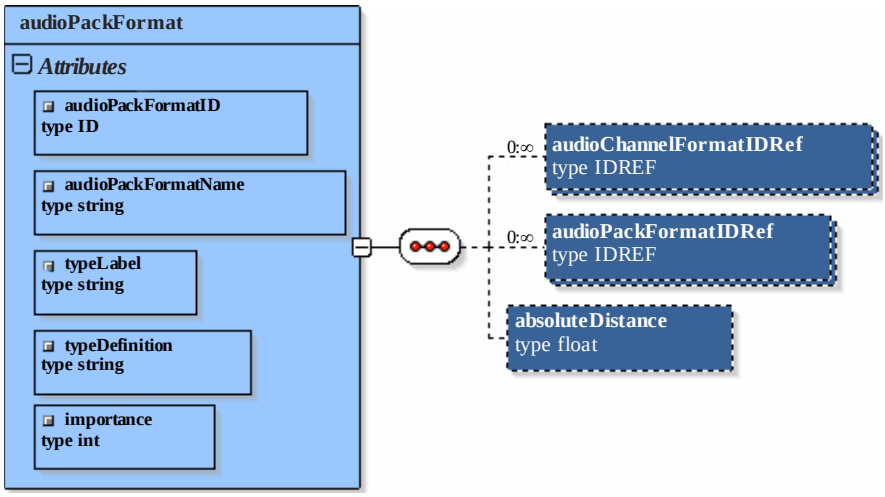
5.5 audioPackFormat

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 must match those in the referred audioChannelFormats. The sub-elements within audioPackFormat are dependent upon the typeDefinition or typeLabel of the audioPackFormat element.

FIGURE 10

audioPackFormat



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5.5.1 Attributes

TABLE 18

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*
typeDefinition	Description of the type of channel	DirectSpeakers	Optional*
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

* At least one of typeLabel or typeDefinition is required.

There are five different defined typeDefinitions:

TABLE 19

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

5.5.2 Sub-elements

TABLE 20

audioPackFormat sub-elements

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.

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.

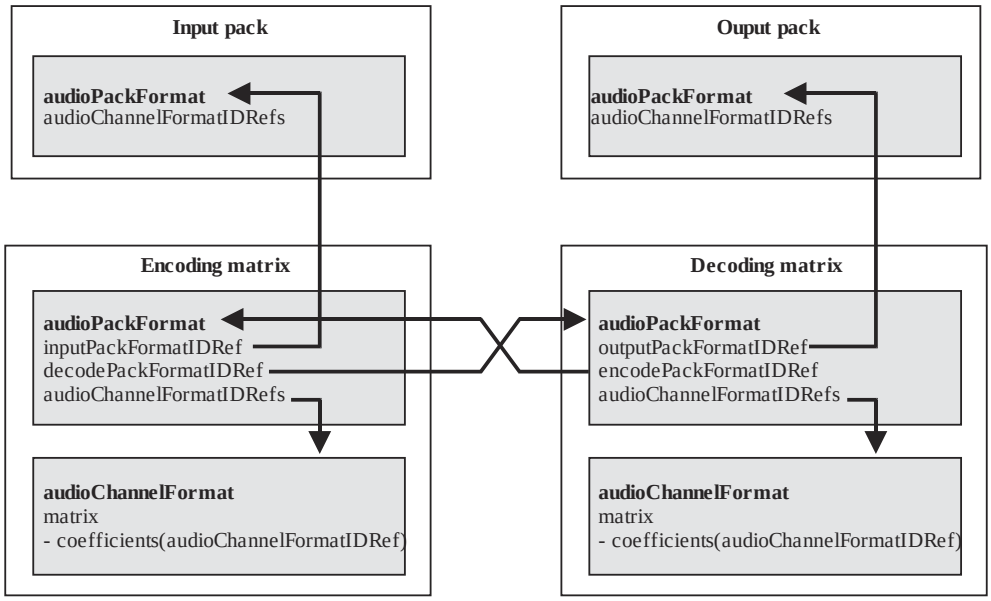
The matrix can either be an encoding, a decoding matrix or a direct matrix. An encoding matrix converts a channel-based (“DirectSpeakers”) input pack into a matrix-encoded pack. A decoding matrix takes matrix-encoded pack and converts into a channel-based output pack. Related encoding and decoding matrices can be cross-referenced.

For example, Stereo to Mid/Side would be an encoding matrix, and Mid/Side to Stereo would be a decoding matrix.

The diagram in Fig. 11 shows how encoder and decoder matrix audioPackFormats relate to each other, as well in the input and output audioPackFormats and audioChannelFormats.

FIGURE 11

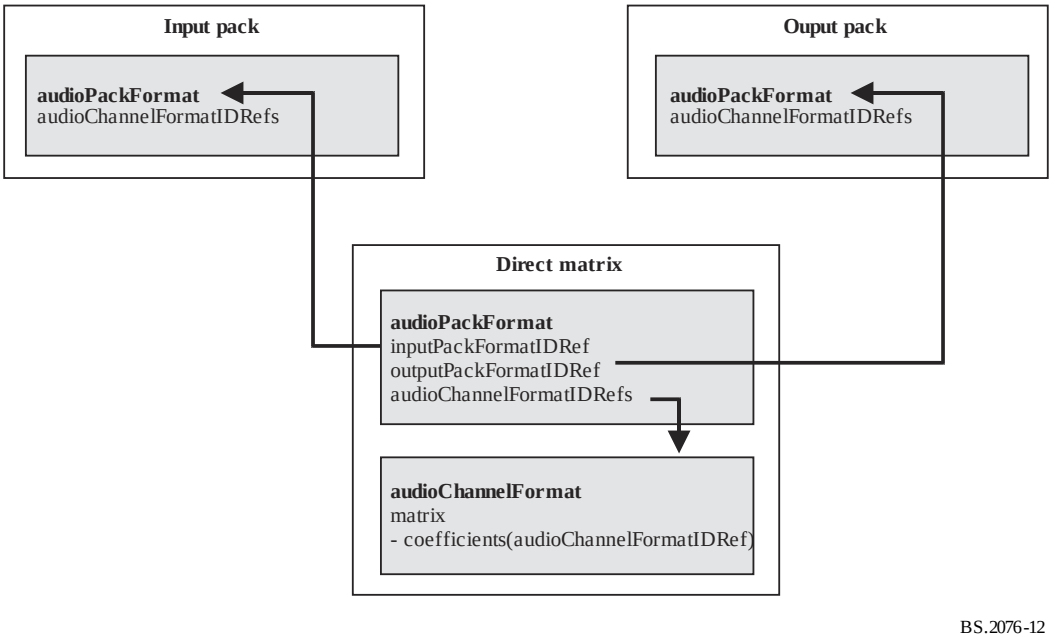
Encode/Decode Matrix relationships



The diagram in Fig. 12 shows how a direct matrix audioPackFormat relates to input and output audioPackFormats and audioChannelFormats.

FIGURE 12

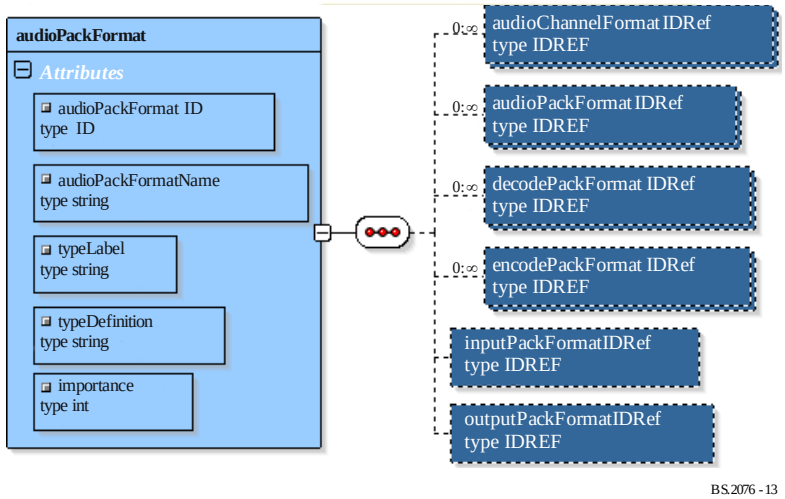
Direct matrix relationships



The structure of the Matrix version of the audioPackFormat is shown in Fig. 13.

FIGURE 13

audioPackFormat Matrix version



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 20

audioPackFormat sub-elements for Matrix

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

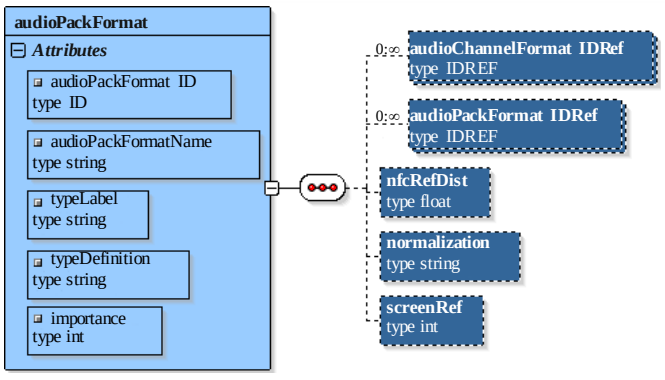
```
<audioPackFormat audioPackFormatID="AP_00021001"
audioPackFormatName="MidSide_Encode" typeLabel="0002"
typeDefinition="Matrix">
  <decodePackFormatIDRef>AP_00021101</decodePackFormatIDRef>
  <inputPackFormatIDRef>AP_00010002</inputPackFormatIDRef>
  <audioChannelFormatIDRef>AC_00021001</audioChannelFormatIDRef>
  <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. It is common that a pack of HOA components/signals will share the same normalization, NFC compensation and/or screen-relation. However when the parameters are specified within an audioBlockFormat, these values overwrite those given in the audioPackFormat.

FIGURE 14

audioPackFormat HOA version



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5.5.5.1 HOA Sub-elements

TABLE 21

audioPackFormat sub-elements for HOA

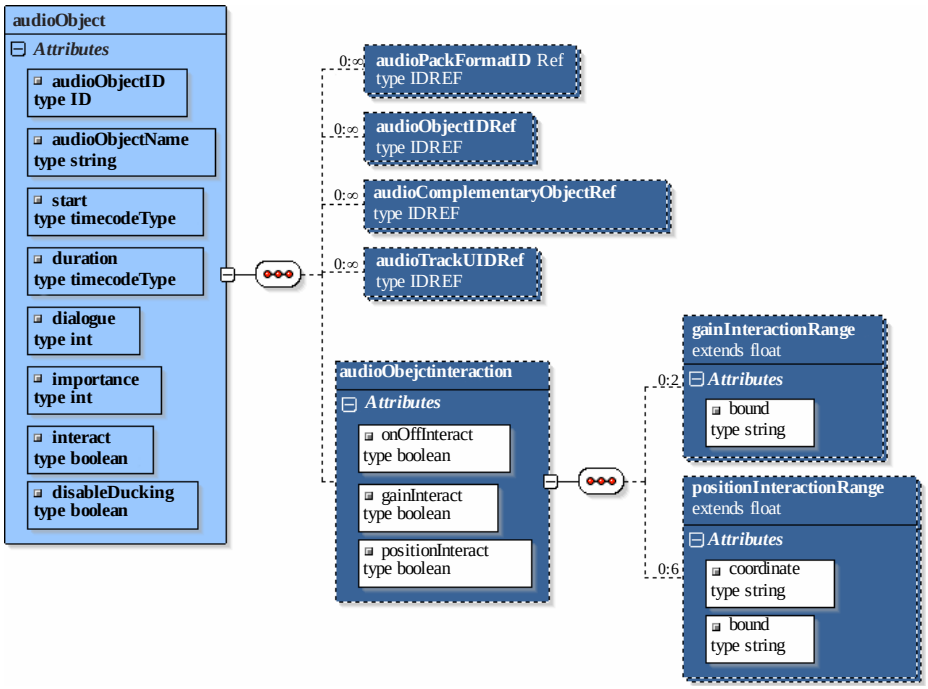
Element	Description	Units	Example	Quantity	Default	Required
normalization	Indicates the normalization scheme of the HOA content (N3D, SN3D, FuMa).		N3D	0 or 1	SN3D	Optional
nfcRefDist	Indicates the reference distance of the loudspeaker setup for near-field compensation (NFC). If no nfcRefDist is defined 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.

FIGURE 15

audioObject



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5.6.1 Attributes

TABLE 22

audioObject attributes

Attribute	Description	Example	Required
audioObjectID	ID of the object	AO_1001	Yes
audioObjectName	Name of the object	dialogue_stereo	Yes
start	Start time for the object, relative to the start of the programme	00:00:00.00000	Optional
duration	Duration of object	00:02:00.00000	Optional
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
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
interact	Set to 1 if a user can interact with the object, 0 if not.	1	Optional
disableDucking	Set to 1 to disallow automatic ducking of object, 0 to allow ducking	0	Optional

5.6.2 Sub-elements

TABLE 23

audioObject sub-elements

Element	Description	Example	Quantity
audioPackFormatIDRef	Reference to an audioPackFormat for format description	AP_00010001	0…*
audioObjectIDRef	Reference to another audioObject	AO_1002	0…*
audioComplementaryObjectIDRef	Reference to another audioObject that is complementary to the object, e.g. to describe mutually exclusive languages.	AO_1003	0…*
audioTrackUIDRef	Reference to an audioTrackUID (when using a BW64 file according to [7] this is listed in the <*chna*> chunk)	ATU_00000001	0…*
audioObjectInteraction	Specification of possible user interaction with the object.		0 or 1

If the value of audioTrackUIDRef is set to ATU_00000000 then it does not refer to a track in the file, but refers to a silent or empty track. This could useful for multichannel formats where some of the channels are not being used, so instead of storing zero value samples in the file, this silent track is used instead thus saving space in the file.

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 should only be included in one corresponding parent audioObject for each set of mutually exclusive contents. The parent audioObject with the audioComplementaryObjectIDRefs should be the one that contains the default version of the set of mutually exclusive contents.

5.6.4 audioObjectInteraction sub-element

An audioObjectInteraction element describes any possible user interaction with the corresponding parent audioObject. It should be present only if the "Interact" attribute of the parent audioObject is set to 1. In case the "Interact" attribute of the parent audioObject is set to 0, any audioObjectInteraction element should be ignored. The audioObjectInteraction element has the following attributes and sub-elements.

TABLE 24

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 25

audioObjectInteraction sub-elements

Element	Coordinate attribute	Bound attribute	Description	Units	Example
gainInteractionRange	N/A	min	Minimum gain factor of possible user gain interaction (gainMin = gain (or 1.0 if not defined) * gainInteractionRangeMin)	linear gain value	0.5
	N/A	max	Maximum gain factor of possible user gain interaction (gainMax = gain (or 1.0 if not defined) * gainInteractionRangeMax)	linear gain value	1.5
positionInteractionRange	azimuth	min	Minimum azimuth offset value of possible user position interaction	Degrees	–30.0
	azimuth	max	Maximum azimuth offset value of possible user position interaction	Degrees	+30.0
	elevation	min	Minimum elevation offset value of possible user position interaction	Degrees	–15.0
	elevation	max	Maximum elevation offset value of possible user position interaction	Degrees	+15.0
	distance	min	Minimum normalized distance of possible user position interaction	0 to 1	0.5
	distance	max	Maximum normalized distance of possible user position interaction	0 to 1	0.5
positionInteractionRange	X	min	Minimum X-axis offset value of possible user position interaction	Normalized Units	–0.5
	X	max	Maximum X-axis offset value of possible user position interaction	Normalized Units	+0.5
	Y	min	Minimum Y-axis offset value of possible user position interaction	Normalized Units	–0.2
	Y	max	Maximum Y-axis offset value of possible user position interaction	Normalized Units	0.0
	Z	min	Minimum Z-axis offset value of possible user position interaction	Normalized Units	0.1
	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">
  <gainInteractionRange bound="min">0.5</gainInteractionRange>
  <gainInteractionRange bound="max">2.0</gainInteractionRange>
  <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 change to an attribute that can be set by the user should 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 position and gain of a sound source is the combination of the attributes of the position and gain sub-elements of the *audioBlockFormat* and all the changes caused by interaction in the hierarchy of *audioObjects* that refer to the *audioBlockFormat*.

5.6.5 Sample code

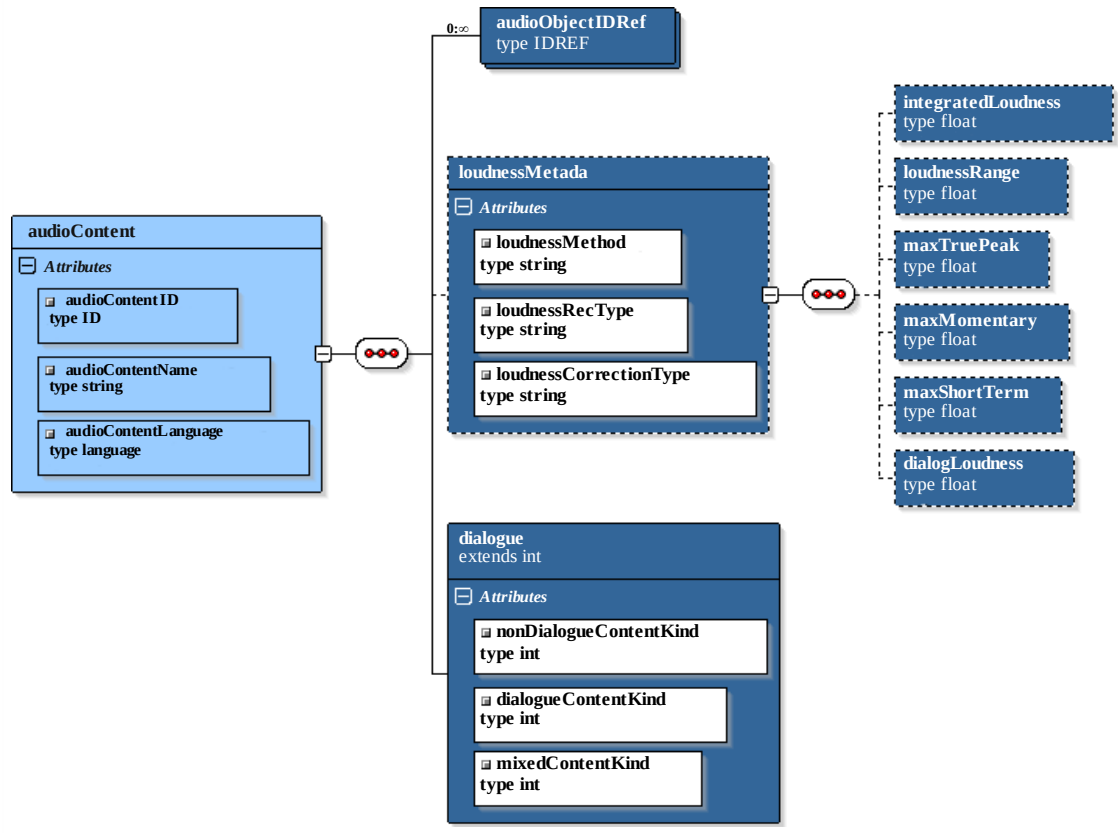
```
<audioObject audioObjectID="AO_1001" audioObjectName="Dialogue_stereo">
  <audioPackFormatIDRef>AP_00010001</audioPackFormatIDRef>
  <audioTrackUIDRef>ATU_00000001</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000002</audioTrackUIDRef>
</audioObject>
```

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.

FIGURE 16

audioContent



5.7.1 Attributes

TABLE 26

audioContent attributes

Attribute	Description	Example	Required
audioContentID	ID of the content	ACO_1001	Yes
audioContentName	Name of the content	Music	Yes
audioContentLanguage	Language of the content	en	Optional

5.7.2 Sub-elements

TABLE 27

audioContent sub-elements

Element	Description	Example	Quantity
audioObjectIDRef	Reference to audioObject	AO_1001	1…*
loudnessMetadata	See § 5.7.3		0 or 1
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

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 28

dialgoue 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 29

dialogue types

nonDialogueContentKind	**Description**
0	undefined
1	music
2	effect
dialogueContentKind	**Description**
0	undefined
1	(storyline) dialogue
2	voiceover
3	spoken subtitle
4	audio description/visually impaired
5	commentary
6	emergency
mixedContentKind	**Description**
0	undefined
1	complete main
2	mixed
3	hearing impaired

5.7.4 Loudness attributes and sub-elements

TABLE 30

loudness attributes

Attribute	**Description**	**Example**
loudnessMethod	The method or algorithm used to calculate the loudness.	“BS.1770”
loudnessRecType	The RecType indicates which regional recommended practice was followed in the loudness correction of the audio	“R128”
loudnessCorrectionType	The correction type is used to indicate what correction the audio, for example, file-based or real-time.	“File-based”

The audio could be measured by various means, relating to loudness algorithm, regional recommended practice followed, and by what correction type. The loudnessMethod or algorithm used will typically be BS.1770, but in the future, there could be newer methods. The RecType 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 CorrectionType specifies how the audio has been correlated: in an off-line file-based or a real-time process.

TABLE 31

loudness sub-elements

Element	Description	Units	Example
integratedLoudness	Integrated loudness value	LKFS/LUFS	−23.0
loudnessRange	Loudness range	LU	10.0
maxTruePeak	Maximum true-peak	dBTP	−2.3
maxMomentary	Maximum momentary loudness	LKFS/LUFS	−19.0
maxShortTerm	Maximum short term loudness	LKFS/LUFS	−21.2
dialogueLoudness	Loudness of the average dialogue	LKFS/LUFS	−24.0

NOTE – 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.

5.7.5 Sample code

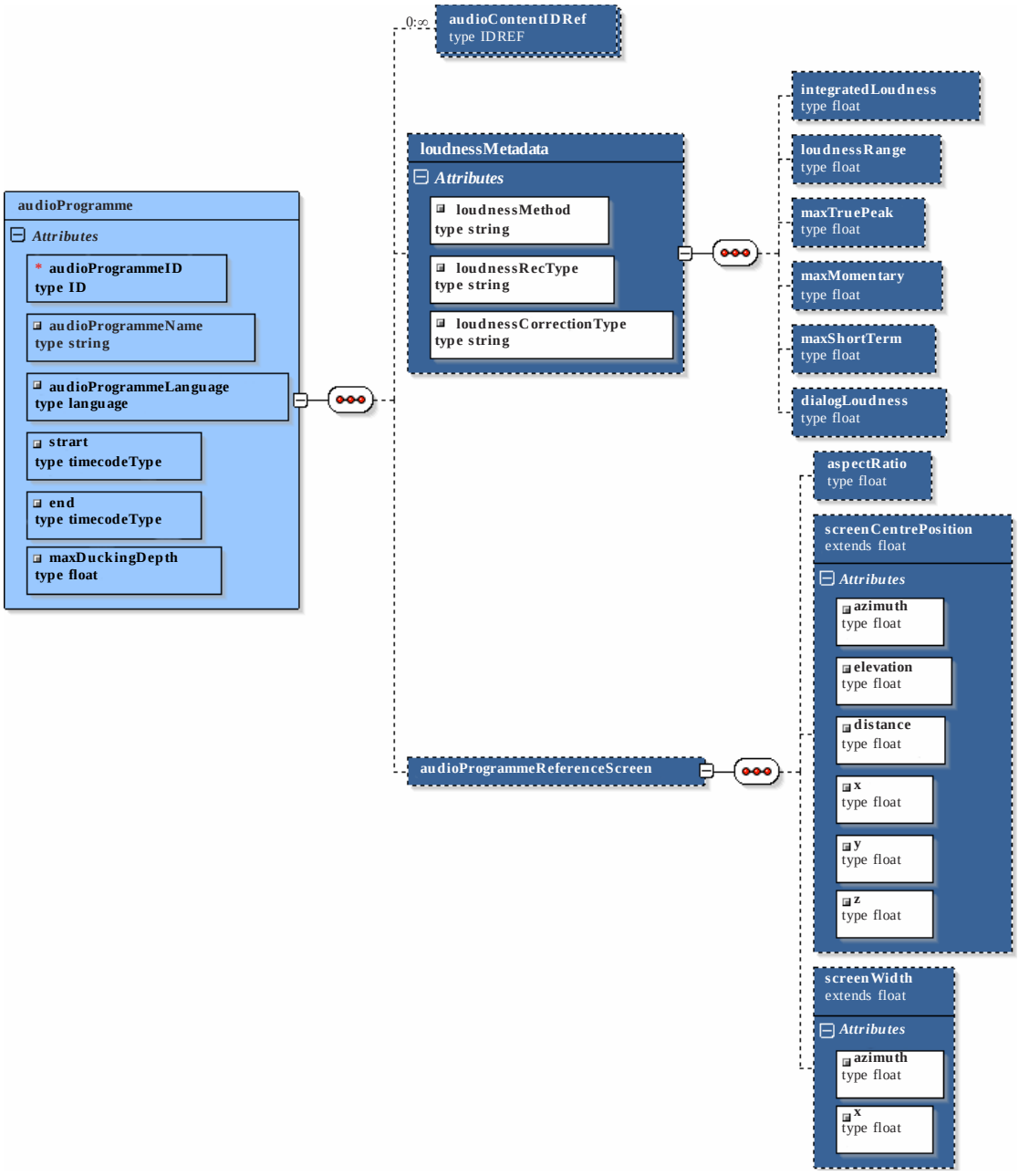
```
<audioContent audioContentID="ACO_1001" audioContentName="Music">
  <audioObjectIDRef>AO_1001</audioObjectIDRef>
  <loudnessMetadata>
    <integratedLoudness>-23.0</integratedLoudness>
    <maxTruePeak>-2.3</maxTruePeak>
  </loudnessMetadata>
</audioContent>
```

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.

FIGURE 17

audioProgramme



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5.8.1 Attributes

TABLE 32

audioProgramme attributes

Attribute	Description	Example	Required
audioProgrammeID	ID of the programme	APR_1001	Yes
audioProgrammeName	Name of the programme		Yes
audioProgrammeLanguage	Language of the dialogue	fr	Optional
start	Start time for the programme. The number of decimal places for the seconds should be a minimum of 5. There should be enough decimal places used for sample-accurate timing.	00:00:10.00000	Optional
end	End time for the programme. The number of decimal places for the seconds should be a minimum of 5. There should be enough decimal places used for sample-accurate timing.	00:10:00.00000	Optional
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 33

audioProgramme sub-elements

Element	Description	Example	Quantity
audioContentIDRef	Reference to content	ACO_1001	1…*
loudnessMetadata	See § 5.8.4		0 or 1
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 § 9.7).		0 or 1

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.

TABLE 34

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

TABLE 35

audioProgrammeReferenceScreen sub-elements

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
	X	X-coordinate of the centre of the screen	Normalized units (abs(X) ≤ 1)	−0.3
	Y	Y-coordinate of the centre of the screen	Normalized units (abs(Y) ≤ 1)	−0.2
	Z	Z-coordinate of the centre of the screen	Normalized units (abs(Z) ≤ 1)	1.0
screenWidth	azimuth	Width of the screen in polar coordinates (azimuth opening angle theta)	Degrees (0 < theta ≤180)	+58.0 or +96.0
	X	Width of the screen in Cartesian coordinates (width of the screen on the X-axis)	0 < X <= 2	0.8

5.8.4 Loudness attributes and sub-elements

TABLE 36

loudness attributes

Attribute	Description	Example
loudnessMethod	The method or algorithm used to calculate the loudness.	“ITU-R BS.1770”
loudnessRecType	The RecType 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 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 or algorithm used will typically be “ITU-R BS.1770” as defined in Recommendation ITU-R BS.1770 [5], but in the future, there could be newer methods. The RecType 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 CorrectionType specifies how the audio has been correlated: in an off-line file-based or a real-time process.

TABLE 37

loudness sub-elements

Element	Description	Units	Example
integratedLoudness	Integrated loudness value	LKFS/LUFS	−23.0
loudnessRange	Loudness range	LU	10.0
maxTruePeak	Maximum true-peak	dBTP	−2.3
maxMomentary	Maximum momentary loudness	LKFS/LUFS	−19.0
maxShortTerm	Maximum short term loudness	LKFS/LUFS	−21.2
dialogueLoudness	Loudness of the average dialogue	LKFS/LUFS	−24.0

NOTE – 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.

5.8.5 Sample code

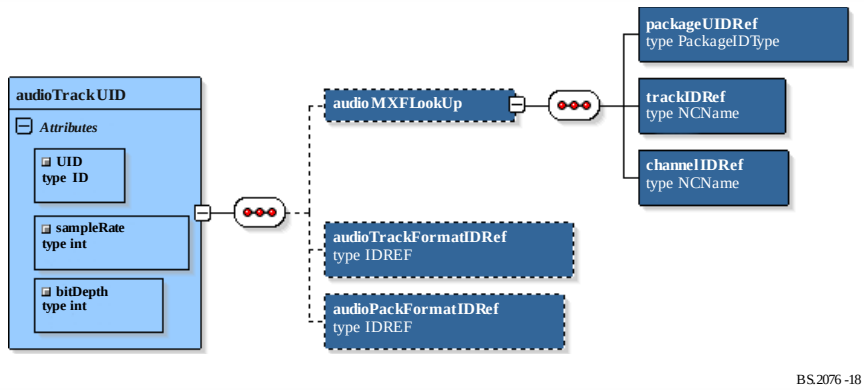
```
<audioProgramme audioProgrammeID="APR_1001" audioProgrammeName="Documentary">
  <audioContentIDRef>ACO_1001</audioContentIDRef>
  <audioContentIDRef>ACO_1002</audioContentIDRef>
</audioProgramme>
```

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. It also contains sub-elements that allow the model to be used for non-BW64 applications by performing the job of the <*chna*> chunk. When using the model with MXF files the audioMXFLookUp sub-element (which contains sub-elements to refer to the audio essences in the file) is used.

FIGURE 18

audioTrackUID



5.9.1 Attributes

TABLE 38

audioTrackUID attributes

Attribute	Description	Example	Required
UID	The actual UID value	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 39

audioTrackUID sub-elements

Element	Description	Example	Quantity
audioMXFLookUp	See § 5.9.3		0 or 1
audioTrackFormatIDRef	Reference to an audioTrackFormat description	AT_00010001_01	0 or 1
audioPackFormatIDRef	Reference to an audioPackFormat description	AP_00010002	0 or 1

5.9.3 MXF sub-elements

MXF has different meanings for the terms ‘track’ and ‘channel’ from their use in the ADM. In MXF ‘track’ is the storage medium containing audio or video, and for audio this ‘track’ can be sub-divided into ‘channels’.

TABLE 40

MXF sub-elements

Element	Description	Type	Example
packageUIDRef	Reference to an MXF package	UMID string	urn:smpte:umid: 060a2b34.01010105.01010f20.13000000. 540bca53.41434f05.8ce5f4e3.5b72c985
trackIDRef	Reference to an MXF track	int	MXFTRACK_3
channelIDRef	Reference to a channel track	Int	MXFCHAN_1

5.9.4 Sample code

```
<audioTrackUID UID="ATU_00000001" sampleRate="48000" bitDepth="24"/>
```

5.10 audioFormatExtended

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

5.10.1 Sub-elements

TABLE 41

audioFormatExtended sub-elements

Element	Description
audioProgramme	Description of the whole audio programme.
audioContent	Description of the content of some audio within the programme.
audioObject	The link between the actual audio tracks and their format.
audioPackFormat	A description of a pack of channels that relate together.
audioChannelFormat	A description of an audio channel.
audioStreamFormat	A description of an audio stream.
audioTrackFormat	A description of an audio track.
audioTrackUID	The unique identifier for an actual audio track.

5.10.2 Attributes

Attribute	Description	Example	Required
version	ADM version name	“ITU-R_BS.2076-1”	Optional

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 versions 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.2076-1”.

5.10.3 Sample code

```
<audioFormatExtended version=”ITU-R_BS.2076-1”>
  ...
</audioFormatExtended>
```

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 42

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

The yyyy part is a four digit hexadecimal number that represents the **type** of element it is, by using the typeLabel values. Currently there are 5 defined type label values and the possibility to define user custom types:

TABLE 43

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	1xxx to Fxxx	For user custom types.

The xxxx part is a four digit hexadecimal number, which identifies 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 ITU-R BS.2094 [8]. Some examples of these common defintions are shown in Table 44.

TABLE 44

Examples of common definition channel labels

Attribute	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 ITU-R BS.2094 [8]. Some examples of the common definitions are shown in Table 45:

TABLE 45

Examples of common definition for audioPackFormat

Attribute	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 should start at 1 for the first block. The yyyyxxxx values should 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. The yyyyxxxx values should match those of the reference audioStreamFormat ID.

The audioProgramme, audioContent and audioObject 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 (0000-0FFF) set aside for now may be useful in future; for example, EBU R 123 configurations may use them.

IDs with a zero value should 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 to explain. The following describes how a BW64 file does access 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.
- **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.

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 46

<chna> chunk example

Track No	audioTrackUID	audioTrackFormatID	audioPackFormatID
1	00000001	00010001_01	00010001
2	00000002	00031001_01	00031001
2	00000003	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.

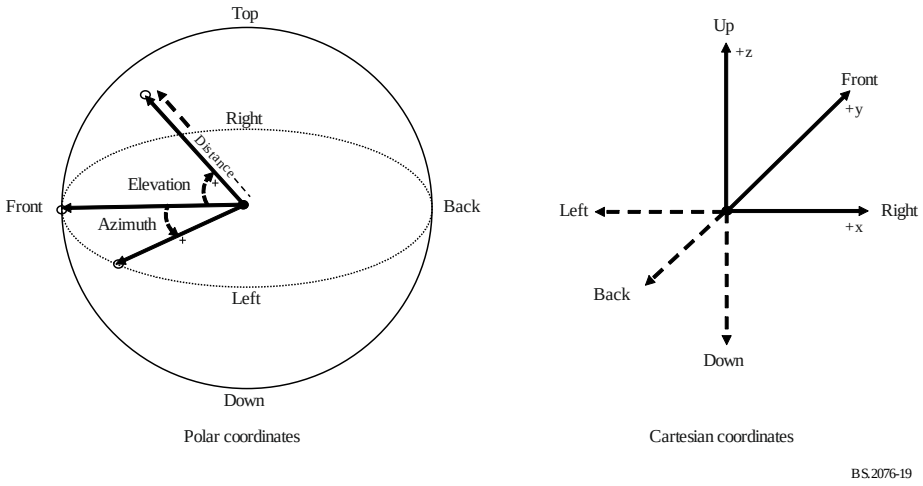
Cartesian coordinates, which is also used for object-based audio, and is supported by using X, Y and Z as the coordinate attributes. It is recommended that normalized values be used here, where the values 1.0 and −1.0 are on the surface of the cube, with the origin being the centre of the cube.

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 19

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:

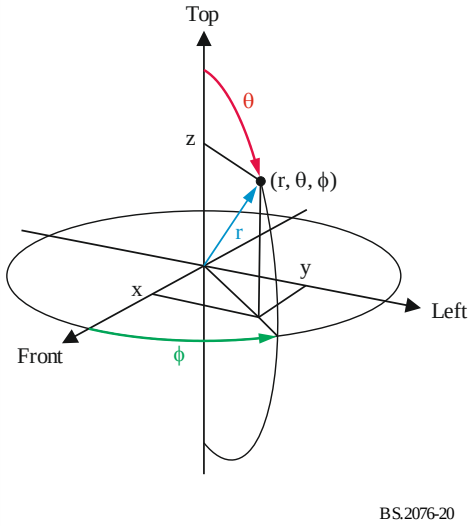
- **X** – front to back, with positive values to the front.
- **Y** – left to right, with positive values to the left.
- **Z** – top to bottom, with positive values to the top.

To avoid confusion with the other Cartesian system, it is recommended the axes be labelled ‘X_HOA’, ‘Y_HOA’ & ‘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 the following Fig. 20.

FIGURE 20

Spherical and Cartesian coordinate system as used for HOA



9 Object-based parameter descriptions

9.1 gain

The **gain** parameter is a linear gain and controls the level of the audio signal in the object. At rendering 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.

9.2 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.

9.3 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).

9.4 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** should be no longer than the block's duration.

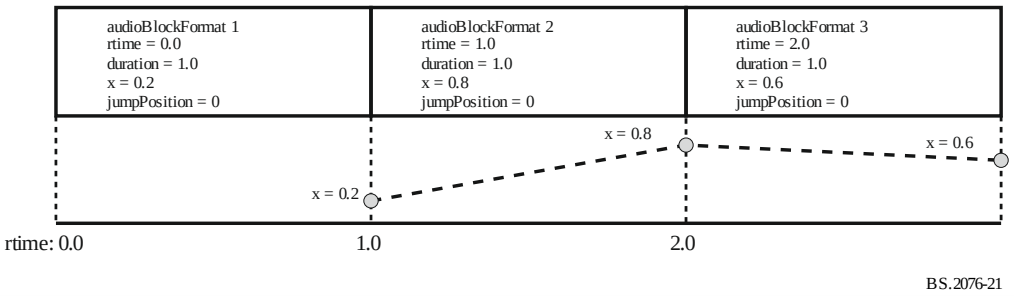
The **interpolationLength** parameter allows the interpolation of a moving object to be done over a shorter time period than the next update time. This allows the control of the crossfading of objects that may be desirable due to processing done to objects. If the value is set to zero then the object 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 dymanic parameter's value varies over time. The first example in Fig. 21 shows when jumpPosition is set to zero (or not used), so the 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 proceded by another block the x value is only known at the end of the block, and undefined before that.

FIGURE 21

Interpolation with no jumpPosition



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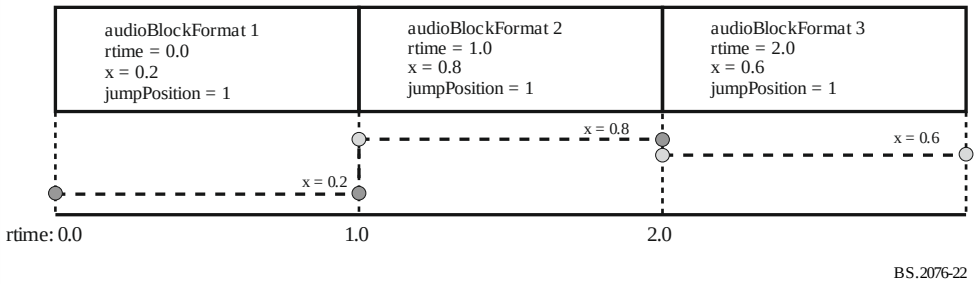
The second example in Fig. 22 shows how the value of x varies when jumpPosition is set to 1 and no interpolationLength is set. The value of x is set at the beginning of the block and maintains that value throughout its duration. This also shows that the first block has a defined position from the beginning, and thus illustrates that it is recommended to set jumpPosition to 1 for the first block in a sequence.

FIGURE 22

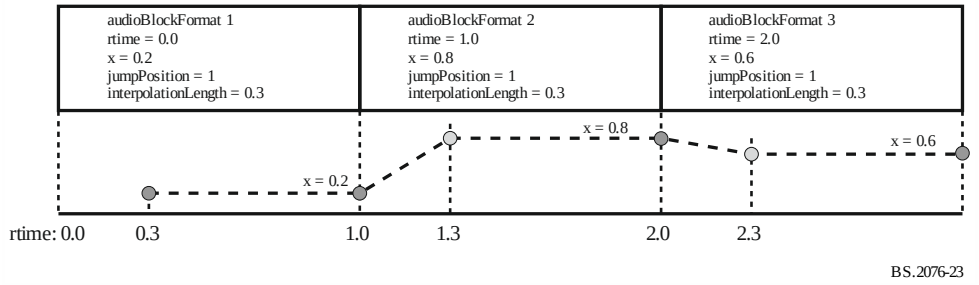
Interpolation with jumpPosition set



The third example in Fig. 23 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 23

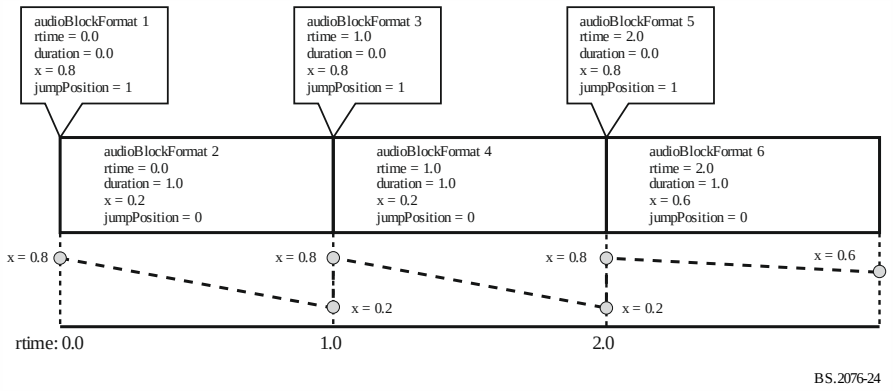
Interpolation with interpolationLength used with jumpPosition



The fourth example in Fig. 24 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 24

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, gain, and objectDivergence.

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

9.5 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.

Varying this parameter over successive blocks should be avoided.

9.6 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** attribute allows 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 45 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 0.5.

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

TABLE 47

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 configuration 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.

9.7 screenRef

The **screenRef** flag is used to indicate whether the object 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 48

Default screen size

Azimuth of left bottom corner of screen	29.0°
Elevation of the left bottom corner of screen	−17.5°
Aspect ratio	1.78 (16:9)
Width of the screen	58° (as defined by image system 3840 x 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. This results in the following values (orientation of the Cartesian coordinate axes as in § 8):

TABLE 49

Default screen size in Cartesian coordinates

X-coordinate of the centre of the screen	0.0
Y-coordinate of the centre of the screen	0.8341
Z-coordinate of the centre of the screen	0.0
Aspect ratio	1.78
Width of the screen	0.9428

9.8 importance

The **importance** parameter allows a renderer to discard objects below a certain level of importance, with 10 being the most, and 0 the least. Varying this parameter over successive blocks should be avoided.

10 Scene-based parameter descriptions

10.1 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 is the order value, m is the degree value, ϕ is azimuth, and θ is elevation

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

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

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

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

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

10.2 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 50

HOA FuMa normalization

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

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.

10.3 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.

10.4 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 § 9.7 for additional information regarding the production screen-size parameter.

10.5 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:

$$n = \left\lfloor \sqrt{\mathrm{ACN}} \right\rfloor,$$

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

11 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

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 should 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 51

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 & 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 52

Channel-based example content elements

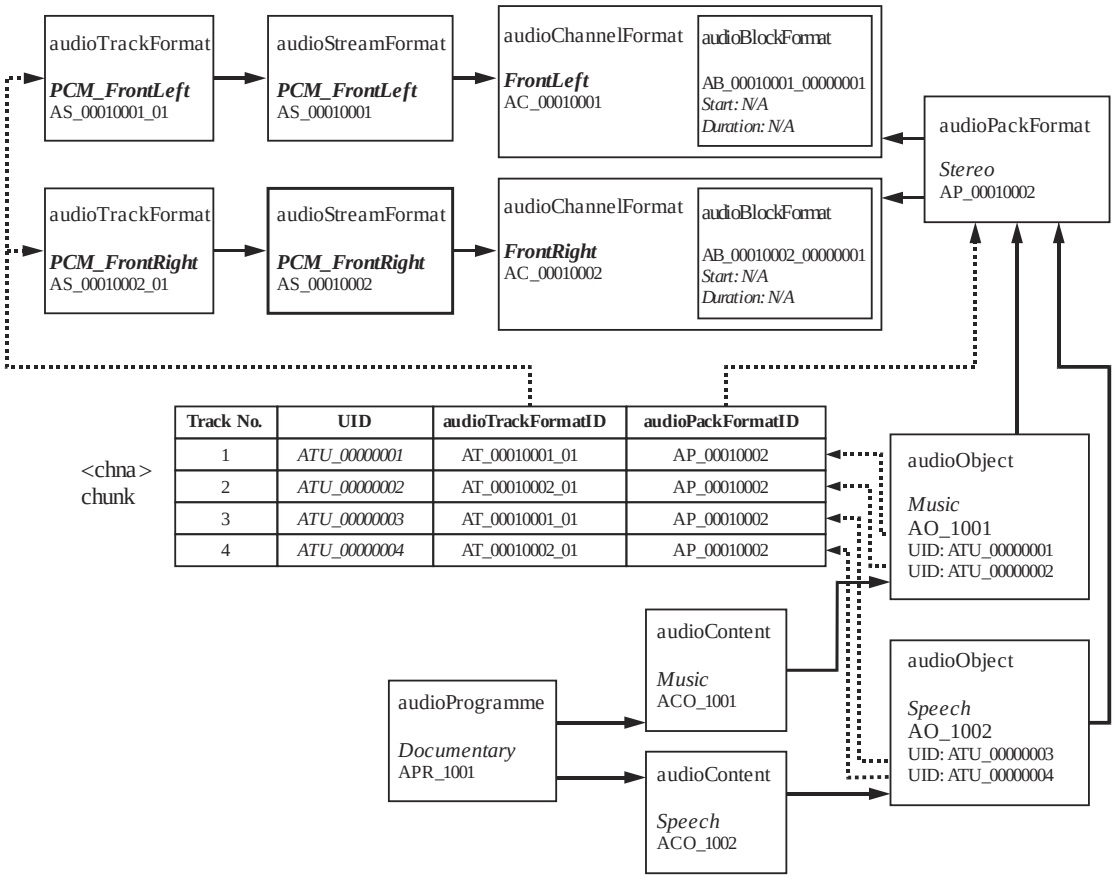
Element	ID	Name	Description
audioObject	AO_1001	Music	Object for ‘Music’, stereo format
audioObject	AO_1002	Speech	Object for ‘Speech’, stereo format
audioContent	ACO_1001	Music	Music content
audioContent	ACO_1002	Speech	Speech content
audioProgramme	APR_1001	Documentary	Programme ‘Documentary’ containing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

1.2 Element Relationships

The diagram 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 25

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 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.

2.1 Summary of elements

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

TABLE 53

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 54

Object-based exmaple content elements

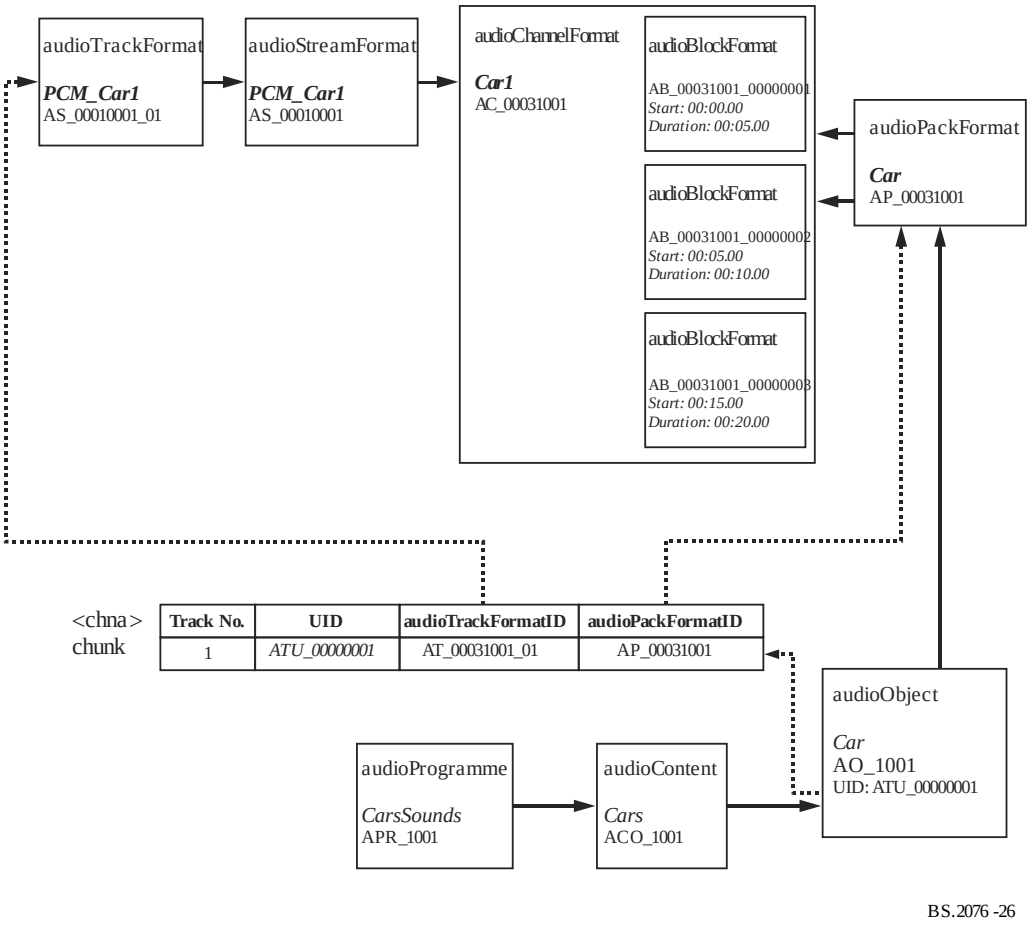
Element	ID	Name	Description
audioObject	AO_1001	Car	Object for ‘Car, stereo format
audioContent	ACO_1001	Cars	‘Cars’ content
audioProgramme	APR_1001	CarsSounds	Programme ‘CarsSounds’ containing ‘Cars’ content

2.2 Element Relationships

The diagram 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 26

Object-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 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>
```

3 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.

3.1 Summary of elements

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

TABLE 55

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
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 56

Scene-based example content elements

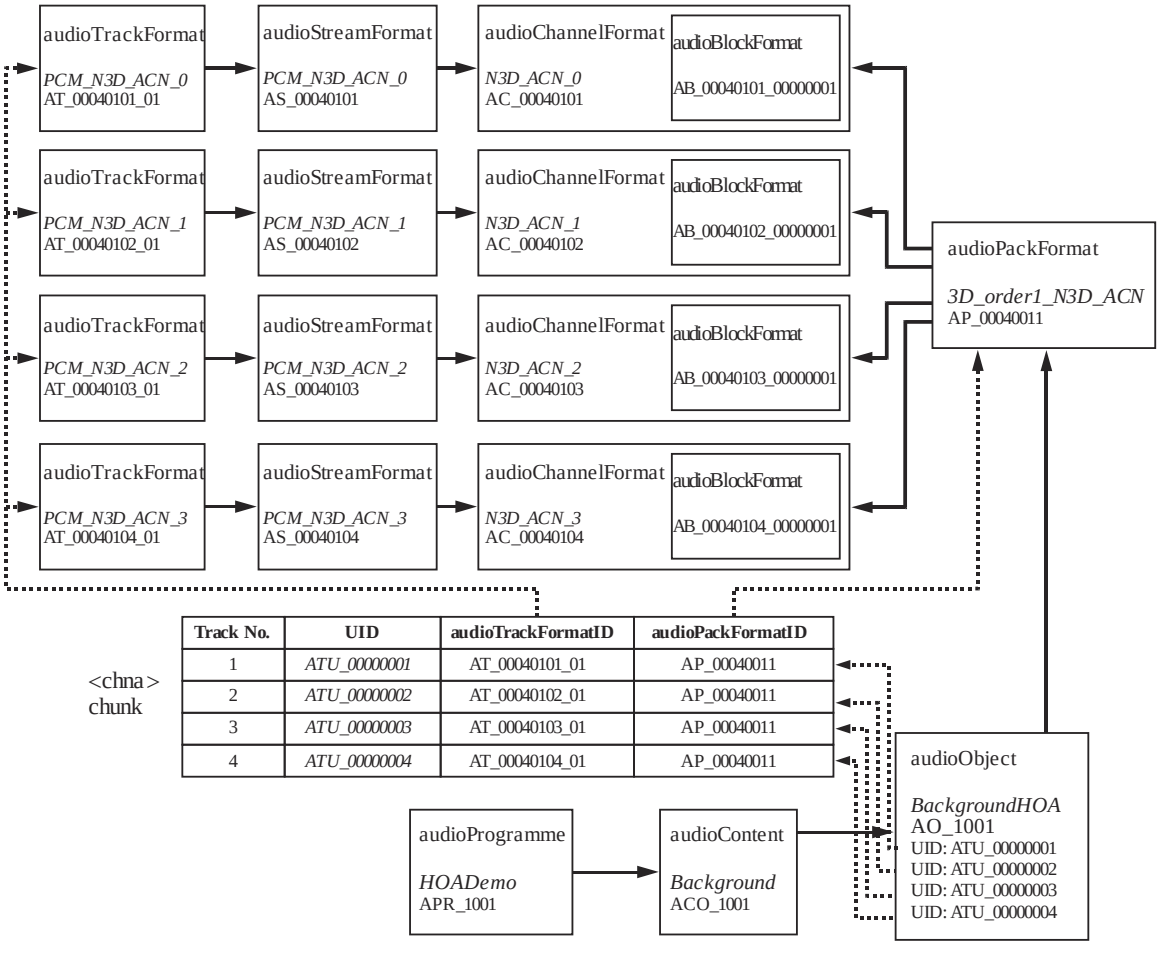
Element	ID	Name	Description
audioObject	AO_1001	BackgroundHOA	Object for 'BackgroundHOA', 1st order HOA format
audioContent	ACO_1001	Background	'Background' content
audioProgramme	APR_1001	HOADemo	'HOADemo' containing a 'Background'content

3.2 Element Relationships

The diagram shows how the defined elements relate to each other. The top half of the diagram covers the elements that describe the 4 channels of the 1st 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 27

Scene-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 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>
```

4 Material exchange format mapping example

The ADM has been designed to not only allow BW64 files to become a flexible multichannel file format, but also be incorporated by other file formats. Currently, material exchange format ((MXF) – SMPTE 377M), which carries both video and audio, has a rather limited capability in terms of specifying its audio format. The ADM could be used by MXF files in a similar way to BW64 files allowing a comprehensive format description of the audio.

MXF files often use EBU R123[1] ("EBU Audio Track Allocation for File Exchange") audio track configurations. This is a set of channel and matrix-based track allocations for between 2 and 16 track files or streams. This example will show how a particular R123 configuration can be represented by the ADM that is suitable for MXF.

This example will demonstrate how the 4a R123 configuration can be represented by the ADM. This configuration uses 4 tracks:

TABLE 57

MXF example track configuration

Track Number	Track Use	Group
1	Stereo Left (PCM)	PCM Stereo pair
2	Stereo Right (PCM)	
3	MCA (coded audio)	Multichannel audio coded stream
4	MCA (coded audio)	

4.1 Summary of elements

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

TABLE 58

MXF 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
audioTrackFormat	AT_10011001_01	CodedAudio1	Defines track as containing coded data
audioTrackFormat	AT_10011001_02	CodedAudio2	Defines track as containing coded data
audioStreamFormat	AS_00010001	PCM_FrontLeft	Defines stream as PCM
audioStreamFormat	AS_00010002	PCM_FrontRight	Defines stream as PCM
audioStreamFormat	AS_10011001	CodedAudio_5.1	Defines stream as coded data
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

[1] EBU R 123 – EBU Audio Track Allocation for File Exchange.

TABLE 58 (*end*)

Element	ID	Name	Description
audioChannelFormat & audioBlockFormat	AC_00010003 AB_00010003_00000001	FrontCentre	Describes channel as front centre with a position and speaker reference
audioChannelFormat & audioBlockFormat	AC_00010004 AB_00010004_00000001	LFE	Describes channel as LFE with a position and speaker reference
audioChannelFormat & audioBlockFormat	AC_00010005 AB_00010005_00000001	SurroundLeft	Describes channel as front right with a position and speaker reference
audioChannelFormat & audioBlockFormat	AC_00010006 AB_00010006_00000001	SurroundRight	Describes channel as front right with a position and speaker reference
audioPackFormat	AP_00010002	Stereo	Defines a stereo pack referring to two channels
audioPackFormat	AP_00010003	5.1	Defines a 5.1 pack referring to six channels

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

TABLE 59

MXF example content elements

Element	ID	Name	Description
audioObject	AO_1041	R123_4a	Object for R123 4a configuration
audioObject	AO_1002	R123_Stereo	Object for stereo
audioObject	AO_1004	R123_5.1	Object for 5.1

4.2 Element Relationships

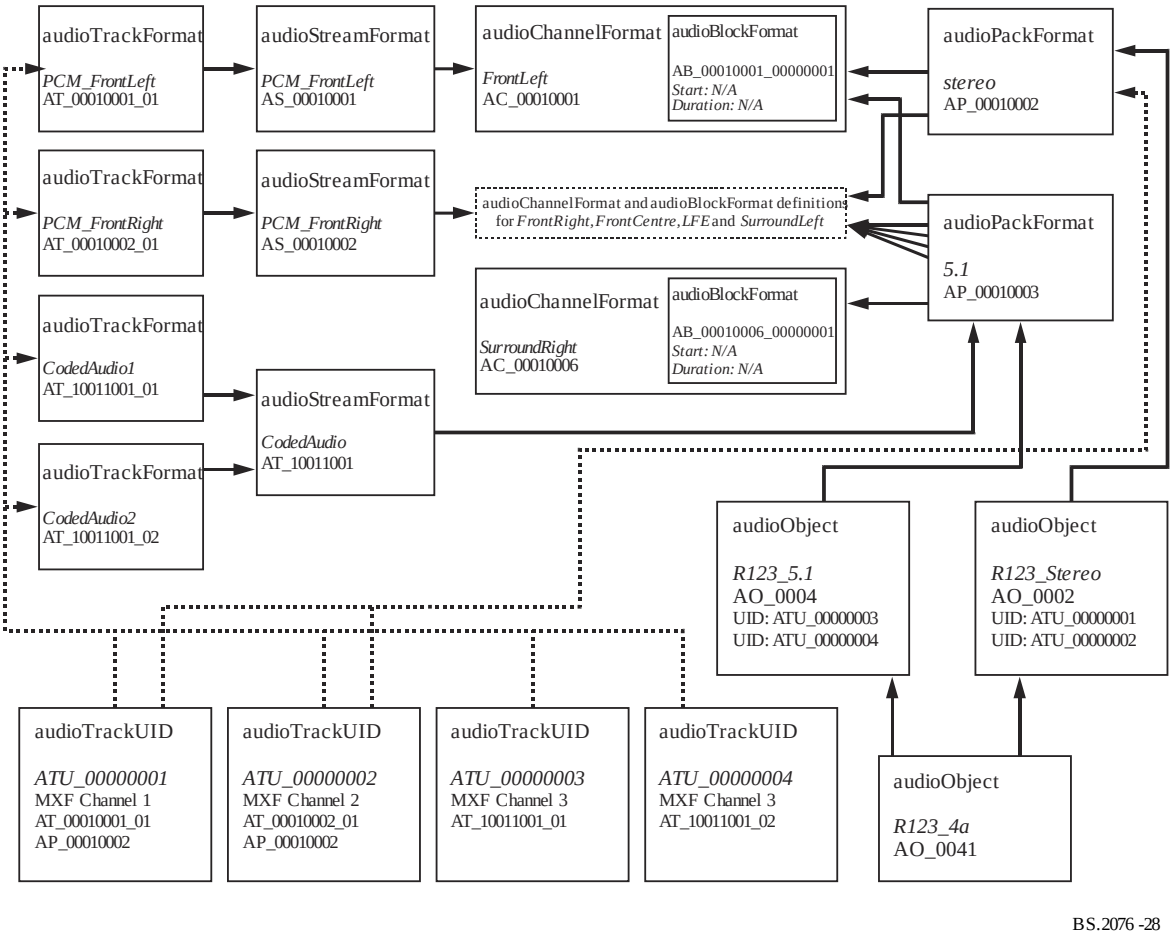
The diagram shows how the defined elements relate to each other. The top half of the diagram covers the elements that describe the two-channel stereo PCM format and the six-channel coded audio 5.1 encoded format. In the coded audio part, two audioTrackFormats refer to a single audioStreamFormat as coded audio requires that two tracks are combined to decode the audio signals. The coded audio audioStreamFormat refers to an audioPackFormat as it is representing a group of channels rather than a single one. This 5.1 audioPackFormat refers to the six audioChannelFormats that describe each channel.

The R123 4a configuration is represented by an audioObject (named ‘R123_4a’), which refers to two further audioObjects (for the stereo and 5.1 groups), which contain the references to the audioTrackUIDs. This demonstrates the nesting feature of audioObjects.

As MXF does not feature a <*chna*> chunk, it uses sub-elements of audioTrackUID to generate references to the essences within the MXF file. The audioMXFLookUp sub-element is designed to facilitate these relationships.

FIGURE 28

MXF mapping 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_00010002" audioPackFormatName="Stereo"
typeLabel="0001" typeDefinition="DirectSpeakers">
  <audioChannelFormatIDRef>AC_00010001</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_00010002</audioChannelFormatIDRef>
</audioPackFormat>

<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>
```

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

<!-- ############ -->
<!-- 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_10011001"
audioStreamFormatName="CodedAudio_5.1" formatLabel="1001"
formatDefinition="CodedAudio">
  <audioPackFormatIDRef>AP_00010003</audioPackFormatIDRef>
  <audioTrackFormatIDRef>AT_10011001_01</audioTrackFormatIDRef>
  <audioTrackFormatIDRef>AT_10011001_02</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_10011001_01"
audioTrackFormatName="CodedAudio1" formatLabel="1001" formatDefinition="data">
  <audioStreamFormatIDRef>AS_10011001</audioStreamFormatIDRef>
</audioTrackFormat>

<audioTrackFormat audioTrackFormatID="AT_10011001_02"
audioTrackFormatName="CodedAudio2" formatLabel="1001" formatDefinition="data">
  <audioStreamFormatIDRef>AS_10011001</audioStreamFormatIDRef>
</audioTrackFormat>
```

The second excerpt (below) covers the content part, in this case audioObjects and audioTrackUIDs, which should be contained within the MXF file. The audioTrackUIDs contain the audioMXFLoopUp elements that locate the essence within the MXF file.

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

<audioObject audioObjectID="AO_1041" audioObjectName="R123_4a">
```

```
  <audioObjectIDRef>AO_1002</audioObjectIDRef>
  <audioObjectIDRef>AO_1004</audioObjectIDRef>
</audioObject>

<audioObject audioObjectID="AO_1002" audioObjectName="R123_Stereo">
  <audioPackFormatIDRef>AP_00010002</audioPackFormatIDRef>
  <audioTrackUIDRef>ATU_00000001</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000002</audioTrackUIDRef>
</audioObject>

<audioObject audioObjectID="AO_1004" audioObjectName="R123_5.1coded">
  <audioPackFormatIDRef>AP_00010003</audioPackFormatIDRef>
  <audioTrackUIDRef>ATU_00000003</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000004</audioTrackUIDRef>
</audioObject>

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

<audioTrackUID UID="ATU_00000001">
  <audioMXFLookUp>
    <packageUIDRef>urn:smpte:umid:060a2b34.01010105.01010f20.13000000.540bca53.41434f05.
8ce5f4e3.5b72c985</packageUIDRef>
    <trackIDRef>MXFTRACK_3</trackIDRef>
    <channelIDRef>MXFCHAN_1</channelIDRef>
  </audioMXFLookUp>
  <audioTrackFormatIDRef>AT_00010001_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010002</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000002">
  <audioMXFLookUp>
    <packageUIDRef>urn:smpte:umid:060a2b34.01010105.01010f20.13000000.540bca53.41434f05.
8ce5f4e3.5b72c985</packageUIDRef>
    <trackIDRef>MXFTRACK_3</trackIDRef>
    <channelIDRef>MXFCHAN_2</channelIDRef>
  </audioMXFLookUp>
  <audioTrackFormatIDRef>AT_00010002_01</audioTrackFormatIDRef>
  <audioPackFormatIDRef>AP_00010002</audioPackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000003">
  <audioMXFLookUp>
    <packageUIDRef>urn:smpte:umid:060a2b34.01010105.01010f20.13000000.540bca53.41434f05.
8ce5f4e3.5b72c985</packageUIDRef>
    <trackIDRef>MXFTRACK_3</trackIDRef>
    <channelIDRef>MXFCHAN_1</channelIDRef>
  </audioMXFLookUp>
  <audioTrackFormatIDRef>AT_10011001_01</audioTrackFormatIDRef>
</audioTrackUID>

<audioTrackUID UID="ATU_00000004">
  <audioMXFLookUp>
    <packageUIDRef>urn:smpte:umid:060a2b34.01010105.01010f20.13000000.540bca53.41434f05.
8ce5f4e3.5b72c985</packageUIDRef>
    <trackIDRef>MXFTRACK_3</trackIDRef>
    <channelIDRef>MXFCHAN_1</channelIDRef>
  </audioMXFLookUp>
  <audioTrackFormatIDRef>AT_10011001_02</audioTrackFormatIDRef>
</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 60

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 61

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

TABLE 61 (*end*)

Element	ID	Name	Description
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
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 62

Personlized example content elements

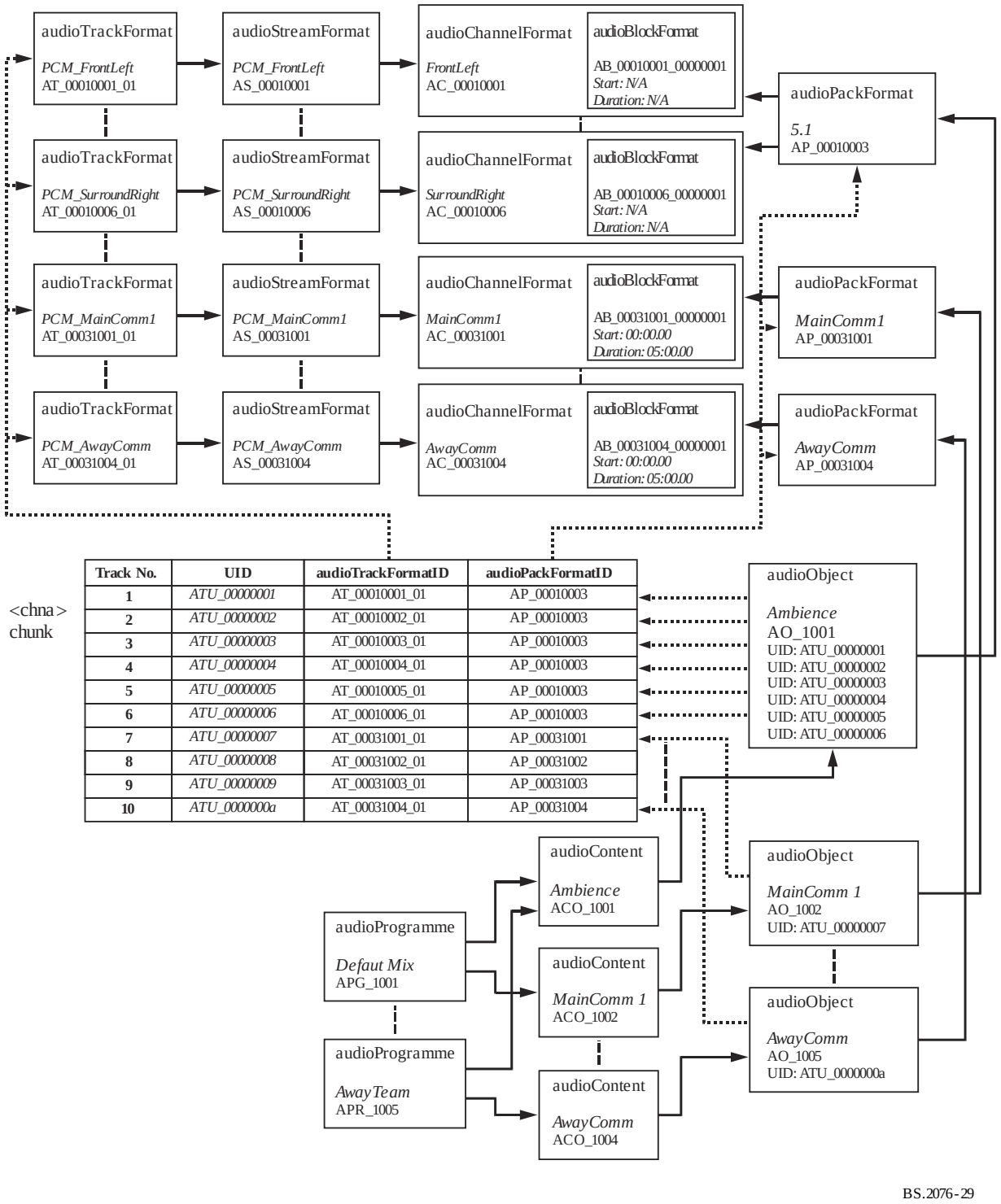
Element	ID	Name	Description
audioObject	AO_1001	Ambience	Object for ‘Ambience’, 5.1 format
audioContent	ACO_1001	Ambience	‘Ambience’ content
audioObject	AO_1002	Main_Comm1	Object for ‘Main_Comm1’, mono format
audioObject	AO_1003	Main_Comm2	Object for ‘Main_Comm2’, mono format
audioContent	ACO_1002	Main_Comm	‘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 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 29

Personalised audio example diagram



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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">200</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 63

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

TABLE 63 (*continued*)

Element	ID	Name	Description
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
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

TABLE 63 (*end*)

Element	ID	Name	Description
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
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 64

22.2 example content elements

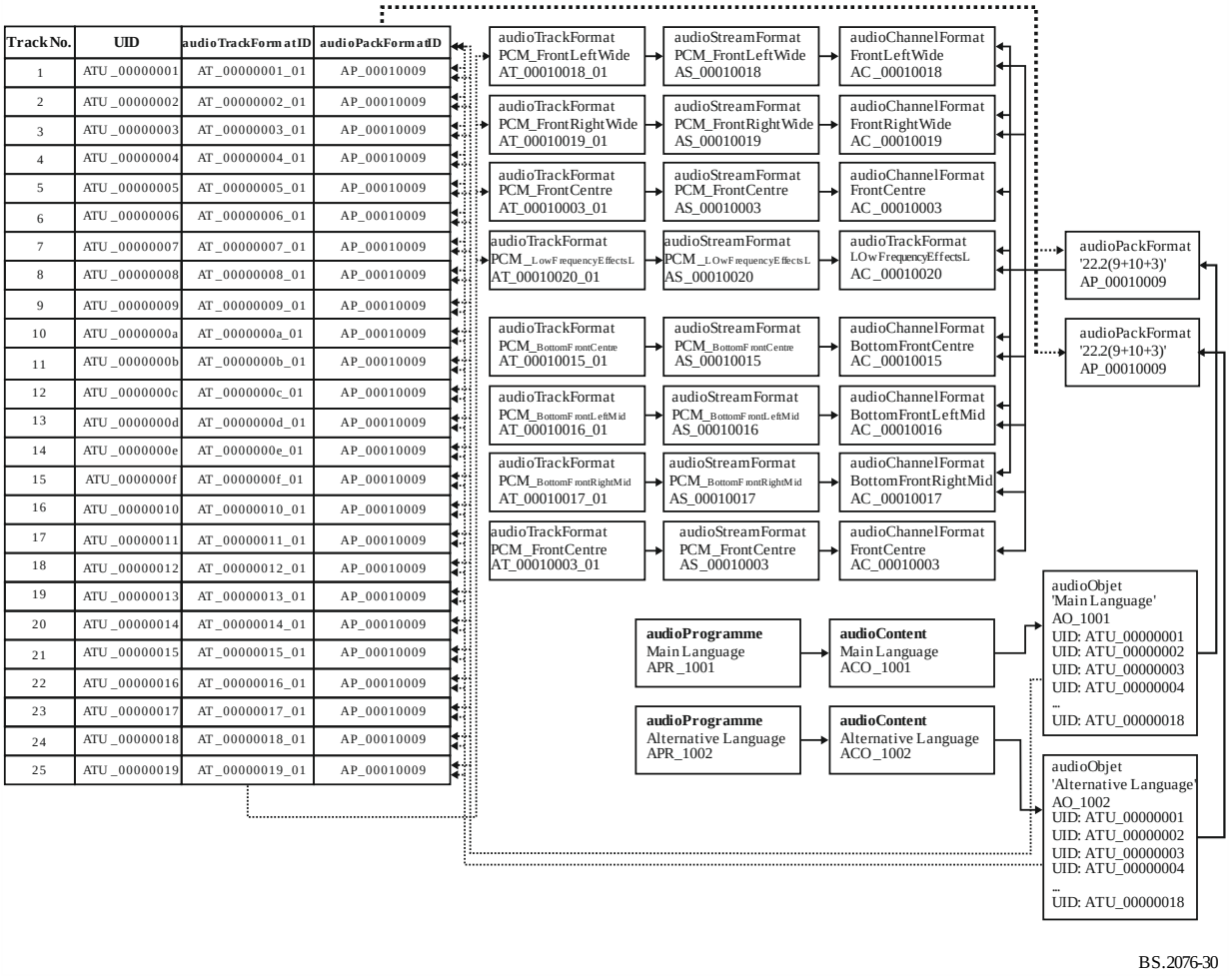
audioObject	AO_1001	MainLanguage	Object for 'MainLanguage', 22.2 format
audioObject	AO_1002	AlternativeLanguage	Object for 'AlternativeLanguage', 22.2 format
audioContent	ACO_1001	MainLanguage	'MainLanguage' content
audioContent	ACO_1002	AlternativeLanguage	'AlternativeLanguage' content
audioProgramme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

6.2 Element Relationships

The diagram 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 30

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">
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```
  <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">
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  <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>
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  <audioTrackUIDRef>ATU_00000008</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000009</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_0000000a</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_0000000b</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_0000000c</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_0000000d</audioTrackUIDRef>
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  <audioTrackUIDRef>ATU_0000000f</audioTrackUIDRef>
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  <audioTrackUIDRef>ATU_00000015</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000016</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000017</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000018</audioTrackUIDRef>
</audioObject>

<audioObject audioObjectID="AO_1002" audioObjectName="Alternative_Language">
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  <audioTrackUIDRef>ATU_00000001</audioTrackUIDRef>
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  <audioTrackUIDRef>ATU_00000019</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000004</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000005</audioTrackUIDRef>
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  <audioTrackUIDRef>ATU_00000009</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_0000000a</audioTrackUIDRef>
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  <audioTrackUIDRef>ATU_00000017</audioTrackUIDRef>
  <audioTrackUIDRef>ATU_00000018</audioTrackUIDRef>
</audioObject>

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

<audioPackFormat audioPackFormatID="AP_00010009" audioPackFormatName="22.2"
typeLabel="0001" typeDefinition="DirectSpeakers">
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  <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>
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  <audioChannelFormatIDRef>AC_0001000c</audioChannelFormatIDRef>
  <audioChannelFormatIDRef>AC_0001001e</audioChannelFormatIDRef>
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  <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>
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```
<!-- ############ -->
<!-- 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">200</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">
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    <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">200</frequency>
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    <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>
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<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>
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  </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">
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    <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>
```

```
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    <position coordinate="elevation">-30.0</position>
    <position coordinate="distance">1.0</position>
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</audioChannelFormat>

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audioChannelFormatName="BottomFrontRightMid" typeLabel="0001"
typeDefinition="DirectSpeakers">
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    <speakerLabel>B-045</speakerLabel>
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    <position coordinate="elevation">-30.0</position>
    <position coordinate="distance">1.0</position>
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</audioChannelFormat>

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

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

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

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

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

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

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

<audioStreamFormat audioStreamFormatID="AS_00010001"
audioStreamFormatName="PCM_FrontLeft" formatLabel="0001" formatDefinition="PCM">
  <audioChannelFormatIDRef>AC_00010001</audioChannelFormatIDRef>
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  <audioTrackFormatIDRef>AT_00010001_01</audioTrackFormatIDRef>
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<audioStreamFormat audioStreamFormatID="AS_00010002"
audioStreamFormatName="PCM_FrontRight" formatLabel="0001" formatDefinition="PCM">
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  <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">
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  <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">
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  <audioTrackFormatIDRef>AT_0001000c_01</audioTrackFormatIDRef>
</audioStreamFormat>

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

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

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

<audioTrackFormat audioTrackFormatID="AT_00010019_01"
audioTrackFormatName="PCM_FrontRightWide" formatLabel="0001" formatDefinition="PCM">
  <audioStreamFormatIDRef>AS_00010019</audioStreamFormatIDRef>
</audioTrackFormat>
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<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">
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</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 65

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 66

Matrix example content elements

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

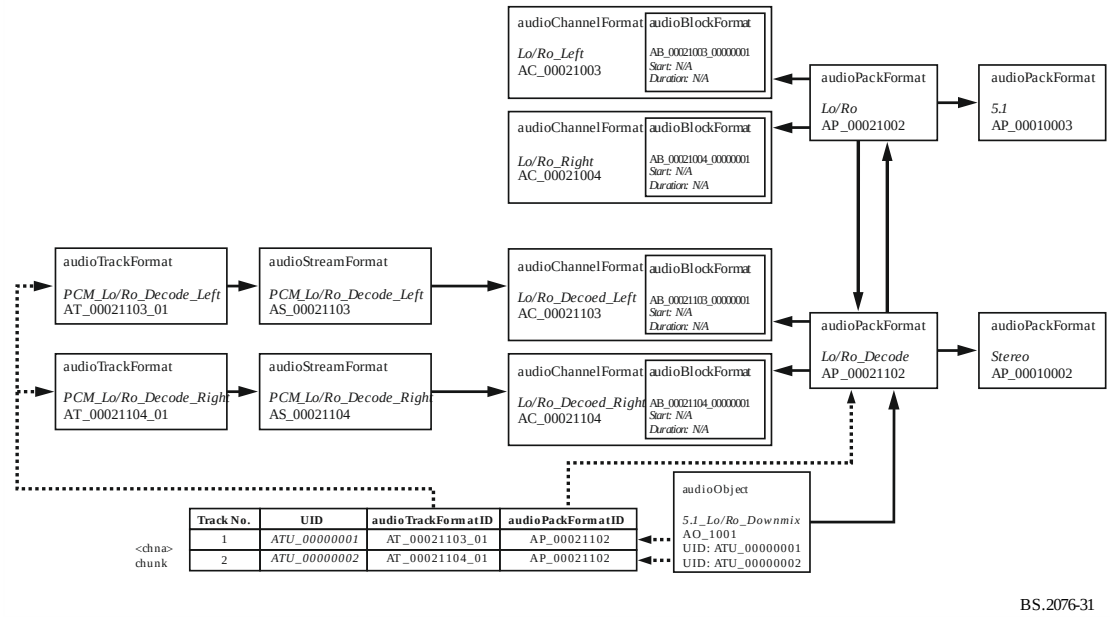
7.2 Element Relationships

The diagram 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 31

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 (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>
```