



Foto: Johann Dafelemaier/IRT

Adaptive, Immersive, Interactive

# OBJECT-BASED AUDIO INNOVATIONS BY EU PROJECT ORPHEUS

**Text** [Andreas Silzle](#), [Werner Bleisteiner](#), [Michael Weitnauer](#), [Milon Gupta](#)

## INTRODUCTION

Imagine you could adapt the length of a radio documentary as you require or listen to a radio drama from the positions of different protagonists in the play. These and many more personalised, immersive listener experiences become possible due to a novel technological concept called object-based media, which will fundamentally change the production and user experience of radio broadcasts and multimedia productions. Key tools and apps for implementing object-based media for audio content have been developed by ORPHEUS, an EU-funded research project performed by ten major European media industry players.

Broadcasting architectures and infrastructures have been developed, refined and optimised over the last 100 years. Up to now, the final product delivered to the audience, was assembled, edited, mixed and configured as an unchangeable entity, leaving little or no options for adjustments according to the reception conditions and the personal preferences of the recipient. The object-based media approach fundamentally changes this principle: A production is now a collection of media assets, so-called 'objects', along with parameters, or 'metadata', describing their attributes and relationship. This package is delivered to an end-user device, where it gets optimally 'rendered' according to the capabilities of the device, environmental conditions and user preferences.

On 15th May 2018, the ORPHEUS consortium presented their results at a workshop in Munich to about 120 representatives of the global media industry. The event was hosted by IRT, the research institute of the public broadcasters of Germany, Austria, and Switzerland. Below, we provide an overview on the final results and the demonstrations presented at the workshop. For a more in-depth description of the project see [1, 2].

## RESULTS

The ORPHEUS project has created a full set of tools and applications for all stages of the complete broadcast workflow. The consortium ran two successful pilots

- Technical guidelines for implementation including a reference architecture and source code of an OBA production renderer, published by the EBU TR042 and Tech 3388 [3, 4]

to demonstrate the key features and benefits of object-based broadcasting, including immersive sound, foreground/background control, language selection, and enhanced programme services. In addition, Pilot 1 was the first ever live object-based interactive radio drama, and was produced using the BBC's IP Studio platform. Pilot 2 premiered the introduction of variable-length functionality for audio. These pilots have proven the advantages of object-based media as a universal, innovative approach for media production and its applicability in real-world broadcast environments. The key achievements of ORPHEUS include:

- Object-based audio capturing and production tools by BBC, b-com, IRCAM, MAGIX
- Pre-processing, rendering and encoding applications by IRT and Fraunhofer IIS (MPEG-H)
- Reception devices and apps by Trinnov (Altitude 32) and elephantcandy (iOS app)

## THE ORPHEUS REFERENCE ARCHITECTURE

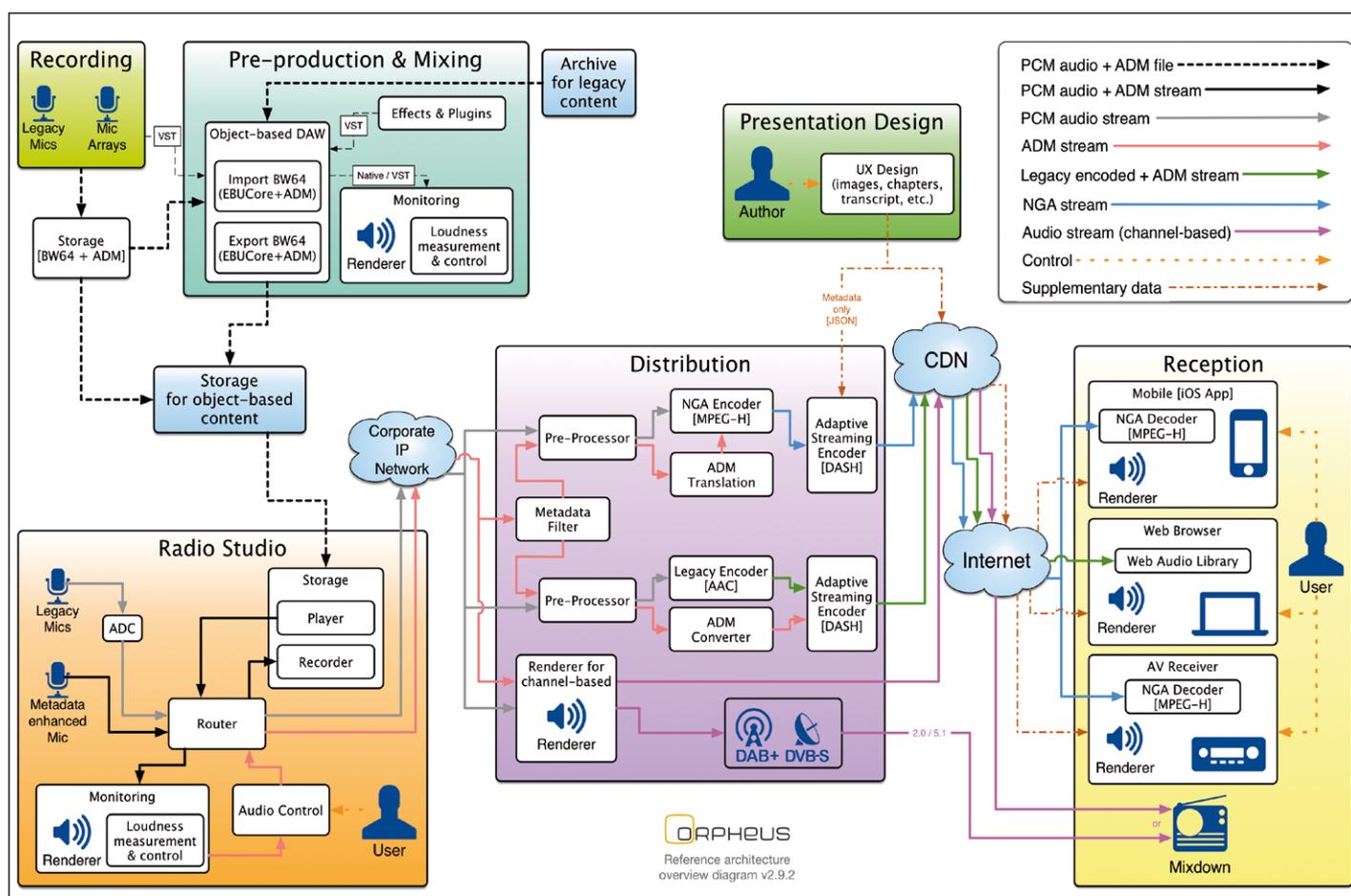
Currently, a few broadcasters have taken on with adoption of so-called Next Generation Audio (NGA) in general or object-based audio specifically. They are hardly equipped with a full set of tools and applications that span from content production to distribution. Some successful pilot productions exist, but in general the broadcasting community has just started embracing NGA technologies. So they need to experiment and learn. One of the major objectives of ORPHEUS was the specification of a reference architecture for end-to-end object-based production and broadcast workflows. To achieve this, the ORPHEUS consortium first specified a pilot implementation architecture which was the basis for the pilots in the project. Using an iterative process, and based upon the findings and lessons learned from these ORPHEUS pilots, the reference architecture was

developed. This Reference Architecture (see figure 1) has been presented at the workshop.

Unlike the actual pilot implementation architecture, this reference architecture is more format- and interface-agnostic, allowing it to be used more easily as a general guideline for other broadcasters. A detailed description of the Reference Architecture has been recently published as EBU Tech Report 042 [3]. The document provides an example of a Next Generation Audio workflow from a broadcaster's perspective based on open standards.

## ORPHEUS APP

An evaluation version of the ORPHEUS app for iOS demonstrates the project achievements. It uses the OBA productions made by BBC, BR and FHG, and is available upon registration from the project website (<http://bit.ly/oa-app-reg>).

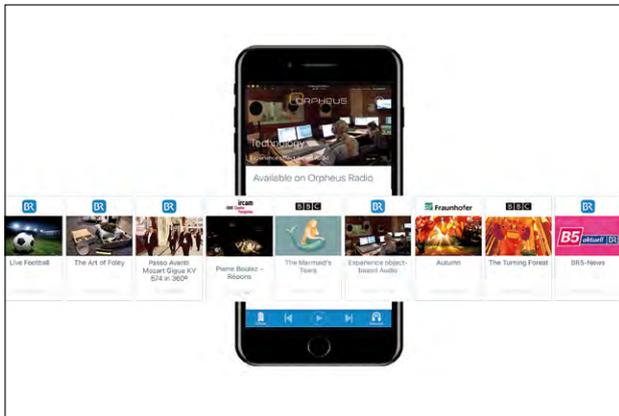


▲ Figure 1: The ORPHEUS Reference Architecture for a complete end-to-end object-based workflow

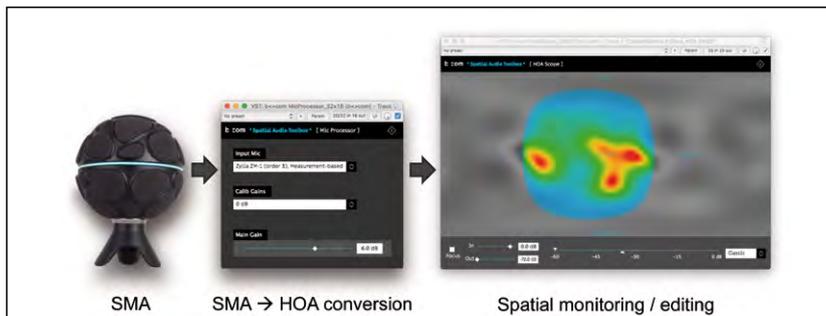
These productions show the advantages of object-based audio in a broad range of radio formats, including football report, documentary, radio drama and music.

## PRESENTATIONS

The nine presentations at the ORPHEUS workshop covered important aspects of the project, including the developed reference architecture, the used NGA codec MPEG-H, the OBA production DAW Sequoia, OBA productions from France TV, BR and BBC, as well as the design and implementation of an OBA end-user app.



▲ Figure 2: ORPHEUS iOS app with specially produced OBA content (Foto: Werner Bleisteiner/BR)



▲ Figure 3: HOA recording, monitoring and editing (b<com) (Foto: Nicolas Epain/b<com)



▲ Figure 4: Reproduction chain: MPEG-H coded audio in a DASH stream, Trinnov AV receiver Altitude32 and a 3D loudspeaker setup with up to 32 loudspeakers, each measured and acoustically corrected. (Quelle: Benjamin Duval/Trinnov)

The final round table with production experts discussed the subject: 'What's next? – The road ahead to implementation'. Videos of the presentations and the round table are available at <http://bit.ly/oa2ws-p>.

## DEMONSTRATIONS

Fraunhofer IIS and b<com demonstrated capturing tools. The upHear technology of Fraunhofer IIS uses compact microphone arrays. Even with a planar array a three-dimensional sound field recording is possible with the help of parametric spatial sound capturing. Figure 3 shows the HOA production chain by b<com, which is using a small microphone array, a plugin to convert recorded sound to HOA format, and a further plugin to monitor and edit it.

Magix expanded their DAW Sequoia with several features necessary for OBA production, like BW64+ADM im- and export, 3D panning and 3D MPEG-H rendering with new 3D speaker setups, metadata editing, including variable length production.

Fraunhofer IIS presented their prototype of a 3D MPEG-H soundbar. With this the OBA content produced in 4+7+0 (ITU notation) format could be reproduced. Even the sound engineers were surprised about the convincing 3D envelopment. The user

interface for TVs necessary for interactivity was shown as well.

France TV presented their OBA production workflow using Pyramix. BBC R&D explained their production of an interactive radio drama, 'The Mermaid's Tears'.

IRT has developed an experimental production tool for object positioning in 3D space. Furthermore, they presented their new Pre-processor to reduce the number of objects in an OBA production to adapt to different distribution platforms. They showed the new EBU ADM renderer, BBC and IRT have contributed to.

IRCAM presented their ADMix Tools. These standalone Windows and macOS applications allow recording, playback and rendering of ADM files. They can be used in conjunction with digital audio workstations (DAW) which are not able to handle ADM files.

As a representative from the British research project S3A ([www.s3a-spatialaudio.org](http://www.s3a-spatialaudio.org)), Prof. Trevor Cox presented their ideas about 'media device orchestration', using several loudspeakers already available in the room, like WLAN and Bluetooth devices or mobile phones, and connecting them to a reproduction array for OBA content.

## USER EVALUATIONS

Two end-user evaluations were conducted about the accessibility, operability and usability of the new object-based media features in the iOS app. The following experience dimensions have been identified in the context of OBA: audio, information and usability experience. A lab test by b<com generated results on acceptance and acceptability before and after the usage of the app (see figure 5 and 6). Although the expectations before usage were generally high, they were constantly surpassed with few exceptions.

Fraunhofer IIS and BR used a field test in the open innovation lab JOSEPHS®. Two scenarios "on the go" with headphone reproduction and simulated airplane noise and a surround sound loudspeaker home reproduction were set up (see figure 7).

The overall results about which feature or function was liked most can be seen in figure 8. The details of both tests and two further evaluations are available in the public ORPHEUS deliverable D5.6 (<https://orpheus-audio.eu/public-deliverables/>). Further public deliverables and

publications explaining different aspects of OBA are freely available on the ORPHEUS website. The results of the user evaluations show that the OBA results of ORPHEUS could

- provide end-users with a future-proof radio service which exceeds their expectations,
- support the industry in mastering the technical challenges in object-based audio (OBA) and IP-based delivery, and
- help broadcasters in their transition to

OBA production processes and thus stay relevant in the fast-changing Internet world.

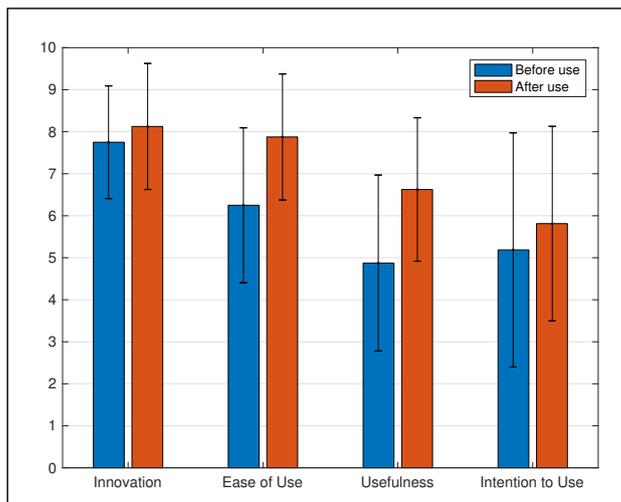
**SUMMARY**

The goal of ORPHEUS has been to bring the experience of object-based content to mass media audiences. The project demonstrated the new rich user experience through the implementation of close-to-market workflows. ORPHEUS has

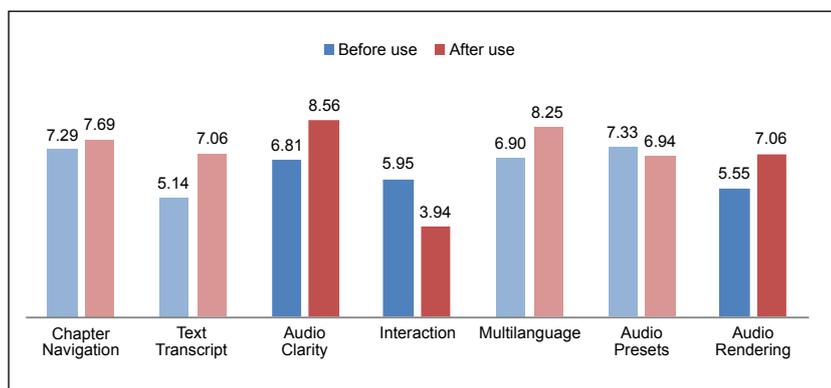
published reference architecture guidelines on how to implement object-based audio chains [3].

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▲ Figure 5: Overall acceptance (before) and acceptability (after use) of the ORPHEUS app, n=16

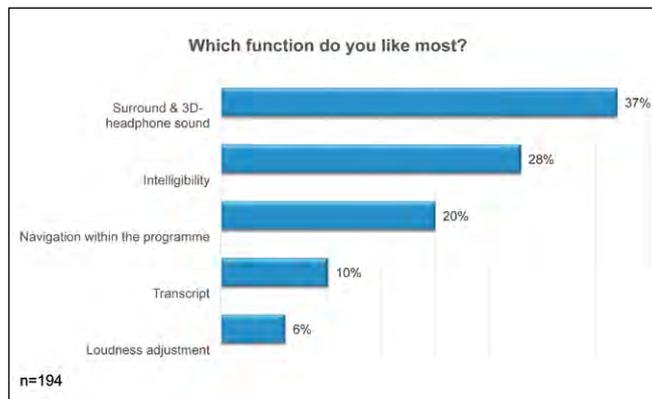


▲ Figure 6: Perceived feature usefulness: before and after use. Note: the bars with more saturated colours indicate that the change in rating was found to be statistically significant. N =16



Quelle: Werner Bleisteiner/BR

▲ Figure 7: ORPHEUS installation at JOSEPHS® (Quelle: Werner Bleisteiner/BR)



▲ Figure 8: Which feature and function do you like most? n = 194, for more details see deliverable 5.6 [5].

**References**

[1] Silzle, A., R. Sazdov, M. Weitnauer, et al. The EU Project ORPHEUS: Object-based Broadcasting – for Next Generation Audio Experiences. 29th Tonmeistertagung – VDT International Convention. 2016. Cologne, Germany

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[3] EBU TR 042, Example of an End-to-end OBA Broadcast Architecture and Workflow. 2018, European Broadcasting Union, Geneva, Switzerland

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[5] D5.6: Report on Audio Subjective Tests and User Tests; Deliverable of EU project ORPHEUS 2018. <https://orpheus-audio.eu/public-deliverables/>