D2.3.2

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D2.3.2 – Common Technical Components (II)

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D2.3.2 – Common Technical Components (II)

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1. Introduction

The aim of this deliverable is to provide an overview of the technical activities within the HBB4ALL project on a cross pilot as well as on the cross sub-pilot level. This includes the description of joint R&D work between the partners, commonly gained knowledge as well as commonly used technical components.

It further includes the description of commonly used technical standards as well as how the knowledge gained within the project is used to contribute to standards.

The document is a follow up on deliverable 2.3.1 Common technical components (I), which had the aim to identify technical components as well as standards and protocols used by the pilots to realize their advanced accessibility services for their web, mobile and HBBTV based media applications.

In contrast to the first deliverable, which only had the aim to provide an overview about existing technical components and planned developments for the HBB4ALL project within all pilots, this deliverable focusses on a description of the cross-pilot and sub-pilot synergies as they have been identified and are being carried out by the project partners.

2. Common technical components and activities for Pilot A "Multiplatform subtitling services"

2.1. Introduction

Pilot A covers all subtitling activities in HBB4ALL. These encompasses development of prototypical subtitle production workflows required to provide better and new subtitle services offering accessibility options such as customisation and translation, the production of various types of services for the sub-pilots and running complementary user experience tests. During the pilot operational phase the following services are targeted:

1. ***Customizable Subtitles***: These services are designed to allow the viewer to customise the presentation of subtitles on the screen according to their needs. Four sub-pilots will offer customizable subtitles for VoD services. In Germany, Spain and Switzerland these will be HbbTV subtitles for catch-up TV services. The Portuguese sub-pilot will focus on customised subtitles for wide focus multi-platform.
2. ***Automated News Service***: These services offer subtitles that have been automatically produced using real-time speech recognition and translated using real-time machine translation. Two sub-pilots, Spain and Switzerland will offer this service
3. ***MOOC - Customised Subtitles for Online learning***: This service aims to offer increased accessibility to online learning by developing customised subtitles for online learning environments, while the actual topic of the service will be on how to provide advanced accessibility options.

The focus of activities in Pilot A is to develop new services in a cost-efficient manner in line with traditional broadcast services and existing workflows. Broadcasters' system components and production workflows were documented and analysed as a prerequisite for the change requirements for processes and interfaces. Based on this information the EBU-TT-D Conversion Framework was developed and is being trialled. Tests with EDU-TT-D subtitle rendering have involved cross sub-pilot testing by IRT, RBB, RTP, TVC, UPM and VIC and for each sub-pilot at least two partners have collaborated closely together. This has ensured a strong collaboration and exchange of information and knowledge and common approach among all Pilot A partners
Producing services that run on HbbTV-enabled devices is also a clear focus of the majority of sub-pilots. Lab test conducted in the sub-pilots and the complementary user experience test results have also helped shape the development of the services and systems.

2.2. Technical components overview

In general the technical components of Pilot A can be divided into two categories: the production of subtitles (authoring & processing) and the presentation / rendering of subtitles. The partners commonly decided that for the rendering of the subtitles in VoD applications EBU Tech 3380 (EBU-TT-D) should be applied. Therefore every software component that supports this standard could potentially be used by multiple sub-pilots in Pilot A and could prove the benefits of interoperability through the use of standard formats.

The technical components that use EBU-TT-D are:

- Subtitle interpretation tool for browsers (UPM)
- HbbTV customizable subtitles for VoD (RBB)
- Live Broadcast-Internet subtitle viewer (VIC)
- Component for rendering Subtitles (TVC)

The technical components for rendering the subtitles themselves are tightly integrated in the existing VoD infrastructure of the partners, especially the respective video player. As the purpose of the VoD player goes beyond the purpose of providing subtitles (and also other partner-specific aspects had to be taken into account) the room for common use of components on the player side was very limited. But because a common format has been used, interoperability tests could be started by exchanging content between partners and checking this content in the different player applications. The component subtitle rendering test could be used by several partners to prove the standard compliance of each player application.

Although the vSubtitle component (VSX) does not use EBU-TT-D but WebVTT instead an interoperability check could be made through the conversion of EBU-TT-D to WebVTT.

More room for the use of common technical components exists in the production part. All broadcaster sub-pilots align the production of broadcast subtitles with the production of VoD subtitles and are able to take the same broadcast specific subtitle format as a base (EBU STL) and have to produce the same format as output (EBU-TT-D). As the Open Source Subtitle Conversion Framework (SCF) implements this task, partners RBB and RTP plan to use it operationally. TVC uses the SCF for development to integrate the conversion functionality into their subtitle production infrastructure.

The use of an alternative, lightweight subtitle editor was started because a new technology became available and a cooperation with an European company from Romania (SyncROsoft) could be initiated. The implementation has not finished yet but because the format that natively can be edited is EBU-TT-D it is expected that this component will be tested and possibly be used by other HBB4ALL partners.

To guarantee the standard conformance of the produced EBU-TT-D subtitle content the technical component EBU-TT-D XML Schema was developed. In various parts of the chain the conformance of the EBU-TT-D file can be checked through this XML Schema. The schema is and will be used by VIC (and indirectly via the SCF by RBB and RTP).

The technical component EBU-TT-D Test assertions for HbbTV 2.0 was developed and contributed to the HbbTV consortium where it will be the base for conformance check in future TV devices. Although these new devices not available on the market are at the current stage of the project, the assertions guarantee that future TV devices have the same conformance against the technology developed in HBB4ALL and a later switch of the production infrastructure will be as smooth as possible.

2.3. Technical objectives within this period

The general common technical objective of WP3 was to integrate the new services provided in the sub-pilots in the existing infrastructure. To accomplish this, the partners had an intensive exchange about the restrictions and the possibilities of the new technologies and how they could be integrated. Wherever possible a common approach was chosen. The main areas of exchange have been on the subtitling format EBU-TT-D and the integration of a subtitling rendering functionality in an HbbTV application. Apart from the informal exchange common components (see section 2.2) have been tested and used by the partners.

The HBB4ALL plan to investigate and implement technologies for the "live" streaming of subtitles was followed up intensively. VIC implemented the future technology to realise this use case (EBU-TT-D and MPEG DASH) with his Technical Components Live-Broadcast-Internet synchronizer Broadcast Internet Viewer and strategies of implementation have been discussed with IRT. IRT worked together with encoder and TV manufacturers to support the same technology and plans to demonstrate the results on IFA and IBC.

As the use case of live streaming of subtitles is very urgent (more and more users are viewing the linear TV over internet connected devices instead of classic broadcast TV sets) IRT initiated an informal network to discuss the technical solutions for this use case. Apart from other external companies the HBB4ALL partners RTP, RBB, UPM and VIC participated in the discussions of this network.

2.4. Common activities per partner

The partners of WP3 have collaborated jointly to fulfil the technical objectives described above. The scope of the collaborations have been manifold including the joint work on specific technical components, the collaboration on the usage and adaptation on standards as well the exchange of know-how in different technical areas related to subtitle production, publishing and delivery as well as personalized subtitle rendering. The following table gives an overview on the joint technical activities for each partner:

Partner	Joint technical activities with other partners
IRT	- IRT met VIC in September 2014 to discuss adoption of MPEG DASH for their pilot and bring their development closer to the current need in the market. - IRT met RBB to coordinate integration of EBU-TT-D in their workflow and system infra structure. - IRT checked TVC EBU-TT-D output on conformance. - IRT started communication between UPM and JW Player developers. - IRT initiated an informal network for the live subtitling over broadband. VIC, RBB, UPM and RTP participated in this network. - IRT worked with SwissTXT and RBB on the use case of live subtitling (workshop March 2015) - IRT worked with GPAC and subcontracted them to adapt the open source MP4box software; MP4box now is able to generate HbbTV 1.5 compliant MPEG DASH streams.

RBB	- EBU-TT-D Cross Sub-pilot rendering tests. RBB are involved in cross sub-pilot rendering tests. We have provided RBB content for other partners to test and we in turn will test content from RTP. - RBB subtitling software and ARD-wide centralised VOD environment has being adapted for processing EBU-TT-D data. For this we use the EBU-TT-D subtitling conversion framework provided by IRT - Together with IRT and a device manufacturer we are currently testing the production of subtitles for live streams on HbbTV devices.
VSX	- VSX has changed ideas with UPM to collaborate on a joint personalized subtitle rendering tool based on vsonix' vSubtitle component. This plan has been withdrawn as the subtitle rendering component of vsonix can not be used in the JW player targeted by UPM - VSX is testing the subtitle conversion framework provided by IRT to check the usage of the framework for WebVTT based subtitle publishing
TVC	- TVC tested EBU-TT-D subtitle format samples from RPT and RBB partners. - TVC generated EBU-TT-D subtitles and passed IRT EBU-TT-D validation tests. During this process some improvements and corrections for this validation tests where proposed to IRT and accepted. - TVC will follow a similar approach as IRT on which user personalization parameters have to be able to be changed, regarding the subtitling personalization flexibility.
UPM	- UPM is working in a plugin to depict EBU-TT-D subtitles in JW Player, which is used by RTP in its website. For this reason, the contact between UPM and RTP is permanent. For this purpose, UPM is using a REST API developed by RTP to make the subtitle files available. The EBU-TT-D files are obtained by means of the framework provided by IRT. - UPM has kept the contact with IRT to exchange ideas about subtitles. IRT enabled the connection between UPM and the JW Player development team. - UPM has kept the contact with VSX to analyse the use of the subtitling toll in other pilots. - UPM has tested the JW Player plugin with additional content provided by RBB and TVC.
VIC	- IRT initiated an informal network for the live subtitling over broadband. VIC, RBB, UPM and RTP participated in this network. - VIC integrated in September 2015 the EBU-TT-D XML Schema technical component in the Automated HbbTV Multilingual News Broadcast Subtitles service. - IRT invited VIC to test the generated DASH stream in the Automated HbbTV Multilingual News Broadcast Subtitles service with a HbbTV 2.0 prototype device. This collaboration will be planned and performed in the last three months of 2015. - IRT invited VIC to test the modified DASH-IF client implementation

	against different DASH enconder output from professional encoders. This collaboration will be planned and performed in the last three months of 2015.

2.5. Common technical components

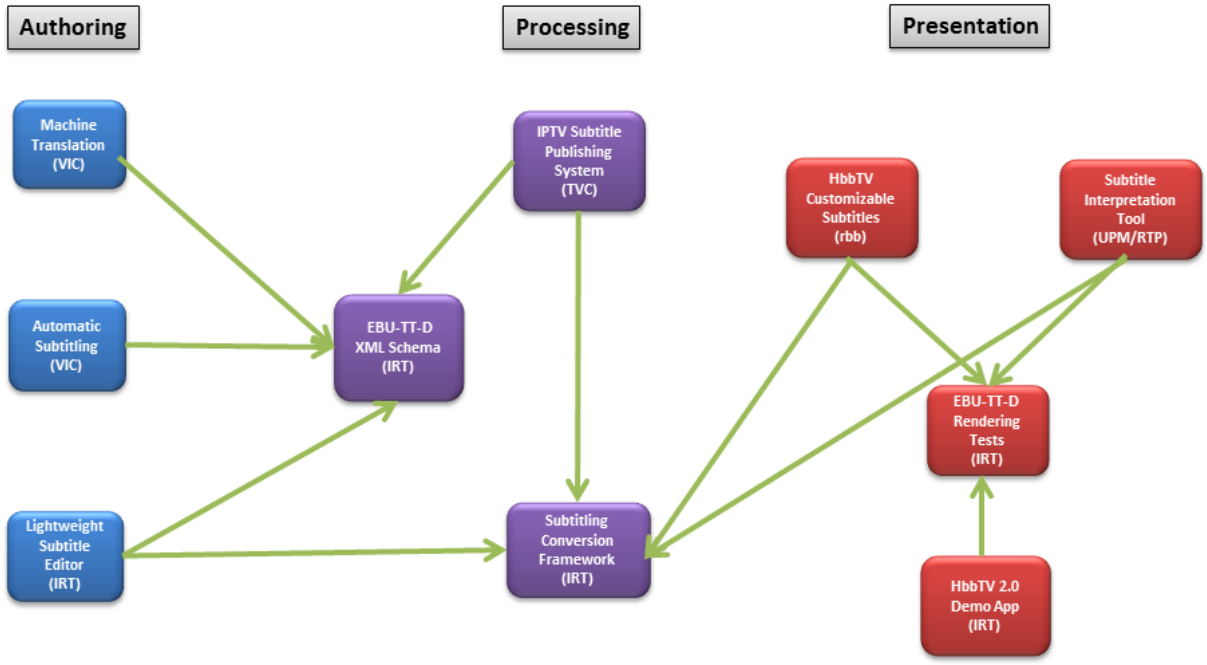

Figure 1. Overview of the common technical components in Pilot-A

Figure 1 shows the common technical components used in Pilot-A, i.e. those that have an inter-sub-pilot relation. Specifically, as also mentioned in section 2.2, this relates to those components using EBU-TT-D. An overview of each these components and the way they relate is given in the following sections.

More details of the service components and the sub-pilot integration can be found in HBB4ALL deliverable D3.2 [7].

2.5.1. Subtitling Format Conversion Framework (IRT)

2.5.1.1.1. Description of component and functionality

The Subtitling Conversion Framework (SCF) uses open standard technologies to convert subtitles from legacy formats used in broadcast production into EBU-TT-D subtitles. To increase usage this framework is published as Open Source.

The SCF uses platform independent technologies especially XSLT and Python. The main source format for the conversion is the wildly used EBU STL. Formats that can be generated are STLXML

(an XML representation of EBU STL), EBU-TT Part 1 (Subtitle XML Format for Archive and Exchange), EBU-TT-D (Format for Internet Distribution) and EBU-TT-D-Basic-DE (Simplified format for Internet Distribution of Subtitles in Germany).

2.5.1.2. Sub pilot usage

The conversion framework is used by RBB and RTP for their sub-pilot services. Both broadcasters use the framework to bridge their subtitle production for broadcast and their requirements to provision subtitles for broadcasted content over the "broadband" channel. The result is used for their VoD portals for PC and mobile (RBB and RTP) as for the HbbTV VoD portal (RBB). The SCF could be integrated in their system architecture with a minimum of integration effort. While RBB is using the framework through a manual conversion step initiated by the subtitle editor RTP has fully automated the conversion step.

The broadcasters chose to use different profiles of EBU-TT-D: RTP uses the full format and RBB uses the simplified EBU-TT-D version called EBU-TT-D-Basic-DE. These results are generated from different components of the conversion framework.This is an implicit proof of the modular structure of the framework.

TVC was one of the first adopters of the framework. The broadcaster used this framework mainly in his first implementation phase to kick-off development with EBU-TT-D. It helped TVC to build in EBU-TT-D support in the subtitling system they use (Fingertext Server).

VSX will use the SCF for conversion of EBU-TT-D to WebVTT so that subtitle content that is provided by broadcasters could also be used by their subtitle application.

2.5.2. EBU-TT-D XSD

The EBU-TT-D XML Schema is used to validate the conformance of the produced subtitle files against the EBU Spec Tech 3380.. The SCF development also benefited from the EBU-TT-D XSD: it was used to test the SCF software. Because RBB and RTP make use of the SCF, the EBU-TT-D XSD component is therefore also used by the sub-pilots from RBB and RTP. TVC uses the component to check the conformance of the files used by their subtitling server. In September 2015 VIC integrated the EBU-TT-D XML Schema technical component in the Automated HbbTV Multilingual News Broadcast Subtitles service. The automatically generated subtitles in the different languages use this component in two different stages. A first offline validation has been performed to tune the components and provide compliant subtitles. Nevertheless, a real time validation is performed to check the compliance of the generated subtitles to check the potential problems and modified the components accordingly.

The EBU-TT-D XSD has been contributed to the EBU standard activity and it is now available under an open source licences on github[1].

[1] https://github.com/ebu/ebu-tt-d-xsd/tree/editors-draft

2.5.3. EBU-TT-D Rendering Examples

The EBU-TT-D rendering example component is a package of EBU-TT-D samples, images and videos that facilitates the check if rendered subtitles are correct according to the EBU-TT-D spec.

UPM and RBB are planning to use the EBU-TT-D Rendering Examples to test their HbbTV Applications. The examples are also used by the HbbTV 2.0 Demo App,

2.5.4. Lightweight EBU-TT-D editor

The lightweight EBU-TT-D editor is based on the Oxygen XML editor and allows the native editing of EBU-TT-D. It is based on the Oxygen EBU-TT-D plugin. This component is in development because the technology to implement this editor became available only at a later stage in the project: the base is Oxygen Editor 17 which was published in April 2015.

It is expected that several partners will test and/or use this component.

2.5.4. EBU-TT-D assertions

EBU-TT-D test assertions have been developed for the HbbTV 2.0 test suite. They should guarantee the standard conformant implementation of the technologies used in HbbTV. When HbbTV 2.0 devices that have been tested against these assertions become available for the target audience of the partners this will assure the sustainability of the infrastructure that has been built up in the HBB4ALL project.

2.6. Standards and formats used in Pilot-A

As described in section 2.1 EBU-TT-D will be used extensively in HBB4ALL for the production and the rendering of subtitles. The group specifying the EBU-TT-D is the XMLSubs Working group of the EBU. IRT chairs the activity of EBU-TT-D and is the responsible editor of the specification. Through HBB4ALL IRT could contribute and continue its chairing activity which led to the publication of EBU-TT-D in January 2014 and the publication of errata in March 2015. In the same role IRT also supervised the publication of EBU Tech 3381. This document specifies how EBU-TT-D is packaged in the ISOBMFF container and is the base of the use of EBU-TT-D with MPEG DASH. As a member of the EBU group SCREEN also actively contributed to this activity. The standard was published as final version 1.0 in October 2014.

IRT contributed also to the EBU-TT-D XML Schema of the EBU group (see section 2.5.2).

One major goal of HBB4ALL is also to investigate the future change of the subtitling production architecture because of the integration of new broadband delivery channels. The IRT test workflow is therefore setup to use EBU-TT not only as distribution format but also as base production and archive format. This change will be needed to have future proof production for multiformat delivery and replace the current teletext based subtitling infrastructure. The format that is planned to be used for this change is EBU-TT Part 1. IRT is chair and responsible editor of this activity and contributed in this role to the needed update of the spec to the version 1.1. The publication of this update is

planned for September 2015. One main goal for the update is to align the spec with EBU-TT-D which is used intensively by HBB4ALL. As a member of the EBU group SCREEN also actively contributed to this activity.

One other important change of the infrastructure is the transmission of non file-based subtitle content. For the live transmission of subtitles (which is not only be used for live events but also for subtitles contribution to downstream and upstream broadcast systems) only proprietary and/or largely constrained transmission strategies are used. Future infrastructure will therefore benefit from a standardized technology to solve this use case. The spec EBU Tech 3370 [8] tries to fill this missing standard gap and was published as a draft in June 2015. The BBC chairs this activity of the XMLSubs working group and is the responsible editor. IRT and SCREEN contributed actively to EBU Tech 3370 as member of the XMLSubs working group. The HBB4ALL partners reviewed the draft spec and contributed with feedback to the EBU working group.

All EBU-TT specifications are also based on the Timed Text Markup Language (TTML)[11] which is published in the responsibility of the World Wide Web Consortium (W3C). This dependency improves the interoperability with other Subtitles standards which also are based on TTML and used especially in North America. These standards are amongst others SMPTE-TT [9], SDP-US [10] and the future IMSC [12]. The base technology of these standards should all be the same and the TTML standards activity becomes therefore very important for the interoperability of the HBB4ALL technical components that are based on EBU-TT-D. Through HBB4ALL IRT contributed to this standardisation activity and participated in telephone conferences and face to face meetings.

Due to a split in the standardisation community that happened long before HBB4ALL started not only TTML standards are used as subtitling formats for "internet based distribution". While main content providers like a lot of broadcasters, streaming content providers and film studios are using TTML based formats, the "HTML5 community" has decided to specify an alternative format that is now published as WebVTT [13]. This format is backed by the major browser manufacturers and although still in draft status it is widely available on web browsers on all platforms. As the decision to use one of the formats depends on the distribution environment there is not the "one" subtitle and caption format for the web. This split could also be noticed in HBB4ALL where VSX has chosen WebVTT instead of EBU-TT-D because the technical environment is closely linked to the HTML5 standard.

The technology gap between these two formats has caused problems in the industry and as both formats will be in the market for the next years there is an urgent demand for a standard mapping between TTML and WebVTT. In his role of invited expert of the W3C TTWG IRT is currently actively contributing to a document that defines a standard mapping between TTML and WebVTT. In the context of the HBB4ALL activity IRT also responded to the wide review call for WebVTT and provided feedback to the standard which has been taken up by the WebVTT editors[2].

[2] https://lists.w3.org/Archives/Public/public-timed-text/2015Feb/0000.html

As part of the common standards activity on HbbTV, IRT contributed as member of the HbbTV consortium. One major contribution have been the contribution of EBU-TT-D related test assertions for HbbTV 2.0 [3].

IRT and other partners also reviewed and tested an EBU-TT-D reference implementation by the EBU[4].

Summarising, following standards are being used and contributed to within the scope of Pilot A:

- EBU Tech 3370, EBU-TT, Part 3, Live subtitling applications, System model and content profile for authoring and contribution
- EBU Tech 3380 EBU-TT-D Subtitling distribution format EBU-TT-D
- EBU Tech 3381 Carriage of EBU-TT-D in ISOBMFF
- EBU-TT Part 1, version 1.1 (to be published in 2015)
- WebVTT, The Web Video Text Tracks Format, Draft Community Group Report, 10 August 2015
- ETSI TS 102 796 V1.2.1 (2012-11) Hybrid Broadcast Broadband TV ("HbbTV 1.5")
- HbbTV 2.0 Specification (2015-05-01), HbbTV Association, May 2015 (to be published as ETSI TS 102 796 V1.3.1, autumn 2015)

[3] The assertions are not publicly available, only the HbbTV 2.0 Specification, see [5]
[4] https://github.com/ebu/dash.js

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

3.1. Introduction

Pilot B aims at providing and evaluating additional audio services to allow improved access to TV content for various user groups. Following audio services are targeted (detailed information can be found in HBB4ALL deliverable D2.3.1 [1]):

- ***"Clean Audio" (CA) service***, aiming at enhancing the dialogue intelligibility of TV programs. The main objective is to adapt existing technologies to realise a production-sided component to automatically create CA versions of existing (stereo and 5.1) audio signals.
- ***Audio Description (AD)***, providing a description of the action mixed with the dialogue) and spoken foreign language translation subtitles, automatically generated from text to speech synthesis. The AD mix will be generated automatically based on the original audio signal, AD phrases and timing metadata.
- ***Additional audio channels for multi-language transmission*** (e.g. for non-native speakers) which also assists in language learning.

The developments for Pilot B focus on the implementation of the relevant production-sided components for the creation of the appropriate audio signals and assets. Both current production workflows and the realization of the required delivery mechanism towards the end user are taken into account. For all services Pilot B focusses on using MPEG-DASH to provide (multiple of) the appropriate audio signals in an efficient way to the end user, by means of adaptive streaming via the Internet, saving data in the broadcast channel by doing so. The use of HbbTV end user devices is a clear target as well. Alternatively, applications will be made available for the evaluation on a PC (running e.g. in a web browser).

Whereas the CA generator component is being developed by IRT, intensive tests have been carried out in close cooperation with RBB to evaluate parameter settings and to optimise the usage within the sub-pilots – further tests are also planned together with UAB. The support for MPEG-DASH (HbbTV 1.5) in the multi-audio services has been harmonised by means of an intensive exchange of know-how and implementation choices between IRT and TVC.

Beyond the mere technology, TVC and UAB have closely cooperated in several user tests (see HBB4ALL deliverable D4.2 [6]) to refine the requirements for tested technical components.

Regarding common technical standards, with respect to the provisioning of the additional audio services towards HbbTV devices, specifically HbbTV 1.1 and 1.5 as well as MPEG-DASH are to be mentioned.

3.2. Technical components overview

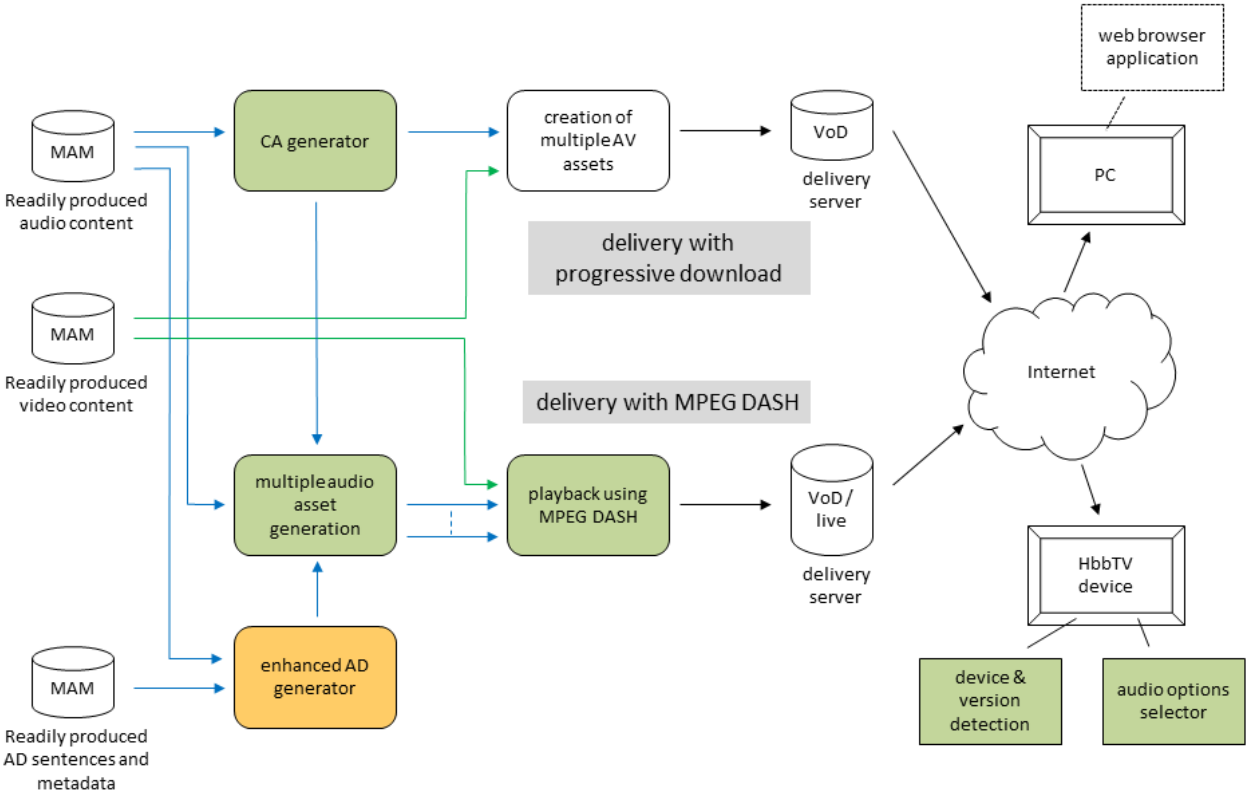

Figure 2. System architecture combining Pilot B components in a common virtual workflow

The general system architecture overview shown in **Figure 2** illustrates how an audio workflow could look like if all components would be combined. As not all components are used in each sub-pilot, moreover, not all components will be integrated in actual audio workflows and some represent semi-manual processing steps, this does not represent a real-life situation but merely shows a potential "full integration" to illustrate the potential of the combined output generated by the partners in Pilot B. The components that are being developed in HBB4ALL are highlighted; those that are marked green are used in multiple sub-pilots.

All Pilot B components are built upon the premise that readily produced content will be reused. This would allow an easier and cost efficient integration in existing workflows. In practice this means that the components may handle stereo and 5.1 audio signals at their input. In **Figure 2** this is illustrated on the left hand side by the Media Access Management (MAM) systems. Following workflow steps can be distinguished:

Creation of pilot content:

- *Clean Audio:* The *CA generator* processes stereo or 5.1 content to create one or multiple CA versions of the input signal. For use in the sub-pilots this component will probably run semi-automatically; an operator is needed to select the input signals and to transfer the output signals.
- *Audio Description:* The *enhanced AD generator* automatically creates an audio mix containing the original audio track and the appropriate AD sentences (timely mixed with the original audio track based on the available metadata, this component will only be used in the AD sub-pilot in Catalonia).
- *Multiple Languages:* The original sound track as well as (a) dubbed version(s) (or any other language versions) are readily available from the audio MAM and are further processed "as is".

Asset publishing and delivery:

- *Progressive download:* For a VoD service using progressive download, for each audio version a separate AV asset will be provided. This step may be done manually in HBB4ALL, depending on the number of assets that need to be processed for the sub-pilots. Specifically this will be required for the sub-pilot in Berlin-Brandenburg, where it is planned to provide multiple CA versions to the end user.
- *MPEG-DASH:* Before creating MPEG-DASH assets, the audio signals are converted into the appropriate format; for this purpose the *multiple audio asset generation* component has been developed. It processes any audio signal in Pilot B and generates a version in MP4 format for use in the MPEG-DASH delivery.
  The *playback using MPEG-DASH* component processes multiple audio assets and a video asset to create the MPEG-DASH assets for publishing. The thusly realised assets will be hosted on existing server platforms for access by the end user and distributed via Internet.

Reception / end user platforms

- *PC:* As far as PCs are used in the sub-pilots, a web browser application will be developed to allow end users access the content in the service offered. This does not require a full blown application. It is planned to use PC access for the users taking part in the sub-pilot in Berlin Brandenburg.
- *HbbTV device*: For the use of HbbTV devices in various sub-pilots, several specific components have been developed as part of the appropriate HbbTV application:
  - The *device & version detection component* may be used to adapt the service behaviour (e.g. the version of content delivered) to the device brand or the HbbTV version it supports.
  - The *audio options selector component* allows the end user to select, in the HbbTV application user interface, the audio component he is interested in.

3.3. Technical objectives within this period

Within Pilot B following technical objectives were planned until M20 (July 2015):

- Extending and finalising the implementation of the CA generator (IRT).

- Testing CA in lab tests and user tests with focus group (IRT and RBB).
- Implementation of the MPEG-DASH / HbbTV relevant components (TVC with support by IRT (exchange of know-how regarding specific implementations)).

3.4. Common activities per partner

The partners of WP4 have collaborated jointly to fulfil the technical objectives described above. The scope of the collaborations have been manifold including the joint work on specific technical components, the collaboration on the usage and adaptation on standards as well the exchange of know-how in different technical areas related to subtitle production, publishing and delivery as well as personalized subtitle rendering. The following table gives an overview on the joint technical activities for each partner:

Partner	Joint technical activities with other partners
IRT	- IRT has implemented and tested the Clean Audio (CA) generator (see section 3.5). - Cooperatively with RBB, IRT carried out two series of CA lab tests and user tests to obtain feedback from potential end users. Based on the test results, the CA implementations still need to be further adapted to optimise the usage within the sub-pilots in Berlin-Brandenburg as well as Catalonia; a final round of labtests before the CA sub-pilots is therefore planned for autumn 2015. - The outcome of the user tests in Germany will also be the basis for CA user tests in Catalonia: whereas in Berlin-Brandenburg multiple CA versions (with differing parameter settings) will be offered to the end user, in Catalonia the provisioning of only one CA version is foreseen. For the latter case, the “optimal” settings will be cooperatively defined between IRT and TVC. - With respect to the creation of CA assets for use in the sub-pilots, it is currently foreseen that IRT will support RBB, TVC and UAB in processing CA versions of the selected content; installation of the CA component on site at a service provider is under discussion. - IRT has intensively tested MPEG-DASH support in HbbTV devices in his laboratories and carried out interoperability tests with TV manufacturers during HbbTV interoperability events, see section 6.2.1. - IRT supported TVC’s development of components to support MPEG-DASH asset creation and service delivery in its workflow, specifically the playback using MPEG-DASH component, regarding the choice of software tools (GPAC and MP4box) and their settings to be used for the creation of MPEG-DASH assets and the generation of the MPD manifest files. The technical basis used by IRT and TVC thus is the same; further experience regarding MPEG-DASH interoperability will be exchanged during the remainder of the project. - IRT and TVC have exchanged know-how on how to best realise the selection of the desired audio stream in a multiple audio HbbTV application. The common technical basis for HbbTV applications is used

	by IRT for interoperability testing and by TVC to create their audio option selector component. Information on the status of support of multiple audio components by current HbbTV devices can be found in section 6.2.1.
RBB	- Based on the work with IRT before and during the lab tests, RBB will prototypically implement an instance of the Clean Audio generator. This will enable creation of Clean Audio content and thus is needed for the large-scale test to be carried out in WP4. - RBB with support of IRT is preparing the CA sub-pilot, which is planned for January 2016 in the region of Berlin-Brandenburg.
TVC	- TVC was supported by IRT on the *playback using MPEG-DASH* component. Based on IRT's experience TVC chose the same software tools for VoD (GPAC and MP4box) and their settings to be used for the creation of the first tested MPEG-DASH assets and the generation of the MPD manifest files. TVC implemented its playback component in order to work properly with the MPEG DASH streams generated with these tools. Further technical results and knowledge will be exchanged with IRT during the remainder of the project. - TVC and IRT exchanged know-how on how to realise the desired audio stream selection in an HbbTV application. TVC used this knowledge to later develop the audio option selector (see also section 6.2.1). - TVCs CA generation will be supported by IRT, which has generated a CA generation component. TVC proposed some contents for the generation of CA to IRT. This contents where discarded by IRT because the high quality of audio, and was discussed to select more suitable contents for the future CA generation of IRT. - TVC is working together with IRT and UAB in the selection of more suitable contents for the CA generation. Supporting UAB on the data collection from the specific questionnaires oriented to discover which contents could be improved with the CA service. - TVC has planned with UAB the realisation of some lab tests with user target of the additional audio services of CA, AD.

3.5. Common technical components (joint achievements)

The main technical goals for Pilot B relate to the realisation of the Clean Audio generator (which is a novelty in this field) and the use of MPEG DASH / HbbTV for content publishing and distribution. The technical components that are used in multiple sub-pilots for Pilot B relate to these goals, as can be seen from **Figure 2** (components highlighted green):

- The Clean Audio generator is planned to be used in two sub-pilots and several user tests;
- The HbbTV and MPEG DASH components, for content publishing and distribution via IP, as well as access by the user in the HbbTV application are planned to be used in all Catalonian sub-pilots (and some also are planned for use in Pilot A)

A brief description of the respective components and an overview of the sub-pilots in which they are planned to be used is given here. For further details, please refer to HBB4ALL deliverable D4.2 [6].

3.5.1. Clean Audio generator (IRT)

3.5.1.1. Description of component and functionality

Due to the limitations of the HbbTV 2.0 standard and restrictions on the audio production side, it was decided to implement the Clean Audio (CA) generator as server-based approach instead of a client-based approach, which means that pre-produced content will be transmitted to the user. The input signals for the CA generation will be existing content from TV productions, to optimally support readily available audio formats in current production workflows, i.e. either 5.1 or stereo signals. The output of the CA generator is a stereo signal, as this format is the most widely supported by end user devices.

The CA generator automatically processes the input signal and creates a "clean" version with improved speech intelligibility. In a first step the speech / dialogue is separated from the rest. In the case of 5.1 content, the Center signal is used directly (as this in most cases only contains speech); in case of stereo content, a dedicated algorithm is applied onto the input feed to extract the speech. In the "basic mode", the CA generator then enhances the relation of speech (gain) to the rest of the signal. The "advanced mode" in an intermediate step applies additional signal processing to further emphasize speech relevant frequencies in the audio signal. Further information can be found in HBB4ALL deliverable D4.2 ([6], section 2.1).

3.5.1.2. Sub-pilot usage

The Clean Audio generator will be used in the CA sub-pilots in Berlin-Brandenburg and Catalonia to create CA assets from the selected audio material. Most likely IRT will generate the CA assets for use by RBB, TVC and UAB; installation of the CA component on site at a service provider is under discussion. The results of all preliminary lab tests and user tests will be used to select optimal settings for the CA generation for the use in both sub-pilots, thus making sure that technically the end users in the sub-pilots will be provided CA signals of the same quality. For the CA sub-pilot in Berlin-Brandenburg it is envisaged to provide multiple (e.g. three) CA versions (processed with different settings), from which the end-user can choose; for the CA sub-pilot in Catalonia most likely a single CA version will be used.

Whereas Clean Audio is targeted for viewers with hearing impairments, it may also serve as improvement for listening in other situations. UAB therefore plans user tests, in parallel to the CA sub-pilot in Catalonia, to determine whether CA can make second language acquisition easier and how the use of CA, combined with Audio Description (AD), affects the likeability and comprehension of AD for visually impaired people.

3.5.2. Multiple audio asset generation (TVC)

3.5.2.1. Description of component and functionality

The generation of multiple audio assets for a single video asset was primarily needed for the transport and delivery of different audio languages in the same file using an MPEG DASH based streaming solution, to allow the client / receiver to select the preferred one. The generation takes as input the original language (different from Catalan) and the audio dubbed in TVCs studios (in Catalan). The different output audios are edited with the correct formats and all tracks are included with the video in a single file.

TCV has adapted his general workflow to work with files containing these two audios, including his Media Asset Management (MAM), which stores the contents to be published. The multiple audio assets stored in the MAM have different formats than the needed for their publishing. The publishing of the contents by TVC is always based on using MP4 files with stereo audio. Because of that, TVC has developed a component that encodes the MAM files in MP4 format with the original language or the Catalan version. Detailed information can be found in HBB4ALL deliverable D4.2 ([6], section 2.3).

3.5.2.2. Sub-pilot usage

This component will be used in all three Catalan sub-pilots. The CA, AD, and other language audio tracks will be handled as multiple audio assets in the respective sub-pilot to deliver the respective audio service in addition to the original one. Also, if TVC founds suitable contents to which offer the three different audio services all three audios will be included into the same stream with the original one (for example: normal audio dubbed in Catalan + CA + AD + original language audio in English).

If the last option is finally possible, all three Catalan sub-pilots will be performed using the same contents and HbbTV application to deliver to the end-users these multiple audio contents. Thus, users will be able to select the specific audio they need (or want) to hear, testing its corresponding audio service. As the same contents would be used for the three sub-pilots, lots of efforts will be saved on video encoding, processing, storing and delivery.

3.5.3. HbbTV audio options selector (TVC)

3.5.3.1. Description of component and functionality

To allow the users to access to the pilot's B functionality of switching between the different audio options available, TVC has developed an audio selector. This selector focuses on switching between Audio Components present in the same MPEG DASH stream, the most efficient scenario. This component consists of a dropdown menu which contains all different audio options present in the stream and allows the selection of any of them to be played on the HbbTV end-user device. It is located on the player bar, and when one audio is selected and playing it shows the language descriptor of the audio currently being played, or "CA"/"AD" for the clean audio / audio description.

In the best case scenario, this selector is capable of setting the different available audio options from the information present in the MPEG DASH Media Presentation Description (MPD) file, identifying and separating them by their language attribute. Then, when another audio is selected by the user, the selector finds it in the selector's list by searching its language and sets it as the next Audio Component to be played. Further information can be found in HBB4ALL deliverable D4.2 ([6], section 2.4).

3.5.3.2. Sub-pilot usage

This component will be used in all three Catalan sub-pilots. The CA, AD, and other language audio tracks will be handled as multiple audio assets in the respective sub-pilot to deliver the respective audio service in addition to the original one. Also, if TVC finds suitable contents to which offer the three different audio services all three audios will be included into the same stream with the original one (for example: normal audio dubbed in Catalan + CA + AD + original language audio in English).

If the last option is finally possible, all three Catalan sub-pilots will be performed using the same contents and HbbTV application to deliver to the end-users these multiple audio contents. The HbbTV audio options selector will be needed to allow the end-users to select the audio they want to hear among the four offered: normal (original audio track), CA, AD or other language.

3.5.4. Playback of audio content using MPEG-DASH (TVC)

3.5.4.1. Description of component and functionality

To serve and play multiple audio contents the additional audio streams, for clean audio, audio description or different languages, are included as separated audio components in the same MPEG DASH asset. For example, in the simplest multiple audios scenario, contents with one video and two different audios, the chunks generated are of each one of the components and the MPD manifest contains three adaptation sets: one for the video component, one for the first audio component, and one for the other audio component. In this case, the end user, by means of the HbbTV player on the end user device, can correctly play the MPEG-DASH content and select the audio stream he wants to be played among all the audio components presented in the MPD.

With different solutions for the Video On Demand or the Live case, the MPD and segments can be generated for streaming MPEG DASH contents with more than one audio component available. To separate the different audios in independent adaptation sets the language attribute of the audios has been used. Also, in all cases tested, each audio and video component has only one representation, one quality and one bit-rate, they are not adaptive in the bit-rate sense. Videos with more than two different audios have been tested and worked correctly in some of the HbbTV devices. The end-user can change the audio been listened at any temporal point of the content, continuing the video playback listening to the new audio from that point on. Detailed information can be found in HBB4ALL deliverable D4.2 ([6], section 2.5).

3.5.4.2. Sub-pilot usage

For all three Catalan sub-pilots the content will be delivered and played as MPEG-DASH streams with multiple audios. For that reason, the playback of audio content using MPEG-DASH will be used too at the CA, AD and other language sub-pilots. Thus, we can take advantage of the multiple audio handling of the MPEG-DASH standard and test the three different audio services using the same contents. Also, the same HbbTV application will be used for all sub-pilots to play and test that streams.

In case MPEG DASH is used in the Berlin-Brandenburg sub-pilot, the same approach for audio asset preparation and audio playback/selection will be used. IRT and TVC have been in close contact and exchanging testing results with respect to the delivery and playback of multiple audio components in a single MPEG DASH stream. The generation of MPEG DASH assets and MPD file as well as the component selection implementation in the end user application is shared amongst all sub-pilots in Pilot B.

3.5.5. HbbTV device and version detection(TVC)

3.5.5.1. Description of component and functionality

Detecting the concrete device and the supported HbbTV version is necessary to ensure that the features used in the running HbbTV application are compatible with this specific device and will work correctly. This detection is done by retrieving the device's User-Agent. In the same way, the device detection can determine a specific TV brand, or device vendor, which could have a wrong behaviour or known open issues that affect all devices of this brand similarly.

With that, knowing the device which is running the HbbTV application some vendor-specific corrections or adaptations of is functions could be added to the application, as far as possible. Even without having different solutions depending on the device or HbbTV version, this detection would allow making the multiple audio features only available for the TV models and versions involved in the pilot, which we know that correctly supports them from our lab tests. Detailed information can be found in HBB4ALL deliverable D4.2 ([6], section 2.6).

3.5.5.2. Sub-pilot usage

This device and version detection component could also be used for all the Catalan sub-pilots involved in this Pilot B, adding it to the HbbTV application we use to play the MPEG-DASH streams. With this component we could focus the sub-pilot integrating the different audio options and audio selection functionalities, MPEG DASH based, for a specific HbbTV device, as could be the particular TV model tested successfully on beforehand. In that more controlled sub-pilot case we could make the HbbTV application only visible or displayed for those users that have the desired TV model and not accessible for the rest.

3.6. Common standards and formats used in Pilot B

For Pilot B the common standards and formats across the sub-pilots are those that are relevant for the asset publishing and distribution, supporting specifically HbbTV end user devices (HbbTV v1.1 and v1.5). The delivery of multiple audio by means of adaptive streaming asks for the use of MPEG-DASH, which impacts the asset creating, publishing and delivery via IP. The usage of MPEG-DASH for adaptive streaming is shared across Pilot A and Pilot B, see section 6.1.2.

Formal references:

- ETSI TS 102 796 V1.2.1 (2012-11) Hybrid Broadcast Broadband TV ("HbbTV 1.5")
- ISO/IEC 23009-1:2012 - Information technology -- Dynamic adaptive streaming over HTTP (DASH) -- Part 1: Media presentation description and segment formats
- MPEG-DASH Profile for Transport of ISO BMFF Based DVB Services over IP Based Networks

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

4.1. Introduction

The aim Pilot-C is the realization of an online UI adaptation and personalization service that allows the provision of personalized accessibility features for web and HbbTV based media services. The online accessibility service is based on the UI framework that was developed in the EU project GUIDE "Gentle UIs for elderly people" by vsonix together with other partners and which is now further maintained as an open source project. The Software as a Service (SaaS) platform was developed by vsonix within this period. It includes APIs and functions for user management as well as the necessary mechanisms for UI adaptation. It further includes an application for the definition of user accessibility profiles on PC, mobile and HbbTV platforms.
This application called AccessGUIDE was redesigned and implemented by vsonix based on the GUIDE UIA application. Beside UI adaptation it also includes functions for the definition of user preferences for adaptive subtitles (see Pilot A) and for a text to speech service provided by the overall service.
Based on the AccessGUIDE design provided by vsonix for PC and mobile platforms, PPG has worked in an HBBTV 1.5 based version of the AccessGUIDE. The UI personalization service was integrated in an online video learning application ("MOOC"), which will be provided as a webcast service for interested parties in Europe on PCs and mobile devices.
It is further integrated and trialled in two additional HbbTV showcases provided by PPG and SCREEN. For this purpose PPG and Screen have collaborated on an HBBTV capable javascript version of the API.

The updated objectives of the Pilot related to the objectives in the DoW can be summarized as:

Objective C1

The realisation of an online accessibility service based on the GUIDE framework providing functions for user profiling as well as a web based API (javascript) that can be used by online and TV application developers to use the service.

Extension of the GUIDE user profiles by vsonix in collaboration with UAB and Screen to support additional parameters for UI adaptation.

The realisation of an API version for HBBTV platforms by PPG and SCREEN

The provision of an online screen reader feature as part of the oveall service.

Objective C2

Provision of a user testing and profiling application (AcessGUIDE) as part of the UI adaptation service. This application is an essential part and allows the determination of user preferences based on a number of accessibility tests. It is designed as a customizable white label service that can be used by application developers to include UI adaptation based on user profiles into their applications. It is provided by vsonix for PC and mobile platforms. In addition PPG work on an HbbTV version of the service.

Objective C3

The realisation of a MOOC addressing topics related to media accessibility as a webcast service for PC based and mobile platforms by vsonix in collaboration with UAB, which is providing the content. The course will be available in English, with German and Spanish subtitles.

The realisation of media on demand showcase provided by SCREEN for HbbTV 1.5 using the UI adaptation framework for the provision of personalized accessibility features.

The realisation of an HbbTV showcase by PPG based on an existing application of NPO (Netherlands Public Broadcasting).

Objective C4

The realisation of expert group discussions and early user trials by vsonix and UAB in order to acquire refine the user requirements for the UI adaptation framework as well as for the MOOC application (done in last period).

User experience testing of different end user related aspects of UI adaptation in webcast and HbbTV applications based on the integrated UI adaptation framework (Mid – End 2015) involving users from Spain (UAB) .

A final (online) user evaluation of the MOOC and the Access GUIDE based on online questionnaires.

4.2. Technical components overview

In the following we will give an overview on the common technical components that are implemented and used in Pilot C by the different trials and services. The following architecture diagram (Figure 3) gives an overview on the main technical components developed an integrated and how they are used within the different sub-pilots and show-cases that are addressed in the WP.
The common technical components that have been identified by the partners and that are described in further detail in chapter 4.5 are:

1. The UI adaptation and user profile service provided by vsonix for PC, mobile and HBBTV platforms that can be used by application developers to integrate user profile based accessibility into their applications.
2. The text to personalized speech rendering service that constitutes an essential part of the overall service
3. The AccessGUIDE application, which was developed by vsonix for PC and mobile platforms and is transferred by PPG and SCREEN to be used on HBBTV 1.5 platforms.

Those components are the basis for all accessibility feature provided by the MOOC sub-pilot as well as by the HBBTV showcases provide by SCREEN and PPG.

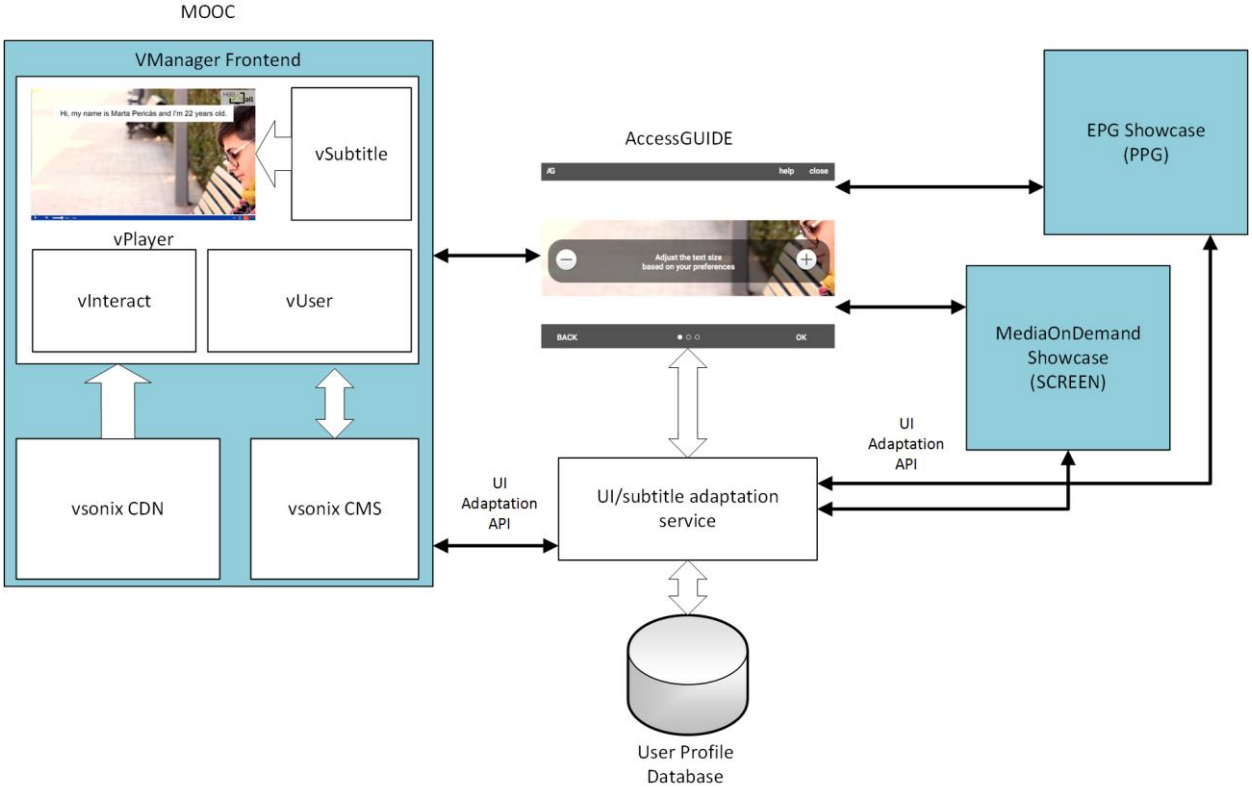

Figure 3. Common system architecture as basis of Pilot C

4.3. Technical objectives within this period

The technical objectives for WP5 for this period have been:

- The realization and integration of the UI adaptation service including the UI adaptation API by vsonix, which is an online accessibility service based on the GUIDE framework for PC, mobile and HBBTV platforms including a user profile service to store the user's UI preferences. The service also includes a cloud based "text to speech" rendering service.
- The realisation of the AccessGUIDE that allows users to determine user and device based profiles for accessible UIs and subtitles. The AccessGUIDE application was realized by vsonix for mobile and PC platforms. PPG provides a prototypical HBBTV version of the application.
- The usage of those components (UI adaptation service incl. text to speech rendering service and AccessGUIDE) by the different sub-pilots, showcases as a common technical basis. Those sub-pilots include a MOOC (Massive open online course) service on media accessibility by VSX and UAB, a Media on demand showcase by SCREEN using the UI adaptation framework as well as the program guide showcase by PPG.

4.4. Common technical activities per partner

The partners of WP5 have collaborated jointly to fulfil the technical objectives described above. The scope of the collaborations have been manifold including the joint work on specific technical components, the collaboration on the usage and adaptation on standards as well the exchange of know-how in different technical areas related to subtitle production, publishing and delivery as well as personalized subtitle rendering. The following table gives an overview on the joint technical activities for each partner:

Partner	Technical activities with other partners
VSX	- Within this period vsonix has implemented the online UI adaptation service based on the GUIDE framework and provided an API that allows developers to integrate the functionality of the service into their media applications. The service provides a user profile generation service that allows developers to determine the accessibility requirements of the individual users to adapt their UI according to these requirements. - The requirements for the UI adaptation API have been derived in collaboration with the other technical partners involved in the WP, SCREEN and PPG, to make it suitable to their software environments. - Another activity was the development of the AccessGUIDE application, which is the user frontend for the UI adaptation service. The AccessGUIDE was re-designed as a white-label software to be integrated in arbitrary media services. The re-design was based on requirements that were collected from the technical partners SCREEN and PPG as well as from the test results of the user tests conducted by vsonix in collaboration with UAB. - The UI design of the AccessGUIDE has been based on the accessibility guidelines provided byW3C-WAI. The interaction design has been achieved through the close collaboration of vsonix with PPG, which will

	provide an HBBTV version of the application.
PPG	- PPG has co-worked with vsonix on the wireframes and UI designs for the HbbTV version of the AccessGUIDE. The technical collaboration between the partners also included the exchange of source code for the realisation of the AccessGUIDE application on all targeted platforms. This activity has been conducted in close collaboration and communication between the partners. - PPG has also collaborated with vsonix on the definition of the requirements for the UI adaptation API that are now used by PGG to integrate the UI adaptation service into their EPG showcase.
SCREEN	- SCREEN has worked with vsonix on the definition of the requirements for the UI adaptation service. This also includes the specification of the AccessGUIDE as a white-label software to be integrated into the showcase provided by SCREEN. - SCREEN has further worked with vsonix and PPG on an HbbTV compatible version of the API and backend functions
UAB	- Together with vsonix UAB has worked on planning, realisation and evaluation of the user tests, which were the basis for the adaption of the user requirments for the AccessGUIDE application.

4.5. Common technical components

In the following we give an overview on the technical components that are commonly used by the partners for the realisation of their services and showcases.

4.5.1. UI adaptation service (VSX)

4.5.1.1. Description of component and functionality

The UI adaptation service is targeted at the storage of personalisation information for supported apps on a per-device-per-user base. The service may be utilized through generic HTTP POST requests, which return the requested information such as adaptation values or meta-information about given adaptation requirements. Since only generic HTTP requests are required to communicate with the service, it is fairly easy to wrap the service in a client side JavaScript API and abstract away the asynchronous network requests. One such abstraction wrapper is also provided by the UI adaptation service and may be included by supported applications.

The UI adaptation service is available under a dedicated public domain which means it basically is available to any web-based application. Each application may configure the service to only utilize parts of it, such as only a subset of the available adaptation requirements or a specific combination of colors.

4.5.1.2. Sub pilot usage

The UI adaptation service is publicly available on the web and thus may be used by pilots easily. Specifically, pilot may decide to use the HTTP interface of the service directly or use the JavaScript abstraction layer which is also provided by the service. On embedded devices several restrictions may apply regarding JavaScript execution performance or HTML5 support, so that it is not possible

for those embedded HbbTV applications to utilize the provided JavaScript abstraction interface. In these cases, a separate, stripped-down abstraction layer may be created by the sub-pilots which allows developers to enjoy the comfort of JavaScript function calls while the asynchronous network requests are hidden away.
Sub-Pilots will benefit from using the service in that they are now able to provide a much more optimized experience for the user based on the information they retrieve from the UI adaptation service. This will ease the interaction process for the user and in the end lead to a higher customer satisfaction and improved interaction efficiency.

4.5.2. Access-GUIDE (VSX)

4.5.2.1. Description of component and functionality

AccessGuide serves as the frontend for the UI adaptation service. Its function is to lead the user through a series of quick assessments to establish their preferred UI settings. These user preferences are then passed on to the API, which stores them on the server. Each instance of AccessGuide is tied to a specific application, so that the user preferences can only be accessed by the respective application they have been established for (its "host application").
AccessGuide may be configured by its host application to show only a subset of assessments based on the supported UI requirements.

The use may activate AccessGuide from any designated button in the web application. Once AccessGuide gets activated, it will show as an overlay on top of the host application. The user may discard the AccessGuide anytime through the assessment process. Of course it is possible to repeat the assessment or redo any assessment at any time in the future.

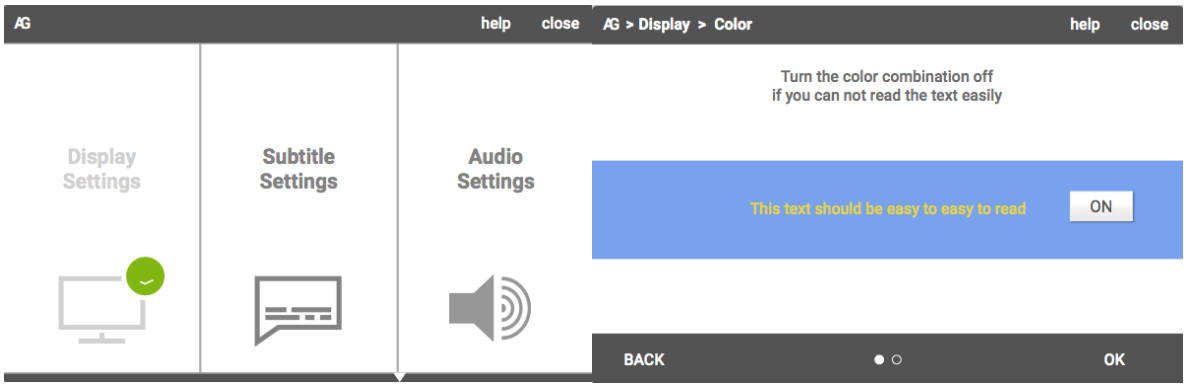

Figure 4. AccessGUIDE redesigned as white label software

4.5.2.2. Sub pilot usage

Since AccessGuide is a vital extension of the UI adaptation service, it is also available to any web based application that includes the UI adaptation service. While it is possible to communicate directly with the UI adaptation service to store user preferences, AccessGuide provides a convenient way for application developers to outsource the assessment process in a flexible and configurable application. This means the application developer does not need to think about how the user

preferences will be established, but can simply annotate any button in their application as the launcher for AccessGuide and are done.

4.5.3. Text-to-Speech Service (VSX)

4.5.3.1. Description of component and functionality

The text-to-speech service offers a convenient and easy-to-use opportunity for application developers to provide audible descriptions of user interface elements. The text-to-speech service can be utilized by calling the respective function of the AccessGuide API, which will then take care of providing the developer with the spoken equivalent of the given text in near-realtime. The generated audio will of course honour the applicable adaptation values of the current user such as preferred gender of the speaker, preferred speed, and volume.
After the TTS request has been submitted to the server, an individual URL will be generated which makes the TTS output available to the application for instant replay through common HTML5-based audio playback techniques supported by all common browsers in their latest version.

4.5.3.2. Sub pilot usage

As a part of the AccessGuide API the text-to-speech service is made available to all sub pilots that decide to include the API. The service can be used to generate just-in-time audio samples. Whenever the application wants to provide the user with text-to-speech it can start a request and will retrieve the audio file with minimal latency. Applicable adaptation requirements such as speech volume, speech speed or speaker gender will automatically be fetched from the user profile and applied to the audio.
Using our TTS service in multiple sub-pilots results in a coherent TTS experience for the user event across application boundaries, since the voice, intonation and pronunciation will always be consistent with the adaptation requirements of the user and the same TTS has been used throughout.

4.6. Common standards and formats used in Pilot-C

The communication with the service backend takes place using the standard HTTP 1.1 protocol, which transmits JSON-encoded data back and forth. The text-to-speech service generates audio samples from speech synthesis markup (SSML), which allows to include various properties relating to speech such as pitch etc. The audio is delivered in the MPEG-3 sample format, which is a widely adopted standard that receives broad support among both browsers and the HTML5 standard. HTML5 is used by the AccessGuide application to assess the adaptation requirements of the current user.

5. Common technical components and activities for Pilot D "Sign language interpretation"

5.1. Introduction

Pilot D is in charge of sign language interpretation services in HBB4ALL. The DoW identifies these objectives:

Objective D-1 A prototype version of a complete sign language interpretation production workflow chain for broadcasters which enables basic (HbbTV1.1/1.5) and advanced (HbbTV2.0) customised HbbTV sign language services

Objective D-2 Hbb/IP TV-based sign language services allowing users to customise the size and positioning of sign language interpretation in an overlaid window for large-scale provision and testing in Portugal, Germany (Berlin-Brandenburg), provided by RBB, IRT, RTP, UPM, and UAB

Objective D-3 An HbbTV-based avatar signing service in Spanish provided by Vicomtech allowing users to access Text-to-Signing for content with a well-defined semantic framework such as weather forecasts.

Objective D-4 Additional user experience testing of various end user-related aspects of sign language interpretation in the hybrid world involving users from the target groups which will inputs to work on metrics for the Quality of Service done by UAB.

The objective D-1 is fulfilled in this WP by means of the design of a generic signing workflow model, flexible enough to be deployed in the variety of possible signing scenarios, including an HbbTV-based signing service.

The objective D-2 is satisfied by means of two service pilots. On the one hand, an HbbTV-compliant signing service, deployed in Berlin-Brandenburg by RBB. On the other hand, a PC-based signing services, enabling the double screen functionality for recorded content. This service will integrate RTP programmes, with the technical support of UPM.
The objective D-3 is satisfied by the work carried out by VIC, which has created an avatar signing service for a limited semantic domain (weather forecast) integrating technologies such as sign acquisition and rendering and automatic translation.
Finally, objective D-4 is mainly carried out by UAB, which has started a variety of user tests to measure the user expectation and preferences in the signing service. UPM is collaborating in the edition of the audiovisual test material.

The key standards of Pilot D are:

- HbbTV 1.1 - ETSI TS 102 796 V1.1.1 (2010-06) Hybrid Broadcast Broadband TV
- HbbTV 1.5 - ETSI TS 102 796 V1.2.1 (2012-11) Hybrid Broadcast Broadband TV
- HbbTV 2.0. Published by the HbbTV initiative in February 2015. To be published as ETSI norm with the code 102 796 V1.3.1 in autumn 2015.

- HTML5 (W3C Recommendation available in: http://www.w3.org/TR/2014/REC-html5-20141028/)

5.2. Technical components overview

The general architecture diagram is shown in the figure. This diagram depicts a generic workflow model that satisfies the variety of possible signing implementation. It has been built in the project thanks to the active technical cooperation among partners. This workflow model (that satisfies Objective D-1) was introduced in deliverable D6.1 and it has been completed and improved in deliverable D6.2.

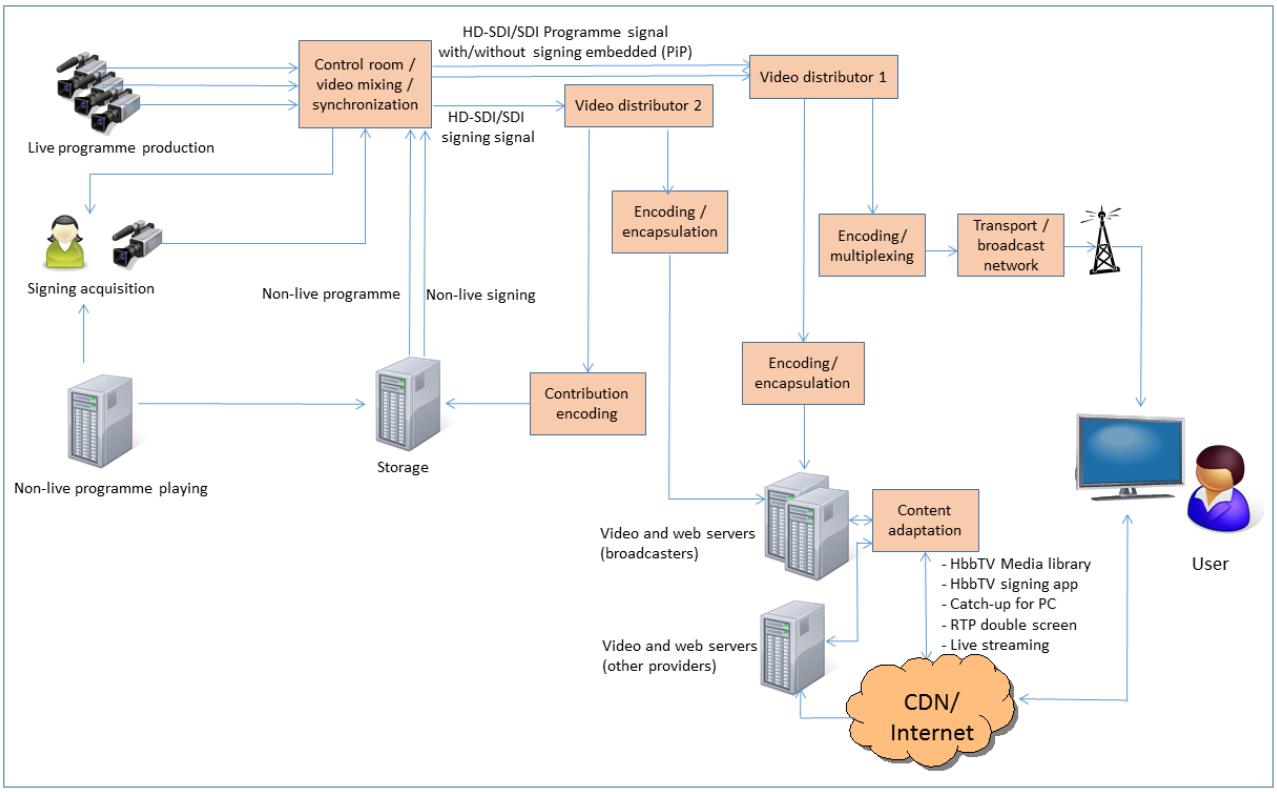

Figure 5. Technical components in Pilot D

5.3. Technical objectives within this period

The overall technical objectives within this period has been:

- The integration of the HbbTV signing service to be deployed by RBB in the Berlin/Brandenburg sub-pilot
- The integration of the web-based signing service with double screen functionality to be deployed by RTP and UPM in the Portuguese sub-pilot
- The development of the avatar signing service for weather forecast by VIC
- The improvement of a common technical approach for the signing workflow.
- The edition and creation of test material in sign language by UAB and UPM.

5.4. Common technical activities per partner

The partners of WP6 have collaborated jointly to fulfil the technical objectives described above. The scope of the collaborations have been manifold including the joint work on specific technical components, the collaboration on the usage and adaptation on standards as well the exchange of know-how in different technical areas related to subtitle production, publishing and delivery as well as personalized subtitle rendering. The following table gives an overview on the joint technical activities for each partner:

Partner	Technical activities with other partners
UPM	UPM has collaborated with UAB to obtain audiovisual material for user tests. UPM recorded video clips of signing implementation for the first user tests. UPM has generated the video clips for the UAB user tests, editing the audiovisual content and the sign language interpretation in the same video signal. UPM has created the sign-language questionnaires in web interfaces for the UAB user tests. UPM has kept the contact with RTP to integrate the web interface of the Portuguese subpilot. Finally, UPM has compiled the technical workflow approaches provided by RTP and RBB to propose the common signing workflow model.
VIC	Based on the avatar signing application, VIC has created a video demo where the avatar signs a weather forecast at the same time the tv presenter. This video demo was sent to UAB with the aim of being evaluated by deaf people. VIC reviewed the questionnaire and the results of the tests provided by UAB in order to improve the prototype.
RBB	RBB had initially planned a sign language pilot based on a HbbTV2.0 application that allowed viewers to choose and customise the presentation of a sign language interpreter on the TV screen. The signer is delivered via the IP channel and the main TV picture via the broadcast channel, and the final video is compiled by the application which relies on tow video decoders in the receiver. However, as dual video decoders are not mandatory in HbbTV2.0, RBB is working on a concept for a cloud –based/server-side solution that will allow us offer customisation without the need to two decoders. IRT will support us in the development of a test application.
RTP	RTP has been in close contact with UPM to provide information about the double-screen functionality in the RTP website for signing. The Portuguese sub-pilot is based on this functionality. Moreover, RTP has shared its experience in signing with the rest of WP6 partners.
IRT	IRT cooperates with RBB regarding the implementation of an HbbTV2.0 showcase, based on MPEG DASH and the use of the multi-stream synchronisation feature, adding a sign language interpreter delivered via Internet and resynchronised with a broadcast service.
UAB	UAB has designed a pre-pilot test consisting of two expert users interviews for the signing avatar developed by VIC. UAB has conducted the pre-pilot test with expert users and reported the feedback to VIC to further enhance the signing

	avatar. UAB created, translated and recorded the questionnaires for the pilot test to be carried out and evaluate the avatar developed by VIC for the project. The design of the bilingual tests (in SL and oral language) is being developed by the UAB team in close collaboration with the UPM team using an innovative fully-accessible design so that the pilot to asses VIC avatar can reach more end-users. UAB has extended this collaboration with UPM to create bilingual questionnaires for the rest of user tests.

5.5. Common technical components (joint achievements)

5.5.1. HbbTV Playout system for tests (UPM)

UPM has a wide experience in the development of HbbTV applications and play-out systems. As a result of this experience, UPM has developed a complete HbbTV play-out system that has been available in the WP6 for tests. The introduction of an HbbTV application in a digital television stream is based on two prerequisites:

- The generation of specific signalling, according to HbbTV and DVB norms. In fact, the DVB norm specified by HbbTV is conceived for application signalling and carriage in any connected TV system - not just HbbTV. This signalling includes the URL where the hybrid terminal will find the complete HbbTV content.
- The generation of a DSM-CC object carousel to include application data in the broadcast transport stream.

The results of these processes are multiplexed with the rest of audio, video and data components. The hybrid terminal can, based on the information obtained via broadcast, retrieve the complete application data via the broadband network.
The component developed by UPM is able 1) to generate the specific HbbTV signalling, 2) to multiplex the HbbTV-related content with the audiovisual content and 3) to broadcast the resulting stream in lab conditions to test the HbbTV content in actual receivers.

5.5.1.1. Sub pilot usage

The playout system and the involved devices have been resources available for the rest of partners in the project in this period. They have been used to play HbbTV demo content in meeting between UAB and UPM.

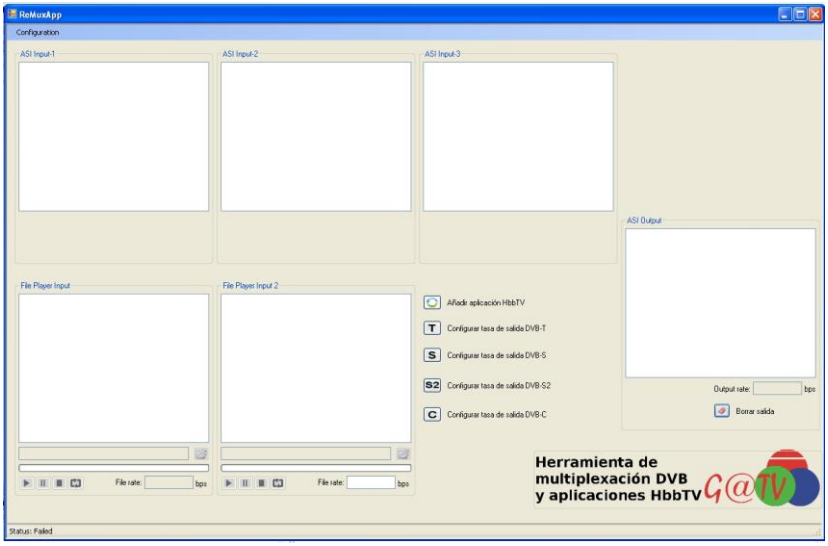

Figure 6. HbbTV play-out component developed by UPM

5.6. Common standards and formats used in Pilot-D

- HbbTV 1.1 - ETSI TS 102 796 V1.1.1 (2010-06) Hybrid Broadcast Broadband TV
- HbbTV 1.5 - ETSI TS 102 796 V1.2.1 (2012-11) Hybrid Broadcast Broadband TV
- HbbTV 2.0. Published by the HbbTV initiative in February 2015. To be published as ETSI norm with the code 102 796 V1.3.1 in autumn 2015.
- HTML5 (W3C Recommendation available in: http://www.w3.org/TR/2014/REC-html5-20141028/)

6. Cross Pilot technical activities

6.1. Commonly used standards and formats on cross-pilot level

This chapter highlights aspects and features from current and/or future versions of the HbbTV specification that strongly relate to the cross-pilot activities.

6.1.1. HbbTV

The HBB4ALL consortium strongly supports HbbTV as the main target platform beside PC based and mobile implementations for some of the targeted services. Within all pilots HbbTV 1.0 or 1.5 based versions of accessibility services are foreseen to be implemented in order to support the already existing and widespread standard. The consortium will also support the HbbTV 2.0 standard; while this specification was published in January 2015 by HbbTV, HbbTV 2.0 devices will not be deployed during the project's lifetime. Manufacturers plan to have first devices implementing all mandatory features in 2017.

Therefore the partners will follow a dual strategy: first, HbbTV-based services and applications will be developed in such a way that they are supported by devices that currently are – or in the medium term will be – in the market.

Second, to make sure that future accessibility services can make appropriate use of the additional value offered by HbbTV2.0, the partners will gather requirements from the trials in HBB4ALL and contact manufacturers to persuade them to implement the applicable features[5]. Currently the consortium tries to liaise with manufacturers for showcases of single features like subtitling with EBU-TT-D for on demand content, streaming of live subtitles using MPEG-DASH with embedded EBU-TT-D subtitles or the delivery of alternative audio-tracks for broadcast content using the Multi-stream synchronisation feature. A showcase for DASH and EBU-TT-D is planned for 2015 with demos at IFA and IBC, for further details please refer to (D3.2 section 8.1.16) and for DASH also the specific paragraphs in this chapter. For the more complex feature multi-stream synchronisation, first prototypes are foreseen in 2016. HBB4ALL will try to work on a showcase for this feature with a manufacturer as well.

As a member of HbbTV, IRT contributed to the new specification especially in the domain of subtitling, media synchronisation and companion screen, by proposing and reviewing of specification text and assertions of test cases that will make up the test suite for HbbTV 2.0. The latter was a prerequisite for the specification to be published, to accelerate the availability of a test suite for version 2. This was a lesson learned from HbbTV 1.0 where it took years to accomplish this task which was purely based on volunteering companies. Therefore, the expectation is that the test suite will be available before the first devices hit the media stores.

[5] A dedicated document was created by HBB4ALL for manufacturers' contacts, see http://www.hbb4all.eu/wp-content/uploads/2015/03/HBB4ALL_Chances_HbbTV2.0.pdf

6.1.2. MPEG-DASH

Delivery of (live) streams to HbbTV terminals via the Internet will be based on MPEG-DASH in the near future; this technology is a potential alternative for other platforms as well. Version 1.5 of the HbbTV specification introduced support for adaptive streaming based on MPEG-DASH, initially aiming at improving the perceived quality of video presentation on busy or slow Internet connections. MPEG-DASH can be used in various ways for added-on access services in all HBB4ALL pilots requiring (adaptive) streaming via IP, specifically the subtitling and alternative audio pilots (Pilot A and Pilot B respectively).

Native support for EBU-TT-D subtitles is only available from HbbTV 2.0 onwards, but for the audio pilots HbbTV 1.5 can already be used. There is a minimum of 16 components (known as "Adaptation Sets" for DASH) that need to be supported by HbbTV 1.5 terminals. If there is only one video component, there thus can be up to 15 audio components, covering multiple languages, audio description or clean audio components. In the future this will help to not have to encode and store content multiple times for each combination of video and audio as it is done today. For example, the Arte Mediathek currently includes content in two languages, German and French, both in 3 different qualities for the video, which requires 6 files for a single item in the application. With MPEG-DASH there is the possibility to have only a single video component (provided in 3 different qualities which are automatically selected by the end user device, based on parameters like the available network bandwidth) combined with 2 audio components (one for each language, which is chosen at playtime by the user). This is more efficient for the content / service provider, and more convenient to the user as he gets the best video quality possible without have to care about it himself.

Since several years IRT has been cooperating with CDN operators, encoder and terminal manufacturers to improve and deploy MPEG-DASH technology. Early 2014 IRT successfully showed a live transmission from an encoder via a Content Delivery Network (CDN) to an HbbTV 1.5 terminal. Additionally, IRT is in contact with organizations that work on open source tools like MP4box or ffmpeg which support MPEG-DASH or may support it in the future.

IRT subcontracted GPAC to adapt the MP4box software such that is now able to generate HbbTV 1.5 compliant MPEG-DASH streams, and there is also an early support to embed TTML based subtitles like EBU-TT-D (the task of checking the fragmenting and packaging of EBU-TT-D documents, in accordance with HbbTV 2.0, is ongoing). MP4box has also been used by TVC for the realisation of MPEG-DASH components for its workflow. Please refer to section 6.2.1 for the current availability of MPEG-DASH solutions and results of interoperability tests.

IRT organized a workshop with technical colleagues from the ARD broadcasting network to discuss short and medium term solutions for subtitling in live streams for platforms other than HbbTV, i.e. desktop and mobile. As a result of this workshop DASH is seen as an option for the medium term giving the chance to get rid of proprietary solutions that were and are still required. Potentially DASH can already be used on many devices except for the mobile Apple devices which natively require Apple's HLS. The strategy that was defined in a position paper during this workshop therefore includes HLS with WebVTT as a short term solution and MPEG-DASH with either (preferably) EBU-TT-D or also WebVTT in the medium term to force open standards.

6.1.3. Media Synchronisation

Under the term media synchronisation HbbTV 2.0 adds two new features: one is the so-called multi-stream synchronisation feature that allows presenting a stream delivered over Internet with a broadcast service in a time-synchronised manner, and the other one called inter-device synchronisation enabling the same but presenting the Internet stream on a second device like a smart phone or tablet. Within HBB4ALL Pilot B and Pilot D could make use of that feature to offer a broadcast service with an added-on accessibility feature (audio and sign language respectively) that are delivered via broadband Internet.

Deployments for such multi-stream synchronisation are currently unknown. There were a number of projects in the past in which laboratory prototypes were developed, including HBB-NEXT (this project finished in March 2014). To make this feature available for HBB4ALL, a number of different players like broadcast playout centers, CDNs and terminal manufacturers would have to be convinced to implement it. There is tentative decision with one of the ARD playout centers that is hosted by RBB as well as with at least one manufacturer to implement a showcase in 2016 showing additional content like alternative audio tracks and also sign language interpreter delivered via Internet and resynchronised with a broadcast service.

6.2. Cross Pilot HbbTV activities and components

6.2.1. MPEG-DASH interoperability testing

Since the beginning of the HBB4ALL project MPEG-DASH implementations got widely available at both the client side and the encoder/CDN side. There are solutions by traditional encoder manufacturers that also support other streaming formats like HLS and there are solutions by CDNs and other providers that allow content providers to generate content in a single format for which the CDN then converts the content for the various target platforms.

However, interoperability tests have shown a number of issues with MPEG-DASH implementations. While TV manufacturers mainly have implemented the HbbTV 1.5 profile of DASH as it is required for the French and Spanish HbbTV market, encoder manufacturers looked at the profile of the DASH Industry Forum[6] or even implemented their own profile of DASH. One of the HBB4ALL achievements, carried out by IRT during the last project period, was to make manufacturers aware of the new MPEG-DASH profiles chosen by HbbTV and DVB which hopefully leads to an improved interoperability with TV devices. For the above mentioned HbbTV 2.0 showcase with MPEG-DASH and EBU-TT-D (see section 6.1.1), IRT has found three (potentially four) encoder vendors interested to participate in testing and the showcase implementation. In addition GPAC with the open source tool MP4box was included in the testing.

On other browser-based platforms rendering of MPEG-DASH by the browser is not widely supported. However, W3C defined an API to implement the protocol logic of media streaming on the application level. This API is called Media Source Extensions[7] and extends the HTML5 media elements. A number of companies already offer HTML5 players that make use of this feature.

[6] http://dashif.org/
[7] http://www.w3.org/TR/media-source/

Alternatively this could also be implemented in Adobe's Flash plugin which is still available on Desktop platforms.

Formal HbbTV interoperability testing is carried out during HbbTV interop workshops (in which IRT takes part); additionally TVC carried out interop tests in their labs. Both are being reported in the next subsections.

6.2.1.1. HbbTV interop workshops

During the last HbbTV interop workshops IRT tested various DASH features and streams generated by different encoders. The anonymised results are listed in **Table 1**.

	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	Total
H264/DASH	OK	OK	NOK	OK	OK	OK	OK	OK	OK	OK	NOK	**9**
H265/DASH	NOK	OK	NOK	NOK	NOK	NOK	NOK	NOK	NOK	NOK	NOK	**1**
Enc 1/DASH	NOK	NOK	NOK	NOK	NOK	NOK	OK	NOK	NOK	OK	NOK	**2**
Enc 2/DASH	OK	OK	NOK	OK	OK	OK?	OK	OK	OK	OK	NOK	**9**
Enc 3/DASH	NOK		NOK	OK	OK	OK?	OK	NOK	NOK	OK	NOK	**5**
multiple Audio Components	NOK	NOK	NOK	NOK	OK	NOK	OK	NOK	NOK	NOK	NOK	**2**

Table 1. Anonymised results of MPEG-DASH tests performed during HbbTV interoperability workshop (June 2015).

The tests performed during the HbbTV interop event in June 2015 show a field of 11 different devices (M1-M11), 9 of which implemented MPEG-DASH (M1,M2, M4-M10). All 9 were able to play the content generated by 1 DASH encoder ("Enc 2/DASH") (success marked "OK" in the table), but most TVs failed for the other encoders in the test (marked "NOK"). Interestingly, there was already support for HEVC/H265 with one device supporting the upcoming codec for UHD with MPEG-DASH (line "H265/DASH").

A test with multiple audio components still lacks wide support. While many TVs make the list of audio components available to HbbTV applications, they either fail in providing sufficient information for component identification (e.g. by ID, language attribute or order of the component listing). Or they simply fail or crash after the application selects a new audio component for rendering. However, compared to the previous test 4 months earlier, there were two devices (M5, M7) which completely implement all these steps and thus passed this test.

6.2.1.2. MPEG DASH interop labtests

TVC has performed some MPEG DASH interoperability tests with some different HbbTV devices present in their labs. The results obtained from TVC tests confirm IRT's interoperability tests, as from their tests, TVC obtained that most of the HbbTV devices correctly played MPEG-DASH streams with one audio. All of the HbbTV devices at TVC labs correctly played MPED DASH VoD non bitrate adaptive streams. But only 5 from 8 devices played successfully both VoD bitrate adaptive. And the same 5 devices could also play live video bitrate adaptive and not adaptive.

TVC also tested multiple audio MPEG DASH streams on available HbbTV2.0 prototype devices: these only worked correctly in 2 devices from the 8 available, similar results to to the IRT 'multiple Audio Component' case.

Overall it can be summarised that so far IRT and TVC have tested prototype HbbTV 2.0 devices from 3 manufacturers (names may not be disclosed at this moment) to correctly support multiple audio MPEG-DASH stream selection and playback.

6.2.2. Playback of audio content using MPEG DASH

For the three Catalan sub-pilots in Pilot B multiple audio streams are included as separated audio components in a single MPEG DASH asset. For example, in the simplest scenario, contents with one video and two different audios, the chunks generated are for each of the components and the MPD manifest contains three adaptation sets: one for the video component, one for the first audio component, and one for the other audio component. The components required for the generation of the MPEG-DASH assets, as well as for the selection of various audio streams in the end user device (MPEG-DASH "player") are being tested intensively before being integrated. Different solutions are used for the Video On Demand or the Live case to generate the MPD and segments for MPEG DASH assets. For playback in the end user HbbTV device, the native player in the respective device will be used. TVC did extensive testing on MPEG DASH generation and playback, with support by IRT.

For Pilot A TVC has integrated the subtitling service on his web portal '3alacarta', and all the contents offered there are MP4. Under consideration is the future adaptation of TVC's content delivery services to take profit of the MPEG DASH, preparing all the contents properly and delivering them as MPEG DASH streams. This adaptation will highly depend on the final results obtained at the end of the pilots with users in Catalonia planned for the HBB4ALL project.

For details please refer to D4.2 ([6], section 2.5).

6.2.3. HbbTV audio options selector

The HbbTV audio options selector could be used in both HBB4ALL pilots A and B. In the TVC's Pilot B, for which multiples audios MPEG DASH streams will be offered, this component will be used in all TVC's sub-pilots to allow the end users to switch between the available audio tracks. The component could be used too for the Pilot A after a future adaptation of the contents delivered at TVCs web portal to be MPEG DASH and take profit of its multiple audio capabilities.

For details on this component please refer to D4.2 ([6], section 2.4).

6.2.4. HbbTV device and version detection

HbbTV device and version detection component will also be used in both HBB4ALL pilots A and B. Recognising the specific HbbTV device and its supported version of the HbbTV standard that is running TVC's HbbTV application for Pilot B will be useful, if finally the pilot is openly performed with all the possible Catalan users with HbbTV devices. In this case, this component will be used to select the HbbTV devices that can run TVC's HbbTV testing application for additional audio services, because from different tests performed in the lab it was obtained that only a few amount of HbbTV devices currently correctly supports MPEG DASH multiple audio features (see section 6.2.1). In case of Pilot A this component will be used only in an informative manner, as most HbbTV devices lab tested worked correctly with the subtitling.

For details on this component please refer to D3.2 ([7], section 2.3.4) and D4.2 ([6], section 2.6).

6.3. MOOC on accessibility as cross pilot show case

vsonix worked on a video based learning application ("MOOC"), which is planned to be provided as webcast (online) service for Europe in English. The MOOC acts as a cross-pilot showcase addressing Pilot-C and Pilot-A. The MOOC service will be available for PCs and mobile devices. It integrates a variety of functions including lecture content playback, user access, content related and chats as well as functions for learning assessment.
Regarding its accessibility aspects it will include all the features of the online service including personalized font size, colour schemes, screen reader functionality as well as personalized subtitles.

The content of the MOOC showcase for Spain is developed by UAB in collaboration with vsonix. The goal is to provide an online course for media accessibility. The course will consist of a number of lectures addressing different aspects of media accessibility and interactive functions for learning assessment and feedback provision.
The MOOC service is actually integrated using software components developed by vsonix including vPlayer, a Flash and HTML5-based webcast player that is capable to playback lecture and presentation content as well as vInteract, a software component that provides functions for social interaction including messaging functions. The MOOC will be hosted via vsonix' content delivery network (CDN). The subtitle implementation for the vPlayer is based on standards such as WebVTT.

7. References

[1] *D2.3.1 – Common Technical Components (I)*, HBB4ALL deliverable, July 2014

[2] ETSI TS 102 796 V1.2.1 (2012-11) Hybrid Broadcast Broadband TV

[3] ISO/IEC 23009-1:2012 - Information technology -- Dynamic adaptive streaming over HTTP (DASH) -- Part 1: Media presentation description and segment formats

[4] MPEG-DASH Profile for Transport of ISO BMFF Based DVB Services over IP Based Networks

[5] HbbTV 2.0 Specification (2015-05-01), HbbTV Association, May 2015 (to be published as ETSI TS 102 796 V1.3.1, autumn 2015), https://www.hbbtv.org/pages/about_hbbtv/HbbTV_specification_2.0_2015-08-01.pdf

[6] *D4.2 – Pilot-B Solution Integration and Trials*, HBB4ALL deliverable, scheduled for submission in September 2015

[7] *D3.2 – Pilot-A Solution Integration and Trials*, HBB4ALL deliverable, scheduled for submission in September 2015

[8] EBU Tech 3370, EBU-TT, Part 3, Live subtitling applications, System model and content profile for authoring and contribution, Geneva, June 2015

[9] SMPTE ST 2052, Society of Motion Picture and Television Engineers, "SMPTE Standard for Television Timed Text Format (SMPTE-TT)", SMPTE ST 2052-1:2010, December 2010

[10] TTML Simple Delivery Profile for Closed Captions (US), A profile of TTML for internet delivery of Captions originated in the United States, W3C Working Group Note 05 February 2013, http://www.w3.org/TR/ttml10-sdp-us/

[11] TTML 1.0, Timed Text Markup Language (TTML) 1.0 (Second Edition), W3C Recommendation 24 September 2013, http://www.w3.org/TR/2013/REC-ttml1-20130924/

[12] TTML Text and Image Profiles for Internet Media Subtitles and Captions 1.0, W3C Candidate Recommendation 19 May 2015, http://www.w3.org/TR/ttml-imsc1/

[13] WebVTT: The Web Video Text Tracks Format, Draft Community Group Report , 10 August 2015, http://dev.w3.org/html5/webvtt/