EBU

OPERATING EUROVISION AND EURORADIO

# TR 045

## WHY BROADCASTERS NEED AN OPEN, CODEC-INDEPENDENT WORKFLOW FOR NGA PRODUCTION DEPLOYMENT

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## Abstract

The quality of experience of television viewing continues to rise. Sound is a vital part of television and as well as bringing new heights to the televisual experience, Next Generation Audio (NGA) will enable more services. The technology for NGA is here now, but it will not achieve its potential if nothing is done to overcome the industrial fragmentation of NGA production systems, all essentially doing the same things in an incompatible way.

The EBU aim is to see the Audio Definition Model (ADM) and its serial version, the sADM becoming the backbone of all NGA systems throughout the entire audio chain, from acquisition to production, archive, distribution and reproduction with audio tools (e.g. DAWs, consoles, authoring tools, etc.).

The ADM is a formidable specification and it is intended to define ADM "profiles" as agreed subsets of the ADM, which should be used for specific applications (e.g. production, contribution, distribution, etc.). The EBU's aim is that these profiles will contain mapping instructions for a defined transcoding between profiles and to commercial delivery formats.

Furthermore, the EBU envisions the wide adoption and integration of the EBU ADM Renderer (EAR, specified in EBU Tech 3388) along the end-to-end chain, with transparent and compatible conversions between ADM profiles and encoder specific interfaces.

Adoption of the EAR in production (equipment) will almost inevitably involve some certification process, as well as the promotion of an Open NGA label.

This report discusses these issues in some depth.

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# Why broadcasters need an open, codec-independent workflow for NGA production deployment

| *EBU Committee* | *First Issued* | *Revised* | *Re-issued* |
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**Keywords:** Audio Definition Model, ADM, sADM, Next Generation Audio, NGA, renderer, EBU ADM Renderer, EAR, workflow, production

## 1. Introduction

Media technology is continuously subject to new developments and major changes. More powerful computers, increased efficiency of delivery methods and advances in research are pushing the evolution and the demand for better media experiences. Besides the current changes in the video domain where Ultra High Definition (UHD), High Dynamic Range (HDR) and High Frame Rate (HFR) are rolled out in consumer products and broadcast workflows, audio production and distribution is also facing a major leap. So-called Next Generation Audio (NGA) technologies and systems are becoming established on the market, providing great improvements for both the audience and the production and offering elegant solutions to several problems faced by media organizations.

NGA programme material is multi-purpose and adaptable, allowing NGA-literate receivers to render a suitable output from it for any given playback system and environment, and freeing broadcasters from the need to produce multiple versions of a programme. The basic principle of audio productions, however, will be very similar to today and sound engineers will easily adapt the new technology. The expected costs will be comparable to a traditional channel-based production but with the strong advantage of scalable usage. Considering the growing numbers of platforms, end-devices and systems which a broadcaster needs to serve, the so-called object-based production will eventually save the broadcaster a significant amount of money.

Figure 1 contrasts the basic principles of a traditional, channel-based audio workflow with an object-based approach. Object-based audio is the key technology behind NGA and requires the introduction of certain parameters and metadata (e.g. position, gain, etc.) to be delivered along with the audio signal.

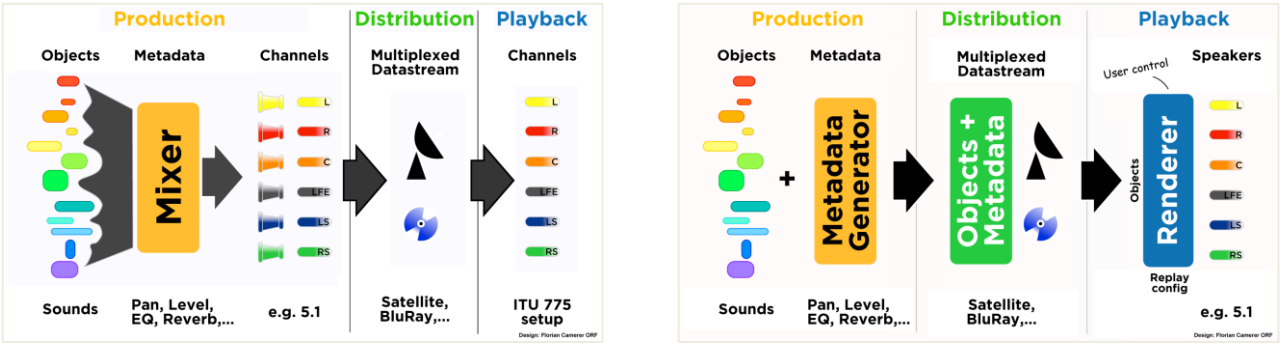


**Figure 1: Basic principles of traditional channel-based (left) and object-based audio (right)**

[1] Clarifications were made to §3 regarding the status of DTS in ETSI publications, a link to IHS was added to §5 and a note was added to the end of §14.

Hybrid approaches where channel-based mixes and objects are used simultaneously (see Figure 2) are of course also possible and might become one of the most often used scenarios.

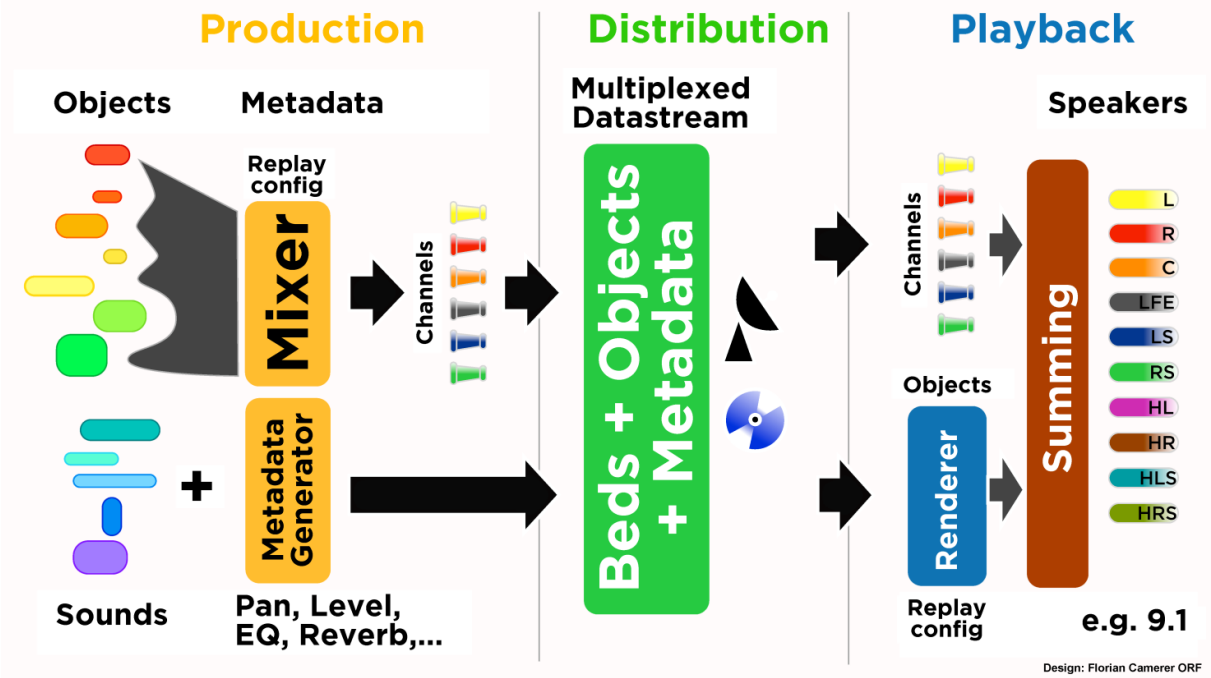


**Figure 2: Basic principle of hybrid NGA approach**

NGA also enables access services, such as for the hearing-impaired, abridgeable or 'flex-time' audio content and can also help to significantly reduce data-rates. In short, audio in broadcasting is evolving to a new experience that includes both immersive and personalised features which require metadata to be fully represented.

## 2. Background

The most relevant NGA systems for the delivery to end users are MPEG-H, Dolby AC-4 and DTS-UHD and, besides a traditional codec, also include other components for playback such as a Renderer, Dynamic Range Control or Loudness Control. All of the systems have a codec-specific metadata format and offer tools and formats for production and contribution; **but none of these are mutually compatible**. The integration of such codec-specific formats in currently available production tools has even led to a fragmented market situation.

## 3. NGA in DVB

ETSI TS 101 154 [2] is the specification for the use of Video and Audio Coding in Digital Video Broadcasting (DVB); it includes

- A list of A/V codecs and formats supported in DVB (including DVB-T/S/C/IPTV/DASH)
- A DVB profile for each codec
- Guidelines for encoding, decoding and signalling

The latest (November 2018) revision of TS 101 154 includes AC-4, MPEG-H Audio and DTS-UHD NGA systems. As of January 2018, ETSI's published version contains AC-4 and MPEG-H Audio only (since DTS-UHD was later to the discussion); this will be rectified as soon as the ETSI publications process allows.

## 4. NGA via HbbTV

The latest HbbTV specification update 2.0.2 includes support for NGA decoders [3]. The currently available NGA codecs in the DVB toolbox AC-4 and MPEG-H can be used for a smart way to offer NGA programmes via IP delivery to the user without the need to change the entire broadcast infrastructure. Even synchronized scenarios where the legacy broadcast audio is replaced by an NGA stream via broadband and played back in sync with the broadcast video is easily possible with this specification. HbbTV 2.0.2 supports the NGA profiles specified in DVB.

What is still missing is the definition of a unified UX/UI to be implemented via the HBBTV NGA API to ease the control of NGA presets or options for users.

## 5. NGA in consumer devices

Currently it has been observed that several CE devices are available which are capable of NGA decoding. There are no published figures to quantify this observation.

*According to IHS (https://ihsmarkit.com), soundbars are currently shipping at about 5.5 million units per annum into Western Europe with an attach rate of 15% or so of total TVs. AV receivers are at the 0.7M level and are slowly being cannibalised by soundbars.*

## 6. A future scenario

A sober view of a future NGA scenario leads to the conclusion that it will be very likely that a broadcaster will need to use more than one NGA codec for delivery since **not all NGA decoders will be available on all platforms**. Furthermore, it appears very likely that there will **not even be one NGA decoder available on all delivery platforms and devices**. To offer programmes on all relevant platforms (e.g. DVB, DAB, On-Demand in Browsers, OTT in mobile Apps etc.), broadcasters will most likely have to deal with multiple NGA delivery systems and it is therefore **essential to be independent of those internal and vendor-specific formats** and tools during the production stages.

In addition to the above scenario, the employ of vendor-specific formats and tools during production is not recommended by the EBU as it in any case increases the risk of vendor lock-in.

Furthermore, the use of proprietary formats or compressed audio signals in archives would not be a desirable situation. To make sure that NGA programmes can be reliably exchanged between broadcasters and other involved parties, a common production format is clearly necessary.

## 7. Open Standards for Codec-independent workflows

Several NGA-related open standards have been published in the past years, driven and supported by the EBU and the R&D institutes of its Members.

## 8. Audio Definition Model

The most important of these open standards is the so-called Audio Definition Model (ADM) that is already or that will be supported by all commercial NGA systems as an interface. This metadata specification was originally published as EBU Tech 3364 in February 2014 and largely formed the basis for the subsequent work that has resulted in Recommendation ITU-R BS.2076 being published in June 2017 [1]. The ADM is a set of defined metadata and parameters for all NGA technologies, to ensure compatibility across all systems. ADM data can be carried within the chunk of the BWF (EBU Tech 3285) and in the BW64 file format specified in Recommendation ITU-R BS.2088. Work is continuing within the ITU in enriching and expanding the ADM, for static file use, for streaming applications to allow live production of ADM content and defining ADM “profiles” as agreed subsets of the ADM, which should be used for specific applications (e.g. production, contribution, distribution, etc.). The EBU’s aim is that these profiles will contain mapping instructions for a defined transcoding between profiles and to commercial delivery formats. The EBU has published

as an initial step towards this an ADM profile for production (EBU Tech 3392).

## 9. Serial ADM

While the audio file format described in Recommendation ITU-R BS.2088 combined with the Audio Definition Model described in Recommendation ITU-R BS.2076 provides the ability to exchange object, channel and scene-based audio files, they are not readily suitable for streaming, particularly of live productions. Therefore, a serialized form is required. With a serial representation of the Audio Definition Model with segmentation of audio and metadata, it will be possible to use the ADM for streaming of NGA content. A serial version of the Audio Definition Model (ADM) is currently under development in the ITU.

## 10. EBU ADM Renderer (EAR)

Another essential component for NGA production is the so-called renderer. It processes audio signals and the accompanying metadata into loudspeaker or headphone signals. Such a renderer is needed in all tools in the chain where NGA programme sound is played back for authoring, monitoring or quality control purposes. The listening experience during content creation should ideally, of course, be identical with the listening experience of devices used by the audience. Moreover, **all tools used within the production stages very obviously need to consistently provide reliable and identical listening experiences to guarantee a high quality of product**. This may seem both trivial and obvious, but it **was not certain to be the case until recently because of the fragmented market situation**.

Through the collaborative development of an open standard for a production renderer by the BBC, the IRT, France Télévisions and b<>com within the scope of an EBU working group, the above goal has become achievable. The EBU ADM Renderer (EAR) has been specified in EBU Tech 3388 [3] and is accompanied by an open-source implementation [4]. The EAR is a complete interpretation of the ADM / sADM format and is basically compatible with the renderers of all NGA decoders in consumer devices. The EBU and the authors of the EAR are working together with manufacturers such as Dolby, Fraunhofer IIS and DTS to establish the Renderer as an international standard within the ITU-R.

## 11. File Formats for ADM

The ADM can currently be stored in BWF files as well as in BW64 files, which is useful for audio-only content. For NGA programmes along with video, IMF and MXF are more appropriate. Even though there is currently no standardised way to include the ADM chunk in MXF or IMF, it can in practice be easily done.

## 12. Ideal Workflow

From a broadcaster's perspective, an ideal workflow for NGA production and distribution is based on open formats and standards, independent of delivery codecs and uses uncompressed audio signals during the production stages. A simplified solution for these essential requirements may be as follows:

The ADM format or the serial ADM (sADM) for live productions is used in all production stages up to the encoding for emission. Only there the ADM is converted to an encoder-specific ADM profile and then delivered in a compressed NGA stream. All production tools that are used before the encoding process should have implemented the EBU ADM Renderer to guarantee a reliable and codec-agnostic monitoring of the ADM format. The use of EBU ADM profiles for production and distribution will ensure that all tools are interoperable and that a broadcaster has the freedom to choose from a variety of appropriate products.

This simplified and ideal NGA workflow assumes that (serial) ADM and PCM is also used for the contribution of NGA signals. A conversion from proprietary or vendor-specific contribution formats such as Dolby ED2 or MPEG-H Audio Low Complexity Profile/Contribution mode is, however,

possible and should be applied by the broadcaster to ensure compatibility with the ADM-based infrastructure.

A successful realisation of a similar open end-to-end workflow was done by the ORPHEUS project [5] and this was published as EBU Technical Report TR 042 [6].

The EBU aim is to see the ADM and sADM becoming the backbone of all NGA systems throughout the entire audio chain, from acquisition to production, archive, distribution and reproduction with audio tools (e.g. DAWs, consoles, authoring tools, etc.).

Furthermore, the EBU envisions the wide adoption and integration of the EAR along the end-to-end chain as illustrated in Figure 3, with transparent and compatible conversions between ADM profiles and encoder specific interfaces.

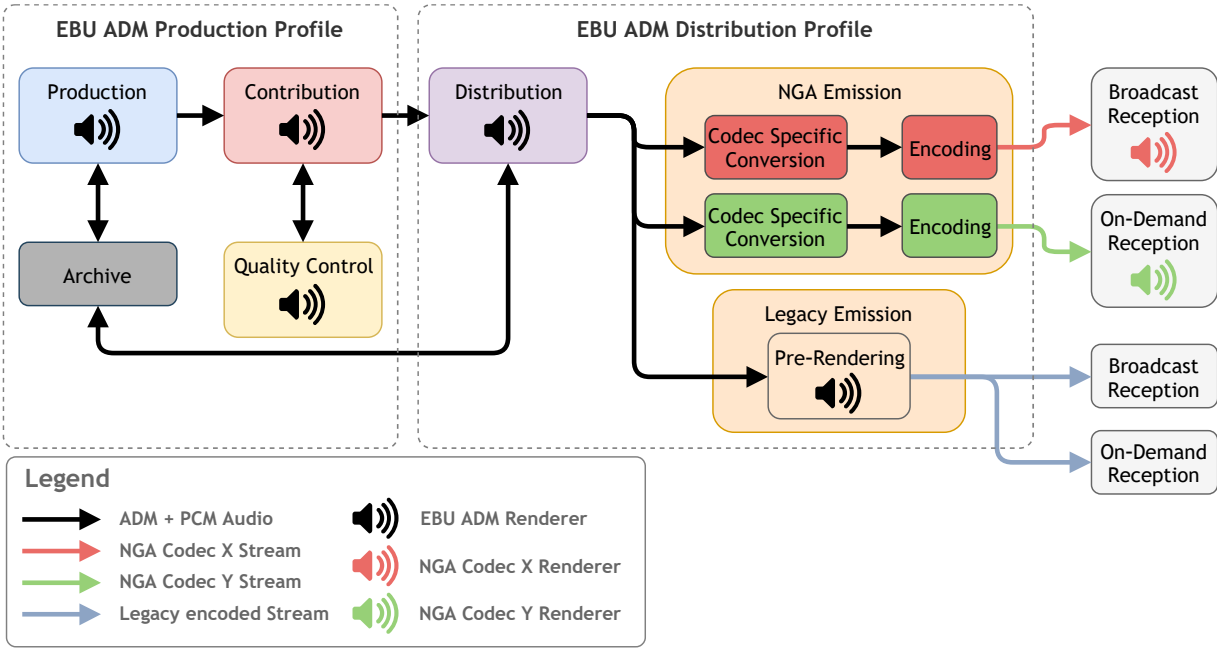


**Figure 3: Simplified high-level overview of an ideal NGA workflow using open and independent standards and formats during the production**

## 13. What is available today

A few relevant open-source projects and documents have been published which will ease the integration of ADM in production tools:

- ADM library (https://github.com/IRT-Open-Source/libadm)
- BW64 library (https://github.com/irt-open-source/libbw64)
- EBU ADM Renderer (EAR) reference implementation (https://github.com/ebu/ebu_adm_renderer)
- EBU ADM Production Profile (https://tech.ebu.ch/publications/adm-production-profile)

Moreover, several tools which support at least a limited subset of ADM are already available:

### 1) ADMix

ADMix tools, edited by IRCAM, offers several applications to read, write, render and extract ADM metadata from BWF files. These tools don't support all ADM configurations today, and they focus on the most important metadata together with audio objects: gain and position (azimuth, elevation, distance).

**2) Pyramix**

This Digital Audio Workstation software, edited by Merging, offers an ADM export option linked to its BWF export function. This feature automatically creates the gain and position metadata for declared objects, and also supports the description of channel-based declared stems.

**3) ProTools**

This Digital Audio Workstation software, edited by AVID, can master channel-based and object-based content thanks to optional Dolby Atmos tools. In parallel, Dolby offers a stand-alone software to convert any Atmos master in a BWF (+ ADM) file, featuring a very limited subset of ADM parameters. Pro Tools now offers an ADM import option that is fully compatible with these BWF (+ ADM) files.

**4) Sequoia**

Extensions to the Sequoia DAW editing and mixing of ADM object-based sound in the context of the Orpheus project

Nevertheless, the reality is unfortunately that ADM files generated by these tools are not necessarily mutually interoperable. So, it must be ensured these and all other relevant tools will support the relevant EBU ADM profiles in the future.

## 14. Roadmap

Several necessary elements to realize an end-to-end NGA workflow based on ADM, sADM and the EAR are still missing:

- EBU ADM Guidelines by mid 2019
- Implementation of the EAR C++ core library as another open-source project by [end of 2019]. This core library will ease the adoption and implementation of the EAR in various production tools such as DAWs, mixing consoles or plugins.
- sADM (serialized ADM) reference implementation based on ITU-R Rec. BS.[sADM] by [end of 2018]. Even though ITU-R Rec. BS.[sADM] has been a stable draft document in the ITU-R for a while, the its official publication is expected by the end of October 2018
- Transport of sADM: The relevant protocols and formats for live transport of sADM need to be updated to carry the sADM in a standardized way. In particular, AES3 and SMPTE2110 will be relevant for this application. [mid 2019]
- Renderer ITU-R Rec. BS.[Renderer] by [mid 2019]. The standardisation of the EAR in the ITU-R is another milestone for the acceptance of the renderer. Current discussions in ITU-R will likely lead to the addition of allocentric panner features to the EAR, which provides better compatibility with AC-4 decoders.
- ADM Profiles: The Audio Definition Model (ADM) is intentionally very generic to support a wide variety of different application areas. Different “ADM profiles” will be defined to constrain the ADM to simplify implementations and to prevent interoperability problems in the production of Next Generation Audio broadcast programmes. The EBU’s “ADM Production Profile” has been submitted to the ITU-R for the October 2018 meeting. In addition, all major NGA contributors seem keen to work together with the EBU on the translation from the production profile(s) to a specific emission profile (codec dependent) to get an operational functioning end-to-end chain. The discussion about the ADM profiles has just started and it is unlikely that the ITU-R Recommendation will be released before the end of 2019
- An ADM validation tool is another important component to make sure that interoperability between production tools is ensured. As soon as such a tool is available, interoperability plug-fests could be arranged targeting the end of 2019.
- ADM integration in MXF/IMF is another crucial step to make sure that the ADM chunk can be

carried by these relevant video file formats. By 2019.

- User Experience (UX) / User Interface (UI) HbbTV NGA API: To simplify and harmonize the user control of NGA adaptation or interaction features, the HbbTV specification needs to be extended to provide a common API and especially UX and UI independent from the NGA system. All major NGA contributors will work together with the EBU in HbbTV for the specification of such APIs. The requirements should be available by mid 2019.

*Note: The list of tasks will be updated as work progresses along the lines listed above.*

## 15. References

[1] ITU-R BS.2076 (Audio Definition Model) https://www.itu.int/rec/R-REC-BS.2076-1-201706-I/en

[2] ETSI TS 101 154 V2.3.1 (DVB Specification) https://www.etsi.org/deliver/etsi_ts/101100_101199/101154/02.03.01_60/ts_101154v020301p.pdf

[3] HbbTV Specification 2.0.2: https://www.hbbtv.org/wp-content/uploads/2018/02/HbbTV_v202_specification_2018_02_16.pdf

[4] EBU Tech 3388: EBU ADM Renderer https://tech.ebu.ch/docs/tech/tech3388.pdf

[5] EBU ADM Renderer (EAR) reference implementation https://github.com/ebu/ebu_adm_renderer

[6] ORPHEUS project website https://orpheus-audio.eu/

[7] EBU Tech Report 042: Example of an end-to-end OBA broadcast architecture and workflow https://tech.ebu.ch/docs/techreports/tr042.pdf

[8] EBU Tech 3392 (ADM Production Profile) https://tech.ebu.ch/docs/tech/tech3392.pdf