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Guidelines for the use of the ITU-R ADM Renderer

BS Series
Broadcasting service (sound)



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Note: This ITU-R Report was approved in English by the Study Group under the procedure detailed in Resolution ITU-R 1.

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(2019-2022)

1 Overview of ITU-R ADM Renderer**1.1 Introduction**

Advanced Sound Systems¹ (AdvSS) technology² is a new challenge for the broadcast and broadband industries. Users are strongly encouraged to share their experiences with the ITU-R to help create the most valuable documentation for AdvSS. In particular the experiences of content creators and system developer are very much welcomed.

This Report is intended to provide guidelines for the use of the ITU-R ADM Renderer, which is specified in Recommendation ITU-R BS.2127, and which is a complementary component of the ITU-R Advanced Sound System, specified in Recommendation ITU-R BS.2051 and ADM metadata specified in Recommendation ITU-R BS.2076.

The ADM Renderer can be seen as part of the evolution, or an extension, of mixers and down-mixers that are often used today, where the principal of allowing creative control of the listening experience is continued or extended into the environment of AdvSS. The ADM Renderer is also a bridge between today's audio production and the new world of AdvSS.

It is expected that future sound systems used for audio-visual media will include the ITU-R's AdvSS. This technology is intended to provide an improved sound experience that can be more 'immersive' for users, and/or provide additional audio signals to give users a more personalised experience. AdvSS require new signal formats to be used, and they may require a greater number of listening-room loudspeaker positions or specialised sound bars (or possibly if used, binaural headphones) than is needed for existing stereo and 3/2 multichannel sound systems specified in Recommendation ITU-R BS.775. The ADM Renderer and its functionality specified in Recommendation ITU-R BS.2127 is based upon known methods that are currently being deployed in production/delivery and reproduction systems for AdvSS/NGA today.

NOTE – In this Report the term 'ADM Renderer' is used to mean the ITU-R ADM Renderer.

1.2 Audio elements and their uses

The ADM Renderer in this case generates the required loudspeaker signals from 'audio elements' that are input to it via a delivery platform. These 'audio elements' are combinations of a particular sound and the required signalling ('metadata') that define how the sound should be reproduced by the receiver. There are three types of audio elements.

- 1 Channel-based
- 2 Object-based
- 3 Scene-based.

Each of these has unique attributes:

¹ Recommendation ITU-R BS.2051 – Advanced sound system for programme production.

² Sometimes known as Next Generation Audio, of which AdvSS is one application.

- Channel-based – the format essentially used for today’s audio: mono, stereo, and multichannel sound systems, where signals correspond to positions of reproduction loudspeakers, and can be fed directly to them.
- Object-based – where sound ‘objects’ are recorded, and the mixing and panning information is recorded with them, but not executed until the sound is reproduced.
- Scene-based – where sound is recorded in standard directional patterns that can be transformed to any desired reproduction geometry. This is also known in its basic form as ‘Ambisonics’ recording, though a more developed form, Higher Order Ambisonics (HOA), is also used.

The ADM Renderer converts the audio elements to audio signals to feed for loudspeaker configurations or headphones. It may need to address any or all three types of audio elements. The ADM Renderer can be implemented in hardware or software, noting that there may be an impact on the performance and functionality in each case.

The ADM Renderer may avoid the need for multiple version masters for different encoding/transmission systems as well as playback systems. It has the potential to save time, cost, and/or enhance the audience experience, depending on the system configuration.

As content creators and sound engineers adopt advanced sound system technologies, renderers will become a necessary utility in production, postproduction and for delivery to broadcasters. Versions of the renderer will also be part of domestic receiving equipment.

The basic principles of AdvSS are outlined in Recommendation ITU-R BS.2051. The ADM Renderer is specified in Recommendation ITU-R BS.2127, which provides a reference interpretation of the ADM metadata specified in Recommendation ITU-R BS.2076.

1.3 Renderer implementations

As noted in § 1.2, a renderer could be implemented either as dedicated hardware or as software. The cost, size and wiring would therefore be similar to other audio processing equipment, depending on the design and capabilities of the unit.

Depending on the application, renderers may be simple to use, or they may require more sophisticated control and configuration. Renderers that are very simple to use, or transparent to the user, would be desirable in a broadcast or broadband receiver. Renderers with more sophisticated control and configuration options may be needed to meet a sound engineer’s production requirements, and to arrange the format required to be delivered to the broadcast or broadband system.

The data rate of the audio element metadata is usually a small fraction of the total audio data rate, but an overhead need to be allowed with streaming or broadcast to accommodate it.

Renderers are necessary in media receivers for consumer use and will be included in appropriate future home entertainment systems. To encourage suppliers to offer equipment with the best listening experience in home entertainment systems, it can be valuable that there is competition for quality/cost in the home systems that different companies provide. Thus the specifications and flexibility of the renderer used in the design of the domestic receiver should be a matter for the manufacturers themselves, provided they can interpret appropriately the audio elements.

Programme makers and those who monitor and check delivery however do necessarily need a renderer that can be made available by multiple manufacturers. This will enable uniformity in the delivery of the rendered format, and the experience the user will have with their delivered media content, given that it is delivered in the correct format.

Programme making can be needed in ‘real-time’ or following postproduction in ‘non-real-time’. Renderers will be needed to cope with both of these circumstances. Currently, a software

implementation of the ADM Renderer is available (link to the software given in Recommendation ITU-R BS.2127) which can be used for non-real-time production.

The ADM Renderer specified in Recommendation ITU-R BS.2127 can thus be used for programme production, programme monitoring, and where needed for subjective evaluations (given other elements of the methodology are standardised). It may also serve as a guide for renderers in domestic equipment.

1.4 The options and usage for the ADM Renderer

The object sound signals delivered for AdvSS are described using positional metadata which uses either spherical coordinates to indicate the sound's relative direction from the listener or Cartesian coordinates to indicate the sound's location in the room. The ADM Renderer can decode and interpret both types of coordinates, and if needed, can convert between them, although such conversion cannot by nature be exact.

This conversion is not invertible, so conversion back and forth should be avoided. The user of the ADM Renderer can make a choice based on how the content was produced, and the likely media user's environment. The ADM Renderer specification also includes information on an alternative Point Source Panner should it be required.

Having a single standardised production renderer will bring greater consistency to the process of AdvSS content production and delivery to the end user. It should increase production levels, and thus eventually result in lower costs and more widely used AdvSS. The alternative would be for programme makers to buy proprietary equipment which, although satisfactory, may restrict the programme maker into using that kind of equipment.

Using the ADM Renderer, the content provider will know that, if they buy end user equipment that conforms to the ITU-R Recommendation, they will be able to cope with all eventualities for coordinate systems and will be able to experience what the listener will experience with his/her programme. Content makers will be 'future proofing' their investment in production equipment, which will, following wider use and volume production, become less expensive.

The interfaces and electrical connections should be straightforward as the 'input' is essentially the baseband decoded received signal, audio and metadata. The audio 'output' would be wired or wireless connections to the loudspeakers.

The user will have to select the option of Coordinate system, and if available in their equipment, the Point Source Panner. The user will need to input the details of the loudspeaker arrangement in use unless this is done automatically by the equipment. How much of the configuration is automated will depend on how the equipment is designed and implemented, but in principle operation should be relatively simple. Operator training and familiarisation equipment manuals will be needed.

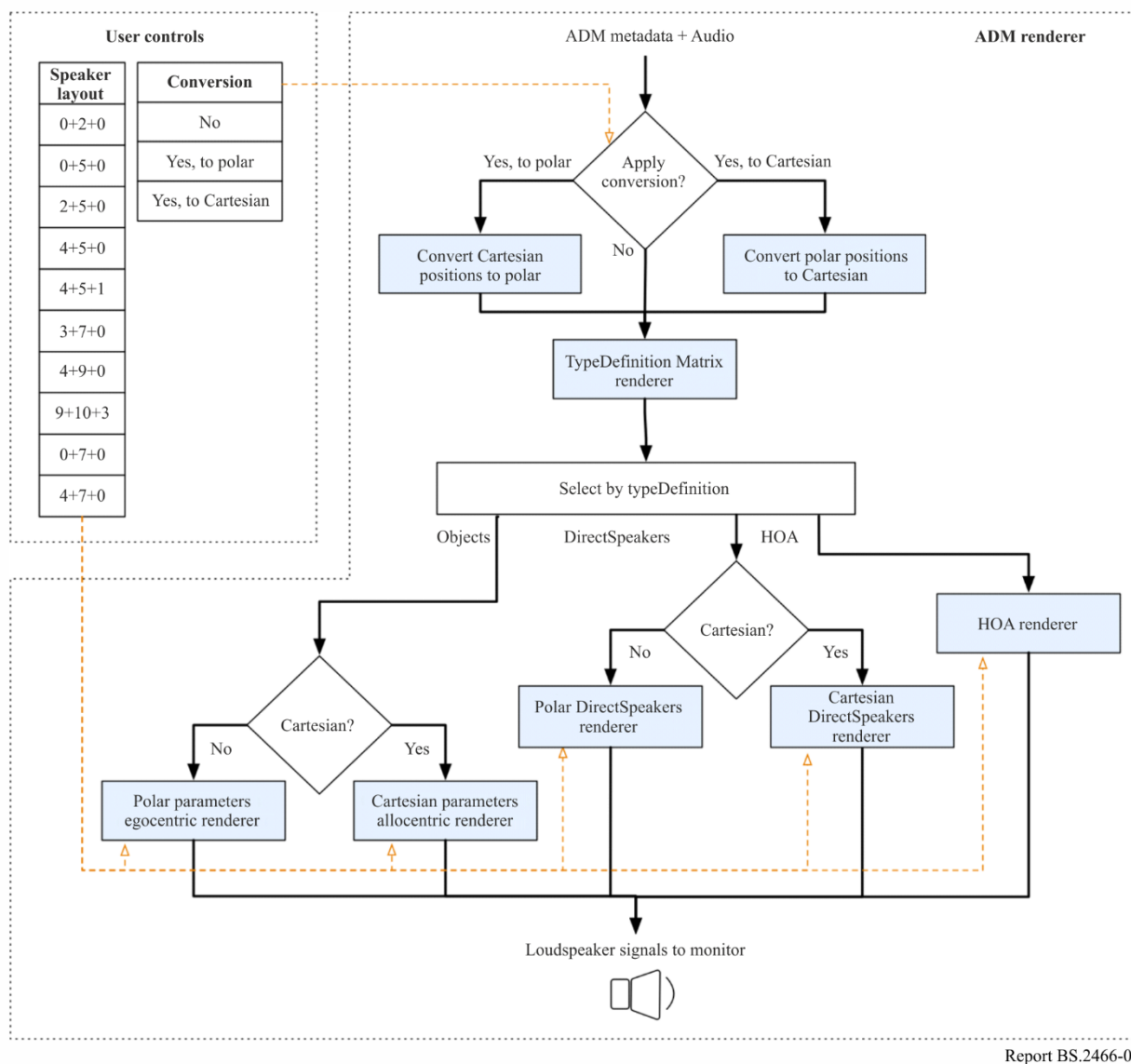
The media production team will need training and practice in content production using AdvSS. It will open up new and exciting media experiences for sound producers, viewers and listeners, and challenge the creativity of content production teams. The media world will need to plan the migration to the new audio environment, coordinating the production of programmes with the availability of suitable reception systems. It may be appropriate, for example, to plan the migration based on major steps in delivery systems, such as combining it with the use of UHD TV.

The ADM Renderer specification was created to serve the media community, and to encourage and accelerate the use of AdvSS. It will serve a need for a standardised system for use in programme production and monitoring and, if needed, quality evaluations. It also will help equipment manufacturers with the design of renderers for consumer equipment.

The reproduction of AdvSS in the home may be expected to use a loudspeaker set up which applies loudspeaker positions from those specified in Recommendation ITU-R BS.2051. The loudspeaker

positions are input to the renderer to provide the correct inputs and co-ordinates to achieve the programme maker's / sound engineer's intent. Specially designed sound bars may function by creating faux loudspeaker positions.

FIGURE 1
Simplified architecture and user controls overview



Report BS.2466-01

The supported target loudspeaker layouts include 0+2+0, 0+5+0, 2+5+0, 4+5+0, 4+5+1, 3+7+0, 4+9+0, 9+10+3, 0+7+0, and 4+7+0 systems (per Recommendation ITU-R BS.2051). The ADM input file may contain audio description for one DirectSpeakers layout, e.g. 4+9+0, while the specified target may be a different layout, e.g. 0+5+0. If the target layout includes fewer loudspeakers than the number of loudspeakers in the DirectSpeakers configuration, the ADM Renderer acts as a down-mixer. However, if the target layout includes more loudspeakers, the audio signal associated with each DirectSpeaker channel will be directed to the nearest target loudspeaker (i.e. no up-mixing of the audio content).

The ADM Renderer supports a number of optional parameters that allow the specification of, among other things, the real loudspeaker positions and screen dimensions of a reproduction setup.