# D2.3.3

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CONNECTEDTV Accessibility

# D2.3.3 – Final Common Technical Components report

Project no. 621014
**HBB4ALL**
Hybrid Broadcast Broadband for All


CIP- Pilot actions
Competitiveness and innovation framework programme 2007-2013


# D2.3.3 – Final Common Technical Components report


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# Table of Contents

# 1. Introduction

The Hybrid Broadcast Broadband for All project (HBB4ALL) has investigated Access Services in the hybrid broadcast-broadband TV (HbbTV) environment. One of the most prominent challenges faced by broadcasters is the requirement to add Access Services in a cost-efficient manner, also to audio-visual content delivered via Internet, while remaining consistent with the Access Services available on traditional broadcasts and their respective workflows. A new additional challenge is to offer viewers the opportunity to customise the Access Services they are using to best meet their personal preferences or needs.

HBB4ALL has tested Access Services in four interlinked Pilots; Pilot-A: Multi-platform subtitle workflow chain; Pilot-B: Alternative audio production and distribution; Pilot-C: Automatic User Interface adaptation – accessible Smart TV applications; Pilot-D: Sign-language translation service. During the operational phase of the HBB4ALL project (for all Pilots A to D formally running from August 2015 – July 2016) the project partners implemented field tests to gather user feedback and to assess the acceptance and quality of services in various scenarios.

This deliverable gives an overview of the common technical activities of each pilot within the final project year. It further contains an overview of the project partner's contributions to standardisation during the last year of the project based on the project's results as well as the actual and planned standardisation activities beyond the project for each partner that was involved in standardisation activities.

It further contains an **overview on actual and planned exploitation activities and opportunities for the technical results of the project** on a per partner basis as well as the individual partner's exploitation strategy.

The document is a follow up on deliverable D2.3.2 Common technical components (II).

# 2. Common technical activities within final project period

In the following we will give an overview on the common technical activities conducted within the different pilots throughout the final project year:

## 2.1. Common technical activities for Pilot A "Multiplatform subtitling services"

The sub-pilots in Germany, Spain and Portugal all adopted the EBU-TT-D standard for subtitles. In the final year of HBB4ALL, in addition to running sub-pilots, partners in Pilot A worked together to test the interoperability of EBU-TT-D. This activity was coordinated by IRT.

The aim of the tests was to gain insights on common issues which may occur when EBU-TT-D subtitle content and rendering solutions from different providers are combined. This was necessary as in practice subtitle content will normally be rendered by a variety of software/hardware players. Yet due to varying interpretations and/or coverages of the applicable specifications (EBU-TT-D and also HbbTV where appropriate) the actual rendering results may differ from the rendering intended by the subtitle author. This can affect the viewer's experience to a certain extent.

Each partner involved imported content from other partners into their players and recorded the results. IRT compared the intended rendering results – according to the EBU-TT-D source document –with the actual ones by means of visual comparison.

The identified issues were grouped wherever possible and show that sometimes there are still diverging interpretations of the relevant specifications and/or not all features which are used in practice – optional as well as mandatory – are currently implemented.

While the result of the test is a non-exhaustive list of interoperability issues limited to the test set of data, it is assumed that their occurrence is more general. As such the test results encompassing descriptions of the issue, their cause and potential solutions should be helpful to any party who plans to deploy EBU-TT-D subtitles

Please refer to D3.2 [1] and D3.4 [2] for further information on the sub-pilots within Pilot-B.

## 2.2. Common technical components and activities for Pilot B "Alternative audio production and distribution"

In Pilot-B, WP4 of the HBB4ALL project, the partners closely cooperated in the preparation and active pilot phase of the sub-pilots in WP4. Specifically, the Clean Audio sub-pilots in Germany and Catalonia required effective collaboration by RBB/IRT and UAB/IRT/TVC respectively.

In preparation of the Clean Audio sub-pilot in Germany, RBB and IRT cooperatively developed a suitable method to query the test participants on speech intelligibility. This method had to be agnostic of the user's device (TV, PC or mobile device) and in the end was based on statements by users on intelligibility relative to the time code in the program. Additionally, an appropriate online questionnaire was designed to support this test method. Whereas RBB had selected content to be used in the field trial, IRT verified its technical suitability (e.g. with respect to audio mix) and carried out the Clean Audio processing. The evaluation of the field trial results again was a cooperative activity.

For the Clean Audio sub-pilot in Catalonia, UAB and IRT in close cooperation developed a new testing methodology, to eliminate the weak points of the testing methodology for lab tests on speech intelligibility, that had been used up till then. TVC carried out an intensive search for content in its archives, which was

verified by IRT regarding its technical suitability (e.g. with respect to audio mix). IRT also handled the Clean Audio processing and hosted the software test environment for the tests which were further coordinated by UAB. The evaluation of the test was handled by UAB with support by IRT.

Beyond these activities, no further common technical activities were required during the last project phase.

Please refer to D4.2 [3] and D4.4 [4] for further information on the sub-pilots within Pilot-B.

## 2.3. Common technical components and activities for Pilot C "Automatic UI Adaptation"

In Pilot-C, WP5 of the HBB4ALL project vsonix has worked on different technical activities related to the AccessGUIDE service framework for the personalisation/adaptation of online video applications as well as on the online course on media accessibility (MOOC), which is technically provided by vsonix with content developed by UAB.

The main technical activities in the final year were to include mobile support for the AccessGUIDE user profile generation application as well as for the MOOC. All underlying service components have been further enhanced in order to follow a responsive design approach, which automatically adapts its UI to the underlying runtime environment. Both the AccessGUIDE application as well as the MOOC now support all actual smartphones (Android and iOS) as well as tablets.

In order to be able to provide the user with the UI best suited for their device we have evaluated several approaches. We decided to implement the well-known and widespread framework Bootstrap (http://getbootstrap.com/), which is developed by Twitter Inc. Bootstrap allows for easy definition of screen behaviours based on predefined screen dimensions and grid templates. Depending on how the elements have been classified they are displayed differently. Bootstrap was used as a framework for all components related to the AccessGUIDE framework and the MOOC.

For the MOOC, vsonix has developed a website that contains all the course material as webcasts. It includes a media library, functions for user management, interactive questions, as well as the possibility for users to discuss on the course content. The course was published in August 2016 under www.accessguide.tv/course. The playback of the course content is based on vsonix' accessible and interactive online video playback solution vPlayer that supports subtitle personalisation including font type, size and position, an adaptive UI, the possibility to switch between signer and non-signer content as well as a screen-reader function for all UI elements. To support the playback on mobile devices the vPlayer now also supports native HTML5-based video streaming technologies such as HLS and MPEG-DASH, since flash-based streaming mechanisms are not available on mobile platforms. This has been integrated in the platform by vsonix within the final project year. The personalisation of the UI elements and the subtitles is based on the AccessGUIDE framework.

Beside the technical activities by vsonix, Screen has developed an integration with the AccessGuide API allowing this service to be used in interactive services supported by the Screen content publishing system.

Please refer to D5.2 [5] and D5.4 [6] for further information on the sub-pilots within Pilot-B.

## *2.4. Common technical components and activities for Pilot D "Sign language interpretation"*

The most intense common technical activity in Pilot D "Sign language interpretation" has been carried out by RTP and UPM to deploy the Portuguese signing subpilot. This subpilot has extended the previous live double screen functionality in the RTP website to cover catch-up content and customisation options. This activity has stimulated the cooperation between both partners to allow a joint deployment. The subpilot has been focused on a concrete news programme named "Jornal da tarde".

RTP has provided a REST API to access the programme main video and additional information. RTP has also provided information about the streaming technology to access the signing signal via Internet. On the other hand, UPM has taken advantage of the mentioned resources to enable the daily automatic recording of the programme signing and to develop the web interface where the service is provided, including the customisation options. In close cooperation with RTP, UPM has worked on two different web players: JW Player (widely deployed in the world) and VideoJS (open source).

Moreover, UPM has been in charge of providing the service by means of its servers. This close cooperation has also extended to the execution of user tests.

Please refer to D6.2 [7] and D6.4 [8] for further information on the sub-pilots within Pilot-B.

# 3. HBB4ALL impact on standardisation

## 3.1. Introduction

During the project lifetime, HBB4ALL partners have contributed to various standardisation activities, to support future products and processes regarding Access Services. From a technical point of view, the use of standardised solutions can increase the amount of Access Services offered, either via broadcast or using the Internet, or by combining both. Standardised approaches on the production side will help to harmonise service offers and the support of specific features for better Access Services. HBB4ALL has elaborated technology, guides of good practice, metrics, and recommendations which were brought up for standardisation.

For subtitles, in the scope of HBB4ALL contributions to the standardisation of new subtitle formats were delivered, to meet the requirements of modern subtitle workflows (contribution, production, distribution, archiving), having in mind the delivery of subtitle services via broadcast as well as Internet. Also, based on the experience and know-how available in the project, recommendations regarding the service design were made to raise the Quality of Service from the end-user point of view. Whereas the HbbTV 2.0 specification had been finalised before the start of the project, no contributions to the standard itself were possible. However, some activities were undertaken to support the uptake of HbbTV 2.0 in the market.

The following gives an overview of the standardisation activities and achievements of HBB4ALL partners who have a seat in the appropriate standardisation bodies. The activities will continue beyond the project lifetime, to support further use cases regarding subtitle production and delivery (specifically also for broadband scenarios) and for further improvement of the quality of Access Services in general.

## 3.2. UAB standardization contributions

UAB has been actively participating in the drafting of the below listed standards. These standards are anonymous but in some cases such as Audio subtitling (ISO/IEC 20071-23) UAB co-edited the standard, which took two years coinciding with the life of HBB4ALL.

During the life of the project Audio description (ISO/IEC 20071-21) which had been started before HBB4ALL was active, was finished and also co-edited by UAB. In the final year of HBB4ALL Captioning (ISO/IEC JTC1/SC35/WG6) has started, and again much information from HBB4ALL has been added and it will be developed in the future. UAB has contributed to the drafting of the following documents with information from the HBB4ALL results from tests:

- Audio description (ISO/IEC 20071-21)
- Audio subtitling (ISO/IEC 20071-23),
- Captioning (new item ISO/IEC JTC1/SC35/WG6),
- User needs (reworking series ISO29138
- Accessibility Terms and Definitions (UN/ITU SG16 Q26)

Three other standards were co-edited by UAB for the UN agency ITU

- Saks, Andrea and Pilar Orero (2015) FSTP.ACC-RemPart Guidelines for supporting remote participation in meetings for all. Geneva: ITU (http://www.itu.int/dms_pub/itu-t/opb/tut/T-TUT-FSTP-2015-ACC-PDF-E.pdf)
- Saks, Andrea and Pilar Orero (2015) FSTP-AM Guidelines for accessible meetings. Geneva: ITU (http://www.itu.int/dms_pub/itu-t/opb/tut/T-TUT-FSTP-2015-AM-PDF-E.pdf)

- Saks, Andrea and Pilar Orero (2015) Draft new Recommendation F.791 (ex F.ACC-TERM) Accessibility terms and definitions. Geneva: ITU (http://www.itu.int/ITU-T/aap/AAPRecDetails.aspx?AAPSeqNo=3373 )

Finally, UAB started in March 2016 drafting the standard for Easy Reading in the Spanish Standardisation agency AENOR.

## 3.3. IRT standardization contributions

### 3.3.1. EBU-TT

Today's distribution platforms offer a higher quality display of subtitling and more flexible positioning options than traditional analogue television. File- and IP-based production facilities demand clearly specified ways to carry subtitles during production, exchange, archiving and distribution to their customers, including the use of online services. To handle these new contexts, broadcasters need a low-complexity, but thoroughly specified subtitling format.

To meet these requirements, the EBU Working Group "Subtitles in XML" (XMLSubs) has developed EBU-TT, which stands for EBU Timed Text. EBU-TT is the follow-up to the widely used EBU STL format (EBU Tech 3264). The EBU-TT family currently consists of several specifications[1]. It is based on TTML (Timed Text Markup Language), developed by the World Wide Web Consortium. Timed Text is textual information that is associated with timing information. HBB4ALL partners IRT and Screen actively contributed to the activities in EBU XMLSubs, together with BBC, an HBB4ALL advisory board member – all activities in this group were coordinated by EBU, also an HBB4ALL advisory board member.

Under coordination by IRT, HBB4ALL partners undertook several activities to further develop the EBU-TT specifications and at the same time promote its usage and interoperability also in other standardisation fora. Furthermore, contribution to EBU standardisation activities was a cooperation of several partners, see section 3.5.2.

### 3.3.2. World Wide Web Consortium (W3C)

In addition to the work on EBU-TT, IRT undertook activities to strengthen the compatibility / exchangeability with subtitle formats used on the web. IRT participated as member of the W3C Timed Text Working Group (TTWG) in standardisation of the new update of TTML (TTML2)[2], and the publication the recommendation of IMSC 1 format[3]. The main focus for IRT in the TTWG was to ensure compatibility with the defined standard for HbbTV (EBU-TT-D) and improve also interoperability with the HTML5 ecosystem for web applications. Both activities have been chaired by HBB4ALL advisory board member BBC.

### 3.3.3. DVB TM-SUB

IRT actively participated in the TM-SUB working group in DVB, which focusses on subtitles for current and future services (including UHDTV). The objective is to reach harmonization with the new subtitle standards. Specifically, IRT has contributed to the specification for transmission of TTML-based subtitles in MPEG2 Transport Streams.

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[1] https://tech.ebu.ch/subtitling
[2] https://www.w3.org/TR/ttml2/
[3] https://www.w3.org/TR/ttml-imsc1/

### 3.3.4. HbbTV

Whereas the HbbTV 2.0 specification had been finalised before the start of the HBB4ALL project, no formal contributions to the standard itself were possible. However, some activities were undertaken to support the uptake of HbbTV 2.0 in the market.

IRT contributed to the review of the HbbTV 2.0 test suite and also developed EBU-TT-D Assertions for the test suite (see section 4.1.5). The HbbTV test suite provides a set of test material to enable implementers to test devices against the HbbTV specifications and other associated specifications. It is suitable for suppliers of complete devices and also suppliers of hardware and software components. The HbbTV test suite is designed to be passed 100% by compliant devices and as such is a part of the HbbTV specification.

Based on HbbTV 2.0 prototype devices, IRT implemented showcases and other tests to support the interoperability between upcoming implementations (also part of the formal HbbTV interop testing to verify support of technical features which are required for specific Access Services) (see D3.2 [1]).

## 3.4. UPM standardization contributions

UPM standardisation contributions in HBB4ALL have focused on two different scales: an international one and a national one. Concerning international standardisation, UPM elaborated a contribution about signing services in HBB4ALL for the IRG-AVA group of ITU (International Telecommunications Union) to inform about the signing activities in HBB4ALL. This contribution was not conceived as a part of a future recommendation or specification, but a way to inform ITU and create awareness about the activities carried out in the project, taking into account the alignment between the project and the ITU group.

IRG-AVA is the Intersector Rapporteur Group on Audiovisual Media Accessibility and it enables the cooperation among other ITU groups: ITU-R SG6 (Broadcasting Service), ITU-T SG9 (Broadband cable and TV) and ITU-T SG16 (Multimedia). According to ITU, this group studies topics related to audiovisual media accessibility and aims at developing draft Recommendations for "Access Systems" that can be used for all media delivery systems, including broadcast, cable, Internet, and IPTV. The connection with HBB4ALL is clear, since the project provide new access services for the smart convergent ecosystem of media delivery systems.

This contribution was named as the project (Hybrid Broadcast Broadband for All) and sent to the group co-chairs in September 2015, to be considered in the IRG-AVA meeting of October 2015. It was based on an article presented in the symposium IEEE BMSB (Broadband Multimedia Systems and Broadcasting) in June 2015.

Concerning standardisation activities in a national scale, UPM has participated in the working group created by CNLSE (Spanish Sign Language Standardization Center) to produce the document "Guidelines of good practices for the integration of sign language on TV". This document is intended as a code of good practice for the provision of sign language service on TV in a national scale. In this way, it is not a technical specification but a service specification to provide more enjoyable signed programmes on TV. It is expected to be published by the Spanish Royal Board on Disability at the end of 2016.

## 3.5. Common standardisation activities

### 3.5.1. IEC TC 100

The International Electrotechnical Commission (IEC) is the world's leading organization that prepares and publishes International Standards for all electrical, electronic and related technologies. The IEC is one of three global organizations (IEC, ISO, ITU) that develop International Standards for the world. The TCs (Technical Committees), SCs (Subcommittees) and Project Teams (PT) / Maintenance Teams (MT) carry out the standards work of the IEC. The IEC TC 100 prepares international standards in the field of audio, video and multimedia systems and equipment. Technical Area (TA) 16 focusses on developing international publications addressing aspects of active assisted living (AAL), accessibility, usability and specific user interfaces related to audio, video and multimedia systems and equipment within the scope of TC 100.

Through the Technical Secretary of TA16 in TC 100, HBB4ALL was invited to the IEC TC 100 meeting on 23-25 May 2016 to present the HBB4ALL activities and results. IRT, as a representative for the whole project, gave an overview presentation, update on HBB4ALL and discussed the potential standardisation with the IEC TC 100 members. Specifically, for the Accessibility Services being investigated in HBB4ALL (Subtitles, Alternative Audio and Sign Language), the required standards' implementations in end user devices were presented. The presentation definitely created some interest.

From the broadcasters' perspective the required features are already present in TV related standards (specified by EBU, DVB, HbbTV) – the issue is rather the implementation of non-mandatory features rather than their specification. Currently, from that point of view, no specific need for additional standardisation has been identified. It was highlighted which features would improve the market situation for the deployment of new access services as for example a customizable signing application. In case a specific feature needs to be standardised, the requesting party / company needs to be directly involved in the proposed standardization efforts (if not leading it). It was agreed that for each effort the right standardization group needs to be identified; international standards can also be done by other standard bodies like MPEG.

### 3.5.2. EBU Standardisation activities

The HBB4ALL partners IRT and SCREEN have actively contributed to the XMLSubs Working Group of the EBU[4]. IRT chaired and was the responsible editor for the work on the following subtitles format specifications that were published in 2014:

- EBU Tech 3380 - EBU-TT-D
- EBU Tech 3381 - EBU-TT-D in ISOBMFF

IRT chaired and was responsible editor of the EBU-TT Part 1 (EBU Tech 3350) update that was published at the beginning of 2015. In June 2015 EBU published v0.8 of EBU Tech 3370: EBU-TT Part 3 Live Subtitling and requested for industry comments[5]. IRT initiated and coordinated the feedback of the HBB4ALL partners on specification EBU TECH 3370, which was given in September 2015.

The EBU XMLSubs Working Group in 2016 worked on the stable release of the document EBU Tech 3360 which defines the mapping between EBU STL and EBU-TT. This document should be seen as an important support and often pre-requisite for broadcasters' migrations of the complete subtitles production chain from a teletext scenario to a multiformat and multiplatform scenario. It is also of benefit for the provision of

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[4] https://tech.ebu.ch/groups/pdfxp
[5] https://tech.ebu.ch/publications/tech3370

subtitles for HbbTV and Web applications (as developed in HBB4ALL) and make them more efficient. This standard activity is chaired by IRT and Screen is the responsible editor.

IRT and Screen also continued their engagement in the EBU-TT Part 3 Live Subtitling activity (EBU Tech 3370) which provides the first standardized way for the contribution of live subtitles. This specification also is highly important for the realisation of linear broadband-only live streams that can be consumed by HbbTV 2.0 devices using also MPEG DASH technology. This activity has been chaired by the HBB4ALL advisory board member BBC.

Screen is the responsible editor of the EBU-TT Part 2 (EBU Tech 3360) document which describes how to convert existing EBU STL format files (EBU Tech 3264) into the new EBU-TT standard. In June 2013 EBU published the first draft of this document v0.9 of EBU Tech 3360: Mapping EBU STL to EBU-TT Subtitle Files and requested industry comment.

# 4. Exploitation of technical components per partner

One of the main results of the HBB4ALL project is the individual service components that were developed by the partners as a basis for the different pilots and sub-pilots. In the following we will list the different components per project partner:

## 4.1. IRT

### 4.1.1. Subtitling Conversion Framework

The Subtitling Conversion Framework (SCF), developed by IRT, uses open standard technologies to convert subtitles from legacy formats used in broadcast production into EBU-TT-D subtitles. The SCF is structured as different modules where each module implements one conversion step. The conversion modules that are currently supported are:

- EBU STL to STLXML (STLXML is an XML representation of EBU-STL)
- STLXML to EBU-TT Part 1
- STLXML to STL
- EBU-TT Part 1 to EBU-TT-D
- EBU-TT-D to EBU-TT-D-Basic-DE
- FLASHDFXP to EBU-TT-D-Basic-DE

Additional information can be found in HBB4ALL deliverables D3.2 [1] and D3.4 [2].

Availability: To encourage a wide adoption, this framework has been published as Open Source. It has been released in alpha status on Github (https://github.com/IRT-Open-Source/scf) under a free open source license (Apache 2) license but nevertheless is already being used in production. A beta version is planned for release by the end of the HBB4ALL project.

Exploitation: IRT will continue to develop the SCF beyond the scope of HBB4ALL and to promote its usage, to allow wide adoption of the framework as well as of EBU-TT / EBU-TT-D and to support further use cases. IRT is available as technical partner, on a project basis, to support companies who plan to use the SCF.

### 4.1.2. Lightweight Subtitle Editor

The Lightweight Subtitle Editor is a low-cost XML editor for EBU-TT-D subtitles that is customized for the re-purposing of subtitles for Internet distribution. It is built on the XML editor oXygen. Additional information can be found in HBB4ALL deliverable D3.2 [1].

Availability: A basic version of this authoring tool has been lab-tested; IRT plans to pursue further development, as there is a need for a subtitle editor which is low-cost, has a very high usability factor, meets requirements to produce professional, accessible subtitles, allows production in new subtitle formats (e.g. EBU-TT-D, IMSC 1 and WebVTT), and can be integrated in different existing platforms and workflows.

Exploitation: IRT plans to offer this development and support for realization for specific usage scenarios. E.g. in case the service provider / broadcaster only has limited (financial) resources for creating / modifying subtitles and does not need a large, complex subtitling suite to do the job. Typically, interest from special interest channels, non-profit organisations, smaller enterprises could be expected.

### 4.1.3. EBU-TT-D XML-schema

The EBU-TT-D XML Schema provides the possibility to validate EBU-TT-D XML documents against the specification EBU-TT-D (EBU Tech 3380). The work was contributed to the EBU and will be further maintained by IRT as part of the EBU standardization work. Additional information can be found in HBB4ALL deliverable D3.2 [1].

Availability: The XML Schema is currently published as version 1.0. It may be used by anybody working with EBU-TT-D. It is available under a free open source license from Github (https://github.com/ebu/ebu-tt-d-xsd).

Exploitation: IRT will continue to promote the usage of the XML-Schema as a tool to leverage EBU-TT-D products and services in the market based on these standards.

### 4.1.4. EBU-TT-D Rendering Tests

This reference material facilitates a standard conformant implementation of EBU-TT-D, as it is not guaranteed that a presentation processor will make a conformant rendering of an EBU-TT-D document: this check has to be done manually. For the manual review, reference material is required to compare to the presented material. IRT has provided the reference material, which was used by HBB4ALL partners to verify and improve their EBU-TT-D implementations. Additional information can be found in HBB4ALL deliverable D3.2 [1].

Availability: The test set was developed and extended during the HBB4ALL project. It is available from Github (https://github.com/IRT-Open-Source/irt-ebu-tt-d-application-samples) and are subject to the Apache 2.0 license.

Exploitation: IRT will continue to promote the usage of the rendering test material as a tool to leverage EBU-TT-D compliant and interoperable products and services in the market.

### 4.1.5. EBU-TT-D Assertions for HbbTV 2.0

HbbTV 2.0 assertions build the basis for a test suite to check conformance against the HbbTV 2.0 specification. IRT provided assertions for EBU-TT-D implementation and adaptation in HbbTV 2.0. These assertions define the expected rendering given EBU-TT-D features and provide the necessary references to the specification. Additional information can be found in HBB4ALL deliverable D3.2 [1].

Availability: The HbbTV assertions are available from the HbbTV consortium as part of the HbbTV 2.0 test suite.

Exploitation: Test assertions are used to verify features in the specification to make sure an HbbTV 2.0 implementation is conform with the specification. The EBU-TT-D test assertions thus leverage standard compliant and interoperable products and services in the market based on HbbTV 2.0 and EBU-TT-D.

### 4.1.6. Testing Environment for End-to-End Subtitle Workflows

The Testing Environment is used to test the potential integration of new services into an existing subtitle workflow. One of the main requirements in this scenario is that existing services continue to be delivered with their respective reliability. The system comprises a complete end-to-end subtitle scenario distributing Teletext and DVB subtitles within a valid MPEG Transport Stream. The setup reproduces a typical broadcaster's production environment as might exist within many German public broadcasters.

The environment forms the basis for testing the integration of new distribution channels as well as other components that potentially can be integrated into a running broadcaster's system. One candidate for test implementations is a migration to EBU-TT as the master and editing format for subtitles. Another candidate is the subtitle distribution via Internet by using MPEG-DASH streaming.

Availability: Generally, this testing environment is not open to the public. IRT uses it as a tool to support its subtitle activities on a project-basis.

Exploitation: IRT used the test environment to gather know-how on subtitle workflows. It will be further used as a tool, providing a test and reference environment also for future use cases and developments. Also it is planned to be used when supporting contractors on a project basis.

### 4.1.7. Subtitle validation solution "subcheck"

Many broadcasters have a demand for validation of subtitle files before these are contributed to them, e.g. to verify that subtitle files comply to certain subtitle specifications or in-house requirements. A software solution was targeted, which can be used by human operators (through a user friendly web interface) as well as by computer systems (by means of a standardized REST interface). Such a solution allows the subtitle contributor to check the subtitle file and if required correct possible defects before sending it to the broadcaster.

Availability: In cooperation with the company BaseX GmbH a subtitle validation solution called "subcheck" as described above has been prototyped. In cooperation with the German/French broadcaster ARTE, "subcheck" was applied to a real world use case and ARTE's in-house rules for subtitle files were successfully implemented.

Exploitation: The development of "subcheck" will continue beyond the scope of the HBB4ALL project. IRT plans to use this tool to support broadcasters in verifying subtitle files based on their specific requirements.

### 4.1.8. Clean Audio generator

This software tool was developed to automatically generate a stereo audio signal with increased speech intelligibility from readily mixed/produced audio mixes (either 5.1 or stereo) for TV programmes. Additional information can be found in HBB4ALL deliverable D4.2 [3].

Availability: A prototype implementation is available from IRT. Licensing can be made possible to third parties, the licensing scheme is currently unknown.

Exploitation: IRT will continue to raise interest for the need to increase Speech Intelligibility with the aim of putting this or similar solutions into operation, potentially also by having additional field tests with further interested broadcasters. The Clean Audio generator will be used as a tool to support this work. An actual product would most likely be brought to the market via a licensing party.

### 4.1.9. HbbTV MPEG-DASH/ISOBMFF Segmenter and Packager

This software component is an extension to the open source software MP4box, and was developed within the scope of HBB4ALL. As a result, MP4box now directly supports generation of MPEG-DASH streams compliant with the MPEG-DASH profiles defined in HbbTV 1.5 and 2.0. This includes support for the segmentation and packetization of subtitles based on the EBU-TT-D standard. Additional information can be found in HBB4ALL deliverable D3.2 [1].

Availability: The component is available from Github (https://github.com/gpac/mp4box.js) under the GPAC licensing scheme (http://www.gpac-licensing.com/).

Exploitation: MP4Box is widely used: by the video community, by many cloud infrastructures for preparation of multimedia files for playback, and by academics. They all now can use MP4Box to generate HbbTV compliant MPEG-DASH streams and by doing so leverage HbbTV based products and services (specifically for the new standard version 2.0) in the market, thus also leveraging Access Services making use of this technology.

## 4.2. RBB

### 4.2.1. HbbTV customizable subtitles for VoD

The service component HbbTV-Based Customisable Subtitle for VoD Playback was used in the German sub-pilot in combination with the Subtitling Format Conversion Framework developed by IRT. The component is divided into a server-based EBU-TT-D subtitles parser module, the enhancement of the existing Mediathek (VoD Portal of ARD, Europe's largest public broadcasting network) video player to support customisable subtitles and the adaptation of the HbbTV Mediathek graphical user interface (GUI).

The service component was rolled out for the German sub-pilot on 14 April 2015, initially for RBB HbbTV catch-up TV service "RBB Mediathek". On 12 May 2015 the service component was introduced in the "ARD Mediathek", this service bundles catch-up content from all ARD broadcasters.

Addressing the demands that arose from our extensive end user pilot tests the GUI of the player –has been considerably improved since its first launch in 2015. In addition, its functionalities have been extended. The following functionalities are now included:

- select and de-select subtitles
- adapt the font size
- adapt the position of subtitles for display on the screen. Subtitles are rendered with an underlying 67% opaque black box.
- adapt subtitle background/contrast

The overall ARD HbbTV Mediathek structure changed from a multi-tenant system at the beginning of the sub-pilot to an integrated model in early 2016. This means that all broadcasters using the ARD HbbTV Mediathek structure now share the same functionalities. The system is currently used by eight German regional TV channels, one national German TV channel "One" and the "ARD Mediathek" which contains, as explained above, all on demand content from regional ARD broadcasters. The content is filtered according to which broadcaster or TV channels' Mediathek/portal is selected, but the look and feel remains similar and the set of functions are the same. As the new system uses the service component HbbTV-Based Customisable Subtitle for VoD Playback, once subtitles are available anywhere in the Mediathek, they are automatically customisable, thanks to the developments and progress made in HBB4ALL.

## 4.3. UPM

### 4.3.1. Subtitle interpretation tool for browsers

UPM has created two subtitle interpretation tools for browsers in the project. This activity has been carried out with the collaboration of RTP since the main focus of this Portuguese broadcaster is on the provision of audiovisual content via Internet for computers, smartphones and other IT devices. In these cases, the audiovisual content is interpreted and depicted in web players embedded in web browsers. Since the service

provision only requires a web player, the service is offered in any device that supports a web browser. UPM and RTP have taken advantage of this feature to extend the focus of the project beyond HbbTV TV sets and receivers.

The abovementioned subtitling tools have been developed for two different web players: JW Player and VideoJS. For this decision, it was taken into account the RTP opinion as broadcaster. Both tools interpret EBU-TT-D subtitles.

These tools are available for future deployment in RTP website, beyond the open access subpilot carried out in the project. The use of one or other tool depends on the strategic decision of RTP concerning the player integrated in its website. Moreover, these tools will be released with open-source licenses to achieve a wider exploitation after the end of the project. This is also a way to promote the use of the EBU-TT-D as an open specification of subtitle delivery in the current connected world.

## 4.4. VSX

### 4.4.1. AccessGuide

The Software as a Service (SaaS) platform was developed by vsonix. It includes APIs and functions for user and profile management as well as the necessary mechanisms needed for UI adaptation on PC and mobile platforms.  It includes an application for the generation of user accessibility profiles for PC and mobile and platforms. The access service includes functions for UI personalisation targeting the definition of accessible font types, size or colour schemes. Beside UI adaptation it also includes functions for personalized subtitles as well as a personalized text to speech service that could be integrated as a screen-reader or for spoken subtitle applications.

The AccessGUIDE service consists of several components:

- AccessGUIDE Web-App:  The Web-App guides the user through a series of dialogs to establish his preferred UI settings.
- AccessGUIDE API: The AccessGUIDE API is the JavaScript based interface to the AccessGUIDE Service.
- AccessGUIDE Online Service: The AccessGUIDE service represents the backend component of the adaptation functionality. It exposes several functions through a publicly-available REST API that allow application developers to create, store, and retrieve adaptation profile information.
- AccessGUIDE TTS: The AccessGUIDE text to speech functionality provides application developers an on-the-fly text-to-speech services with speech parameters adjusted to the adaptation requirements of the current user profile.

Availability: The AccessGUIDE service will be available and further maintained and disseminated via the website www.accessguide.tv

Exploitation: The aim of vsonix is to integrate the service into its online video application platform vPlayer to become an integrated platform for accessible online video (see below).

### 4.4.2. vPlayer

"vPlayer" was developed by vsonix as a basis for online applications dealing with interactive video learning content on PCs and mobile platforms. The overall platform includes a content management service as well as an interactive and accessible online video player for the playback of course content with advanced navigation and search functionality.  Based on AccessGUIDE, the online video platform supports a number of

personalisable accessibility features like multi-language subtitles, screen reader functions, multi-language spoken subtitles as well as switching between signed and non-signed content.

Availability: The vPlayer is an essential part of the vsonix service and application portfolio being an online video service provider and integrator of online video applications. It's already available in various online video applications that are provided by vsonix to its industry customers.

Exploitation: In the future it is planned to integrate and extend both services further in order to become a dedicated online platform for accessible video content. This could be used by third parties to host their video content online while benefiting from the accessibility features of the platform. One aim will be to develop and integrate additional accessibility services into the Access GUIDE backend such as an online service for automatic subtitling as well as an avatar based signing service. To realize such kind of services additional research is still needed to improve the quality e.g. of the automatically generated subtitles. From our point of view those services are needed to provide a cost effective accessibility service for online video content. The realisation of such as an integrated accessible online video service could be subject of a new European research project that deals with the open issues to be addressed e.g. on reliable speech to text technologies for different content domains as well avatar animation for sign language.

### 4.4.3. MOOC

The online course on media accessibility is provided by vsonix in collaboration with UAB. It is structured in four units, which are: Accessibility, Subtitling/Captioning, Audio Description and Sign Language. The course is addressed to everyone: from users to policy makers, accessibility managers, broadcasters, access service providers or just anyone interested in the topic. There are some learning outcomes that the course adresses such as: making students familiar with the basic concepts and services of media access services, exploring fundamental techniques in the process of audio description, subtitling/captioning/sign language, introducing the professional to the process of audio description, subtitling/captioning/sign language as well as teaching the use of language technologies for accessibility services.

Availability: The course was published in August 2016 under www.accessguide.tv/course and is freely available to all interested parties that register to the course.

Exploitation: vsonix will maintain and support the availability for the next years. The aim is to create awareness for the topic of media accessibility and to disseminate the topic based on the content of the online course.

## 4.5. VIC

### 4.5.1. Automatic Subtitling Component

The Automatic Subtitling Component developed by VIC within HBB4ALL is capable of automatically generating intralingual subtitles from pre-recorded and live English audiovisual content in the broadcast news domain. In addition to automatic transcription, automatic capitalization, punctuation and segmentation modules have also been developed to produce quality subtitles.

Availability: The performance of the component can be tested on pre-recorded content through a web-based application6, to which users can upload the content(s) to be subtitled and receive the corresponding automatic subtitles in their email inboxes.

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[6] http://212.81.220.68:8086/SDK_web/login.php

Exploitation: VIC plans to continue developing the component after the end of the project and to promote its usage for subtitling pre-recorded and live news-like contents and for a wider range of applications, such as parliamentary transcription or multimedia content analytics.

### 4.5.2. Subtitle Translation Component

The implemented Subtitle Translation Component can automatically translate pre-recorded and live English subtitles in the broadcast news domain, both manual and automatic, into Spanish and vice versa. While the source time-codes are maintained, subtitle segmentation is adjusted to the linguistic properties of the target language.

Availability: The component is available as a Web Service, which can be accessed through an API that can process both subtitle files and/or individual subtitles.

Exploitation: VIC will continue developing the component after the project ends and will promote its usage for generating interlingual subtitles of pre-recorded and live news-like contents and for a wider range of applications, such as interlingual virtual communications.

### 4.5.3. Live Broadcast-Internet Subtitle Viewer and Synchroniser

The Live Broadcast-Internet Subtitle Viewer and Synchroniser module, developed by VIC, is based on open source technologies. In particular, it is based in Gstreamer[7], released under the LGPL. VIC contributes to open source initiatives in order to promote open approaches for media workflows.

In HBB4ALL, VIC extended Gstreamer to enable the creation of a MPEG-DASH stream with automatically generated EBU-TT-D subtitles. To validate the module, VIC also extended the DASH-IF[8] video player, under BSD-3 license, in order to render the video and the EBU-TT-D subtitles.

Availability: VIC's contribution will be published under Apache 2 license once the project ends.

Exploitation: VIC will continue to develop the solution beyond the scope of HBB4ALL and to promote its usage, to allow wide adoption of the solution

## 4.6. TVC

### 4.6.1. HbbTV customizable subtitles for VoD

The CCMA decided to use EBU-TT-D subtitling format for their HbbTV VoD service, as this format is mandatory from HbbTV version 2.0. With this aim, the CCMA developed several components and mechanisms on their subtitling and publishing workflows which allow the translation from their native subtitling format to EBU-TT-D and the publishing for HbbTV service.

The first HbbTV subtitles for VoD component was deployed on HbbTV CCMA public service named "TV3alacarta" on June 2015. The subtitling service component version was based on two modules: the EBU-TT-D subtitle parser module and the rendering module which print the subtitles as HTML+CSS code over video synchronously.

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[7] https://gstreamer.freedesktop.org/
[8] http://dashif.org/software/

This subtitling service component was rolled out in CCMA HbbTV public service until November 2016, when the service was improved with the new implementation of the subtitling component with customization features:

- Adapt the font size (small, normal, large)
- Change subtitling position on screen (upside or downside)
- Change subtitling background (black or transparent)

The new CCMA HbbTV allows the user to modify the subtitling service to their liking or preferences for better viewing and reading, with a new front-end button and menu design. All 5 CCMA TV channels offer access to HbbTV subtitling services on compatible SmartTV's.

CCMA has increased the percentage of subtitled production up to about 80% on its main TV3 channel and 95.6% on its CS3/C33 youth and cultural channel, in parallel with the deployment of the subtitling service on HbbTV.

### 4.6.2. Multiple audio asset generation for HbbTV VoD service

Taking profit of the Audio Description (AD) and Original Soundtrack (OST) workflow already implemented for broadcast, TVC stroved to improve, adapt and expand its workflow for broadband requirements. While production and repository for AD and OST content could be the same for broadband and broadcast, some components needed to be modified or created with new functionalities and services to deploy to HbbTV VoD service.

TVC's HbbTV VoD service, "TV3alacarta", was also improved to support AD and OST content with new developments to discern whether AD and/or OST information is actually provided for a content asset, and with a new front-end buttons design to access audio variants.

Ideally, TVC had planned to use the features of the MPEG-DASH codification. MPEG-DASH is a mandatory feature for HbbTV 1.5 and on the provisioning side would have a large advantage in the content management as it would allow one video asset to have multiple audios associated with it.

Unfortunately, still too many interoperability issues were detected with current HbbTV 1.5 devices (see HBB4ALL Deliverable D4.2 ) For that reason a solution based on progressive download with MP4 codification format has been adopted for the current implementation, expanding compatibility to HbbTV 1.0 SmartTV's. The current solution publishes different variant files for every video asset:

- One VoD variant with original program video and dubbed Catalan audio track.
- One VoD variant with original program video and original sound track (OST) when available.
- One VoD variant with original program video and Audio Description track when available.

As the AD and OST features have been fully integrated and deployed in TVC's HbbTV VoD TV service, potentially any user in Catalonia can access to them with an HbbTV compatible device.

## 4.7. SCREEN

### 4.7.1. Subtitle Authoring Component

Screen has implemented an EBU-TT –D export function as an option within the standard commercial product for subtitle preparation from Screen (WINCAPS QU4NTUM).

### 4.7.2. Subtitle prototype EBU-TT-D renderer

Screen has also developed a prototype renderer that decodes EBU-TT-D documents and produces corresponding subtitle images using HTML 5 and JavaScript. This prototype is currently being used to evaluate the possibility of a subtitle preparation tool for EBU-TT-D documents that is completely web-based.

### 4.7.3. Subtitle Contribution Component

Screen has developed a data insertion component for transporting EBU-TT data in the VBI / VANC spaces of an SDI video signal. This component will be offered for use within the commercially available Screen subtitle transmission system.

### 4.7.4. Subtitle Conversion Component

Screen has developed an EBU-TT conversion component for the real-time conversion of (live) subtitle content in proprietary formats into EBU-TT-D format for onward delivery to HbbTV distribution systems. This component will be offered for use within the commercially available Screen subtitle transmission system. When used in conjunction with existing components in the Screen subtitle transmission system the conversion of a wide range of other formats of subtitle data is possible. This component performs real time conversion and is therefore suitable for live subtitling applications and recorded subtitle applications that are 'played out' in real time.

### 4.7.5. Subtitle Distribution Component

Screen has developed a conversion tool that will support the conversion of EBU-TT files to EBU-TT-D files. This functionality has been implemented as two new components designed for use within a commercially available Screen data conversion tool (MediaMate). Using these new components and existing components in the tool it is possible to convert any supported format of subtitle file into an EBU-TT format file and vice versa.

### 4.7.6. AccessGuide integration in PLASMA Gold

Screen has developed an integration with the AccessGuide API allowing this service to be used in interactive services supported by the Screen content publishing system.

## 4.8. RTP

### 4.8.1. Subtitle plug in for web players

RTP focused its work in the provision of subtitled content using web technologies for multiplatform devices, such as smartphones, tablets and desktop, to play along with the RTP Play on RTP website. In this way, in collaboration with UPM, RTP technological partner in this project, RTP implemented in its currently web player a plug in that has the capability to read EBU TT-D files, in order to offer subtitle customisation features, such as font size, positioning and subtitle alignment in the screen. RTP and UPM had the opportunity to create a plug for two different players – JW Player and Video JS.

### 4.8.2. Subtitling Conversion Framework (SCF)

RTP fully automates the production for the EBU-TT-D subtitles on the basis of the Subtitling Conversion Framework (SCF) created by the partners IRT. The subtitler uploads an .stl file he created for broadcast

production to a database. This is the common workflow for broadcast subtitle production. The subtitles are then automatically converted through a scheduled task, when the subtitled programme is published online. RTP implemented an automated mechanism that schedules tasks for conversion, contribution and publishing of subtitle files. Through this mechanism no additional manual time resource is needed for the addition of the subtitle files.

### *4.8.3. RTPPlay Rest API*

RTP has provided a RTPPlay REST API to provide and to enable UPM access to the content used in the tool development for WP6. Since RTP didn't have the possibility to provide the storing capabilities to record the sign language video, UPM has worked on recording on the fly the signing stream for live content to include it in a web-based catch-up application. The programme content (catch-up) is available by means of the API created by RTP. This API also offers metadata about the content to be signed.

# 5. Overall exploitation strategy per partner

## 5.1. IRT

IRT has built up and extended its know-how in several fields; this section describes the respective exploitation plans which are supporting, but not limited to, the further deployment of Access Services in the market.

EBU-TT / EBU-TT-D: The know-how on the novel subtitle format EBU-TT that was built up in HBB4ALL generally will be made available by IRT to any interested company on a project basis. Specifically, also the EBU-TT-D interoperability tests that were carried out with HBB4ALL partners gave detailed insight in the current status of implementations. As EBU-TT support starts to spread in the market, a substantial number of requests for specific support with EBU-TT implementations is expected, e.g. asking for consultancy or for development of EBU-TT profiles for dedicated use by a specific broadcaster.

EBU-TT-D is being used as subtitle format in online public media libraries of the German public broadcasters. IRT supported this development. As a next step, a migration of the production workflow and potentially archives to use EBU-TT as a subtitle format would be possible. Such processes take time; IRT is active in the respective public broadcasters' working groups to support them. The EBU-TT standardization work continues beyond the scope of HBB4ALL, see section 3.3.

Speech intelligibility: IRT will continue to raise interest for the need to increase speech intelligibility. The know-how that was built up in HBB4ALL generally will be made available to any interested company on a project basis and to drive further developments in this field.

For an actual "Clean Audio" service further work can help to further improve the understanding of the requirements of the targeted user groups. E.g. additional listening tests, with more broadcasters / service providers, specifically as field tests, would be useful. IRT is continuously looking for further cooperation options with broadcasters to further improve speech intelligibility and is contributing in various working groups to appropriate (technical) specifications.

For the Clean Audio generator, potential other fields of application are also being examined. IRT had several inquiries to verify if the Clean Audio processing can change the input signal for a Speech To Text engine (e.g. used for automatic subtitle generation) such that the machine understanding of dialogue could be improved.

HbbTV: The HbbTV 2.0-related know-how that was built up in HBB4ALL generally will be made available to interested companies on a project basis.  As HbbTV 2.0 compliant receivers are expected to come onto the market in 2017, also a migration of services that make use of HbbTV 2.0 features becomes interesting. Many broadcasters are thinking about this and IRT supports them.

IRT closely cooperates with manufacturers to develop prototype applications for demonstrations and to verify the respective HbbTV 2.0 implementations. Within HBB4ALL e.g. an HbbTV 2.0 prototype application was developed, supporting live streaming on the Internet, using MPEG-DASH streaming and EBU-TT-D subtitles (see HBB4ALL deliverable D3.2 [1]) [9].

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[9] The application is available on http://hbbtv-live.irt.de/ebuttd/showcase, and may be used for verification / testing of the mentioned feature implementation in HbbTV 2.0 receivers. Generally, the source code is not open; IRT offers his know-how on HbbTV application development generally on a project-basis.

## 5.2. *RBB*

In addition to customised subtitles for VoD in HBB4ALL, RBB also tested a new ARD-wide HbbTV application for customised subtitles for linear TV. Although the application was not developed in HBB4ALL but stems from developments in the research project HBB-NEXT, the RBB HBB4ALL team worked closely with the developers and designers to ensure cohesion between both applications in terms of functions and wording. The app was re-designed in 2015 and a test of the new look and feel and the usability of the app was included in the HBB4ALL pilot. The HbbTV customisable subtitle application for linear TV was rolled out for all ARD channels in 2016. In the meantime other European broadcasters have approached RBB about introducing this function.

The roll out of the customisable subtitles in the linear HbbTV application and the catch-up TV HbbTV application in the ARD means that TV viewers throughout German now benefit from an improved, personalised subtitle user experience thanks to the advances made in HBB4ALL and previous European Commission funded projects such as HBB-NEXT and DTV4ALL. It also indicates the high level of acceptance of the customisation feature by broadcasters and end users and demonstrates the suitability and relevance of HbbTV as a standard to enable enhanced, personalised services.

RBB will continue to use the knowledge gained in HBB4ALL to improve its access services, where possible further develop services together with other members of the ARD and share know-how with related broadcasters, for example through the EBU. RBB will use the results of HBB4ALL as a basis for further research activities. An example of one such activity is the recently founded interest group on accessibility, initiated by IRT with representatives from German, Austrian and Swiss broadcasters. At the first scheduled meeting in December 2016, RBB will attend and in a presentation and discussions share its experience on customised subtitles, in particular the challenges of bringing customisation to more platforms.

RBB plans to introduce EBU-TT-D for live streams together with the introduction of MPEG DASH. This development will benefit from the knowledge gained in HBB4ALL.

RBB will issue guidelines for the on screen presentation of sign language interpreters in HbbTV applications. These guidelines will be publically available and cover the issues of customisation options and parameters. In addition RBB has also written best practice guidelines for the production of sign language services. These will be applied to future sign language production at RBB. ARD accessibility experts have already signalised they are interested in receiving these guidelines.

## 5.3. *UPM*

UPM has gained knowledge in a variety of technologies along the duration of HBB4ALL. Firstly, the implementation of technical components and technical tools for the deployments of sub-pilots has increased the UPM knowledge about the creation of web-based access services. The sub-pilots deployed by UPM and RTP in HBB4ALL are characterised by the use of web browsers to depict the audio-visual content and the access services. The advantage of this approach is the extension of the services to any device containing a web browser (computers, laptops, smartphones and tablets). However, each web browser has also its peculiarities. This has been a lesson learnt when trying to extend the access service functionality to a wider variety of devices. On the other hand, UPM has also achieved a better experience in the development of tools and plugins for different web players since two of them have been considered in the project: JW Player and VideoJS. UPM has learnt another lesson in the project: the importance of preserving as much as possible the production and distribution running workflow in broadcaster premises.

HBB4ALL has allowed UPM to gain experience and knowledge in EBU-TT and EBU-TT-D specification since the subtitling tool implemented in the project is based on it. The preference for open and standardised formats is key for a public research institution like UPM.

UPM has also gained experience concerning user tests. Although UPM had widely worked with actual users (e.g. in subjective quality assessments for video encoding), there is not a unique valid approach for such user tests. HBB4ALL has shown that any user survey requires a previous preparation to design a valid methodology. Precisely, in this field of user tests UAB and UPM have introduced a valuable innovation in HBB4ALL: the use of sign language questionnaires to be used in sign language surveys. In this way, an additional step of written language questionnaires is avoided, getting a better approach from the methodological perspective. Sign language questionnaires may be exploited in other projects and initiatives beyond HBB4ALL and UAB and UPM are studying the way to achieve this overall exploitation.

## 5.4. VSX

During the time of the HBB4ALL project vsonix has further developed its interactive online video player "vPlayer" to become a hosted player solution for the provision of accessible online video content. The player now provides advanced accessibility features such as customisable subtitles in different languages, spoken subtitles, user interface adaptation as well as a screen reader function for people with visual disabilities.

For the future it is planned to further develop the solution to integrate advanced rendering capabilities for sign language animation as well as a multi-device synchronisation mechanism that will allow the rendering of the personalised accessibility features (e.g. subtitles or audio descriptions in a certain language) on a second-screen device such as a smartphone or augmented-reality glasses.

Through the integration of the AccessGUIDE personalisation service, the access services of vPlayer are already now fully customizable. It is planned to further integrate the two services and to streamline the visual appearance and design merging them as one integrated product. This will be completed by an online hosting service and subtitle editing service, which will allow customers to provide their content accessibly using the "vPlayer" solution.

Providing accessible online video services will be an essential part of vsonix' business strategy in the future. During the project lifetime we already started different projects with our industry customers that benefit from the multi-language subtitle feature of the player. vPlayer was developed mainly for eLearning and corporate education purposes. The customers are using it mainly for staff training and development. The customers using the online video solution today come from various sectors including electrical engineering, software development as well as from the financial and pharmaceutical industry. Many of those customers have an international background. They are multinational companies that have the demand to provide multi-language content for their employees. With the results of the HBB4ALL project, vsonix is now in the position to offer those customers an ideal solution for the provision of multi-language educational content.

Another important result that vsonix has gained from the project is the online course on media accessibility. vsonix aims to further maintain the course, disseminating it together with UAB to become available to everyone that is interested in the topic.

## 5.5. VIC

VIC has built up and improved its expertise in several fields. This section describes the respective exploitation plans which are supporting, but not limited to, the further deployment of Access Services in the market.

Automatic Subtitling: Automatic subtitling is an applied research and development line where VIC has been working for the last ten years and will keep working in the foreseeable future. The work carried out in HBB4ALL has served to optimize the integration between inter and intralingual subtitling technology (speech recognition and machine translation) and to advance its applicability in live scenarios.

Despite there is still work to be done at the technological level, especially regarding spontaneous speech (e.g. talk shows, interviews, dialogues) and low-quality/noisy backgrounds (e.g. music, sound effects, user generated content), the state-of-the-art of current technology is applicable and can help make subtitling more productive and reach new application scenarios.

VIC is and will keep closely collaborating with broadcasters, content producers and subtitling companies, adapting and transferring its automatic subtitling technology to support them in the challenging task of making the increasing amount of multimedia content accessible for the deaf and hard of hearing.

MPEG-DASH: VIC is promoting an open media streaming approach over HTTP that will be able to fulfil the requirements of the media streaming in the future. In this sense, VIC is working on a low latency media streaming solution over HTTP, minimising the impact of using an HTTP-based pull-based approach, exploiting all the benefits and mitigating the introduced latency.

On the other hand, VIC is also contributing to the standard in order to enable a distributed streaming solution over HTTP. VIC is pushing the technology towards the coexistence of different transport mechanisms, such as P2P, and to make possible a real-time CDN switching at a segment level.

## 5.6. TVC

Subtitling: The development of the project allowed the CCMA to increase its know-how in terms of improved subtitling workflows and multiple subtitle format adaptation to achieve different devices in a multi-platform environment. The commitment with EBU-TT-D subtitling format adopted for HbbTV 1.0 and 1.5 has allowed anticipating in the deployment of HbbTV subtitling service using the same format that HbbTV 2.0 will use. The CCMA considered of special interest to share their knowledge and developments through the publication of its open source code in GitHub platform for the use and enjoyment of other broadcasters interested in accessibility.

Multi Audio: Although it was not possible to adopt MPEG-DASH standard for multi audio content purposes due to interoperability issues, the main objective of the project was achieved with the deployment of audio description and original sound track services on current CCMA HbbTV VoD using MP4 codification format and multiple asset files which extends the compatibility to HbbTV V1.0 and V1.5. CCMA will go on working to improve its access services using the knowledge gained in HBB4ALL as a basis for further research activities, and has introduced new project proposals aimed to accessibility matters. In the same way CCMA contributes with the HbbTV Association in standard definition and interoperability groups, aimed to resolve interoperability issues and work for future.

## 5.7. UAB

UAB will exploit the many documents generated under D2.6.2 for the other projects they are leading such as ACT and participating ADLAB PRO. These documents are crucial since there is no European benchmarking for Media Access Services. While these docs do not offer any actual benchmarking they offer guidelines on how to promote quality services.

The Department of Culture of the Catalan Government will adopt the docs under D.2.6.2 as guidelines for quality of service. These docs D2.6.2 have also been presented to EDF, EBU and ACT and will be used to guidelines quality in both public and commercial EU broadcasters.

## 5.8. SCREEN

Screen have developed a number of components (as listed above) that allow the deployment of commercial systems to support subtitling and user adaptation within an HbbTV based broadcast ecosystem.

Screen have gained a detailed understanding of EBU-TT during the HBB4ALL project and now have a much clearer understanding of the differences between legacy subtitle formats and the potential (and the limitations) of subtitle provision when using web based technologies and extensible data representations (e.g. XML).

Screen are continuing to investigate the use of ANC packets for the distribution of EBU-TT data within SDI video signals, a use case which imposes a number of limits on data bandwidth and carriage (e.g. error handling). Screen anticipate that a formal specification on the appropriate carriage strategy for EBU-TT data within SDI video will be required in the future. Screen intend to continue working within the EBU-TT standards group on this issue.

Screen have also gained a better understanding of the potential marketplace for HbbTV solutions as the HbbTV standard is slowly adopted by European broadcasters.

Screen have gained considerable experience of the native subtitling capabilities and the supported features available to HbbTV applications in currently deployed HbbTV set-top boxes.

## 5.9. RTP

The participation in this project was very fruitful for RTP, for several reasons.

- First, it was a huge opportunity for RTP to share its point of view and knowledge on accessibilities with others European partners, such as broadcasters, accessibilities investigators and technological partners and also to collect many of their knowledge. It was also a good opportunity to follow the state of the art on media accessibility.

- Second, and despite the fact of HbbTV does not exist in Portugal, RTP participation in HBB4ALL was important because in this way the project also focused its interest in the exploitation of online accessibility and not only in HbbTV standards. The project had the possibility to embrace more media accessibility area.

The participation in HBB4ALL project was also an opportunity to join RTP with its viewers/users and several others authorities such as accessibilities experts and media regulators. RTP considers that it is important to hear what the users have to say. For this reason, it was important the participation of the two major Portuguese deaf and hard of hearing associations in the users tests carried out by RTP, for the subtitling and signing implementations. This participation was also an opportunity to identify some less positive aspects and also to identify what limitations RTP has concerning the accessibilities area.

However, as a result of RTP participation in HBB4ALL project, we can say that RTP is now more prepared for the future of accessibilities than it was three years ago, when the project started.

## 5.10.  HC

HC entered the HBB4ALL project enthusiastically with its social innovation platform background in accessibility and media, and also its ability to connect people and stakeholders from different communities. In charge of dissemination and Advisory Board activities of the HBB4ALL project, HC intends to exploit results to go some more steps forward towards an inclusive society.
For HC, future innovating activities relay on strategy and marketing approaches and could take the following form:
- Be a pivot or "bridge" for "dissemination", "exploitation" for future technological and societal innovation projects that build on, among other things, the HBB4ALL results;
- Open doors and build further partnerships within the European and international ecosystems;

- Encourage and organize events, think tanks and even (strategic) working groups, according to the needs of future projects and ecosystem stakeholders needs.

In the post-project, the exploitation of HBB4ALL results, the following axes are envisaged:
- Public reports and their relay on social networks will be done on the project website as soon as they are publicly available.
- HC's social innovation platform will continue to observe the evolution around HBB4ALL and give echo/feedback of the activities on major issues.
- Activities that begun with the Advisory Board will be monitored on both technological and societal approaches.
- Awareness raising is still necessary for audiovisual and digital in order to move towards an inclusive society, considering the needs of specific populations while being in the interest of all. This is one of HC issues in the sort and longer term.

# 6. Conclusions

In this deliverable we gave an overview on the technical activities within the different pilots during the last project year as well as on how the project's results have been and will be disseminated and exploited by the project partners in the future. Over the last three years, the HBB4ALL project has successfully delivered the tools and technologies that are needed for the provision of customizable access services on HbbTV, PC and mobile platforms. Many of them have already been integrated into running services, which means that already today many users can benefit from the HBB4ALL project results.

# 7. References

[1] D3.2 - Pilot A – Solution Integration and Trials, HBB4ALL deliverable, 2015 (http://www.hbb4all.eu/wp-content/uploads/2015/03/D3.2-Pilot-A-Solution-Integration-and-Trials-2015.pdf)

[2] D3.4 - Pilot-A Evaluations and Recommendations, HBB4ALL deliverable, 2016

[3] D4.2 - Pilot-B Solution Integration and Trials, HBB4ALL deliverable, 2015 (http://www.hbb4all.eu/wp-content/uploads/2015/03/D4.2-Pilot-B-Solution-Integration-and-Trials-2015.pdf)

[4] D4.4 - Pilot-B Evaluations and recommendations, HBB4ALL deliverable, 2016

[5] D5.2 - Pilot C – Solution Integration and Trials, HBB4ALL deliverable, 2015 (http://www.hbb4all.eu/wp-content/uploads/2015/03/D5.2-Pilot-A-Solution-Integration-and-Trials-2015.pdf)

[6] D5.4 - Pilot-C Evaluations and Recommendations, HBB4ALL deliverable, 2016

[7] D6.2 - Pilot D – Solution Integration and Trials, HBB4ALL deliverable, 2015 (http://www.hbb4all.eu/wp-content/uploads/2015/03/D5.2-Pilot-A-Solution-Integration-and-Trials-2015.pdf)

[8] D6.4 - Pilot-D Evaluations and Recommendations, HBB4ALL deliverable, 2016