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Object-based broadcasting – for European leadership in next generation audio experiences

D6.3: Final Standardisation and Dissemination Activity Report

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Abstract

This report documents the standardisation and dissemination activities performed by the ORPHEUS project consortium from March 2017 to the end of the project in May 2018. In addition, it provides an overall assessment of the impact achieved by ORPHEUS in standardisation and dissemination.

[End of abstract]

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Executive Summary

This report documents the standardisation and dissemination activities performed by the ORPHEUS project consortium from March 2017 to the end of the project in May 2018. These activities aimed at achieving the following standardisation and dissemination goals:

- Influence standardisation in the area of audio technologies.
- Create and raise awareness for the ORPHEUS project activities and results among target audiences.
- Encourage interest and involvement for ORPHEUS project activities among target audiences.

In addition, the report provides an overall assessment of the impact achieved by ORPHEUS in standardisation and dissemination.

Standardisation Activities

A lot of standardisation bodies are relevant for the introduction of object-based audio (OBA). Several project partners are heavily involved in these standardization activities, building on decades of experience. The report focuses on the main activities in ITU-R and EBU and the produced technical papers and standards.

A lot of these standardisation activities will be ongoing beyond the project's life time, to define OBA with all necessary details and lay the foundations for success in practice.

A few selected highlights of these dissemination activities include:

- In both standardisation bodies, groups worked for an ADM renderer definition. The first result was published from the EBU as Tech. Doc. 3388. ADM profiles are under discussion.
- The ADM definition in ITU-R was described more precisely in steps, in ITU-R BS.2076 and BS.2388. A serialized version of ADM is on the way to finalisation.
- Deliverable D2.4 on the final reference architecture became EBU TR 042 "Example of an End to End OBA Broadcast Architecture and Workflow".

Dissemination Activities

ORPHEUS performed a plethora of online and offline dissemination activities, based on the project's dissemination plan (deliverable D6.1, March 2016). These dissemination activities included, among others, the publication of papers, the presentation of results at events, and the demonstration of results at exhibitions and workshops.

A few selected highlights of these dissemination activities include:

- Two ORPHEUS workshops for highly relevant audiences of broadcasters, audio technology providers and content producers.
- 30 publications in renowned journals and at prestigious conferences.
- Presentations and demonstrations at 20 major events in the audio/broadcasting sector, including the NAB Show in Las Vegas, and IBC in Amsterdam.
- Seven software items produced and disseminated by ORPHEUS.

Overall Impact Assessment

As documented in sections 2 and 3, the ORPHEUS consortium achieved significant impact through its standardisation and dissemination activities during the 30 months of the project life-span.

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Abbreviations

ADM	Audio Definition Model
AVS	Audio Video System
DVB	Digital Video Broadcast
EBU	European Broadcasting Union
EC	European Commission
ETSI	European Telecommunications Standards Institute
HbbTV	Hybrid broadcast broadband TV
HOA	Higher Order Ambisonics
IAB	Immersive Audio Bitstream
ITU-R	International Telecommunication Union, sector radio communication
ISO	International Organisation for Standardisation
IEC	International Electrotechnical Commission
IMF	Interoperable Master Format
ISO/IEC	Joint Technical Committees of ISO and IEC
MPEG	Moving Picture Experts Group
NGA	Next Generation Audio
SMPTE	Society of Motion Picture & Television Engineers
W3C	World Wide Web Consortium

1 Introduction

This report documents the standardisation and dissemination activities performed by the ORPHEUS project consortium from March 2017 to the end of the project in May 2018. These activities aimed at achieving the following standardisation and dissemination goals:

- Influence standardisation in the area of audio technologies.
- Create and raise awareness for the ORPHEUS project activities and results among target audiences.
- Encourage interest and involvement for ORPHEUS project activities among target audiences.

In Deliverable D6.1 – Dissemination plan and innovation roadmap – we outlined the ORPHEUS approaches and envisaged activities for generating innovation and disseminating project results. In Deliverable D6.2 – Intermediate Standardisation and Dissemination Activity Report – we summarised the major activities in the period from the start of the project in December 2015 to the mid-term after 15 of the 30 project months in February 2017.

In this report, D6.3, we summarise the major standardisation and dissemination activities in the period from the mid-term in March 2017 to the end of the project in May 2018.

The standardisation activities of ORPHEUS in the reporting period are described in section 2. It includes an outline of the targeted standardisation bodies and a description of the performed standardisation activities and outcomes.

The dissemination activities performed in the reporting period are described in section 3. This section is structured according to the main areas of dissemination covered by ORPHEUS: visual identity and logo, website and social media, publications, and events. The section includes two major dissemination activities which were implemented in the second half of the project.

In addition to this documentation of the ORPHEUS standardisation and dissemination activities in the final half of the project, the report provides an overall assessment of the impact achieved by ORPHEUS in standardisation and dissemination over the whole project duration.

2 Standardisation

2.1 Relevant Standardisation Bodies and Main Contribution Areas

The ORPHEUS consortium has identified a number of standardisation bodies and contribution areas which are highly relevant for ORPHEUS. The targeted standardisation bodies have in common that they develop standards related to object-based audio. Thus, ORPHEUS is focusing its standards-related efforts to the selected bodies, in order to achieve maximum impact.

Table 1 summarises the identified standardisation bodies, their degree of relevance, the ORPHEUS partners involved, and the relevant scope.

Standardisation body	Relevance	Involved partners	Scope
ITU-R	High	FHG, BBC, IRT, b<>com	Audio Definition Model (ADM) Streaming of ADM ADM renderer ADM Profile Loudness measurement and loudness handling
MPEG	Medium	FHG, IRT, b<>com	MPEG-H 3DA Codec + Systems DASH Streaming
EBU	High	BBC, IRT, BR, MAGIX, b<>com	Technical Reports on broadcasting technology, incl. OBA Loudness measurement and loudness handling ADM Reference Renderer (EAR)
ETSI-DVB	Medium	IRT, FHG, BBC, b<>com	Digital Video Broadcasting (DVB) Definition of NGA Codecs, Profiles & Levels, and other system aspects
HbbTV	Medium	IRT, FHG, BBC	Hybrid Broadband Broadcast TV (HbbTV) Support of NGA in Smart-TVs
SMPTE	Medium	FHG, BBC	Audio metadata in an interchange format. Extension of Interoperable Master Format (IMF) with an Immersive Audio Bitstream (IAB)
IEC	Medium	FHG	Signaling and transport of NGA codecs in connectivity standards such as S/PDIF and HDMI
W3C	Medium	BBC, IRCAM	Delivery of OBA to the Web/Browsers WebAudio-API Media Source Extension (MSE)

Table 1: Targeted standardisation bodies

In Deliverable 6.2 it is explained in more detail, why and how the selected standardisation bodies are relevant to ORPHEUS.

2.2 Standardisation Activities

The standardisation activities in the project period focused mainly on ITU-R and EBU, where the latter is strictly speaking not a formal standardization body but a standards-related organization. In respect to these standardisation bodies, ORPHEUS partners performed the standardisation activities summarised in Table 2. Note that ORPHEUS partners have also been active in many other standardization bodies, which are indirectly related to OBA. However, here we focus on activities which can be directly attributed to the ORPHEUS project and would not have happened without it.

Standardisation body	Contributions	Involved partners	Standard impacted by ORPHEUS
ITU-R 6B	Work on updates on ADM Metadata	FHG, BBC, IRT	ITU-R BS.2076, ITU-R BS.2094
ITU-R 6B	Contributions on a streamable version of the ADM Contributions on ADM Profiles	FHG, BBC, IRT	tbd., potentially ITU-R BS. 2076
ITU-R 6C	Work on the topic of a standardised renderer for object-based audio (RG33)	FHG, BBC, IRT,	Not yet defined
ITU-R 6C	Work for standardisation of object-based loudness calculation	FHG, BBC, IRT,	ITU-R BS.1770
EBU	Contributions to SP-FAR (Future Audio formats & Renderer) group meetings, planning of "Object Based Audio" workshop	BBC, IRT, FHG, b<>com	EBU TECH 3388 ²

Table 2: ORPHEUS standardisation activities

The following sections provide a more detailed account of the standardisation activities in which the ORPHEUS partners FHG, BBC, IRT, and b<>com have been involved.

2.2.1 Standardisation Activities in ITU-R

ADM Renderer

The major ORPHEUS-related work within ITU-R occurred for the standardisation of a so-called **renderer for Next Generation Audio (NGA) technologies**, including object-based audio. The renderer is a crucial part in the production chain to ensure a predictable quality and reliable result of NGA audio content. The standardisation is currently done in a Rapporteur Group of WP6C (RG33). Multiple ORPHEUS partners are very active in this process and even co-chaired this Rapporteur Group (BBC & IRT). Moreover, FHG and BBC contributed proposal candidates for the renderer in December 2015. Multiple proposals were submitted, and the views and goals of the participating members differ a lot.

In April 2018, the EBU formally proposed its renderer to the ITU-R rapporteur group. This renderer is based on contributions from several EBU member organisations, including BBC, IRT and b<>com. The standardisation process is still ongoing, following the meeting of Study Group 6 in April 2018.

² Is a for minimum the European broadcasters relevant tech paper, but it is not a standard.

Common Definitions for ADM

In addition to the preliminary draft revision of the ADM specification, a new Recommendation of **“Common Definitions for the Audio Definition Model”** was finished in January 2016 and published in April 2016 as ITU-R BS.2094. This Recommendation describes a set of common definitions for audio channels and configurations using the Audio Definition Model (Rec. ITU-R BS.2076)³. On the April 2018 meeting a first revision of the recommendation ITU-R BS.2076-1 got preliminary status.

This is relevant for OBA as the exchange of content in specific formats needs to be defined in an unambiguous way.

In addition, two editorial revisions were created in October 2016: one fixed errors within the ADM specification, and the other one fixed errors in Report ITU-R BS.2388 “Usage guidelines for the audio definition model and multichannel audio files”.⁴ On the April 2018 meeting a draft update of ITU-R BS.2388-2 was created.

A majority of the fixes were proposed to the ITU by ORPHEUS project partners BBC and FHG, based on findings of erroneous or underspecified parts of the ADM during the deployment of the ADM in the ORPHEUS project, i.e. during investigation and implementation of metadata authoring and metadata translations.

Serialised ADM

During the definition of the needed architecture within ORPHEUS, streaming has been considered to be a very relevant use case; hence, a serialised ADM representation for streaming purposes would be very helpful for the project work.

Thus, the BBC promoted the work on a serialised version of the ADM within the ITU. The technical work in ITU-R WP 6B on this topic was mainly based on contributions by the BBC, with support by FHG at the ITU meetings. First, a working document towards a recommendation or report was created in January 2016 and after some refinement, a preliminary draft new Recommendation was created in October 2016. This draft was developed further, but still kept the status of preliminary until April 2018.

The corresponding rapporteur group (RG13) on the topic of “Audio related metadata and file formats” is currently co-chaired by a representative of Dolby Laboratories and a representative of the BBC. The BBC representative has played an active role in coordinating the discussion of refinements and additions to the draft in the period between meetings.

At the meetings held in April 2018, the work on the serialised form of ADM was nearly completed. However, due to some editorial changes still needs to be agreed, the draft remains at “Preliminary Draft New Recommendation.” It is expected that the necessary changes can be agreed such that it will move forward to “Draft New Recommendation,” and hence to approval and adoption, at the next meeting in the autumn of 2018.

ADM Profiles

Due to its broad scope and flexible syntax, ADM can be used in many applications. However, this flexibility has become a problem for interoperability as ADM-files generated by one tool cannot be interpreted by another one. Related problems are undefined behavior when rendering an ADM-file or high cost for implementation and testing. Having recognized this problem, ORPHEUS partners have initiated an effort at ITU-R to define more constraint “Profiles” of ADM for specific applications.

³ <https://www.itu.int/rec/R-REC-BS.2076/en>

⁴ <https://www.itu.int/pub/R-REP-BS.2388/ru>

Such ADM-Profiles consist of a well-defined subset of metadata and specific restrictions with respect to ADM metadata elements, attributes and value ranges.

While the work at ITU-R is still in the early phase of finding a common understanding for the requirements and scope of ADM-Profiles, Fraunhofer has proposed a comprehensive ADM-Profile as a baseline for discussion to RG13. This “ADM Broadcast Emission Profile” is designed for the specific application of controlling low-bitrate audio codecs for Next Generation Audio (NGA), for which audio related metadata must be provided in a well-defined and reliable way. As results from ITU-R are not expected before the end of 2019, Fraunhofer is making its ADM-Profile available to interested companies and seeks to collaborate with those to consolidate the ADM Broadcast Emission Profile with the goal of broad industry adoption.

Loudness Measurement

In the rapporteur group RG32 on loudness measurement for the advanced sound system there were activities on the calculation of OBA. But there were no results up to now, and therefore no extension of the standard regarding OBA loudness calculation. The group was terminated in October 2017.

In the rapporteur group RG-BS.1116 FHG contributed a conference paper⁵ “The Influence of Microphone Directivity on the Level Calibration and Equalization of 3D Loudspeakers Setups”. That has led, together with a similar input from NHK, in April 2018 to a Draft New Report “Effect of Microphone Directivity Regarding Level Calibration and Equalization of Advanced Sound Systems”.

The sub-working group for “Audio-related subjects” was chaired by Ms. Simone Füg (FHG), who was a vice-chair of ITU-R WP 6B.

These roles in chairmanships enable the ORPHEUS partners to ensure that ORPHEUS findings are appropriately discussed and considered.

Lead roles of ORPHEUS partners in ITU-R

ITU-R WP 6C:

Chair: Andy Quested (BBC)

Rapporteur Group (RG27) on Terminology relating to audio and video quality

Co-Chairmen: A. Mason (BBC) & A. Quested (BBC)

Rapporteur Group (RG32) on Loudness measurement algorithm for the advanced sound system

Co-Chairmen: A. Silzle (FhG) [*& S. Norcross (Dolby)*]

Rapporteur Group (RG33) on (Baseline) renderer for use in programme production and quality evaluation of advanced sound systems

Co-Chairmen (initially): F. Melchior (BBC), M. Weitnauer (IRT) [*& S. Oode (NHK Japan Broadcasting Corp.)*]. Latterly, D. Wood (EBU).

Rapporteur Group (RG-BS.1116) on Operational room response

Co-Chairmen: A. Silzle (FhG) [*& I. Dash (Australian Broadcasting Corporation)*]

ITU-R WP 6B:

Vice-Chair: Simone Füg (FhG) [now transferred to Shuichi Aoki (NHK)] – chairmanship of the subworking group of audio-related subjects

⁵ Silzle, A., D. Kosmidis, G.F. Greco, et al. The Influence of Microphone Directivity on the Level Calibration and Equalization of 3D Loudspeakers Setups. 29th Tonmeistertagung - VDT International Convention. 2016. Cologne, Germany.

Rapporteur Group (RG13) on Audio related metadata and file formats

Co-Chairmen: D. Marston (BBC) [*& S. Norcross (Dolby)*]

2.2.2 Standardisation Activities in EBU

The European Broadcasting Union is not a formal SDO (standards development organisation), but it produces recommendations of working practices and technical documents that are widely used by broadcasters. It also organises workshops and seminars to disseminate knowledge about recent and future technical developments. This encourages the sharing of best practices, leading to standardised ways of working.

b<>com took part in the SP-FAR (Future Audio formats and Renderer) group meetings, in which object-oriented audio formats were discussed. Furthermore, IRCAM and b<>com are planning to propose amendments to the ADM format specifications in regard to Higher Order Ambisonic objects.

IRT, BBC R&D, and BR were actively involved in the planning of an **EBU workshop on “Object Based Audio”**, which was held in Geneva on 17-18 May 2017, and where also b<>com, IRCAM and FHG have participated.⁶ The goal of this workshop was to inform the broadcaster-related community about the latest activities in the area of object-based audio and to convince editorial staff and decision makers of the benefits of the technology. ORPHEUS was very visible there with a specific session and additional presentations and demonstrations.

A main achievement of the ORPHEUS project is the document EBU TR 042 “Example of an End to End OBA Broadcast Architectures and Workflow”. It is directly based on deliverable D2.4 “Final Reference Architecture Specification and Integration Report”. Its intention is to provide a guideline for other content producers and broadcasters for building an object-based production and distribution workflow and how to adapt it with an established infrastructure. To achieve this, the ORPHEUS consortium first specified the pilot implementation architecture which was used for the pilots in the project. Based upon findings and lessons learned from the ORPHEUS pilots, the reference architecture has been specified in multiple iterations. Unlike the pilot implementation architecture—the reference architecture is rather format and interface agnostic wherever possible and reasonable in order to be applicable as a general guideline for other broadcasters.

EBU ADM Renderer (EAR): In April 2018 the EBU has published its specification of the EBU ADM Renderer (EAR) for Next Generation Audio – Tech 3388⁷ – and an open-source implementation of the renderer⁸. The EAR is a joint effort of multiple public service media R&D centres (among them IRT and BBC) organized in the EBU Broadcast Technology Futures group and the “b<>com” institute. This definition and the published software is an important step for OBA, it could even solve the long lasting ITU-R activity on this question.

2.2.3 Other, Indirectly Related Standardization Activities

In the following we provide a list of other standardization activities, which are not directly related to the ORPHEUS project but still have impact to the market adoption of object based audio. They are provided for information to the interested reader without claiming a direct origin from the ORPHEUS project.

⁶ Further information about the workshop on the EBU website is available at <https://tech.ebu.ch/events/2016/object-based-audio>

⁷ <https://tech.ebu.ch/news/2018/03/ebu-publishes-open-source-renderer-for-adm-next-generation-audio>

⁸ https://github.com/ebu/ebu_adm_renderer

MPEG-H: Fraunhofer has continued its contribution to the MPEG-H 3D Audio standard at MPEG with editorial support for specification (2nd edition), reference software and conformance bit streams.

MPEH-I: MPEG has started a new work item on immersive media (MPEG-I) which also addresses immersive audio coding and representation. The ORPHEUS partners bcom and Fraunhofer contributed to the requirements and use cases.

HbbTV: Based on contributions by Fraunhofer, the HbbTV specification 2.0.2 has support for Next Generation Audio (NGA) including MPEG-H. Besides contributions to the specification text (which mainly refers to DVB specifications), Fraunhofer contributed to the Test Specification, which includes Test Assertions and Test Content.

DVB: After the successful specification of MPEG-H in ETSI TS 101 154 (in the TM-AVC group) and ETSI EN 300 468 (in the TM-GBS group), Fraunhofer was active in the relevant national bodies who use those DVB specifications as a baseline for their national standards (in particular France, Norway, and England).

AVS: China's AVS 3D Audio Task Group has chosen Fraunhofer IIS as the solution provider for the transmission audio codec of the upcoming 3D Audio standard that will be used in the country's 4K UHD broadcast. Fraunhofer proposed its MPEG-H TV Audio System according to the requirements of China's next-generation broadcasting standard in order to meet the Chinese market demand for immersive and personalized audio.

IEC: Fraunhofer has contributed to IEC 61937-13, which defines the carriage of MPEG-H bit streams over digital audio links, as used in connectivity standards such as HDMI or S/PDIF. It is of high importance to connect consumer electronic devices, such as e.g. a TV or Set Top Box (STB) with an AV Receiver (AVR) or soundbar.

SMPTE: Though ADM and BW64 are the format of choice in ORPHEUS to carry object based audio in production and contribution, there are alternative formats being developed in the industry. One example is the Interoperable Master Format (IMF) defined by SMPTE which is being extended with the Immersive Audio Bitstream (IAB) format to carry audio related metadata. Fraunhofer is monitoring this effort and has investigated the conversion of IAB to MPEG-H.

3 Dissemination

Based on the dissemination plan, which was outlined in March 2016 in deliverable D6.1, ORPHEUS performed a variety of online and offline dissemination activities in the reporting period.

The dissemination activities in the final half of the project from March 2017 to May 2018 included, among others, the continuous update of the project website, the continued bi-annual publication of a newsletter, the publication of papers, online news and social media posts as well as other information material like videos.

It is worth mentioning that most of the dissemination contributions coming from the project saw several partners collaborating together for the respective dissemination activities, whether it was a paper, a conference booth, or another important public event. This demonstrates the high-level of collaboration among all project partners for reaching the dissemination and impact objectives of ORPHEUS.

Among these activities, the highlights described below are particularly noteworthy.

3.1 Project Website

The ORPHEUS website at <https://orpheus-audio.eu/>, which was launched in February 2016, was continuously updated and expanded in the reporting period. It serves as the central reference point for all of the project's communication and dissemination activities. Beyond the home page level, it is structured into five sections:

1. About us
2. Publications
3. Standardisation
4. News
5. Contact Us

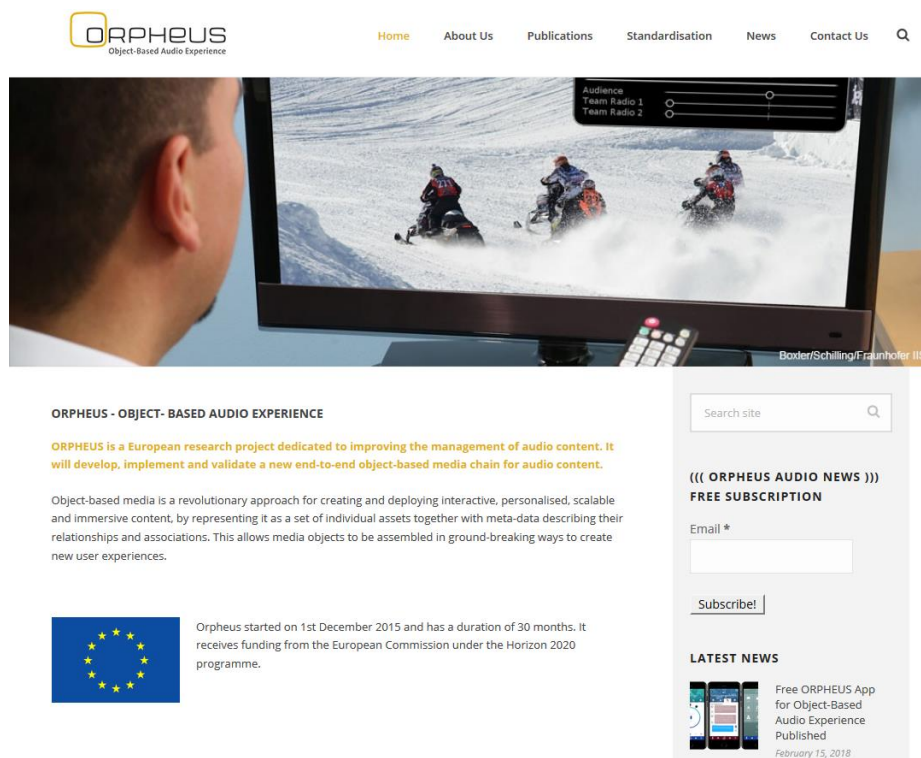


Figure 1: Screenshot of ORPHEUS home page

The website is regularly updated. Particularly in the 'Latest News' section, website visitors will

frequently find new items. The latest news items are also directly visible and accessible via the news column, which also contains aggregated news feeds from the ORPHEUS Twitter account.

The website, which is based on a WordPress implementation, is hosted and managed by Eurescom. Via the content management system, different partners have editing access, thus helping to accelerate the publishing process.

In order to measure the website’s effectiveness, the project has closely monitored the number of visitors. The charts below provide an overview of the number of visitors (Figure 2) and page views (Table 3).

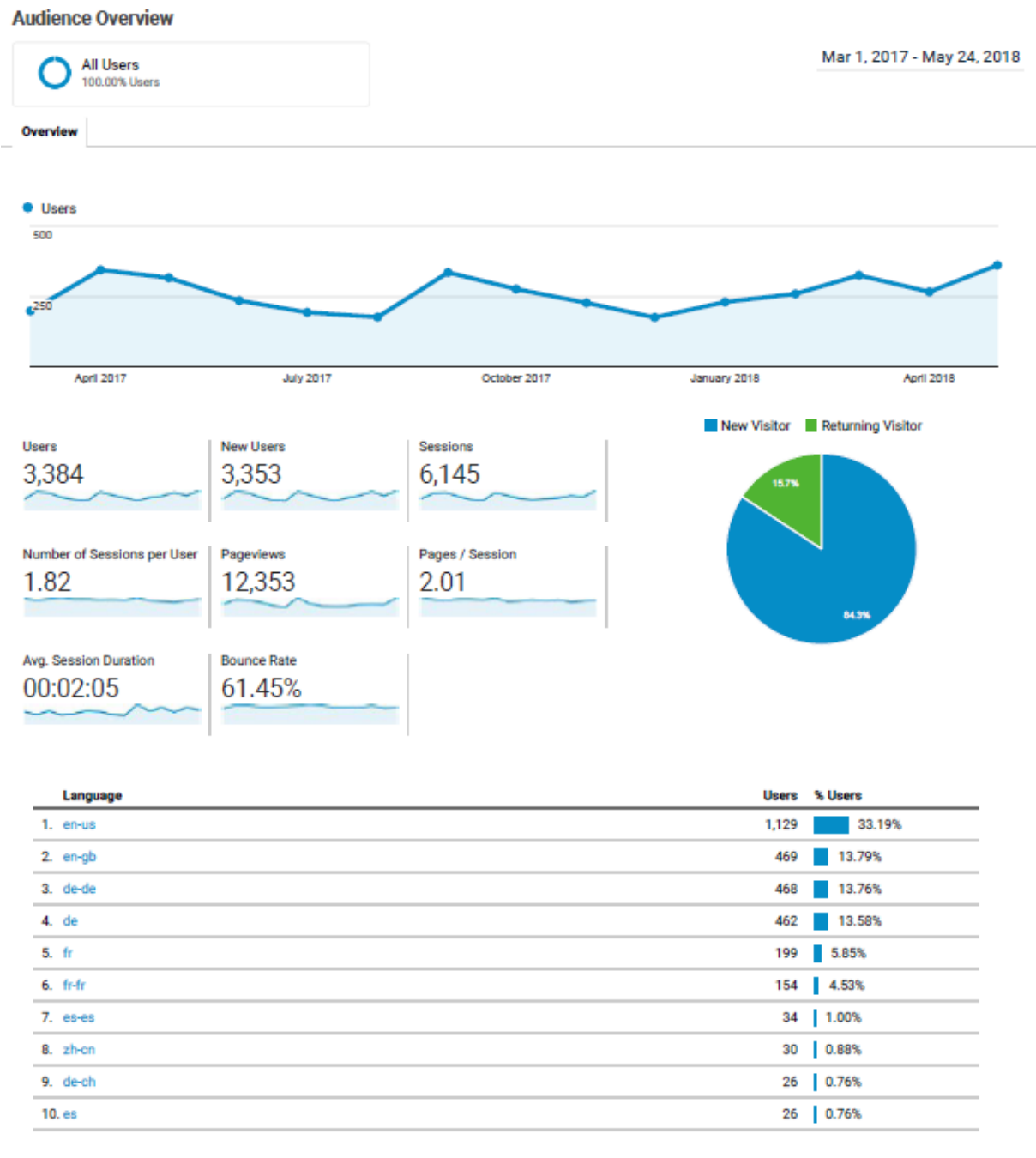


Figure 2: Number of ORPHEUS web visitors

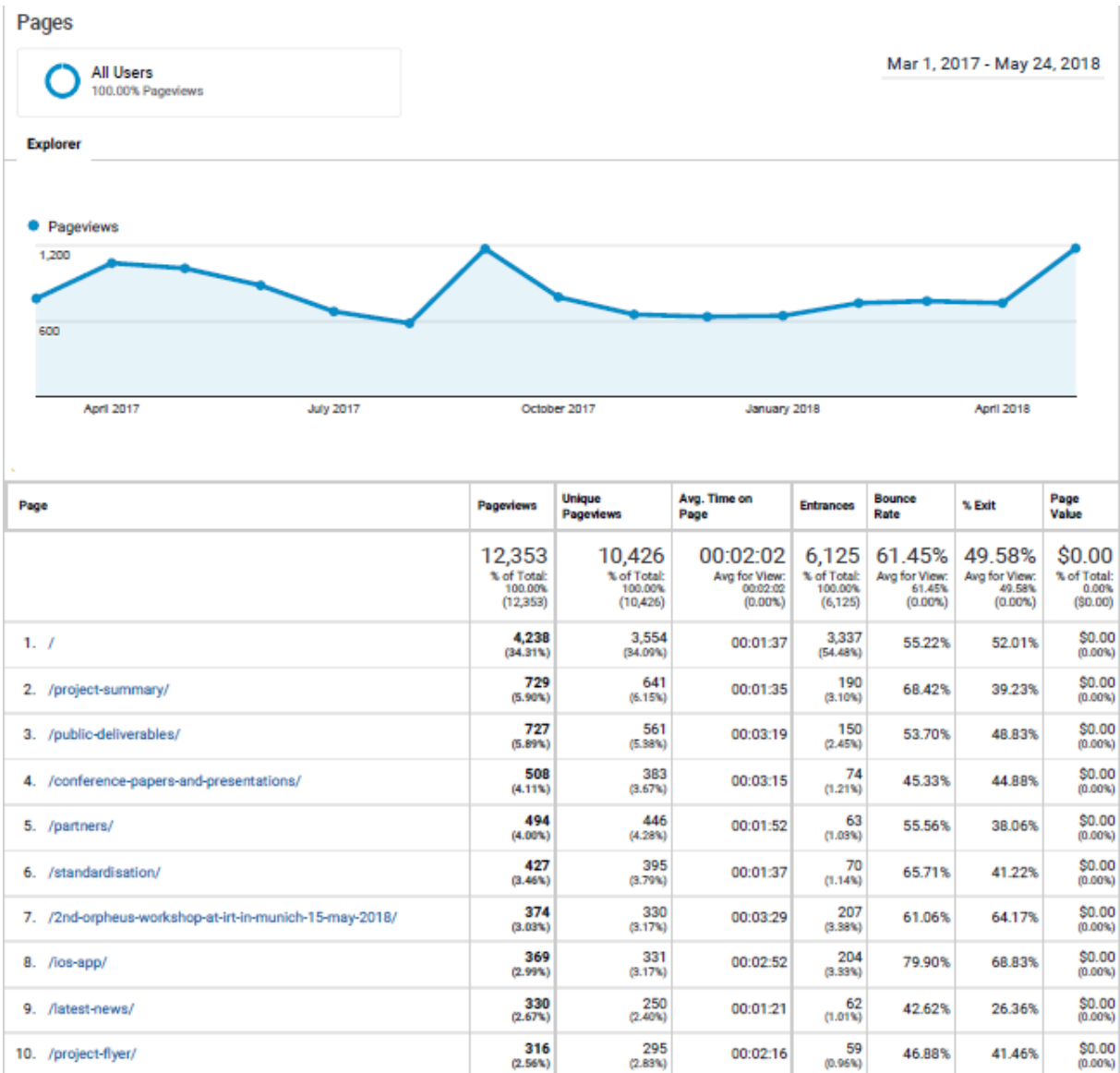


Table 3: Page views of ORPHEUS Web pages

ALL » EVENT CATEGORY: download

Mar 1, 2017 - May 24, 2018

All Users
67.58% Unique Events

Explorer

Event

● Total Events



Event Label	Total Events	Unique Events	Event Value	Avg. Value
	922 (% of Total: 67.15% (1,373))	867 (% of Total: 67.58% (1,283))	0 (% of Total: 0.00% (0))	0.00 (Avg for View: 0.00 (0.00%))
1. https://orpheus-audio.eu/wp-content/uploads/2016/09/orpheus-poster-a1-v02.pdf	129 (13.99%)	121 (13.96%)	0 (0.00%)	0.00
2. https://orpheus-audio.eu/wp-content/uploads/2016/09/orpheus-project-flyer.pdf	66 (7.16%)	65 (7.50%)	0 (0.00%)	0.00
3. https://orpheus-audio.eu/wp-content/uploads/2017/02/orpheus-chris-baume-ebu2016.pdf	59 (6.40%)	56 (6.46%)	0 (0.00%)	0.00
4. http://orpheus-audio.eu/wp-content/uploads/2016/04/orpheus-d3.1_requirements-designs-and-workflows-of-an-object-based-production-environment.pdf	42 (4.56%)	39 (4.50%)	0 (0.00%)	0.00
5. http://orpheus-audio.eu/wp-content/uploads/2016/09/orpheus-d2.1_initial-reference-architecture-specification-report_v1.0.pdf	39 (4.23%)	36 (4.15%)	0 (0.00%)	0.00
6. https://orpheus-audio.eu/wp-content/uploads/2017/03/vdt_2017_01_orpheus.pdf	39 (4.23%)	34 (3.92%)	0 (0.00%)	0.00
7. https://orpheus-audio.eu/wp-content/uploads/2017/07/orpheus-d3-3_object-based_capture-v1-2.pdf	36 (3.90%)	34 (3.92%)	0 (0.00%)	0.00
8. https://orpheus-audio.eu/wp-content/uploads/2018/03/2018_orpheus_workshop_invitation.pdf	35 (3.80%)	33 (3.81%)	0 (0.00%)	0.00
9. https://orpheus-audio.eu/wp-content/uploads/2018/03/2018_orpheus_workshop_program.pdf	33 (3.58%)	31 (3.58%)	0 (0.00%)	0.00
10. http://orpheus-audio.eu/wp-content/uploads/2016/12/orpheus-d3-4-v1-1_implementation-and-documentation-of-a-live-object-based-production-environment.pdf	30 (3.25%)	28 (3.23%)	0 (0.00%)	0.00

Table 4: Top downloads from ORPHEUS website

Deliverable and Flyer Page Views and Downloads

The Public Deliverables page⁹ attracted 27 page views between March 2017 and May 2018.

The page of the Project Flyer¹⁰, which was published in mid-September 2016, attracted 316 page views by May 2018. The flyer was downloaded 66 times in this period.

Referencing of ORPHEUS website on partner websites

All project partners refer to the ORPHEUS website on their respective organisation’s website. BBC R&D is, for example, featuring ORPHEUS prominently on its website, as Figure 3 shows.¹¹

⁹ URL: <https://orpheus-audio.eu/public-deliverables/>

¹⁰ <https://orpheus-audio.eu/project-flyer/>

The Fraunhofer Audio Blog reported several times about the ORPHEUS project.¹²

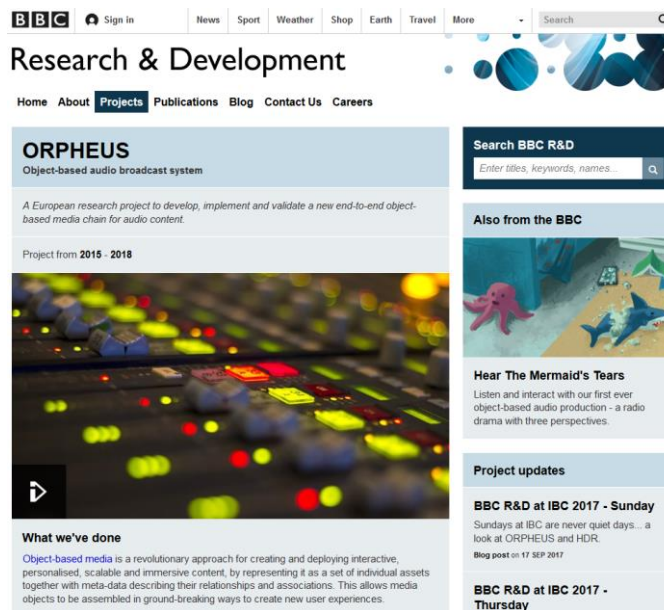


Figure 3: ORPHEUS reference on the BBC R&D website

Other partners either have a dedicated page for ORPHEUS, like for example Eurescom¹³, IRCAM¹⁴ and Elephantcandy¹⁵, or at least a link to the ORPHEUS website.

Accessibility of ORPHEUS website and web documents after the end of the project

The ORPHEUS website will remain accessible for 3 years after the end of the project. Open access documents like papers and public deliverables will remain accessible for a longer period via the Zenodo open access portal at <https://zenodo.org/communities/orpheus/>. According to the Zenodo FAQs, the content stored in the repository is guaranteed to remain accessible for 20 years.

3.2 Social Media

Social Media provide an important channel for communicating with the target audiences of ORPHEUS. The primary Social Media channel used by the project is Twitter.

3.2.1 Twitter

From the various social media options available, the ORPHEUS partners have decided to focus their attention on the most relevant channel within the audio and broadcast community: Twitter. All company partners in the ORPHEUS project run at least one Twitter account, regularly posting news, promoting activities and events, and communicating with their 'followers'.

The consortium's own Twitter account – @ORPHEUS_AUDIO – was set up in January 2016. *Twitter*

¹¹ URL of ORPHEUS page on BBC R&D website: <http://www.bbc.co.uk/rd/projects/orpheus>

¹² <http://www.audioblog.iis.fraunhofer.com/orpheus-final-workshop/>

¹³ URL: <https://www.eurescom.eu/services/management-of-european-rd-projects/ongoing-projects/orpheus.html>

¹⁴ URL: <https://www.ircam.fr/project/detail/orpheus-1/>

¹⁵ URL: <http://www.elephantcandy.com/elephantcandy-part-of-international-consortium-researching-object-based-audio/>

Analytics is used to get in-depth information on effectiveness and to plan further improvements.

As of 30 May 2018, @ORPHEUS_AUDIO had **404 followers**, and had posted **365 tweets**.



Figure 4: ORPHEUS Twitter page

Most of the official Twitter accounts from consortium partners support @ORPHEUS_AUDIO by regular ‘retweeting’.

Besides actively tweeting, the project also carefully monitors the effectiveness of its Twitter activities, e.g. how many followers have joined and what the most popular tweets have been in terms of views, ‘likes’, and ‘retweets’. Below screenshots, as an example, gives an overview of the ORPHEUS Twitter statistics as of May 2018.

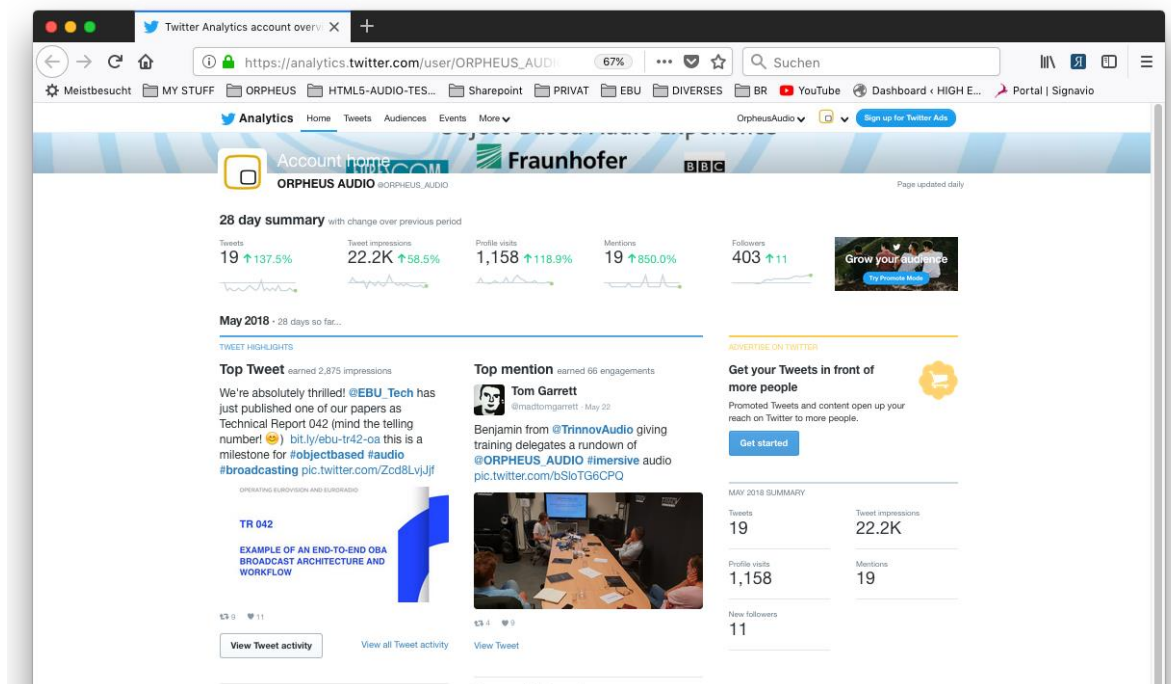


Figure 5: Statistics of @ORPHEUS_AUDIO Twitter account (May 2018)

With a total of more than 400 followers gained during the project's lifetime, ORPHEUS has by far surpassed the follower numbers of most other comparable Horizon 2020 projects or similar publicly funded projects.

3.2.2 LinkedIn

A number of ORPHEUS participants are also members of the global, business-oriented social network LinkedIn. On this network, informal exchange and discussions as well as sharing of professional news take place. At suitable occasions, ORPHEUS has made use of LinkedIn, when relevant news for such a broad and diverse community were available. As an example here is shown (Figure 6) the short post linking to the full report about the 2nd ORPHEUS workshop. The numbers of actions (likes) and total views prove the visibility and interest in the project for a broad range of people.

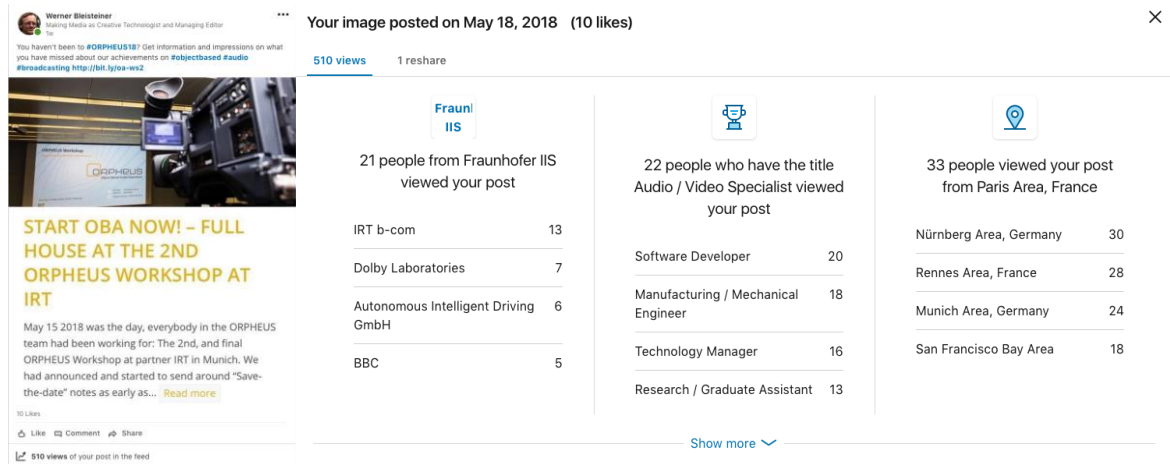


Figure 6: Post and statistics of post related to the 2nd ORPHEUS workshop.

3.3 Publications

3.3.1 Papers and Presentations

A total of 32 papers and presentations have been made by ORPHEUS in the reporting period. Table 5 provides an overview:

Publication date	Type of Publication	Event / Publication name	Papers / presentation title	Authors
2017-05-17	- Conference contribution	EBU Object-Based Audio 2017	Formats and standards, publications and work in progress	- Michael Weitnauer
2017-05-17	- Conference contribution - Presentation	EBU Object-Based Audio 2017	Introduction to Orpheus Project	- Andreas Silzle
2017-05-17	- Conference contribution - Presentation	EBU Object-Based Audio 2017	Reverberation techniques for object-based radio	- Olivier Warusfel - Markus Noisternig
2017-05-17	- Conference contribution - Presentation	EBU Object-Based Audio 2017	Loudness measurement for object-based content	- Michael Meier

2017-05-17	- Conference contribution - Presentation	EBU Object-Based Audio 2017	Object-based and scene-based audio acquisition in ORPHEUS	- Nicolas Epain
2017-05-17	- Conference contribution - Presentation	EBU Object-Based Audio 2017	IP studio and Radio Production	- Chris Baume
2017-05-17	- Conference contribution - Presentation	EBU Object-Based Audio 2017	Pilots and architecture	- Michael Weitnauer
2017-05-17	- Conference contribution - Presentation	EBU Object-Based Audio 2017	Use-cases, user interfaces and content production	- Werner Bleisteiner
2017-05-18	- Conference contribution	High End Munich 2017	Next Generation Audio – ein Ausblick auf die Tonaufnahme- und Übertragungssysteme von morgen.	- Christian Hartmann - Michael Weitnauer - Werner Bleisteiner - Andreas Silzle
2017-07-19	- Presentation	textAV	Object-based broadcasting	- Chris Baume
2017-08-11	- Thesis	Hochschule der Medien	Aspekte der objektbasierten Rundfunkproduktion am Beispiel des EU-Forschungsprojekts ORPHEUS im Bayerischen Rundfunk	- Miriam Böhm
2017-09-07	- Conference contribution	ICSA 2017 - 4th International Conference on Spatial Audio	Software tools for object-based audio production using the Audio Definition Model (ITU-R Recommendation BS.2076)	- Markus Noisternig - Thibaut Carpentier - Olivier Warusfel
2017-09-07	- Conference contribution	ICSA 2017 - 4th International Conference on Spatial Audio	Editing Ambisonic Sound Scenes	- Nicolas Epain - Mohammed Hafsati - Jerome Daniel
2017-09-14	- Conference contribution - Presentation	IBC 2017	Automatic sound source localization for object-based audio recording	- Nicolas Epain - Jerome Daniel

2017-09-14	- Journal	IET Journal (IBC 2017)	ORPHEUS Audio Project: Piloting an End-to-End Object-Based Audio Broadcasting Chain	- Andreas Silzle - Michael Weitnauer - Michael Meier - Olivier Warusfel - Werner Bleisteiner - Tilman Herberger - Nicolas Epain - Benjamin Duval - Niels Bogaards - Chris Baume - Uwe Herzog
2017-10-12	- Presentation	Arab States Broadcasting Union ASBU	Object-based Audio - an overview	- Michael Weitnauer
2017-10-26	- Presentation	EBU New Radio Day 2017	The Orpheus APP	- Werner Bleisteiner
2018-01-23	- Conference contribution	EBU Production Technology Seminar 2018	The ORPHEUS Project: End to End OBA Broadcast Architecture and Workflow	- Chris Baume - Michael Weitnauer
2018-01-31	- Magazine	FKT Magazin	The ORPHEUS Project: Building the Workflow for End-to-End Object-Based Audio Broadcasting	- Michael Weitnauer - Andreas Silzle
2018-02-12	- Presentation	EBU Digital Radio Summit 2018	Piloting an End-to-end Object-based Audio Broadcasting Chain	- Werner Bleisteiner
2018-04-12	- Presentation - Workshop	Meeting of Audio Engineering Society	The Future of Radio - Audio over IP and Object based audio	- Chris Baume
2018-05-02	- Conference contribution	Sounds Amazing	Top Tech Tips	- Chris Pike - Chris Baume
2018-05-10	- Conference contribution	High End Kolleg 2018	ORPHEUS EU Research Project	- Werner Bleisteiner - Benjamin Duval
2018-05-15	- Presentation - Workshop	2nd ORPHEUS Workshop	The Future of Audio is Object-based - Results of ORPHEUS	- Andreas Silzle
2018-05-15	- Presentation - Workshop	2nd ORPHEUS Workshop	The ORPHEUS Reference Architecture	- Michael Weitnauer
2018-05-15	- Presentation - Workshop	2nd ORPHEUS Workshop	Delivering Personalized and Immersed Audio with MPEG	- Harald Fuchs

2018-05-15	- Presentation - Workshop	2nd ORPHEUS Workshop	Object-based and Variable-length Production in Sequoia	- Marius Vopel
2018-05-15	- Presentation - Workshop	2nd ORPHEUS Workshop	The Mermaid's Tears - Creating the World's First Live Interactive Object-based Radio Drama	- Chris Baume
2018-05-15	- Presentation - Workshop	2nd ORPHEUS Workshop	Approaches to Make Programs Variable in Length and Depth	- Werner Bleisteiner
2018-05-15	- Presentation - Workshop	2nd ORPHEUS Workshop	Design and Implementation of an Object-based End User Application	- Niels Bogaards
2018-05-31	- Conference contribution - Presentation	Nordic Sound Symposium	The Future of Audio is Object-based - Results of ORPHEUS	- Andreas Silzle
2018-06-30	- Magazin	VDT Magazin	Adaptive, Immersive, Interactive – Object-based Audio Innovations by EU Project ORPHEUS	- Andreas Silzle - Werner Bleisteiner - Michael Weitnauer - Milon Gupta

Table 5: Publications and presentations

Further journal publications in the Special Issue (Object-Based Audio) of the JAES are in preparation. The target publication date is Jan/Feb 2019.

3.3.2 ORPHEUS Newsletter

ORPHEUS is publishing a bi-annual e-mail newsletter, called 'ORPHEUS Audio News'. The purpose is to inform target audiences about activities and results of the project. Three issues have been published in the reporting period:

- **ORPHEUS Audio News 3 (June 2017):** In the third issue we presented an article on immersive object-based broadcast experiments at BR as well as event reports about the 1st ORPHEUS workshop in London and the seminar on object-based audio at an EBU workshop in Geneva. This issue has been mailed to 117 subscribers – 56 % more subscribers than for the December 2016 issue, which was sent to 75 subscribers.
- **ORPHEUS Audio News 4 (December 2017):** The fourth issue featured in the Highlights section an article on Quality of Experience tests performed at the JOSEPHS Open Innovation Lab in Nuremberg, Germany. The second article highlighted a major result from pilot phase 2, in which ORPHEUS introduced programmes of variable length in MAGIX Sequoia. The Events section featured the event highlight of the year for ORPHEUS, IBC 2017 in Amsterdam. This issue has been mailed to 147 subscribers.



ORPHEUS AUDIO NEWS May 2018

Figure 7: Header of ORPHEUS newsletter

- **ORPHEUS Audio News 5 (May 2018):** The fifth issue featured in the Highlights section a short summary of our major project results and an article about the ORPHEUS iOS app. In the Events section we presented reports about the ORPHEUS activities at the NAB Show in Las Vegas, the Sounds Amazing conference in London, the High End trade fair in Munich, and the 2nd ORPHEUS workshop, also in Munich. This issue has been mailed to 183 subscribers.

Each newsletter is complemented by additional information, e.g. on past and upcoming events. All articles published in the newsletter are also available in the News section of the ORPHEUS website. Anyone interested can subscribe to the Newsletter via a subscription form on the website.

All issues of the newsletter are archived in pdf format on the ORPHEUS website at <https://orpheus-audio.eu/orpheus-audio-news/> where they will be accessible as long as the website is online.

3.3.3 ORPHEUS Flyer and Poster

In September 2016, ORPHEUS produced a 4-page project flyer (Figure 8, left) to inform target audiences about the purpose and activities of the project. 2,000 copies were printed. The remaining copies of the flyer are used by project partners for distribution at events and other occasions. A PDF version is available on the website under “Publications”.

Moreover, the project poster (Figure 8, right), which was also created in 2016, has been used at events and other occasions.



Figure 8: ORPHEUS flyer (left) and poster (right)

3.4 Events

3.4.1 Conferences, Workshops and Exhibitions

ORPHEUS partner organisations were very active during the reporting period in disseminating the ORPHEUS results at major conferences, workshops and exhibitions in Europe and North America, as Table 6 shows.

Date	Event	Place	Type	Partners involved	Type of involvement
22/04/2017 - 27/04/2017	NAB	Las Vegas	Conference & exhibition		booth, demos, banner

17/05/2017 - 18/05/2017	EBU object-based Workshop	Geneva	Workshop	eCandy, FhG, b<>com	Organisation of a 2h Orpheus session within object-based audio seminar, several presentations in other sessions
18/05/2017 - 21/05/2017	High End 2017	Munich	Trade fair	Trinnov	booth
20/05/2017 - 23/05/2017	AES Berlin 2017 - 142nd Int. Convention	Berlin	Conference	BBC	Participation to a panel
13/06/2017	Orpheus mid-project Workshop	London	Workshop	All partners	Organisation, presentations, demos
06/07/2017 - 07/07/2017	Fraunhofer IIS and IDMT SommerCon	Münchsteinach	Fraunhofer-internal workshop	FhG	Presentation about Orpheus
19/07/2017 - 21/07/2017	textAV	New York	Conference	BBC	Presentation on object-based broadcasting, including Orpheus
07/09/2017 - 10/09/2017	ICSA 2017	Graz	Conference & exhibition	IRCAM, b<>com	1 workshop, 1 poster by Ircam; bcom paper presented
14/09/2017 - 19/09/2017	IBC 2017	Amsterdam	Conference & exhibition	all partners	2 papers accepted (one joint project paper, one by b<>com)
12/10/2017	Arab States Broadcasting Union (ASBU)	Tunis	Conference	IRT	remote presentation
24/10/2017	Medientage München	Munich	Conference & exhibition	IRT	presentation of ORPHEUS app at IRT booth
26/10/2017 - 27/10/2017	EBU New Radio Day	Munich	Conference	BR	presentation of ORPHEUS app in one session
08/11/2017 - 09/11/2017	SATIS	Paris	Trade fair	IRCAM	ORPHEUS ADM tools presented at a booth
01/12/2017	ORPHEUS at JOSEPHS Opening	Nürnberg	Opening event	FhG	Press release by FhG, short introduction to what is shown by ORPHEUS representatives

12/02/2018 - 15/02/2018	EBU Digital Radio Week	Geneva	Conference & exhibition	BR, IRT, eCandy	Presentation at Digital Radio Summit on 14 Feb; Demonstration of ORPHEUS app
09/04/2018 - 12/04/2018	NAB Show	Las Vegas	Conference & exhibition	b<>com	booth and Presentation of ORPHEUS at b<>com booth
02/05/2018	Sounds Amazing	London	Conference	BBC	Presentation on ORPHEUS
10/05/2018 - 13/05/2018	High End 2018	Munich	Trade fair	Trinnov	Trinnov showed their OBA AV-Receiver and introduced the project in the High End Kolleg (together with BR)
15/05/2018	ORPHEUS Final Workshop	Munich	Workshop	All partners	Organised by ORPHEUS consortium including presentations and demos
23/05/2018 – 26/05/2018	AES 144 th Convention	Milano	Conference	BBC, IRT, b<>com	The EBU ADM Renderer work was presented and discussed in two relevant workshops. EBU TR042 was also promoted.
31/05/2018 – 03/06/2018	Nordic Sound Symposium	Oslo	Conference	FHG	FHG will present ORPHEUS at plenary

Table 6: Conferences, workshops and exhibitions, March 2017 – May 2018

In the sections below, we describe some of the ORPHEUS event highlights in the reporting period, where the project achieved an excellent dissemination impact towards its target audiences.

3.4.1.1 EBU seminar on object-based audio in Geneva

On 17-18 May 2017, the ORPHEUS team presented selected project results on object-based audio at an EBU seminar in Geneva. The European Broadcasting Union, EBU, is the world's leading alliance of public service media, representing 73 broadcasters in 56 countries. EBU's technical division develops and recommends technical standards, assuring interoperability in international technical broadcast infrastructures. ORPHEUS was invited by EBU to hold an 'object-based audio' seminar, offering a special ORPHEUS session in addition to the regular presentations from stakeholders and market participants.

In the opening session, Ludovic Noblet, Director of ORPHEUS partner b<>com's Hypermedia Research Department, delivered a keynote speech on "Editorial, social, marketing future of multimedia contents and the place of sound in this future. Despite 30 presentations in a row, participants had enough time to see and listen to a dozen demonstrations, staged in the lobby of the big EBU auditorium and some showrooms.



Figure 9: Moderator Matthieu Parmentier from France Television and the ORPHEUS presenters



Figure 10: Nicolas Epain (right) demonstrates b<>com's HOA plug-in for the Eigenmike

Some ORPHEUS team members provided extra lectures, with in depth information on project-related issues:

- Michael Weitnauer (IRT): Formats and standards, publications and works in progress
- Olivier Warusfel & Markus Noisternig (IRCAM): Reverberation techniques for object-based audio
- Michael Meier (IRT): Loudness measurement for object-based content
- Adrian Murtaza (FHG): OBA and Personalization in the context of MPEG-H Audio
- Adrian Murtaza (FHG): MPEG-H Authoring Tools for OBA
- Andreas Silzle (FHG): Introduction to ORPHEUS Project
- Nicolas Epain (b<>com): Object-based and scene-based audio acquisition in ORPHEUS
- Chris Baume (BBC): IP Studio & Radio Production
- Marius Vopel (Magix): Integration of Object-based Audio in Sequoia
- Michael Weitnauer (IRT): Pilots and Architecture

- Werner Bleisteiner (BR): Use-cases, User Interfaces and Content Production

How important is in your opinion object-based audio for broadcasting?



Figure 11: Result of an on-site poll among the workshop participants

The ORPHEUS Session finally provided a concentrated overview on our tasks and achievements so far. Very encouraging were the results of a live poll during the closing round table discussions. According to the poll result, object-based is regarded by the majority as tomorrow’s broadcast technology; open standards for it are essential and the main features of the first implementation cycle are indeed most requested.

Despite strong competition, the ORPHEUS approach was attested to be the most complete, advanced and future-oriented approach to the manifold demands and complex infrastructures of broadcasters.

3.4.1.2 IBC 2017 – Amsterdam, 13 – 18 September 2017

IBC, the International Broadcasting Convention in Amsterdam’s RAI trade fair centre, is the biggest annual broadcast technology event in Europe. In 2017 there was a record participation of 1,700 exhibitors and 57,000 visitors from all over the world. ORPHEUS had a strong presence in both the conference and the exhibition.

Our technical coordinator Andreas Silzle from Fraunhofer IIS presented the ORPHEUS project in the conference session on Object- and data- based media. Nicolas Epain from b<>com introduced their production tools in the session on ‘Advances in audio production’.

Strong presence in the IBC exhibition

In the exhibition, **Fraunhofer**, **BBC R&D**, **b<>com** and **IRT** presented ORPHEUS results at their booths. In addition, the EBU offered us to be prominently featured at the spacious **EBU stand**, which is renowned as a central point of interest for the exchange of new developments and



Figure 12: Floor plan of ORPHEUS partners in the exhibition

the networking hub for public service broadcasters.

The central focus of ORPHEUS in the exhibition was to demonstrate the benefits of our developments to the end-consumer.

At the stands of Fraunhofer and EBU we presented the **ORPHEUS app**, which was developed by our partner elephantcandy.



Figure 14: Screenshot from 'The Mermaid's Tears'

m Parties

BBC R&D focused their presentation of the ORPHEUS project in the IBC Future Zone on their pilot radio drama ‘**The Mermaid’s Tears**’, produced as a test scenario for their IP Studio in Broadcasting House,

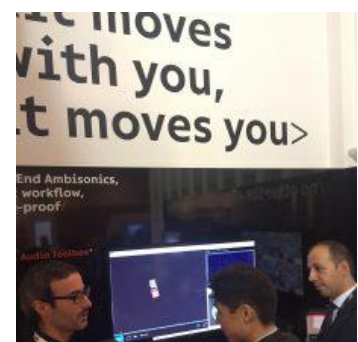


Figure 13: Nicolas Epain at the b<>com booth

London. Prior to IBC, this interactive audio drama was broadcast live, making it the **first live interactive object-based broadcast**, where you can follow the story from the different perspectives of any one of three characters.

ORPHEUS partner **b<>com** presented its plug-in suite Spatial Audio Toolbox for Ambisonics and object-based audio in IBC's Future Zone.

Strong Twitter activities by ORPHEUS and its partners at IBC 2017 resulted in coverage on the IBC Daily as well as in various leading tech magazines during the event.

3.4.1.3 NAB Show, Las Vegas, USA, 7 – 12 April 2018



With around 100,000 attendees every year, NAB Show in Las Vegas is the world's largest show focusing on media technology. Already present in 2016 and 2017, b<>com had again a stand in the 2018 NAB Show Futures Park area where they showcased some of the production tools developed during the course of the ORPHEUS project.

The demonstration presented by Nicolas Epain, audio research engineer at b<>com, took the visitors through the process of creating spatialised soundtracks for immersive media experiences, from production to distribution and playback. The first step of the demonstration focused on recording 3D audio scenes using a Zylia ZM-1 spherical microphone array. The microphone signals were converted into Higher-Order Ambisonic signals (HOA) and monitored using VST plugins developed by b<>com during the ORPHEUS project.

The second step of the demo highlighted post-production and mixing for 360-degree movies using CinematicVR, a tool developed by the French startup Aspic Technologies. This tool allows one to create immersive soundtracks consisting of audio objects, HOA and channel-based audio. The soundtrack obtained can then be exported with metadata in the Audio Definition Model (ADM) format.

In the final step of the demonstration, visitors could experience two different immersive audiovisual experiences: "Alteration" by Jérôme Blanquet, and "Longing for Wilderness" by Marc Zimmermann. The soundtracks of both movies consisted of HOA compressed using the MPEG-H 3D audio codec.

3.4.1.4 Sounds Amazing conference, 2 May 2018



Following the success of “Sound: Now and Next” in 2015, the BBC brought hundreds of audio producers and technologists back to Broadcasting House in London for a full day conference called “Sounds Amazing” on the 2nd of May 2018. The event included talks from the producers of inspiring works such as Blue Planet 2, and featured a technology fair, sponsored by the S3A project, that showcased the latest audio technology. The talks included a session on immersive audio, which memorably demonstrated the power of binaural audio using hundreds of wireless headphones with an on-stage dummy head microphone (see picture).

The talks also featured a number of object-based audio experiences, such as an interactive voice-controlled drama, and a demonstration of media device orchestration. ORPHEUS exhibited in the technology fair, where we presented The Mermaid’s Tears interactive radio drama, and our iPhone app that showcases a variety of object-based experiences. The event received such positive feedback that it will now be run as a regular bi-annual event.

3.4.1.5 HIGH END audio trade show in Munich, Germany, 10 – 13 May 2018

At the HIGH END audio trade show in Munich, Germany (May 10th – 13th, 2018), visitors were able to experience the first Trinnov Audio device that supports the interactive and immersive audio format MPEG-H 3D Audio, introducing the advantages of object-based audio with productions from the ORPHEUS pilots to the audiophile community.

In addition, Benjamin Duval from Trinnov and Werner Bleisteiner from BR in Munich were presenting the outline of the ORPHEUS project daily in the High End Kolleg to the visitors. This, too, was followed with great interest.



Figure 15: Benjamin Duval (Trinnov) demos the ORPHEUS Altitude at High End

3.4.2 ORPHEUS Workshops

3.4.2.1 1st ORPHEUS Workshop – London, 13 June 2017



Figure 16: Plenary session at the 1st ORPHEUS workshop

On 13 June 2017, the 1st ORPHEUS Workshop took place at the BBC's New Broadcasting House in London, UK. The select group of 30 participants included stakeholders from the broadcasting industry. They saw and discussed ORPHEUS results from the first project phase.



Figure 17: IP Studio at BBC's Broadcasting House

The workshop was opened with a welcome address by Dave Walters, Head of Product for Systems & Services at the BBC. After him, ORPHEUS's technical coordinator, Andreas Silzle from Fraunhofer IIS gave a brief overview on the project structure and objectives. After the opening, the audience split into six small groups for touring in parallel through the six demo stations. These stations showed live demos of the current status of project achievements, representing the whole end-to-end chain of ORPHEUS: capturing, editing & mixing, play-out, and distribution & reception.

The demos in detail:

- Nicolas Epain from b<>com demonstrated their capturing and rendering tools for Higher Order Ambisonics.
- Olivier Warusfel from IRCAM presented their comprehensive suite of ADM tools for editing and spatial reverb generation.
- Marius Vopel showed the newly introduced ADM functionalities of MAGIX's SEQUOIA DAW.
- Chris Roberts from BBC's experimental radio studio presented off-the-shelf equipment.
- Chris Baume from BBC R&D showed the project's dedicated all-IP studio with implemented ORPHEUS developments.
- Niels Bogaards from Elephantcandy demonstrated the ORPHEUS radio app receiving MPEG-H

streams, including rendering into different formats and offering specific object-based audio features.

After the demo tours, the final plenary was dedicated to questions & answers and an open discussion with the participants on the ORPHEUS results and their value for the broadcasting industry.

3.4.2.2 2nd ORPHEUS Workshop – Munich, 15 May 2018

At the 2nd ORPHEUS Workshop in Munich, the consortium presented selected ORPHEUS project results to about 120 representatives of the global media industry. The event was hosted by consortium partner IRT, the research institute of the public broadcasters of Germany, Austria, and Switzerland.

According to our workshop concept, the programme (see Table 7) featured a good balance between presentations and hands-on demonstrations.

Time	What	Presenter
09:00	<i>Arrival, Coffee & Registration & Demos</i>	
10:00	Welcome	Ralf Neudel, IRT
10:05	Presentations - ORPHEUS and the architecture behind	
10:05	The Future of Audio is Object-Based—Results of ORPHEUS	Andreas Silzle, FHG
10:35	The ORPHEUS reference architecture	Michael Weitnauer, IRT
11:00	Personalized and Immersive Audio with MPEG-H	Harald Fuchs, FHG
11:25	Lightning talks of demonstrations	All demos. (1 min each)
11:45	Demos	
12:30	Networking lunch & demos	
13:15	Presentations - Production of object-based audio	
13:15	Perfect sound for stunning pictures: France TV's OBA productions	Lidwine Ho, France TV
13:40	Object-based and variable length features in Sequoia	Marius Vopel, MAGIX
13:50	The Mermaid's Tears - Creating the world's first live interactive object-based radio drama	Chris Baume, BBC R&D
14:15	Break & Demos	
15:00	Presentations – Creating new experiences	
15:00	Approaches to make programs variable in length and depth	Werner Bleisteiner, BR
15:25	Design and implementation of an object-based end user application	Niels Bogaards, Elephantcandy
15:50	Media Device Orchestration and the use of ad-hoc devices	Trevor Cox, University of Salford
16:15	What's next? The road ahead to implementation	EBU, BBC, France TV,

		Swedish Radio, BR/IRT
17:00	End	

Table 7: Programme of the 2nd ORPHEUS Workshop

Presentations

Our technical project leader **Andreas Silzle** from Fraunhofer IIS started with an overview of the concept and achievements of ORPHEUS made in the past 30 months. Next, **Michael Weitnauer** from the host, IRT, zoomed into the ORPHEUS Reference Architecture for the complete chain of object-based audio broadcasting. The audio format we have used for consumer delivery was MPEG-H, which is already on air in UHD-TV in Korea and will be introduced in China soon. **Harald Fuchs** from Fraunhofer IIS explained the technical details of this Next Generation Audio codec and the new functionalities it is offering to the audience.

In the **Lightning Talks**, all 15 demonstrations were invitingly highlighted. So for the next one and a half hours 120 visitors of the workshop started to fan out in the halls, rooms and studios of the IRT and discussing matters with the ORPHEUS experts.

After the lunch break, **Lidwine Hô** from the ORPHEUS associated partner France TV started the afternoon session presenting their first experiences with object-based audio for TV. Next, **Marius Vopel** from Magix provided some insights on how OBA production features have been implemented already within the Sequoia DAW. **Chris Baume** from BBC R&D then told the story of how “The Mermaid’s Tears” was to become the first object-based interactive and immersive live radio drama, produced in a totally IP-based environment.

The closing session was dedicated to give some outlook on the future. In pilot phase 2 ORPHEUS has premiered the variable-length functionality for audio. **Werner Bleisteiner** from BR explained the concept and practical approach to that. **Niels Bogaards** from elephantcandy then outlined how object-based audio will enhance the way we use audio apps. Finally, **Trevor Cox** from the related UK based research project S3A even went one step further and told us about how we could orchestrate multiple devices for new audio experiences.

Panel discussion

So, what’s next? It’s the road to implementation. A final panel, moderated by **Simon Tuff** (BBC), who had led us through the whole day, with participants from our associated partners **Paola Sunna** (EBU), **Lars Hedh** (Swedish Radio) and **Matthieu Parmentier** (France TV), along with Chris Baume (BBC R&D) and Peter Fohrwikl (BR) sketched some scenarios on how object-based audio will evolve in broadcasting. A key message to take home was: “Start OBA now!” More precisely: Explore the possibilities, create content, introduce tools into the production and enhance your infrastructure and workflows. Because if you don’t, others will do it – and disrupt traditional broadcasting.

Demonstrations of ORPHEUS results

The demonstrations were the other key part of the programme. 15 demonstrations of ORPHEUS results were spread across the IRT building, offering the interested audience a hands-on demonstration tour during the extended breaks (see Table 8).

#	Demonstration Title	ORPHEUS Partner
1	upHear - Parametric spatial sound capturing with compact microphone arrays	FHG
2	HOA recording with Zylia microphone array	BCOM
3	Object-based production in Sequoia	MAGIX

4	France TV's object-based productions using Pyramix	France TV
5	Preprocessing object-based content for different distribution platforms	IRT
6	ADMix Tools for immersive music productions	IRCAM
7	Experimental production tools for object-based audio	IRT
8	EBU ADM Renderer for object-based audio	IRT & EBU
9	The ORPHEUS App	ECANDY
10	MPEG-H Soundbar	FHG
11	Trinnov Altitude immersive playback	Trinnov
12	The Mermaid's Tears interactive radio drama	BBC
13	MPEG-H 3D Audio for UHD TV	FHG
14	Media Device Orchestration: ad-hoc arrays for spatial audio	S3A
15	User evaluation results from Josephs	BR & FHG

Table 8: Demonstrations at 2nd ORPHEUS Workshop

3.4.3 Audiences Reached Through Presentations at Events

Between March 2017 and May 2018, ORPHEUS reached 3,030 people from its target audiences directly and personally via booths and presentations at 22 events. The total number of attendants at these events was 313,029.

As Table 9 shows, industry representatives, particularly broadcasting professionals, were by far the largest target audience reached – 2,270 people, which is 75 % of all audiences reached. The next-largest target audiences are end-users (330 people, 11 %) the scientific community (280 people, 9 %) and the media (150 people, 5 %). This main target audience profile is fully in line with the target audience priorities defined in the dissemination plan (D6.1).

Event Name	Start Date	End Date	Location	Activity Type	Audience	
					Type	Size
NAB Show 2017	22-Apr-17	27-Apr-17	Las Vegas	Booth, demos	Broadcasting professionals	103,000 ¹⁶ 100 ¹⁷
EBU Object-Based Audio 2017	17-May-17	18-May-17	Geneva	Conference contribution, presentations, workshop participation, exhibition, demonstrations	Broadcasting professionals	120

¹⁶ All visitor of tradeshow

¹⁷ Visitors at booth

High End 2017	18-May-17	21-May-17	Munich	Booth	Consumers and experts	19,889 ¹⁴ 150 ¹⁵
Orpheus Mid-Project Workshop	13-Jun-17	13-Jun-17	London	Project workshop at BBC	Industry	30
Fraunhofer IIS and IDMT SommerCon	06-Jul-17	07-Jul-17	Münchsteinach	Fraunhofer internal workshop	Scientific community	80
textAV	19-Jul-17	21-Jul-17	New York	Presentation on object-based broadcasting including ORPHEUS, workshop participation	Industry	30
ICSA 2017	07-Sep-17	10-Sep-17	Graz	Workshop organisation, poster, paper	Scientific community and industry	200
IBC 2017	14-Sep-17	19-Sep-17	Amsterdam	Booth, exhibition, papers	Industry	60,000 ¹⁴ 400 ¹⁸
Arab States Broadcasting Union (ASBU)	12-Oct-17	12-Oct-17	Tunis	Remote presentation	Broadcasting executives and professionals	500
Medientage München	24-Oct-17	26-Oct-17	Munich	Booth, exhibition	Media	6,000 100
EBU New Radio Day	26-Oct-17	27. Oct 17	Munich	Conference participation, presentation	Media	50
SATIS SCREEN4ALL	08-Nov-17	09-Nov-17	Paris	Booth	Industry	100
ORPHEUS at JOSEPHS Opening	01-Dec-17	01-Dec-17	Nuremberg	Exhibition, demo, booth	End users	250
EBU Production Technology Seminar 2018	23-Jan-18	25-Jan-18	Geneva	Conference contribution, presentation	Broadcasting professionals	200
EBU Digital Radio Week	12-Feb-18	15-Feb-18	Geneva	Conference contribution, presentation, workshop participation, exhibition, demo	Broadcasting executives and professionals	120

¹⁸ At all four booths

NAB SHOW 2018	09-Apr-18	12-Apr-18	Las Vegas	Booth	Broadcasting professionals	102,000 ¹⁴ 100 ¹⁵
Meeting of Audio Engineering Society	12-Apr-18	12-Apr-18	Southampton	Presentation	Industry	50
Sounds Amazing	02-May-18	02-May-18	London	Conference contribution, exhibition	Industry	100
High End trade fair	10-May-18	13-May-18	Munich	Booth	End users and experts	20,000 ¹⁶ 40 ¹⁷
High End Kolleg	10-May-18	13-May-18	Munich	Conference	End users and experts	40
2 nd ORPHEUS Workshop	15-May-18	15-May-18	Munich	Workshop	Industry	120
AES 144 th Convention	23-May-18	26-May-18	Milano	Conference	Industry	100
Nordic Sound Symposium	31-May-18	03-Jun-18	Oslo	Conference contribution, presentation	Scientific community and industry	100
					TOTAL	313,129¹⁹ / 3,030²⁰

Table 9: Target audiences reached via event presentations, March 2017 – May 2018

¹⁹ All attendees at events where ORPHEUS had dissemination activities

²⁰ All participants/ visitors of sessions or booths organized by ORPHEUS

3.5 Interviews and Media Coverage

3.5.1 Interviews

Best of IBC 2017 – Interview with Andrew Mason, BBC R&D, IET.tv, September 2017



Figure 18: Screenshot of video interview with Andrew Mason

In a video interview published on the IBC website and on IET.tv, the video channel of IET (Institution of Engineering and Technology), Andrew Mason, Senior Technologist at BBC R&D, speaks about the ORPHEUS research project and explains how the BBC is experimenting with object-based audio. The interview was recorded at the exhibition of IBC 2017 and has a length of 6:53 min.

Web link:

<https://www.ibc.org/production/video-bbc-randds-work-with-object-based-media/2643.article>

3.5.2 Media Coverage

ORPHEUS attracted considerable media attention, which resulted in good media coverage – see the examples below.

Online articles:

- Object-Based Audio and Sound Reproduction, by Joao Martins, audioXpress, 26 April 2018, URL: <http://www.audioxpress.com/article/object-based-audio-and-sound-reproduction>
- The ORPHEUS Project – Building the Workflow for End-to-End Object-Based Audio Broadcasting, FKT-Magazin 1-2/2018, 31 January 2018, URL: <https://www.fkt-online.de/archiv/artikel/2018/fkt-1-2018/22430-the-orpheus-project-building-the-workflow-for-end-to-end-object-based-audio-broadcasting/>
- NHK normalises 8K in the Future Zone at IBC, RedShark News, 17 September 2017, URL <https://www.redsharknews.com/production/item/4924-nhk-normalises-8k-in-the-future-zone-at-ibc> (the last third of the article features the demos of ORPHEUS at IBC 2017)

Radio:

- Radio interview with Markus Noisternig about ORPHEUS, FranceInter, 1 June 2017
- Radio interview with Michael Weitnauer about ORPHEUS, Bayern 2 Notizbuch, 21 June 2017
- NZZ 3.6.2017, 18:31 Uhr Digital Audio/ TV-Bilder mit Raumklang NZZ

3.6 Software Created and Disseminated by the Project

Software generated by the consortium is another type of result disseminated by the project. Some software is openly available for free, other software upon request.

A list of software produced by the ORPHEUS project and the respective form of availability is shown in Table 10.

#	Name	Functionality	Status	Partner	Availability	Link
1	ADMix tools suite	Standalone ADM tools: Player, Renderer, Recorder and ExtractXLM	ready	IRCAM	free	http://forumnet.ircam.fr/fr/produit/spat/admix-en/
2	Sequoia	DAW with ADM and OBA features	prototype	MAGIX	In next release version 15	https://www.magix.com/de/musik/sequoia/
3	ORPHEUS app	demo app with OBA demo content and all interactivity features	demo app	Elephant-candy	on request	https://orpheus-audio.eu/ios-app/
4	MPEG-H encoder and decoder	Encoding and decoding of MPEG-H, Low Complexity Profile, Level 3	product	Fraunhofer IIS	on request (with licensing program)	https://www.iis.fraunhofer.de/de/ff/amm/produkt/digirundfunk/digirundfunk/tv-audio.html
5	MPEG-H DASH Live-Encoder	PC-based real-time encoding from MAD1 and DASH streaming output	prototype	Fraunhofer IIS	on request	https://www.iis.fraunhofer.de/de/ff/amm/produkt/digirundfunk/digirundfunk/tv-audio.html
6	IRT pre-processor	reduction of the number of objects	prototype	IRT	on request	
7	EBU ADM renderer	ADM Renderer for use in NGA broadcasting	ready	IRT, BBC	free	https://github.com/ebu/ebu-adm-renderer Documentation: https://tech.ebu.ch/publications/tech3388
8	b<>com Spatial Audio Toolbox	MicProc: plugin for spherical microphones HOAScope: plugin to visualize the HOA sound field	ready	b<>com	on request (with licensing program)	https://b-com.com/fr/node/1711

Table 10: Software created and disseminated by ORPHEUS

3.7 Continued Access to Public Project Documents

The ORPHEUS consortium will ensure continued access to public project documents beyond the end of the project through open access. Open access documents like papers and public deliverables will remain accessible for a longer period via the Zenodo open access portal at <https://zenodo.org/communities/orpheus/>. According to the Zenodo FAQs, the content stored in the repository is guaranteed to remain accessible for 20 years.

4 Overall Assessment of Impact Achieved

As documented in sections 2 and 3, the ORPHEUS consortium achieved significant impact through its standardisation and dissemination activities during the 30 months of the project duration. This assessment is based on the following evidence:

Standardisation

The consortium has made significant standardisation contributions to all standards relevant for object-based audio, as documented in section 2. Throughout the project ORPHEUS has mainly focused its limited resources on ITU-R and EBU as the most relevant bodies. This approach made sure that ORPHEUS partners had a leading role in the standardisation process for ADM and OBA.

The progress of these standardisation activities will ensure a faster uptake of OBA technologies by broadcasters and multimedia content producers.

Dissemination

Through its manifold dissemination activities, the ORPHEUS consortium managed to raise the awareness for the project's results among target audiences. Moreover, ORPHEUS successfully managed to get target audiences involved.

The continuity of online and offline dissemination activities by ORPHEUS ensured that the large majority of relevant players in the European broadcasting and media production industry learned about the project and its results.

The most striking examples of how the project successfully managed to get its target audiences interested in its results and the opportunities of object-based audio are the two ORPHEUS workshops. They jointly attracted a highly relevant industry audience of altogether 150 broadcasters, audio technology providers and content producers.

The impact of the demonstration of ORPHEUS project results at the two workshops and at large industry events like IBC and NAB Show went far beyond just making target audiences aware that object-based audio exists. ORPHEUS managed to get into a dialogue with the very industry players who could make object-based audio a reality in broadcasting and multimedia production process over the next few years.

As the project website will be maintained for three more years and longtime access to public ORPHEUS documents will be guaranteed via Zenodo, the impact of ORPHEUS will exceed the lifespan of the project, supporting the adoption of ORPHEUS's solutions and object-based audio by industry.

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