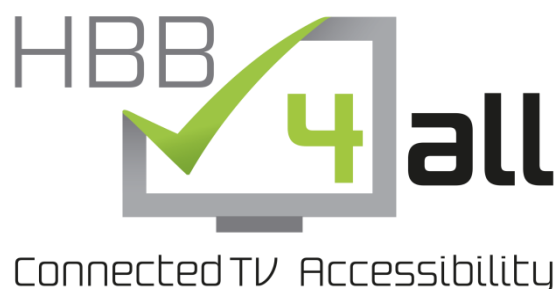


## D6.1

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## D6.1 – Pilot-D Progress report

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D6.1 v1.50

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 Hybrid Broadcast Broadband for All

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### D6.1 – Pilot-D Progress report

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## Executive summary

This deliverable explains the progress of HBB4ALL Work Package 6 / Pilot D for the first year of project execution. This Work Package is validating the capabilities of the transmission by means of a broadband network (i.e. Internet) to provide sign language interpretation for audiovisual content. Two service pilots are being considered:

- HbbTV-based signing service (German sub-pilot). It takes advantage of HbbTV, the standard technology for connected TV, to provide an on-demand sign service.
- IP/Web-based signing service (Portuguese sub-pilot). This service pilot uses a website to provide a customisable window for the signing implementation.

Three additional objectives are being tackled in Pilot D:

- The creation of a new signing workflow model for the authoring and distribution of the signing services. This model is supported by two complementary descriptions: a business approach and a technical approach.
- The creation of an avatar signing service for user tests, focused on weather forecasts.
- The performance of user tests to know user preferences concerning service provision. The project has checked the huge variety of possible implementations.

Task T6.1 and T6.2 are ongoing and the operational phase of the service pilots (T6.3) is expected to start in August 2015 (mentioned as M21 in the DoW).

## 1. Introduction

The Hybrid Broadcast Broadband for All project (HBB4ALL) investigates accessibility in the new hybrid broadcast-broadband TV (HbbTV) environment. One of the most prominent challenges faced by broadcasters is the new requirement to add access services, in a cost-efficient manner, to Internet delivered audio-visual content while remaining consistent with the access services available on traditional broadcasts. An additional complication is the desire to offer viewers consuming Internet delivered audio-visual content a new opportunity to customise the access services they are using to best meet their personal preferences or needs.

The HBB4ALL project will test access services in four interlinked Pilots; Pilot-A: Multi-platform subtitle workflow chain; Pilot-B: Alternative audio production and distribution; Pilot-C: Automatic User Interface adaptation – accessible Smart TV applications; Pilot-D: Sign-language translation service.

The Operational phase of the HBB4ALL project (Task X.3 – Operation Phase for all Pilots A to D) will gather user feedback and assess the acceptance and quality of services in various delivery scenarios implemented using field user tests and also in complimentary qualitative lab tests performed by UAB. There will be a number of different large scale service pilots. In the specific case of Work Package 6 / Pilot D, novel sign language interpretation services will be deployed in different HBB4ALL countries, taking advantage of the HbbTV technology and the transmission of video content in IP networks.

Pilot D will deploy two service sub-pilots. On the one hand, an HbbTV-based signing services will be deployed in Germany. On the other hand, a web-based customisable signing service will be deployed in Portugal. Not only are the service pilots on the focus of Pilot D. As in the rest of Pilots, user tests are an important part of Work Package 6 / Pilot D. The objective of these user tests is to determine the optimal parameters for a high quality service performance. Moreover, these user tests will include an avatar (virtual interpreter) signing service.

### 1.1. Purpose of the document

This document constitutes a report on the progress of Pilot-D, as part of the HBB4ALL project, funded under the Competitiveness and Innovation framework Programme 2007-2013 (CIP). Pilot D is a 3 year sub-project that is divided into 4 tasks. The first two tasks overlap, the final two tasks follow in sequence. Current progress in Pilot D is reported in this document up to the end of month 11 of the project timeline, allowing a month for review before scheduled delivery at the end of month 12.

The first chapter of this deliverable is an executive summary, which condenses the main information of this progress report. The current chapter introduces some aspects of the deliverable, such as the objectives of Pilot D or the terminology. Chapter 3 summarises the results of some previous projects being useful in



HBB4ALL and the current state of the signing service for TV. Chapter 4 explains the current challenges in the signing service provision, the current workflows and the workflow proposed by Pilot-D and some key technologies for the deployment of the service pilots. Chapter 5 revises the three services which are being built in Pilot-D. It includes information about the current state and schedule. This schedule information is also summarised in chapter 6. Chapter 7 explains the service components that are being considered in this Pilot, according to 2.3.X deliverables. Chapter 8 explains the user tests that are being carried out. Chapter 9, 10 and 11 are dedicated to results, conclusions and references respectively.

### 1.2. Summary of Pilot D Objectives

The next table summarises the four main objectives of Pilot D, according to the HBB4ALL DoW.

Objective	Description
D1	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.
D2	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.
D3	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.
D4	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.

Table 1. Pilot D objectives.

### 1.3. Summary of task 6.1

Task T6.1 is named “Definition and preparation of Operation Phase”.

This task shapes the strategy for the operational phase of sign language services in T6.3. It defines which service components will be implemented, integrated and trialled in T6.2 and it produces a plan across countries and testing sites for the large scale trials in the Operation Phase. It will make sure that the pilot service of HbbTV / IP TV -based sign language service will be in place at M21 (August 2015) in the countries selected (Germany and Portugal) which will demonstrate significant impact potential and engages a complete value-chain of stakeholders.

The context of this task is that of minor additions or changes will be needed to existing sign language services already available in both HBB4ALL territories. This includes plans for using existing infrastructure to deliver IP-based sign language services, optimisation of work-flows for the production of sign language with regards to an HbbTV IP TV -based provision. As part of this work, RTP and RBB plan to offer a basic sign language service where the sign language interpreter has a predetermined and fixed position in order to provide a baseline for the evaluation of the customisable size and position of the interpreter when HbbTV 2.0 becomes available. As far as it has been checked during the first year of project execution, HbbTV 2.0

commercial devices or prototypes may not be available for the operational phase of the project. In any case, the German sub-pilot can be deployed based on HbbTV 1.5. This deliverable contains information about the different HbbTV releases and their features (section 4.6).

Unlike the other pilots in this project, the base line service is relatively straight-forward. It requires the broadcasters to use IP delivery instead of a conventional DVB transport stream. The positioning and size of the interpreter as an integral part of the television picture delivered via IP builds on evidence acquired from previous studies conducted in Portugal, Germany and most recently in the DTV4ALL project (see section 3.1.1). In many respects, there are clear heuristics governing the size and position.

For the HbbTV / IP TV customization features, the pilot builds on RBB experience. It will require a robust synchronisation mechanism.

#### **1.4. Summary of task 6.2**

Task T6.2 is named “Solution Integration and Trials”.

Small heuristics trials and lab tests of RTP’s and RBB’s efforts will be undertaken involving volunteers at RTP, RBB, IRT and Screen. HbbTV-based applications for hybrid signing services ideally customisable for end users will be integrated by IRT, RTP and RBB. So end users can choose the size and position of the signer overlay. This will include second screen options, where appropriate. The success of Task 6.2 in putting into place the technology, the infrastructure and the services in place at RBB and RTP is the essential pre-requisite for all large-scale trials in the ensuing Operation Phase. This task also includes the integration of an avatar signing service for a concrete semantic domain (weather forecast). This activity is being carried out by VIC in the project.

#### **1.5. Reference documents**

The following documents are relevant for Pilot-D:

TS 102 796 - V1.2.1 - Hybrid Broadcast Broadband TV – HbbTV 1.5

TS 102 796 - V1.1.1 - Hybrid Broadcast Broadband TV - HbbTV

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

ISO/IEC 14496-30:2014 - Information technology -- Coding of audio-visual objects -- Part 30: Timed text and other visual overlays in ISO base media file format

Digital Television For All (DTV4All) D2.5 -Final Report on mature Pilot Services, Descriptions of the Mature Access Services and Guidelines for their Implementation throughout Europe

Digital Television For All (DTV4All) D3.7 / D4.7 - Joint Recommendations for Future Access Services, Devices and Platforms

Digital Television For All (DTV4All) D4.6 - Descriptions of the Mature Access Services and Guidelines for their Implementation throughout Europe

HBB-NEXT Next-Generation Hybrid Broadcast Broadband (FP7-ICT-2011-7)

D 6.1.3 Final HBB-NEXT System Architecture

HBB-NEXT Next-Generation Hybrid Broadcast Broadband (FP7-ICT-2011-7)

D 7.4.3 3rd Report on Standardization and IPR Protection Activities

HBB4ALL (CIP-IST-PSP-621014)

D2.3.1 Common Technical Components (I) document

**Table 2.** List of reference documents.

## ***1.6. Acronyms and abbreviations***

In this document, when necessary, identified partners within the project are referred to using the abbreviated names initially defined within the Consortium Agreement for HBB4ALL and reproduced on the cover sheet of this document. Moreover, this deliverable uses certain acronyms that are explain in the following section.

## ***1.7. Definitions and glossary***

**Access Service** – the provision of additional services or enhancements that improve the accessibility of TV services for viewers with disabilities or special needs.

**Accessibility** – The degree to which a product, device, service, or environment is available to as many people as possible. Accessibility can be viewed as the "ability to access" and possible benefit of some system or entity. Accessibility is often used to focus on persons with disabilities or special needs and their right of access to entities, often through use of Assistive technology or Access Services.

**Business model** – describes the rationale of how an organization creates, delivers, and captures value. This may be viewed in a narrow sense (*economic value, what are the costs, and if there are revenue streams to pay for them*). Increasingly, a business model includes social or other forms of value.

**Catch-up TV** – A service that allows a viewer to see a TV program independent of when it was broadcast. This is usually a kind of on-demand service on the Internet,

**CDN** – Content Delivery Network. Content repositories especially built to deliver audiovisual content in an efficient manner.

**DVB** – Digital Video Broadcasting. European organization that elaborates specifications for digital TV that are used all over the world.

**HbbTV** – Hybrid Broadcast Broadband TV. Standard technology for Connected TV that supports the HBB4ALL project. HbbTV is a major pan-European initiative building on work in the Open IPTV Forum aimed at harmonizing the broadcast and broadband delivery of entertainment to the end consumer through connected TVs and set-top boxes.

**ILS** – International Sign Language

**IPTV** - Internet Protocol Television

**LSE** – Spanish Sign Language. The avatar signing interpreter is based on this sign language and it appear widely referenced in this deliverable.

**MPEG-DASH** or **DASH** – Motion Picture Expert Group – Dynamic Adaptive Streaming over HTTP. This technology is supported by HbbTV from the version 1.5. It allows an adaptive streaming depending on the network capabilities.

**SLI** – Sign Language Interpretation

## 2. State of the art and results from past projects

### 2.1. Related research on digital and connected TV

#### 2.1.1. DTV4All

RBB was a partner in the ICT-PSP Project DTV4ALL. Here it already started to examine hybrid sign language services. In 2010 RBB carried out a small lab test with 10 deaf people within the project. Here, a very early concept was evaluated, showing an on-demand sign language service on an HbbTV-enabled device.



**Figure 1.** RBB's conceptual prototype of a sign language service.

The results of this test were fed into the early service click dummy preparing the German Pilot Service as described in Section 5.1. The following recommendations were derived:

- A solution where a video on demand with a superimposed sign language interpreter is delivered via the IP-channel of a hybrid device has been shown to be feasible.
- Access to such a solution must be easy. The pop-up window or icon announcing the availability of the on-demand service should remain on screen for several seconds. In future such a pop-up application could be replaced by a dedicated button on the remote control which automatically calls up any programme with sign language interpretation available on demand. Alternatively, on demand delivery of signed programmes could be entered into a user's personal profile on a hybrid TV system and would thus occur automatically each time it is available.

In a second part of the validation session parameters like different variants of screen composition, with different locations and sizes of main and signer video areas for a "truly hybrid" solution with two video

streams were evaluated. If an HbbTV2.0 –showcase were created in HBB4ALL the recommendations derived here will be taken into consideration. In short these are:

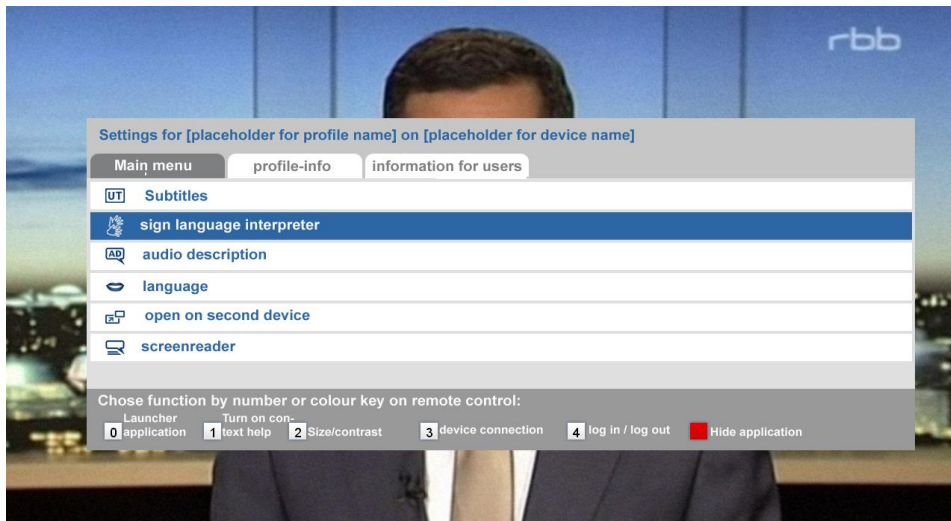
- To allow for personalisation future solutions should enable a separate signing video to be delivered over the Internet that can be combined with the main broadcast programme on the screen. For this the hybrid device should be capable of decoding two different video streams in parallel. Concerning such a future “truly hybrid solution” DTV4All tests resulted in the following recommendations:
- The sign translation video should be customisable to be adjusted by the user in terms of size, position and design of the sign translation video.
- Deaf people welcome a congruent sign language translation. The matching can be improved through buffering a hybrid stream which overcomes the natural delay in real world sign language translation.
- In the hybrid device a video buffer is needed for re-synchronisation of the sign language and the main video. For a delayed signer the video should have an offset of 1.76 sec, for a delayed main video there should be an offset of 4.16 sec. These values should not be exceeded, see DTV4ALL deliverable D3.6.
- State-of-the-art video codecs for sign language video can guarantee optimal image quality for the sign language video.
- The window of a sign language video should preferably be slightly overlapping the window of the main video and be positioned at the top right position on the screen.

### **2.1.2. HBB-NEXT**

In the EU-Project HBB-NEXT inter-device and inter-media synchronization components have been developed that allow for synchronisation of multiple streams on a single device or of multiple streams presented on different devices. For both features different approaches have been implemented and evaluated. One approach is based on existing concepts for media synchronisation, namely to use PCR and PTS which come with MPEG transport streams, that has been extended to work with multiple streams. While it is a simple approach it also has some limitations on use cases, especially if content is pre-produced or is served from a third party.

To enable such use cases a more sophisticated concept was developed that is based on adding content timelines. The timeline chosen for DVB broadcast services is the so-called DVB timeline that is delivered as separate information in elementary streams and which is used to synchronize the content from broadcast with on-demand IP video. This concept is quite flexible and can be implemented also with live streaming on the internet or managed IPTV services using different system formats like ISOBMFF a.k.a. MP4 file format by providing a suitable timeline format.

For inter-device synchronization, additionally timing information is constantly exchanged between devices to synchronise the internal clocks for each media player. On this basis the HBB-NEXT Settings Application showcase is a novel example to demonstrate the feasibility and necessity of synchronization services for both end-users as well as industry-like broadcasters. The settings application offers accessibility services via a unified interface, as depicted in Figure 2.



**Figure 2.** RBB's conceptual prototype of a sign language service.

The service provides the following use-cases for media synchronization:

- IP subtitles and/or sign language video and audio description synchronized to broadcast video on TV.
- Inter-Device Synchronization of DVB-Video on TV to alternate IP audio-streams on connected device (e.g., audio description) and Synchronization of Subtitles to Video Playback on connected device.

User tests with a group of hard-of-hearing and deaf persons were conducted in several rounds at RBB in Berlin.

The DVB broadcast timeline approach to enable inter-media and inter-device synchronization in HbbTV requires technical amendments on all parts of the DVB broadcast-and-play-out chain, i.e. generating of an accurate timeline by the broadcaster, preserving the timeline in the delivery network, and finally using it to tightly synchronise multiple media streams on the end-user devices.

Especially on the client side, a set of parameters needs to be fine-tuned, since in parallel to the reception of the regular DVB streams, the broadcast timeline needs to be extracted and the play-out of “slave” digital media content needs to be buffered and controlled. These actions require a certain amount of processing time, which needs to be considered in the overall media play-out. In exchange for these efforts, absolute timing information is available on the client side. It even provides a useful basis for future developments in

the area of multi-device synchronization: If the timeline is shared among end-devices, it may clearly bring forward frame-precise synchronized services for hybrid media on multiple devices.

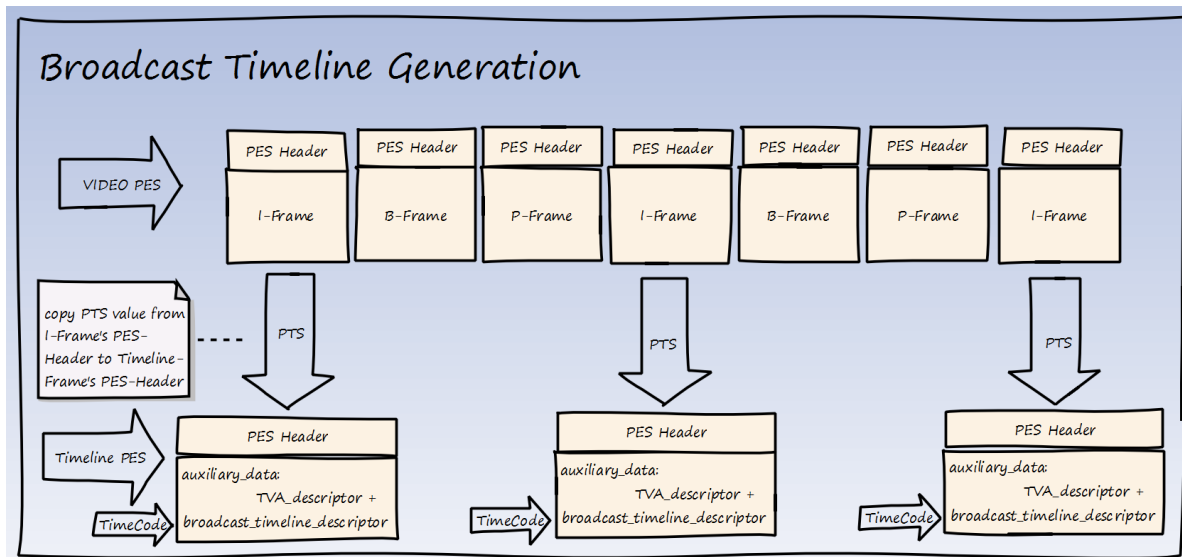


Figure 3. Broadcast timeline generation in HBB-NEXT.

The ability to provide broadband based synchronized services allows for providing services for smaller target groups. Due to the signalization of additional content over IP, external companies can, for the first time, provide additional services. This gives broadcasters the opportunity to outsource features (different language tracks, etc.) and increases the importance of synchronization in future business models in a connected TV environment.

In particular the deliverables of HBB-NEXT work package 4 (<http://hbb-next.eu/index.php/documents>) are describing the HBB-NEXT technology to solve the problem of DVB to IP video synchronization in HbbTV applications and also the usability results.

IRT was mainly involved in the technology part and RBB in the use case part in this work package. So, this work will be the basis for the RBB signer pilot and also the possible RBB and IRT HbbTV2.0 Showcase developments in HBB4ALL.

## 2.2. Related research on usability and customisation

### 2.2.1. GUIDE

The GUIDE (“Gentle user interfaces for elderly people”) project researched the concept of multimodal user interfaces for applications that automatically adapt to the needs and preferences of elderly users with different kinds of mild ageing-related impairments (hearing, vision, motor, cognitive). The GUIDE project focussed on connected TVs and set top boxes and delivered a software framework and application design tools that allow developers to integrate advanced accessibility features into their applications with reduced



development risk and costs, and without having to run comprehensive tests with real users.

GUIDE was intended to support accessibility to applications throughout the entire lifetime of the application: by publishing research into generic accessibility requirements; by supporting application design; by standardising the initialisation of the application when the user first interacts with the application and by continuously supporting adaptation of the application to meet changing user requirements. In order to increase application developer support further and make GUIDE available to HbbTV applications a public API was implemented. Access to core concepts, such as the user-specific impairment levels, is possible from pure web based (and thus, HbbTV compatible) applications with adequate authentication mechanisms in place to properly take care of privacy related issues known in web based applications and APIs.

GUIDE performed three phases of user trials to collect information about user's experiences with technology as well as to make a self-assessment of their impairments. Real interactive tests with a fully integrated user test application covering most of the UI technologies considered for GUIDE were used to collect preference feedback as well as raw data as a basis for user modelling. For the developer requirements, GUIDE performed a public web-based survey which addressed aspects of accessibility and collected data about current practice and features desired for run-time adaptation and design time simulation. Two dedicated developer focus group sessions allowed collection and analysis of requirements from a wide audience.

GUIDE finalised the specification of the GUIDE Framework and Tools, which includes approaches and schemes for performing multi-modal adaptation for web applications, as a software framework that can be installed on STBs and connected TVs. It integrates with web application environments (web browsers) and various types of UI technology. Also developed was a user model which forms the basis for user simulation at design-time and UI adaptation at run-time. This model represents knowledge about the user's impairments, his cognition, perception and motor capabilities and individual preferences. The open nature of the GUIDE API in Hbb4All demands a more flexible user profile in terms of adaptation requirements. The existing user model from GUIDE is carefully adapted towards the needs of a more general and extensible user profile, so that new adaptation parameters may easily be introduced such as subtitle-specific settings (position, transparency level, font size and color).

A prototype application that integrates various forms of user interface technology (gesture recognition, speech recognition, remote control, avatars, etc.) was developed that can perform tests with the user in order to measure his capabilities, when he is using the system for the first time. This "User Initialisation Application" was intended to become an integral part of the GUIDE framework and to be usable by all GUIDE-enabled applications. The User Initialisation Application has to be slightly modified in order to respect the adapted user profile and will be rebranded "Access GUIDE" during this process. Access GUIDE will store collected user information through the GUIDE API in its online database storage. Furthermore, the existing accessibility features of the User Initialisation Application will be improved in accordance with existing accessibility standards such as W3C WAI recommendations.

A prototype of the GUIDE simulation tool was also developed. It takes as input user interface designs and allows developers to evaluate their designs with respect to various vision- and motor impairments. This means that the developer can perceive the user interface as if he had vision impairments, and he can assess how an impaired person can interact with the user interface layout. The simulation is based on a virtual user, which exploits the GUIDE model.

### 2.3. *Avatar signing*

At an international level, the following research works are the most relevant ones at trying to create a translation platform from spoken language to Sign Language using virtual characters.

The European project ViSiCAST<sup>1</sup> [1] and its continuation eSIGN (see Zwiterslood et. al. article in [2]) are among the first and most significant projects related to Sign Language translation. It consists of a translation module and a sign interpretation module linked to a finite sign database. The system translates texts of very delimited domains of spoken language into several Sign Languages from the Netherlands, Germany and the United Kingdom. To build the sign data-base, a motion capture system was used and some captions were edited manually when needed. The result was good regarding the execution of the signs and the technology of that period. However, facial and body expression were not taken into account, which is one of the most fundamental aspects to understand Sign Language correctly.

Dicta-Sign<sup>2</sup> [3] is a more recent European project. Its goal was to develop technologies to allow interaction in Sign Language in a Web 2.0 environment. The system would work in two ways: users would sign to a webcam using a dictation style; the computer would interpret the signed phrases, and an animated avatar would sign the answer back to the user. The project is being developed for the Sign Languages used in England, France, Germany and Greece. In addition authors affirm that their internal representation allows them to develop a translator among different sign languages.

There have been other smaller projects designed to resolve local problems for deaf people in different countries, each project working with the Sign Languages from: United States [4], Greece [5], Ireland [6], Germany [7], Poland [8] or Italy [9]. All of these projects try to solve the accessibility problems that deaf people have to access media information, communicate with others, etc.

Regarding Spanish Sign Language (LSE), there have been several attempts to build an automatic translator. Unfortunately, none of them seem to have had a huge repercussion on the Spanish deaf community. The Speech Technology Group at Universidad Politécnica de Madrid have been working on a both way translation-system from written Spanish into LSE [10] as well as translation from LSE into written Spanish [11]. The system is designed for a very delimited usage domain: the renewal of Identity Document and

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<sup>1</sup> <http://www.visicast.co.uk/>

<sup>2</sup> <http://www.dictasign.eu/>

Driver's license.

In a more challenging project Baldassarri et. al. [12] worked on an automatic translation system from Spanish language to LSE performed by a virtual interpreter. The system considers the mood of the interpreter modifying the signs depending whether the interpreter is happy, angry, etc. A more recent research [13] translates speech and text from Spanish into LSE where a set of real-time animations representing the signs are used. The main goal is to solve some of the problems that deaf people find in training courses.

Finally, the project textoSign<sup>3</sup> is a more oriented product whose goal is to provide a translation service working in real time which may be integrated into websites, digital signage scenarios, virtual assistants, etc.

## 2.4. Current signing services

The first steps in the research managed by UAB (see section 7.2) gave us a full perspective of what formal features could be found regarding sign language interpretation on TV across different countries within and outside EU. The first data collection was made accessing the online platform Sign Language Television for the Deaf (<http://signlangtv.org/>). This platform includes different accessible TV programs from broadcasters throughout 42 different countries. From this website one hundred screen shots were retrieved aimed to show the variety of formats used to include sign languages on screen. A short selection of screen shots is shown in figure 4.



**Figure 4.** Screen shots of signing implementations in Portugal (RTP, HBB4ALL partner), Lithuania (LTV) and Korea (KBS).

Once the data was collected a full range of variable formal features were taken into account. Namely, interpreter gender (male / female); on screen appearance (sub-screen / half screen / chroma); shot size (long shot / medium long shot / mid shot / medium close up); interpreter's clothing colour (plain light-coloured / plain dark-coloured / patterned); interpreter's on-screen size (small / medium / big); interpreter's location on the screen (right / left; top / central / bottom).

Tables 3-8 show the percentages of the observed variation in terms of the above-mentioned on-screen formal features.

<sup>3</sup> <http://www.textosign.es/>

Interpreter gender	
Male	32%
Female	68%

**Table 3.** Interpreter gender.

On screen appearance	
Sub-screen	49%
Split screen	27%
Chroma	24%

**Table 4.** On screen appearance.

Shot size	
Long shot (LS)	30%
Medium long shot (MLS)	7%
Mid shot (MS)	49%
Medium close-up (MCU)	14%

**Table 5.** Shot size.

Interpreter's clothing colour	
Plain light-coloured	14%
Plain dark-coloured	62%
Patterned	24%

**Table 6.** Interpreter's clothing colour.

Interpreter's on-screen size	
Small	24%
Medium	44%
Big	32%

**Table 7.** Interpreter's on-screen size.

Interpreter's location on the screen	
Top right	3%
Right center	21%
Bottom right	40%
Overall right locations	64%
Top left	0%
Left center	19%
Bottom left	17%
Overall left locations	36%

**Table 8.** Interpreter's location on the screen.

Although some broadcasters have style guides for sign language interpretation (SLI) on screen, these results show a good deal of variation that indicates the need for standardisation. Nonetheless, taking these data into

account we can outline some tendencies, namely, a female interpreter wearing plain dark-coloured clothes filmed using a mid shot and inserted on the screen within a medium-sized sub-screen on a bottom right location.

These results from the first data collection process indicated the need to narrow down the list of possible variables to be tested in an experimental environment. So that a second data collection phase was designed to gather information from both the professional group involved, sign language interpreters working on TV (see 4.3), and the end users, signing deaf TV consumers (see 8.2).

### **3. Challenges, Workflows and Technologies**

#### ***3.1. Challenges for signing production and exploitation***

Signing is used by persons who were born deaf or by persons with a variety of cognitive impairments who are able to understand signing in the sign language offered. In general it is hoped that the ‘digital dividend’ should result in more signing of primetime and ‘mainstream’ broadcast programming. The main challenges for providing a signer service are clearly two-fold: the necessary efforts on the production side, as well as the presentation on the user side, oscillating between the demand for a sign language translation and the interference with viewers who don’t need sign language.

The transition to digital distribution of broadcast television has made it technically feasible to provide “closed” sign language access services (ones where the viewer can turn them on or off). This would provide a greater degree of flexibility among viewers and minimise adverse reactions from audiences, as in many countries there is resistance to displaying signing in prime time. Public service announcements during crises are clearly an exception – they should have “open” signing.

The processes involved in the production of a signed version of a programme are broadly similar to the process of captioning (subtitling for a hard of hearing audience). Signing, like captioning, may be either pre-recorded (i.e. created off-line) or produced live (where a signing interpreter performs a similar role to a re-speaking or stenographic live ‘subtitler’). In general, the workflow for the production of signing differs from subtitling primarily in the recording / output aspect; a subtitler creates text, and a signing interpreter ‘signs’ in front of a camera (typically in a ‘green screen’ environment).

#### ***3.2. Current workflows***

##### ***3.2.1. Sign language interpreter for “Kontraste”***

For the monthly current affairs programme “Kontraste” to be broadcasted nation-wide via the ARD main channel “Das Erste”, RBB is producing an additional sign language version for a reception through the common video on-demand services (“Mediathek“). This is quite a simple editorial and technological approach, which is being realised by an external subcontractor and is described as follows:

### **3.2.1.1. Programme**

The current TV show is being recorded live during the air time and stored as video file.

### **3.2.1.2. Sign language interpreter**

The sign language interpreter can prepare herself with the manuscript of the programme, if available, and translates the spoken texts into German sign language. This is being done in a green box for a later chroma key compositing and recorded as video file.

### **3.2.1.3. Composition**

With the help of a video editing software both videos are composed into a single picture-in-picture video, according to the prepared mask and screen partitioning. The resulting video is exported as file and stored locally.

### **3.2.1.4. Provision**

The ready composed video, containing the TV programme with added sign language video, can then be transferred via FTP or the ARD-specific closed broadband network to the facilities of RBB and can be ingested into the video on-demand environment where it is accessible for users from now on.

## **3.2.2. RTP current workflow for broadcast and broadband signing**

RTP is the Portuguese public broadcaster and has a huge responsibility in accessibility issues. The sign language is only one of the several services that RTP offers to deaf and hard-of-hearing people. Moreover, recently was created a resolution for accessibilities by ERC – *Entidade Reguladora para a Comunicação Social* (the entity that regulates the Media) – in which RTP has obligations concerning the minimum number of hours and genres of TV programmes with accessible content.

At this moment, RTP 1 broadcasts almost 75% of its content with Sign Language to the deaf and hard-of-hearing viewers, in the period 9 am – 9 pm. This service is also available in RTP 2, but only in some programs, such as news and debate programs.

The Sign Language service is available in three different modes: in pre-produced programs, such as TV magazines, debate programs or documentaries; in live programs (news and entertainment programs), and in double-screen mode, [www.rtp.pt/wportal/acessibilidades/gestual/](http://www.rtp.pt/wportal/acessibilidades/gestual/).

### **3.2.2.1. Pre-produced programmes with signing for broadcast**

The program is recorded, and then the Sign Language interpreter window is embedded in a post-production phase. The window is squared and is positioned at the bottom left hand corner of the screen, in order to interfere as little as possible with the images. All the written information is properly positioned in line with the Sign Language interpreter window. This service stays available in broadcast as well in broadband -

online emission and VoD programs. All the users have access to this open service. Recently, RTP produced several programs with a different interpreter window. In this case, using a chroma key technology, the interpreter stands on his feet, right next to the program images, giving more emphasis to the sign language translator, allowing to the service viewer a more comfortable experience while is watching TV. This service is available in RTP 2 and RTP Memória (figure 5).



Figure 5. Screen shots of RTP2 (left) and RTP Memória (right).

### 3.2.2.2. Live programs with signing for broadcast

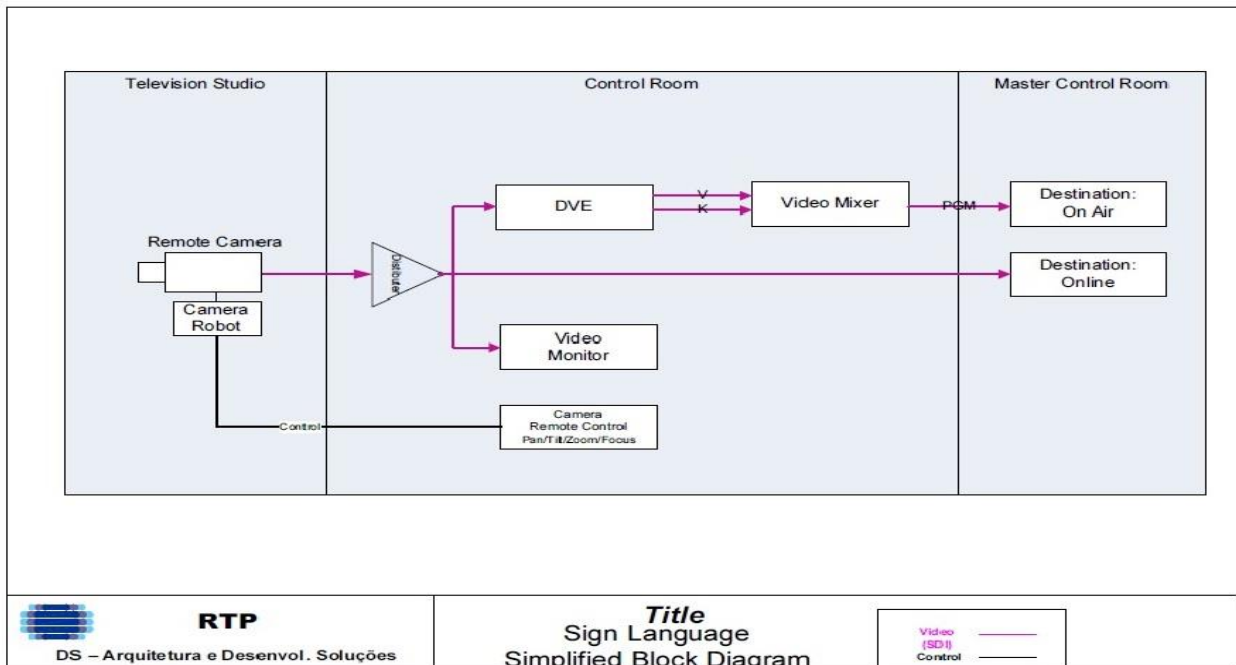


Figure 6. Current signing workflow in RTP.

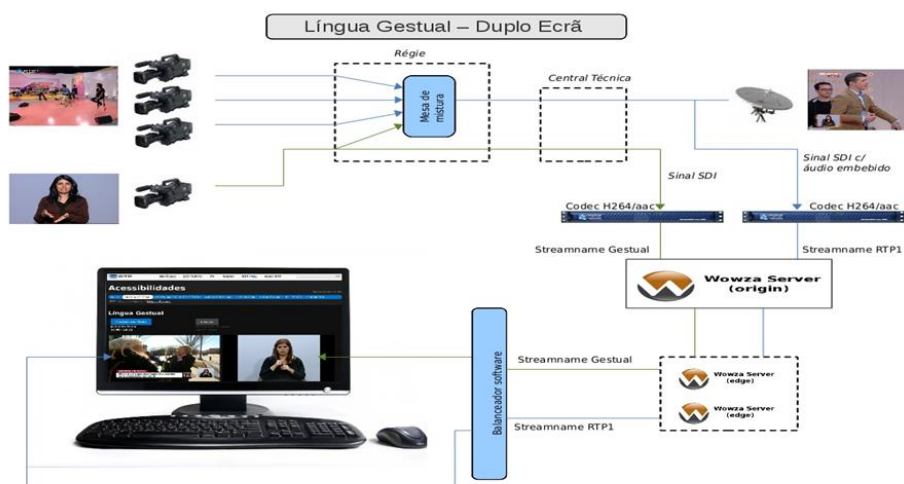
Currently, RTP 1 and RTP 2 are offering the SL service in all news programs and in the more popular live entertainment programs. The concept is the same as the pre-recorded programs but in live broadcast: a square window, positioned at the bottom right/left hand corner of the screen.

The RTP current workflow for live programs with signing can be seen in the simplified block diagram shown in figure 6. The diagram can be read as follows:

1. A remote operated camera is used to capture the Sign Language Interpreter;
2. A Video Distributer is used to send the same video signal to more than one location:
  - a. Destination 1 - Master Control Room. To be used by "Online"; In this process, the Master Control Room switch the SLI signal into online manually. This situation doesn't guarantee the commutation in the exact moment, however the synchronization is not affected.
  - b. Destination 2 - DVE + Video Mixer. DVE processes the signal (e.g., crop and resize), then the signal is composed with the other sources ("To On Air").

### 3.2.2.3. *Online live programs with signing for broadband – Double-Screen*

All the live programs that are broadcasted in RTP 1 and some from RTP 2 are broadbanded in RTP's website (www.rtp.pt), in a double-screen mode. In this case, it is given the same importance to the sign language interpreter as the program that is being translated. The main advantage of this kind of service is that the user can enlarge the translator screen and have it in full screen mode. The only disadvantage is the fact of being online, and the users must be connected to internet to enjoy the service. The RTP current online double-screen workflow can be seen in the diagram shown in figure 7.



**Figure 7.** Current double-screen signing in RTP website.



The next picture shows the result of the process described above:



Figure 8. Screen shot of double-screen signing in RTP website.

When the service is not online, the user can have access to an electronic program guide with the information of the next program available with sign language.

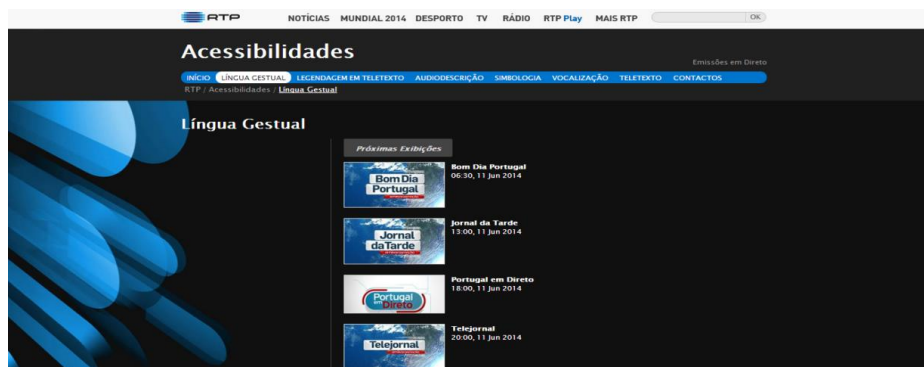


Figure 9. Available interface in RTP website if signing is not being provided.

### 3.3. Requirements for a new workflow model

In order to narrow down the list of possible formal features to be tested later on in lab conditions, we designed a second data collection process aimed to gather information from the two groups directly involved in sign language on TV. On the one hand, sign language interpreting professionals that currently work or have worked on TV and, on the other, signing deaf people who are the targeted audience. For each of these groups a different qualitative data collection method was designed and developed.

#### Professional Interpreters Interviews

Collecting data from sign language interpreters is of utmost importance not only because they can provide professional first-hand information, but also because they can report specific feedback from their Deaf consumers about on-screen SLI. The Deaf community is a minority group which includes not only signing

deaf people but also their families and the professionals that take an active role in their cultural and linguistic daily life. Sign language interpreters have traditionally been an important part of the Deaf community. There are several general conditions to be taken into account from which we highlight the following two:

- 1) Before SLI studies became part of the mainstream education programs, sign language interpreters were normally signing hearing children of deaf parents who would be part of the Deaf community since their early childhood and thus participating in Deaf culture from birth. Still nowadays some of the professionals are CODAs (Children of Deaf Adults) or relatives of Deaf people.
- 2) Sign language interpreters sometimes get feedback from their Deaf clients regarding communication needs. Which are of course potential job tasks and job places for these professionals.

The group of TV sign language interpreters is a small group within the professionals. We chose to contact all the professionals within the Catalan territory and to do so we asked two of the organisations that involved the professional groups to disseminate the information about Hbb4all project. Namely the Catalan Association of Sign Language Interpreters and Deaf-blind communicators, (Associació d'Intèrprets de Llengua de Signes i Guies-Intèrpret de Catalunya, [www.acils.org](http://www.acils.org)) and the Catalan Federation of Deaf People, FESOCA (Federació de Persones Sordes de Catalunya, [www.fesoca.org](http://www.fesoca.org)). The professionals themselves helped spreading the message and providing their colleagues contacts. In total, there are 10 professionals currently working on the TV interpreting setting in both national and local broadcasters and 4 more former professionals which had been the pioneers in introducing sign language TV in the territory were contacted. Due to the numbers of professionals the data collection method used to gather information from the interpreters was personal interviews. In total 11 interviews were held (8 active professionals and 3 former professionals). The interviews were taken in April and May and lasted from 1 up to 3 hours and all the information was note-taken.

The interviews were designed in 5 blocks: 1) personal and professional information; 2) professional experience on TV interpreting; 3) formal features of on-screen insertion (including screen shots when available); 4) feedback from Deaf consumers regarding formal features of on-screen insertion; 5) Open questions about other professional and formal aspects not tackled in the previous blocks.

The results from the interviews showed that both the professionals and signing deafs, the end-users, think the most important on-screen formal feature is size provided that other more basic formal features are met (i.e. light). Sign language on-screen size mainly depends on two formal features: sub-screen size and shot size. When talking about the users's feedback, interpreters mentioned that their deaf consumers mostly complained about the sub-screen size being too small. Whenever changes have been introduced that meant a bigger on-screen appearance, feedback was always positive. Interpreters also noted that shot size also influences the overall size perception. Feedback from the consumers suggests that their preferred option is a medium long shot, just a bit shorter than a knee shot, with some space above head level to allow signs placed in the head area to be clearly seen. However, interpreters working on TV sometimes need to compromise.

When the sub-screen is too small interpreters ask cameramen for a shorter shot size so that hand-size on screen is relatively bigger. Even though using a mid shot implies restricting the grammatical signing space, and thus losing naturalness, this is always preferred to having a longer shot that would make hand size look even smaller. During the interviews, interpreters mentioned that these technical issues are always tackled by the interpreters themselves during their TV assignments and broadcasters are normally unaware of them affecting communication or accessibility at all.

The second on-screen formal feature collected from the user's feedback by professional interpreters regarded background colour. This is a feature that tends to vary greatly. The interviewed professionals mentioned they had worked in many different backgrounds from plain white, grey, orange, all shades of blues and black, or even dotted or patterned backgrounds. This formal variation normally takes into account aesthetic criteria rather than any other kind of criteria so that the interpreter's sub-screen colours match or contrast with the general on-screen composition for a given TV program. Sign language being a visual input, readability on screen partly depends on the colour contrast between background and the interpreter's skin colour and clothing colour. Background colour not only affects readability but users would also complain about eye fatigue, which is also an important fact to take into account. Culturally, sign language interpreters in Spain tend to wear dark plain clothes and in formal assignments black is always chosen among other possibilities. All interpreters currently working on TV said they wear black clothes in their assignments and mentioned that users tend to accept this as part of their uniform. Most of the users complaining about the colour contrast would rather change the background colour than the clothing colour to get a more readable and comfortable and eye-friendly colour contrast.

The last formal feature mentioned by some of the interpreters was speed. Even though this feature was not in our original list the professionals considered it to be one of the most influencing factors to ensure communication. Most TV interpreters work on the News and speech pace in this kind of programs tend to be higher than normal speech rate. According to some authors the news on TVC, the Catalan broadcaster, interpreted into sign language show a rate of 2.8 words per second, this is one more word per second when compared to signing news produced by deaf people at Gallaudet University in Washington DC. The professionals mentioned that they find it difficult to convey every single word and that sometime they need to summarise or omit some less relevant information such as transitions between news or greetings. On the other hand, according to the interpreters some of the deaf consumers find it hard to read finger-spelled names specially for uncommon longer proper names in foreign languages. They mentioned that being able to personalise speed would be a major improvement in accessibility.

A part from the above-mentioned features, specially the interpreters working for La Sexta mentioned to have collected from the deaf users was about the interaction between subtitles and the interpreter's sub-screen. On channel La Sexta the subtitling, interpreting (and even the digital on-screen graphic) overlay in the same screen-area. And from time to time these different layers of information overlap making it difficult for deaf audience to follow the content. The consumers suggested that interpreting and subtitles should not be at the

same on-screen level.

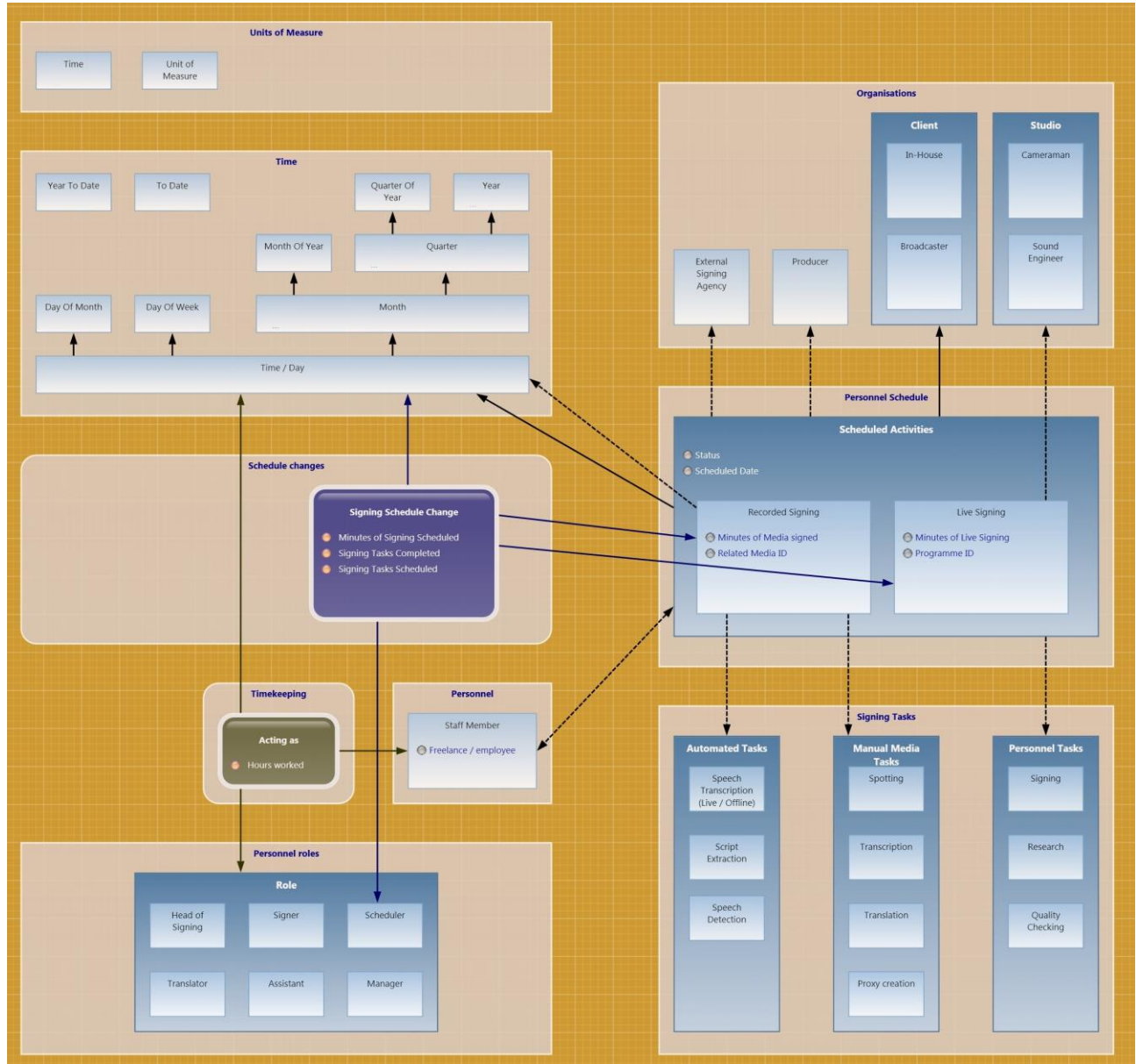
However, all the interviewed professionals agreed that the end-user feedback they mostly get is linguistic in nature: either regarding the lexicon used (i.e the end-users would contact the interpreter to make them aware that regional dialectal signs were used on-screen or providing neologisms to be used), or regarding the general linguistic skills and performance of the interpreter (either to praise it or to suggest improvements).

After the interviews with the professional interpreters and the focus groups with the deaf consumers, the list of formal parameters of SLI on-screen will be narrowed down and the experimental tests can be designed. Tests in lab conditions with on-screen sign language interpretation will be parallel to those carried out to test subtitles in WP3 of the project. The test will include eye-tracking measurement, memory tests, comprehension test and a survey of preferences to assess the end-user experience.

### ***3.4. Business approach for the Hbb4all signing workflow***

The production costs of visual signing are comparable with the cost of providing live captioning. However, currently the greatest commercial challenge to delivering programmes with visual signing on broadcast television networks is the distribution cost. Currently the provision of visual signing (on a broadcast network) for the entire schedule of programmes on a TV channel would incur the significant costs of an additional channel (that carried a version of the programme with open signing - a broadcaster mix). It is considerably more cost-effective to deliver closed signing (as a lower bandwidth overlay), perhaps via broadband, and at the viewer's choice, combine the signing with the broadcast programme in the viewer's receiver (e.g. using HbbTV).

The business models for access services involve two components: a business model for the service provision; and a business model for any device needed by the viewer to access the service. For signing services there is currently no specialised device – as signing services are delivered as open services, either as a separate channel or more commonly as specially scheduled and produced programmes. The main current business models for signing service provision are: production budget funding; private sponsorship; and public funding.



**Figure 10.** Graphical representation of the signing workflow – business approach.

The move to digital distribution and the move from broadcast to Internet-based distribution have major impacts for the provision of signing services. In addition, the rise in popularity of ‘Over-the-top’ delivery of television programmes (e.g. catch up and Video on Demand) has led to a growth in the number of receivers that are connected to both a broadcast signal and a broadband connection. In the future it is anticipated that a transition to closed signing services will leverage a ‘universal design’ approach (i.e. access services will take advantage of the capabilities that will exist in mainstream consumer electronics), thus stepping past the often encountered, “chicken and egg“, situation; where provision does not occur because specialised access

devices are not widely deployed with the target audience.

The business case for commercial broadcasters funding signing access services is not very compelling and the commercial case is not usually perceived as being strong where there are no regulatory requirements. However the use of hybrid delivery and mixing the signing with the programme in the viewer's device also has implications for regulators responsible for frequency and bandwidth allocation. Typically, current visual signing services are bandwidth-hungry, if signing is delivered as an additional channel rather than being offered as an open service seen by all viewers. A closed signing service using hybrid delivery has far lower (or near zero) broadcast bandwidth requirements.

Utilising a hybrid distribution mechanism and capitalising on universal design principles in the viewer's device does at least remove two significant barriers to increased signing service provision: the cost of distribution; and the cost of deploying specialised receiver devices.

Screen have produced a formal 'business model diagram' and documentation for signing production based on information for literature reviews, informal interviews with signing professionals and previous business experience. The business model diagram developed shows the main business objects and relationships involved in the business of producing sign language services for television broadcasts. The model has been tested against the workflows of the WP6 partners and has been found to cover the principal aspects of signing for both live and offline production.

The main diagram in the model uses the DIW methodology developed by Kalido, as a free tool is available for the creation and viewing of this type of diagram. A document has been produced that describes the top-level diagram and the business objects and relationships that the diagram portrays. The diagram does not show all the details of a practical or real business, but establishes a core vocabulary to identify and describe the principal objects and relationships in signing production.

The core business objects in the model are the scheduled activities that essentially describe the activities of the company and the processes that are active at specific points in time. The model expresses certain 'business rules' about the business process (e.g. you cannot 'schedule' an activity without choosing a date). The transactions identified within the model represent events that change information within the model, a transaction connects the entities that are responsible for change and the entities that are changed within the model.

The model defines a group of business entities that are external to the signing production; Studio (subdivided into two subclasses, Cameraman or Sound Engineer), Client, Producer and External Signing Agency<sup>4</sup>.

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<sup>4</sup> An External Subtitling Agency models a business entity that may undertake signing activities, but is external to the modelled business. This models activities that may actually be performed by external resources.

- Producer represents an entity that influences or controls signing activity.
- Client is an entity that commissions and receives / uses the output.
- Studio is a business entity used for a ‘live’ signing service. The model shows there is a necessary interaction between the company and the Studio (e.g. for reception of audio and video feeds of a broadcast that is signed while it is transmitted live).

In addition, the model identifies the personnel and the roles undertaken by personnel during signing activities. The model makes a distinction between a role and a signing task, in that a role is the ‘capability to perform’ a specific signing task. This allows the model to support staff members who change role periodically (e.g. depending upon the signing task that needs doing). The model also specifically separates translation (from a foreign language) and signing (conversion to sign language), as only certain personnel may be capable of both language translation (for example for foreign language programming) and signing.

The signing tasks identified by the model are split into two categories, those that are performed by staff members and those tasks that may be automatically performed by a system. The model also identifies which tasks might apply to recorded or live signing activities. Identified staff member tasks in the model include:

- Proxy Creation – making a low bitrate media asset to facilitate offline signing production.
- Quality Checking - checking offline signing against a pre-determined set of criteria.
- Research - collecting information related to a broadcast to facilitate signing.
- Signing - The act of signing the equivalent of heard audio.
- Spotting - offline determination of signing timing (i.e. when signing needs to occur).
- Transcription - offline conversion of speech in a broadcast into text.
- Translation - offline conversion of ‘text’ in one language into ‘text’ in another language.

The model anticipates that in real practise, signing typically requires a combination of these tasks performed by a single staff member, or a group, in sequence or in parallel. For example ‘offline signing’ may involve Proxy Creation, Research, Spotting, Transcription, *Translation*<sup>5</sup>, Signing and Quality Checking.

Identified automated tasks in the model include:

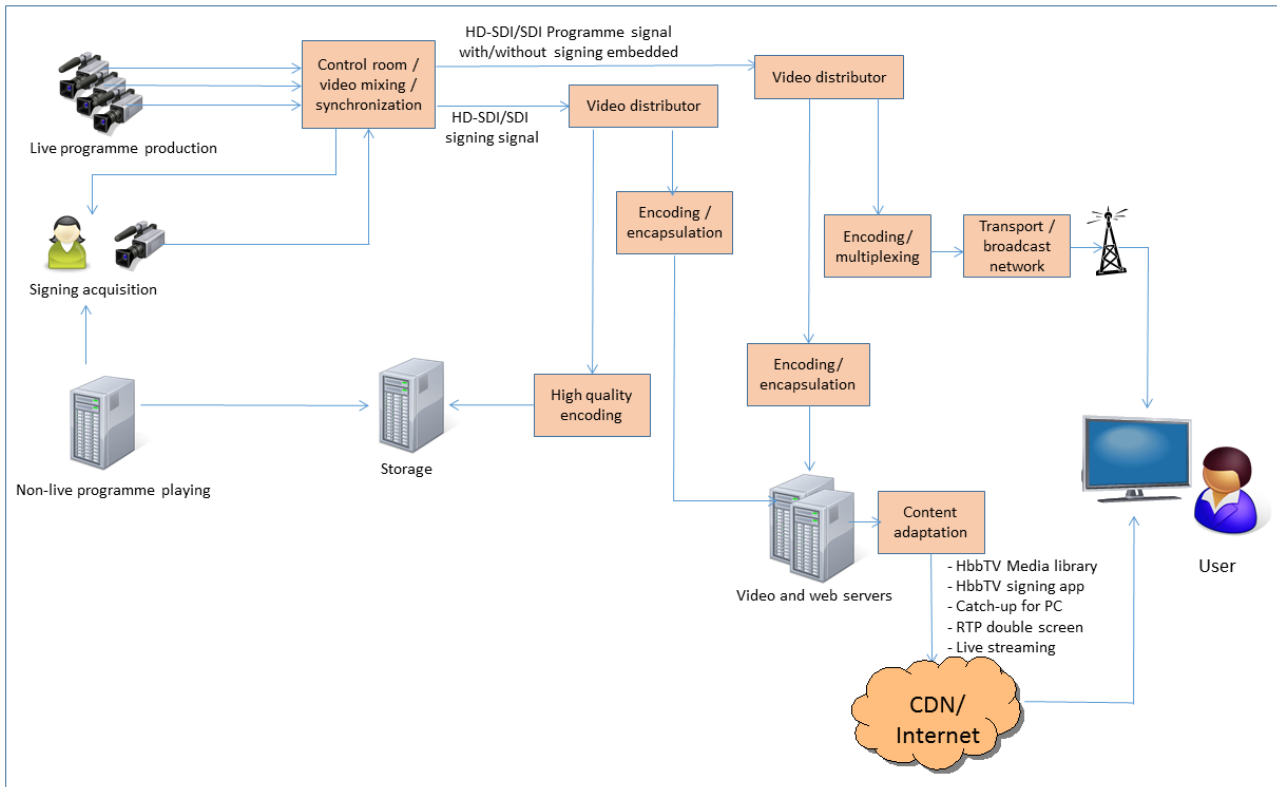
- Script Extraction - automated extraction of dialog text from a script file.
- Speech Transcription - automated conversion of speech from the audio into text.
- Speech Detection - automated detection of speech within the audio to list speech events.

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<sup>5</sup> For a foreign language programme.

### 3.5. Technical approach for the Hbb4all signing workflow

#### 3.5.1. Technical generic signing workflow



**Figure 11.** Signing workflow – technical approach.

This technical generic signing workflow, shown in figure 11, takes into account the following objectives:

- Being flexible enough to be used in the variety of scenarios and particular implementations that are being considered in the project for the operational phase
- Being consistent and compatible with the workflows currently deployed for the signing service in WP6 broadcasters (RTP and RBB)
- Being generic enough to be used by other broadcasters in the future for the provision of sign language interpretation

This model tries to fulfil all the possible requirements that a broadcaster could need. It represents an abstract value chain from the production of the signing service to the end user. The requirements this model satisfies are:

- It can be used for signing in live and non-live programmes. As shown on the left side, the main video can come from a production environment or from a hard drive or a tape.
- It can be used for live or non-live signing. It must be taken into account that a possible scenario



consists in live signing for non-live content.

- The signing interpretation signal can be embedded or not embedded in the main video. If the signing interpretation signal is embedded, this processing would be made in the “video mixing” phase. In any case, the workflow preserves the signing signal as it is.
- It allows to record the signing interpretation and to link it to the main video (storage box).
- It allows the signing service to be delivered by means of the broadcast or broadband networks. On the right side, a hybrid terminal and an end user are depicted.
- It allows the main video to be delivered by means of both networks, too.
- It allows a variety of signing services to be delivered by means of the IP/broadband network:
  - “Truly hybrid” HbbTV approach, involving an HbbTV application able to join two video signal coming from two different networks
  - HbbTV catch-up TV applications, including sign language interpretation
  - HbbTV live streaming applications for signing
  - Live streaming for PC and IT devices
  - Catch-up TV application for PC and IT devices
  - PC applications that integrate both main video and signing interpretation (like RTP double-screen)
  - Use of a second screen for the sign language

Although this version of the workflow model fulfils the requirements identified in the project, it will be refined during the next months until the end of task T6.1 (M20)

### ***3.5.2. Technical implementations for the HbbTV scenario***

From a broadcaster’s and service provider’s point of view HBB4ALL partner RBB has, from scratch, developed two different exemplary workflows for producing a sign language service for an HbbTV-based provision. Although not intended, one can clearly see commonalities with the current workflow that is sketched in section 3.2.1

#### ***3.5.2.1. Live signing workflow***

A possible workflow for a live produced signing service would involve four different stages. Beginning with the actual production of the video material, the TV show will be live produced in a TV studio with all the necessary equipment. In parallel the sign language interpreter, who must monitor the TV show running in the studio, is also being recorded.

The signals of both cameras will be fed into the control room’s video mixer facility, where both videos are being composed together according to the previously defined presentation parameters, like size and position on the screen.

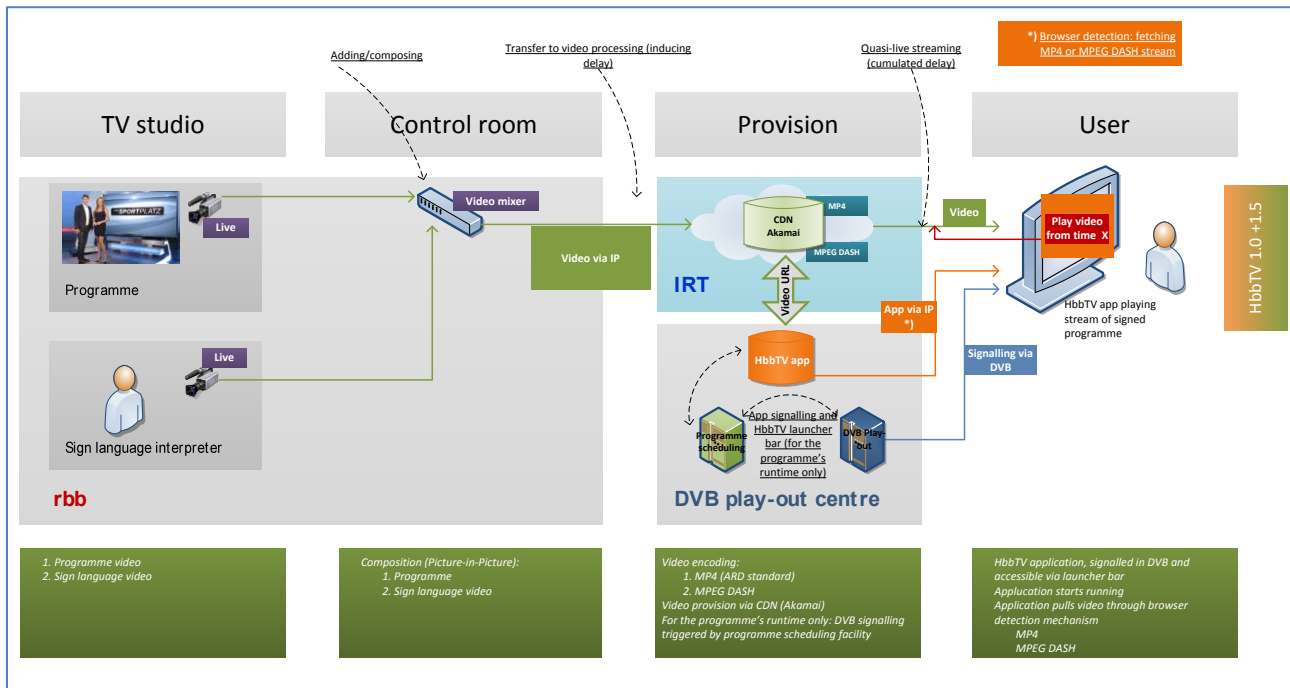


Figure 12. Live signing workflow (RBB).

The resulting video will then be streamed via IP to a third-party CDN provider, where the video stream will be transcoded into the target video streaming formats MP4 (ARD standard profile) and MPEG DASH (for HbbTV v1.5 capable devices). These instances of the video stream there are available for public access and have defined URLs. The needed HbbTV application allows the user to play the available video stream on his HbbTV-enabled devices. As defined in the technical standard, the application must be signalled within the DVB transport stream and at the same time the application must get a launching point for the user to start the app, for the case of RBB as kind of a widget inside the common ARD launcher bar. Both, the DVB signalling and the widget in the launcher bar should be available only for the actual run-time of the TV show.

Once the user has started the HbbTV application, the browser detection mechanism decides which video stream the app has to access, depending on what HbbTV version the end device has implemented, MP4 video for HbbTV v1.0 and MPEG DASH video for HbbTV v1.5. It must be taken into account that the HbbTV v1.0 scenario might require a TS-encapsulated video.

### 3.5.2.2. Pre-produced signing workflow

A possible workflow for a pre-produced signing service is not very different from the live variant. It would also involve four different stages. Here, the TV programme is already recorded, maybe it was aired one day before, and is located on a storage resource, like a DigiBeta tape or as file on a video server. The sign language interpretation can be conducted and recorded with possibilities to re-do certain parts.

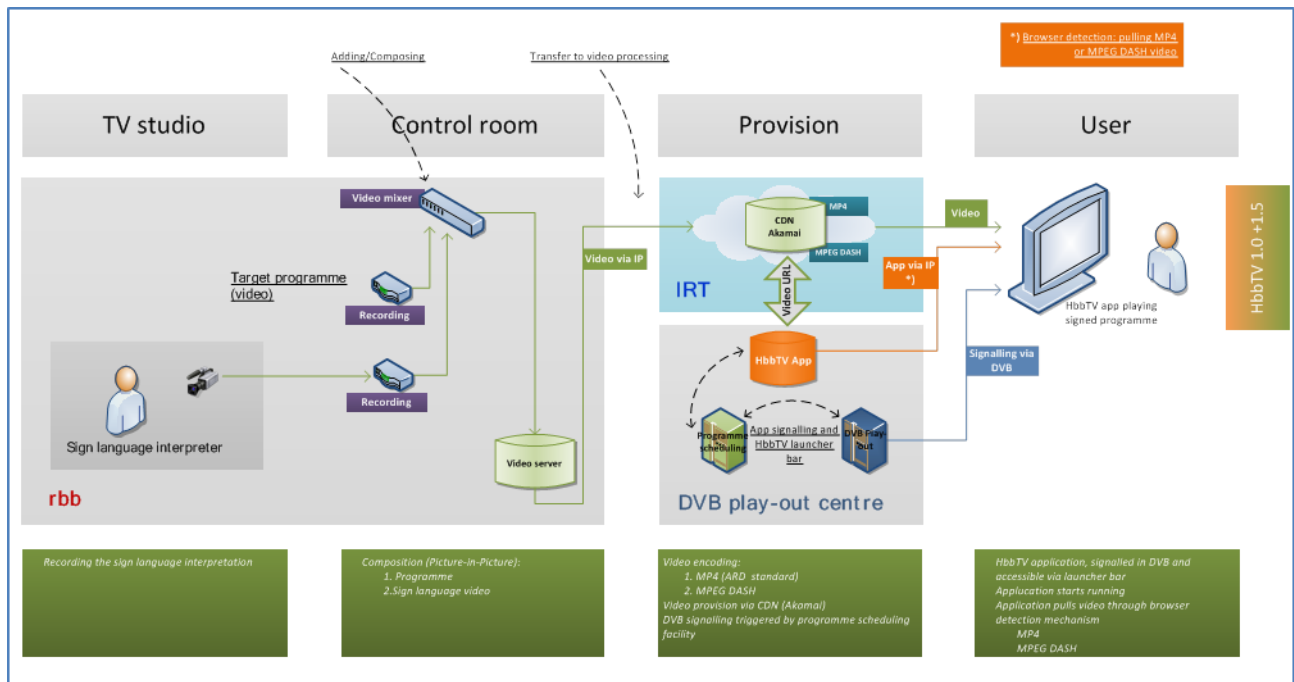


Figure 13. Pre-produced signing workflow (RBB).

Both recorded videos can now be mixed together, composed according to the previously defined presentation parameters, like size and position on the screen. The resulting video is stored on a video server.

The stored picture-in-picture video file can now be transferred to the third-party CDN provider, where it will be processed and transcoded into the target video streaming formats MP4 (ARD standard profile) and MPEG DASH (for HbbTV v1.5 capable devices). These instances of the video stream there are available for public access and have defined URLs. Like in the case of the live signing workflow, the HbbTV application, that will provide access to the video, must be signalled within the DVB transport stream and at the same time the application must get a launching point for the user to start the app, as widget inside the common ARD launcher bar. Both, the DVB signalling and the widget in the launcher bar must be managed, by the TV programme scheduling and the DVB play-out facilities.

The user can then start the HbbTV application, the browser detection mechanism decides which video variant the app has to access, depending on what HbbTV version the end device has implemented, MP4 video for HbbTV v1.0 and MPEG DASH video for HbbTV v1.5.

### 3.5.2.3. Remarks

Looking at these two variants of a signing workflow, a number of facts have to be considered for a better understanding. A live workflow will in any case produce a delay of the signed video, which will cumulate at the transfer to the video processing, at the video transcoding and transferring to the end device.

A pre-produced workflow offers more time for the actual sign language interpretation, which will greatly influence the quality of the interpretation. This also counts for the composition and the synchronisation of the two videos, both can be done manually and thus improves the overall quality of the signing service content. Here, a possible delay can also be eliminated due to the absence of the reference TV show running in parallel.

Both workflows do incorporate trigger points from the programme scheduling and from DVB signalling.

### **3.6. Technologies**

This chapter introduces the new technologies defined in HbbTV 1.5 and 2.0 that can be used for the services of this work package. These are MPEG DASH to enable adaptive live streaming over the internet and multi-stream synchronisation to deliver sign language as a separate stream via internet in addition to a broadcast service.

#### **3.6.1. MPEG DASH**

As the name indicates, DASH = dynamic adaptive streaming over HTTP, MPEG DASH makes use of the delivery protocol of the internet HTTP and provides the mechanism for seamless adaptation of the media quality to the available resources like the network bandwidth. MPEG DASH defines different base profiles for on-demand and live use cases and for MPEG TS and MPEG ISOBMFF based media.

Of those profiles several standardization bodies have chosen the ISOBMFF live profile of MPEG DASH including the HbbTV group for version 1.5 (ETSI TS 102 796 1.2.1).

Support of MPEG DASH by the industry is increasing, encoder manufacturers, CDNs and TV terminals are already available in the market. First services are provided in HbbTV V1.5 markets like France. In Germany measurements have shown that already 10% of HbbTV devices are 1.5 and hence support MPEG DASH.

In the HbbTV V1.5 profile of DASH only audio, video streams but no subtitles are supported. The specification also defines the interfaces for DRM but does not mandate a particular system. This is intentionally left open by HbbTV to the markets where it is deployed.

With version 2 of HbbTV the DASH profile will be updated, it is backwards compatible to 1.5, but includes a number of changes for optimisation and it supports now also subtitles based on TTML and an event mechanism like stream events for broadcast. HbbTV refers to the DVB DASH specification that is published as a blue book on the DVB website.

### **3.6.2. Multi-stream and inter-device synchronisation**

HbbTV version 2 specifies a new feature that allows to synchronise multiple streams on a single device or even on different devices in the home network, the two sub features are called multi-stream and inter-device synchronisation accordingly.

The two features are aligned and share the architecture and technical solutions. Many of the concepts and the architecture can be found in the DVB specification for Companion Screens and Streams (DVB CSS) that also has been published as blue book on the DVB website. While the use case for DVB is mainly inter-device synchronisation of a mobile device with a (DVB) TV, HbbTV has adapted the specification also for multi-stream synchronisation.

The following lists the details of the feature and their dependencies on other features.

- Synchronisation of one video, audio and subtitle component where each of the components can come from a broadcast service or a pre-produced broadband stream is mandatory. The limitation to pre-produced content comes from the optionality to buffer the broadcast service on the terminal.
- Synchronisation of a broadcast service with a broadband stream where both contain video is only mandatory if the TV has sufficient resources to render multiple videos.
- Synchronisation of a broadcast service with a live broadband stream where the broadband stream is not available in time to be synchronised with the broadcast is only mandatory if the TV supports the additional buffer for media synchronisation. The size of the buffer is calculated to work with a delay of a typical MPEG DASH distribution via CDN and a typical maximum bitrate of an HD broadcast service that needs to be cached.

In summary the scenario for this work package where the sign language is delivered as an extra stream is not mandatory for every HbbTV 2.0 terminal, it requires terminals that offer sufficient resources (extra video decoder etc) and if the sign language interpreter is translating live additionally support for the synchronisation buffer is needed.

## **4. Service pilots**

This section describes the progress in the service pilots of the Work Package 6 for this first year of project. On the one hand, the HbbTV-based signing pilot (or German sub-pilot) and the IP/Web-based signing pilot (or Portuguese sub-pilot). Both descriptions include the same subsections: general set-up, current state of work, time frame, user tests and validation method.

Moreover, due to its importance in this Work Package, this section describes the progress in the avatar signing service, which is going to be validated by means of user tests.

## **4.1. HbbTV-based signing pilot**

### **4.1.1. General Set-up**

#### **4.1.1.1. Preconditions**

Starting with the results achieved in DTV4ALL and HBB-NEXT, RBB created a concept for a signing solution in HBB4ALL, resulting in two possible variants.

1. An all-in-one solution: a pre-mixed picture-in-picture video will be pulled via IP on-demand, having main video and signer video integrated. That video will be played in full screen and replace the TV picture rather than adding the sign language video only. The user plays that service when the desired TV programme has started.
2. A true hybrid solution: only the sign language video will be pulled on-demand and added to the live main DVB broadcast video on the screen. This will require two video decoders in the end device, as both videos need to be decoded in parallel. Additionally, both video streams, DVB and IP video, need to have additional timing data that allows for an exact synchronisation. This functionality requires HbbTV v2.0 but would allow for a customisation of the, as the signer video will be rendered independently and can be adapted for instance in size or position on the screen. But two video decoders are not mandatory in HbbTV2.0, which is not yet published and also not yet implemented in end devices.

The before mentioned constraints of the hybrid variant are quite serious, so that offering such a solution to a broader audience makes no sense at the current point of time. That's why RBB decided to go for a hybrid solution at the most in a proof-of-concept showcase. The availability of suitable devices are currently discussed with several manufacturers. The German Service Pilot for the Operational Phase will be the all-in-one variant which will allow for wide reach.

In order to get the integration of that chosen approach started, RBB first developed an HTML click dummy of the planned service, demonstrating the core functionalities for a potential user. After adding an RBB-compliant graphic design, the click dummy was transformed into a prototypical HbbTV service and presented to users of the target group for evaluation as documented in detail in section 7.1.

#### **4.1.1.2. Description**

The integrated prototype as currently demonstrated in the early HbbTV-Demo has four basic functionality levels. First the user will be notified that a sign language video is available for the starting programme. This is done with a small info above the actual HbbTV red button notification, which will be shown automatically once the programme starts. The user can then press the red button and start the HbbTV launcher bar, which is ARD standard behaviour.



Figure 14. Signer service notification.

Once, the launcher bar is started, the user can navigate to the widget he desires, in our case the signer service. By pressing the OK button on the remote control the user starts the actual sign language service, and thus starts playing the prepared all-in-one video.

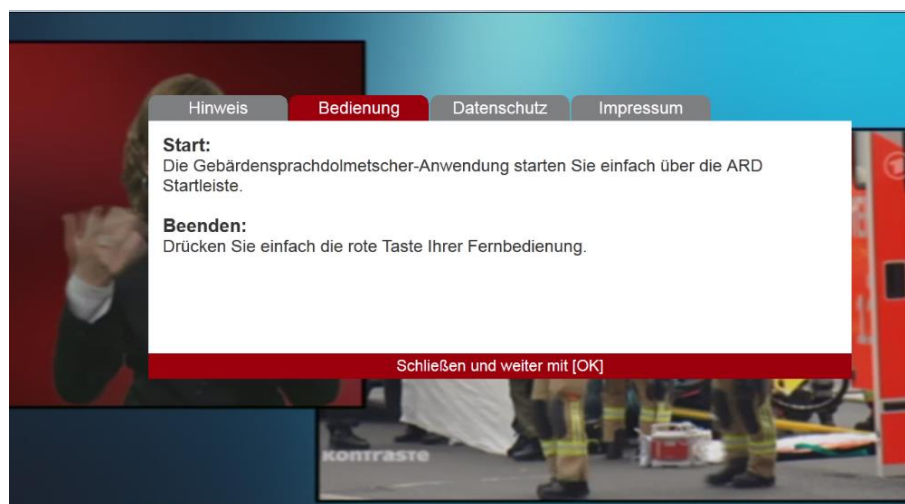


Figure 15. ARD HbbTV launcher bar containing the sign language service widget.

The user now gets informed how to stop the playing service or how to access an embedded help page, data privacy information and an imprint (by pressing “1” and browse through an easily navigable sub menu). When he or she wishes the user can stop the service by pressing the red button. He then will be back in the live broadcast and the HbbTV launcher bar.



**Figure 16.** All-in-one video of the sign language service envisaged by RBB.



**Figure 17.** Help, data privacy and imprint.

The described pilot set-up was the basis for the lab test conducted by RBB, which is documented in sec. 7.1.

#### **4.1.2. Status of work**

According to set-up modelled in section 3.5.2, RBB has started forming the actual production workflow, starting with analysing appropriate TV programmes for a potential use in the trial, planning and dispatching, as well as developing a concept for the provision of the video streams in MP4 and MPEG DASH formats together with HBB4ALL partner IRT. RBB also got in contact with an HbbTV developer for implementing the needed application. Taking into account the efficient work of the editorial teams, RBB considers choosing pre-produced programmes for a sign language translation. The recording of the sign language translation can be done in the time frame between the finalised pre-production of the actual programme and its broadcast schedule; so that the then pre-mixed all-in-one video would be ready for provision exactly in parallel to TV broadcast of the programme.



### ***4.1.3. Time frame***

According to the internal planning the decision which TV programme to translate will be taken by M14, as this is directly influencing editorial and production work in RBB and thus has to be carried out very carefully. The HbbTV application will be ready for deploying by end of M20, utilizing the sign language content produced with the then established workflow.

### ***4.1.4. Test users***

The German pilot can potentially target ~6 million households with HbbTV-enabled devices in Berlin-Brandenburg area and beyond in Germany for a quantitative analysis. For a qualitative validation RBB will again work closely with organisations for the deaf in Berlin and Brandenburg. 10 to 20 users from the target group will be chosen for an evaluation of the pilot, for a TV programme once a week.

### ***4.1.5. Validation method***

Validation will be done with the help of interviews and questionnaires. It is required that all the test users chosen must have an HbbTV-enabled device ready for the pilot phase. RBB aims at organising a closing workshop at the end of the operational phase with all the involved users.

## ***4.2. IP/Web-based service pilot***

### ***4.2.1. General Set-Up***

The main objective of Portuguese pilot is to have the sign language double-screen available in VoD in a multi-platform environment (desktop, tablets and smartphones), to provide a better quality of access by deaf people to the programs that are available with SLI service online. In this moment this service is only available in a live mode.

As explained in this deliverable, RTP is currently providing a large number of signing hours (around 250 hours per month). The sign language interpretation can be watched in a small window in the broadcast programme or in a double-window in live streaming in the RTP website. The double-window feature depicts the SLI service in a window that has the same size than the main video. However, this service is just available for live programmes in the website.

The Portuguese sub-pilot will manage the SLI video signal in a different manner to provide this service for catch-up content in the website via IP transmission. This service will require 1) to adapt the workflow in RTP premises to enable the record of this additional signal and 2) to have suitable equipment for recording. The required integration activities are being executed by RTP and UPM.

Since the SLI video signal will be explicitly managed in the workflow and in the website, additional features will be available, such as the customisation of the signing window (size and position) and the exploitation of the signing window in a second screen (e.g., the user may watch the broadcast programme on his/her main screen whereas the signing window is depicted in a smartphone, laptop or tablet coming from Internet via IP

transmission).

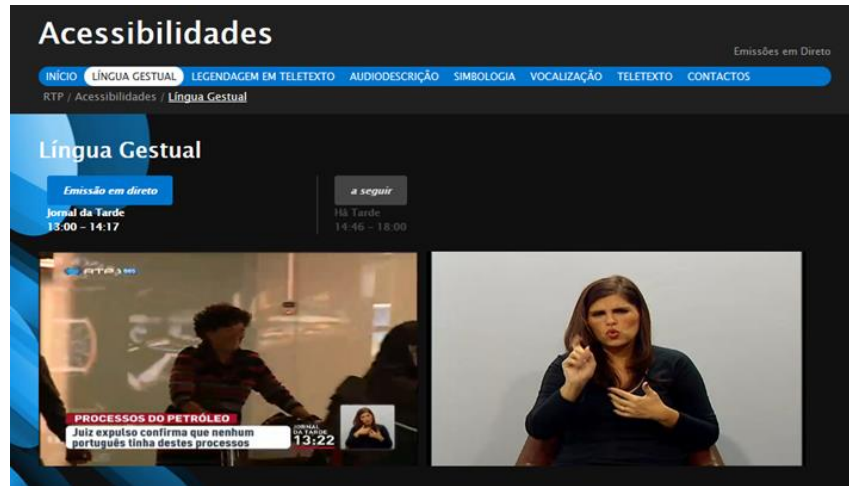


Figure 18. Current double-screen functionality.

#### 4.2.2. Status of work at M12

At M12, the following activities have been carried out in the Portuguese service sub-pilot:

- Analysis of current workflow
- Definition of the service pilot
- Identification of equipment requirements for the service pilot

#### 4.2.3. Timeframe

The deployment of the Portuguese service sub-pilot will satisfy this schedule:

- December 2013 - July 2014. Current service and workflow evaluation
- August 2014 - December 2014. Definition of the service pilot and required equipment
- January 2015 - July 2015. Integration activities in RTP workflow
- August 2015 – August 2016. Operational phase
- September 2016 – November 2016. Elaboration of results, guidelines and conclusions.

#### 4.2.4. Users Tests

RTP, as a broadcaster that offers a wide variety of programmes that include the signing service, is interested to carry out users tests to determine the optimal parameters in the signing service. These users tests will be define in the project with the support of UAB.

#### 4.2.5. Validation Method

The validation method of the Portuguese service sub-pilot will be based on the use of the website information to compile data about the use of the signing service and to collect feedback from user by means of an online questionnaire. To avoid a bias in the results, the method will take into account the differences in the response rate depending on socio-demographic variables.

### ***4.3. Avatar signing application***

The objective of the avatar signing application is to provide a domain specific spoken language-LSE translation platform. Once its performance is validated, it could be easily adapted to other domains in further developments. The application was built and will be tested on the weather domain. This domain was chosen for (1) using a relatively small and predictable vocabulary, (2) having just one speaker and (3) showing graphic help such as weather maps as a cue for potential mistranslation cases.

The application consists of five different modules: (1) a text-to-Sign Language translation module, (2) a gesture capture system to create an internal (3) sign dictionary, (4) an animation engine and a (5) rendering module.

#### ***4.3.1. Text-to-Sign Language Translation Module***

Due to the lack of sufficient annotated data, statistic machine translation approaches were discarded and a Rule-Based Machine Translation approach was chosen. The rules were designed taking into account a corpus from the chosen application domain. To do so, a code-system was created in order to represent LSE signs in written strings. Each concept that in LSE has a fixed sign has its corresponding tag in our written representation of LSE.

Before building the rules from scratch, the language used in the application domain was linguistically analysed. To do so, a domain-specific corpus was compiled ad hoc. In order to make a thorough linguistic analysis, the corpus was tagged semi-automatically indicating the lemma, morphemes and the morphosyntactic information of each token. The linguistic information extracted was used to spot linguistic patterns and to build robust translation rules.

The input text is lemmatized and tagged using an inner dictionary. This tagging includes grammatical remarks (word-class, time-related word or morpheme, etc.) and other kinds of linguistic information that should be taken into account when signing in LSE. Within this process, sentence splitting marks are also inserted following LSE standards. Not all Spanish sentences match with LSE sentences; subordinate clauses, for example, must be expressed in separate sentences in LSE. The strict word order and little abstraction of Sign Languages makes that sentences force these languages to build shorter and linguistically simpler sentences. The LSE sentence splitting process is done by rules taking into account linguistic cues.

The translation module takes as input the pre-processed text and outputs a sequence of signs that strictly follow the LSE grammar. Taking into account the segmentation tags and other morphosyntactic information, it translates the sequence that follows Spanish syntax into a string of codes that follow the LSE linguistic rules through pattern identification. There are three types of translation rules according to the action they imply:

- **Explicitation:** in LSE grammatical information is expressed with explicit gestures. However, in Spanish it is very common to have grammatical information in elliptical form (e.g.: subjects, tense, objects, etc.). This information is usually expressed by inflected word-forms. The explicitation rules combine all the grammatical information contained in the linguistic tags and the semantic information contained in the lemmas. Thus, the output number of tokens, each one of them containing one grammatical or semantic piece of information.
- **Selection of concepts:** LSE does not use many grammatical and semantically void words that verbal languages usually have (e.g.: articles, grammatical words, etc.). The selection rules select the tokens that have to be expressed in LSE and leave out the ones that do not make sense in this language.
- **Reorganization or syntax rules:** these rules change the order of the tokens to adjust it to the syntactic rules of LSE. The output of this module consists of a set of tokens that can be translated directly into a sequence of gestures. The reorganization rules involve splitting of sentences according to LSE rules.

```
Hola qué tal empezamos la que es la última semana de Primavera.  
[hola][qué_tal][último|il][semana][primavera][empezar|ad]  
  
En el mapa isobárico previsto para mañana vemos que la situación continua bastante revuelta  
[mapa][mañana][situación][bastante][mal][ver|ad]  
  
y es que tenemos un frente cálido y como ven nos va afectar prácticamente durante todo el día.  
[durante_el_día|den][frente][cálido][como][ver|ad]  
  
No se mueve demasiado,  
[mover|ad][no|neg]  
  
va a ser bastante lento.  
[bastante][lento]
```

Figure 19. Input text and output sequence of signs.

### 4.3.2. Capture System Module

In order to translate Spanish into LSE, we had to compile a LSE database. To do so we developed a capture system combining two different motion capture approaches. It uses non-invasive capturing methods and allows entering more sign entries easily. The system can be used by any person but only one person can use the system in each capture session.

The majority of the full-body motion capture systems are not accurate enough when capturing hand movements, especially movements involving wrist and finger movements. These movements usually require greater precision. Given their importance in LSE, two motion capture CyberGlove II gloves were used, one

for each hand. These gloves allowed tracking precise movements of both hand and fingers. In addition, they can connect to the server via Bluetooth, which allows more comfortable and free movements when signing.

As mentioned before, body movements have also a great significance in LSE. In order to capture the movements of the whole body, the Organic Motion system was used. This system uses several 2D cameras to track movements. The images are processed to obtain control points that are triangulated to track the position of the person that is using the system. Thanks to this system, the person signing does not have to wear any kind of sensors, allowing total freedom of movement. The captured movements result more natural and realistic. The signs were made by Sing Language experts for a better accuracy and understanding. The person signing had to wear the gloves while standing inside the Organic Motion System at the same time.

In order to join the animations captured with both systems it was necessary to join and process the captions before saving them as whole signs. Autodesk Motion Builder was used for that purpose. This software is useful to capture 3D models in real time and it allows creating, editing and reproducing complex animations. Both CyberGlove II and Organic Motion provide plug-ins to use with Motion Builder that allows tracking and synchronizing the movements in the same 3D scenario in real time. For that purpose three skeletons were needed: one for each hand and one for the whole body. These skeletons were joined in one unique skeleton to simulate the real movements of the person who used the capture system. Motion Builder allowed making it in a semi-automatic way reducing pre-processing. Although both CyberGlove II and Organic Motion obtain realistic movements, in certain cases the capture contained errors due to different reasons, such as calibration or interferences. In these cases, manual post edition of the capture was applied. This manual edition consisted in comparing the obtained animations with the real movements and adjusting the capture using Motion Builder. Capture edition was always done by an expert graphic designer.

Once the realistic animations were obtained, they were stored in a database to feed the application with vocabulary in Sign Language.

### ***4.3.3. Sign dictionary***

The sign or gesture dictionary contains the words used in the code given to each concept linked to the actual gesture that the avatar has to interpret. The gesture dictionary is composed by a finite number of lemmatized concepts gathered from the domain specific corpus. Furthermore, all synonyms are gathered within the same entry. The sign dictionary can contain three types of entries:

- ***One-to-One Concepts***: concepts that match a word-token in Spanish and that are expressed in one sign in LSE. Synonyms are listed under the same LSE sign.
- ***Grammatical or void Words***: these entries are listed in the dictionary as evidence of processing, but are linked to an empty concept. They do not trigger any kind of movement because in LSE they do not exist.
- ***Multi-word Concepts***: some concepts may map to more than one word-token in Spanish. These

concepts are registered as one entry in the gesture dictionary and they map to just one concept in LSE.

The compiled sign dictionary contains 472 lemmas. These entries have proved to be enough to translate the domain-specific corpus used to extract the translation rules. All these concepts or lemmas were captured with Capture System Module and added to the sign dictionary so that they could be interpreted by the virtual interpreter.

#### ***4.3.4. Animation engine***

Our Animation Engine was developed with the aim of providing natural transitions between signs. Each sign should be represented using not only the hands and the face, but at least, also the upper body of the interpreter.

The Animation Engine runs as follows: the appearance of the virtual interpreter is loaded from the Virtual Character database. While the virtual interpreter does not receive any input it has a natural behaviour, involving blinking, looking sideways, changing the weight of the body between both feet, crossing arms, etc. When the Text to Sign Language module sends the translation to the Avatar Engine module, it stops the natural behaviour (except blinking) and starts the sequence of signs. Additionally, the virtual interpreter's expression is also modified using morphing techniques.

The Animation Engine module was developed using Open Scene Graph. It applies any sign animations stored in Sign Language database captured with the Capture System Module previously. In order to concatenate several animations and to obtain realistic movements, a short transition between the original signs is introduced. The implemented algorithm takes into account the final position of a sign and the initial position of the next sign; it was implemented using the technique explained by Dam et., al. [14]. Thus, the final result is the virtual interpreter signing with very realistic movements.

#### ***4.3.5. Rendering***

The objective of this module is to visualize the virtual interpreter synchronized with the multimedia content. For the current prototype, this module inserts the avatar in the broadcasted TV show. For synchronizing the virtual interpreter with the visual content, the system takes into account the time in which each sentence is pronounced in the audio.



**Figure 20.** Broadcasted signal with the signing avatar.

## 5. Roadmap

### 5.1. *Main timeline*

Period	Activity
2014 First half of year	Identification of signing implementations and first user tests (UAB, RBB, UPM); Compilation of current signing workflows (RBB, RTP); Definition of first version of HBB4ALL signing workflow model (Screen, UPM); Avatar signing activity ongoing (VIC)
2014 Second half of year	Definition of the German and the Portuguese service sub-pilots (RBB, RTP, UPM, IRT); signing workflow (business and technical approach) are refined (Screen, UPM); German and Portuguese sub-pilots are planned in detail (RBB, RTP, UPM)
2015 First half of year	Required integration activities for the service pilot deployment (all); Avatar signing activity ongoing (VIC)
2015 Second half of year	Final version of the avatar signing services is released (VIC); Operational phase begins in August 2015.
2016	Operational phase will continue. Execution of Task 6.4 (Evaluation and recommendation).

**Table 9.** Main Timeline in Pilot D.

### 5.2. *Dec 2013 – Jul 2014*

- Click-Dummy and first usability lab tests with 10 deaf testers for the HbbTV-based service pilot (RBB)
- UAB and UPM compile signing implementations and UAB launches tests with deaf users and sign language interpreters.

### **5.3. Jul 2014 – Dec 2014**

- HbbTV Application for all IP signer workflow (RBB)
- IP-based signing service pilot is defined (RTP, UPM)
- Avatar signing service release (basic functionality) (VIC)

### **5.4. Jan 2015 – Jul 2015**

- Technical integration of all IP signer workflow in RBB production workflow
- Developing of hybrid signer showcase (RBB), if there are suitable hybrid terminal/prototypes
- Integration of IP-based signing service (RTP, UPM)
- In March 2014, second version of the avatar based signing service will be released (extended sign modelling) (VIC)
- In July 2015, the final version of the avatar based signing service will be released, at the end of task T6.2 (VIC)

### **5.5. Aug 2015 – Jul 2016**

- The operational phase of Pilot D will take place for this period of time (task 6.3)
- On air field trials for the HbbTV signing application (RBB) (Aug 2015-Jan 2016)
- Customisable IP-based service available in RTP website (RTP, UPM)
- IBC/IFA Showcase for HbbTV2.0 Integration of customizable hybrid signer (including browser sniffer?), if there are available HbbTV 2.0 prototypes.

### **5.6. Aug 2016 – Nov 2016**

- During this period, the evaluation of the service pilots will be done. As a result, recommendation and guidelines will be published to enable improvements in signing provision (UAB).



## 6. Service Components to be developed, integrated and trialed

### 6.1. *Signer HbbTV application*

This component enables a sign language video playback system on HbbTV devices. Within an HbbTV application a pre-mixed picture-in-picture video stream will be offered, that consists of a main TV video and a sign language video area. That playback system gets its input from a video resource like a video server or a web server, where the pre-mixed video is located. Users can launch the signer application from a generic HbbTV launcher bar, which is the standard HbbTV-service offering used by all German broadcasters. MP4 and MPEG DASH video formats are considered for this prototypical implementation.

### 6.2. *Avatar based signing component*

This component allows the generation of a 3D avatar that accepts textual input and interprets the text into sign language based on Vicomtech's proprietary 3D avatar and text to sign language translation technology. Due to restrictions of the translation technology, it has been limited to the meteorological domain ("weather forecast").

Component Name / Version	Features included	Availability
Avatar based signing v1.0	Basic functionality	September 2014
Avatar based signing v1.1	Extended sign modelling.	March 2015
Avatar based signing v1.2	Final release	July 2015

Table 10. Timeline for Avatar features availability.

### 6.3. *HbbTV play-out system for tests*

Both Screen and UPM have a wide experience in the development of HbbTV play-out systems and applications. This experience can be used in the project to easily deploy HbbTV applications, including lab tests and pilot exploitation. These systems include 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.

## 7. User tests

### 7.1. Preliminary tests for the HbbTV-based signing application

As described in Section 5.1 RBB plans the integration of a service to provide the viewer of broadcast TV with simultaneous sign-language translation via IP for the German Service Pilot. The early prototype (HbbTV-based Click Dummy) was tested on the 3th and 4th of July 2014, with deaf users. These were the first tests of the service to be deployed in the RBB Service Pilot next year and brought valuable information as to implementing the actual HbbTV-service.

The purpose of the tests was to improve the service and to identify relevant criteria for content and design. The results will help to ensure that the application is suitably tailored to the target group. Results will be presented to the German network of public service broadcasters ARD and will be incorporated into the ongoing project.



Figure 21. ARD Launcher Bar.

Generally, access to additional services is provided by the ARD Launcher Bar via the Red Button. Applications can be selected and controlled using left/right buttons on the TV's remote control. HbbTV services require internet access and an HbbTV connected television or a set-top box.



Figure 22. Test set-up.

Tests were not only conducted on the HbbTV signing service from RBB but also and on an additional signing service from MDR, another ARD broadcaster. Here, the news programme 'MDR um elf' is streamed live with a signing option available via the internet and via HbbTV; as the live signing option is not broadcast 24/7, these latter tests were conducted offline.

Applications can be selected and controlled using left/right buttons on the TV's remote control. HbbTV services require internet access and an HbbTV connected television or a set-top box.

#### 7.1.1. Test overview

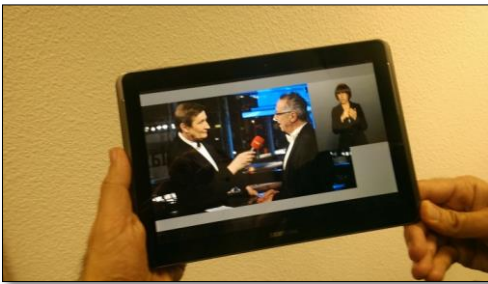
The tests took place on 03.06 and 04.06.2014 at **rbb** in Potsdam, Germany, with a duration of about one and a half hours per test-person. Nine deaf viewers of various age groups tested two services, **rbb**'s HBB4ALL application and MDR's Live Stream.

A signer was present at the tests, which were conducted by a moderator. A second **rbb** employee completed relevant questionnaires and a third made observational notes, which are important for future development of the service. The entire testing was

documented by questionnaires and minutes. Questionnaires used various methods, with ranges from 1-7 (definitely - definitely not), 1-5 (not at all - completely) or 1-10 (mostly likely - not at all likely). For other questions, the employee took full notes of testers' responses.

Summed up, each test session consisted of the following successive modules:

1. general questions regarding the individual media consumption habits of the tester
2. mobile devices (screenshots on devices)
3. introduction to the ARD Launcher Bar
4. testing of the HbbTV signing service
5. testing of the MDR HbbTV-livestream with signer
6. final comments from the tester



**Figure 23.** Mobile set-up.

On 1) Tests began with general questions regarding the individual media consumption habits of the tester. Of the nine testers, eight were regular TV users - one only rarely watched TV. Seven testers regularly used internet-enabled TVs; all testers regularly access the internet using their own computer; eight additionally use a smartphone and seven also use a tablet. The main areas of their media-consumption activities are communication (i.e. email), multimedia (YouTube and catch-up TV) and finding information.

On 2 and 3) To generally evaluate signing services on mobile devices, testers were shown screenshots showing a signer and a video with subtitles, displayed on a smartphone and a tablet PC. Testers were then introduced to the Launcher Bar and shown how to use it to access the signing service.

On 4) Following this introduction, testers were given three tasks which required practical use of the early signer HbbTV-clickdummy. These tasks were designed to test the usability and efficiency of the signing service. Testers were informed that in this prototype, both signed and unsigned versions of video content were not synchronised, thus when switching from a signed service to an unsigned version, or vice versa, playback of the second video would always be from the beginning. This is not the case in the on-air service, which is of course synchronised.

On 6) Finally, interviews with testers were conducted to record their personal impressions and experiences. This information will support future development and optimal implementation of the applications.

## **7.1.2. Results - general**

### **Tester satisfaction with current signing options on TV**

Testers were ambivalent about current signing options, expressing neither satisfaction nor dissatisfaction. All testers indicated that they were either aware of or watched the daily news broadcasts on the ARD channel Phoenix. Two testers said that they preferred that the signers used the ‘clean/original’ “Deutsche Gebärdensprache” signing method and that no broadcast information should be omitted from the translation. All testers noted that the signer display during the ‘Tagesschau’ broadcast was too small and that the size of the display should be customisable.

### **Tester preferences**

For TV films, series and sports broadcasts, testers prefer subtitles. For these genres, the presence of a signer ‘would be too distracting’. For news programmes, testers preferred to have both signing and subtitles options available to them. This also applied to general entertainment programmes, comedy, culture, education, science and informational programming.

For programmes dealing with politics, business and the stock market, five testers would prefer signing, four would prefer subtitles.

For childrens’ programmes, the majority of testers felt that it is important to offer both choices.

Testers prefer to be able to make their own choice between viewing signing and subtitled versions of broadcasts. This is partly due to the fact that not all signers are equally understandable by viewers; when this is the case, subtitles are helpful.

### **Accessibility on mobile devices**

When it is possible to choose between signer and subtitles, seven testers use the signer option on TV, while two preferred subtitles. Testers could also envisage watching videos with subtitles on smartphones and tablets. Testers would also use the signing option when watching videos on smartphone depending upon the size of the signing display; the display used in the tests was described as too small by most testers. All testers would use signing on tablets, recommending the style of presentation used by the ARD channel Phoenix.

### **Accessibility in Mediathek/catch-up TV**

Almost all testers found it important to be able to use signing and/or subtitles in Mediatheks (video-on-demand portals for PCs and HbbTV devices). Only one tester, who did not use such media sources, found it unimportant. Testers also found it “rather important” to be able to record the signing/subtitle overlay in such broadcasts.

### 7.1.2.1. Results: rbb signing app/ early HbbTV-based click dummy



Figure 24. HbbTV Signing app.

Testers very quickly understood how to use the Red Button to display the Launcher Bar.

Various tasks were devised to test the application. During testing, testers commented and expressed opinions and impressions, which were noted.

Testers were asked to undertake three tasks:

- select the HbbTV signing option on the TV set
- read the data protection information and user instructions, and then close them
- close the signing option and return to the live TV broadcast

The results were:

#### Task a):

- Three testers had no difficulty starting the application from the TV screen. Four testers thought that they should press the red button a second time instead of selecting the app from the Launcher Bar and launching with 'OK'. The app was successfully launched either as the result of testers' own initiative or with advice from the session moderator. One tester suggested the use of a dedicated 'signing' button on the remote control.
- From notes taken, it was clear that most testers thought that by pressing the red button, the signing app would immediately be launched. The instruction text should be clarified; the current text ("Please start the sign language interpreter with the red button" is misleading. Clear instructions will improve the functionality.
- Some testers felt that the 'hands' graphic was helpful in recognition of the role of the red button in launching the functionality.
- The functionality of the Launcher Bar was hard to understand. Testers expressed the wish for the placing of text and associated graphics to be reversed, with text on the right of the graphic.

#### Task b):

- When the app is started, a message appears as a screen pop up which announces how to close the app, how to return to the launcher bar and how to find Data Protection information. To check whether the tester has noticed the message, they were asked to 'open the Data protection information page and then close it'.
- One tester found the data information without difficulty, six had minor problems and needed

intervention, and two testers were unable to find the information.

- These two testers searched for Data Protection information and User Instructions in the Launcher Bar rather than recognising the individual (Text, Media Library, Signing) apps.
- Almost all testers used the ‘1’ as an ‘i’ and thus failed to achieve the desired action.
- Other issues included the quick fade-out of on-screen messages. Testers would switch their focus from the TV screen to the remote control and back, by which time the message had disappeared from the screen. One tester wanted the data protection information to be within the signing app.

#### Task c):

- Returning to the TV screen with the red button caused no problems for any tester.
- In the closing discussions, testers evaluated the Launcher Bar positively.
- The size and colour of the signer display were also positively evaluated, although testers wanted to be able to resize the signer display.
- Most testers describe the black border as ‘sad’ (in Germany, a black border accompanies announcements of death). Two testers did not like the red background, and would have preferred blue; one tester noted that the background colour was too bright.
- One tester noted that the positioning of the signer on the left of the screen compared unfavourably to Phoenix, where the signer is positioned on the right, and three others also wanted the Phoenix model to be used. Most testers wanted the relative sizes of TV picture and signer to be more or less equal, and preferred that the signer display did not overlap the TV picture.

#### 7.1.2.2. Results: MDR Signing Application

Testers were asked to:

- a) select a Livestream with the signer option
- b) start a Livestream with the signer option
- c) close a Livestream and return to the TV broadcast

Results included:

- Probably as the result of testing first the rbb service concert, **rbb**, five testers had no difficulty finding the Livestream via the Launcher Bar. Four testers required assistance or eventually found the Livestream themselves, one felt the process was too complicated.
- Starting the Livestream was more difficult, however. Most testers did not read the on-screen advice; two had difficulty and needed support, one tester could not start the Livestream at all, and four eventually achieved this goal after orientation.
- Eight people found that stopping the Livestream was uncomplicated, one needed support. All testers used the ‘exit’ button on the remote control rather than the red button and so returned to the TV

screen without again encountering the Launcher Bar.

- After locating the MDR app, testers did not notice the on-screen advice. An icon would be more effective and noticeable.
- Testers gave a positive evaluation to the presentation of the signer, including graphic presentation, colour and layout.
- Testers found the method of starting the Livestream too complicated. On-screen advice was too small, they didn't notice the text and important icons and were generally confused.
- One tester felt there was insufficient programme information, one wanted to be able to define the position and size of the signer himself.

### **7.1.3. Net Promoter Score for both services**

A new app spreads most effectively when enthusiastic users recommend it. We assess this likelihood with a Net Promoter Score (NPS), and use responses to the question 'How likely is it that you would recommend this app to your friends?' The range of possible answers was from 1 (highly likely) to 10 (highly unlikely).

- Eight of nine testers would highly recommend the HbbTV signer app to friends, and one would not.
- Five testers would recommend the MDR Livestream with signing app to friends, three would not and one had no opinion.

For the HbbTV prototype, this produces a NPS of 78. This score is based on the following:

- All testers belong to the target group. Most of them are involved in corporations and companies, and these kinds of organisations are typical multipliers and networkers of new information.
- The service is both unique and useful to the target group.
- The service is better than currently-offered TV accessibility services.
- The testers will also use and disseminate this app.

For the MDR app, the NPS is rather lower, at 25. The reasons for the disparity are most likely the following:

- The testers had difficulty finding the MDR Livestream, did not notice the on-screen advice and were doubtless demotivated by the time they eventually successful
- The MDR Livestream is not indicated (on-screen) as including an accessibility function, and so is difficult for the target group to identify. The testers would have been better served by a clear indication in both the Launcher Bar and within the application itself.

### 7.1.4. Conclusion

The tested applications were generally well-received and rated by users. All tests were completed and indicated possibilities for improvement, especially in terms of accessibility to the application itself.

#### **rbb HbbTV signing service:**

- Minor design and on-screen notification changes will make the app more accessible and, in the long-term, **rbb** should aim at a personalisable solution.

#### **MDR Live Stream app:**

- Access to the live stream should be made easier. This can be implemented relatively easily by improvement to graphic and text components. The functionalities should be better indicated and made more noticeable. One solution may be to offer the signing functionalities as a stand-alone app, similar to the **rbb** model.

It is important to ensure, in the future, that barrier-free options are available for all platforms (live TV and catch-up services).

### **Incorporation of results into service enhancement and standardisation**

The results of these user tests will be incorporated into future work on accessibility issues.

- **rbb** will enhance its services using these test results. The HbbTV sign language prototype will be enhanced using these results.
- The enhanced sign language app will be evaluated by a group of 30 test users for a period of six months starting in August 2015.
- Results of the long-term test will be reported to the ARD, the European Commission and to relevant standardisation bodies.
- Future development will be undertaken jointly by **rbb** and the Institut für Rundfunktechnik (IRT) in Munich, Germany.

## 7.2. *User tests about sign language interpretation and appearance*

UAB has carried out focus groups with signing deaf users inside the project.

Making a first contact with the end-users and taking their opinions into account was considered of utmost importance in order to determine which of the formal features would finally be considered for the first experimental test. In order to raise interest in the topic within the Catalan Deaf Community we contacted again the Catalan Federation of Deaf People, FESOCA. On the one hand, the group attended the 5th Catalan Sign Language Seminar, organised as a social and scientific event especially for Catalan Sign Language teachers and other members of the deaf community. In this event we were invited to give a 40-minute



presentation about the project. After the presentation, many deaf showed interest on Hbb4all and were willing to share their opinions with us. On the other hand, a video message was recorded in Catalan Sign Language (LSC) asking for collaboration in a focus group to discuss the formal characteristics of sign language on-screen. The original video message can be retrieved at <http://youtu.be/4EJ8quEjT1A>. FESOCA sent the video message to all its associate members, which includes the vast majority of signing deaf people’s associations in Catalonia. A total of 13 users answered the call and according to their availability the focus groups sessions were set on two dates in June and two more in July. Finally, one session in June and one in July with four participants each were held. The other two were cancelled because the rest of the participants could not attend. The FESOCA secretary suggested that further tests be organised in the associations to grant a bigger participation.

The focus groups were organised to discuss all the formal features of on-screen interpreting that had been previously discussed on the interviews with the professionals. Specially taking the results from the interviews as a starting point for the group discussion. The skeletal outline of the focus group is provided in Table 11.

(1) Presentation	Hbb4all Formal features of SLI on-screen (not content oriented)
(2) SLI on TV clips	To illustrate different on-screen interpreting to the Catalan or Spanish broadcasters
(3) Formal features selected from the interviews	Size Colour-contrast Speed SLI, subtitling and DOG on-screen layout
(4) Other formal features	Sub-screen, split-screen Framed-screen, chroma Interpreter location: right/left; top/centre/bottom Interpreter position: sitting, standing Shot: MS, MLS, LS, MCU Interpreter gender: male, female Interpreter physical appearance
(5) SLI on TV screen shots	Ten screen shots showing a wide variety of formal characteristics of SLI on-screen were selected to illustrate several compositions of the above-mentioned formal features and encourage discussion with the features not yet tackled.
(6) Open questions	What features determine accessibility the most? What features are irrelevant or less important?
(7) Activity	Drawing on a piece of paper the best and the worst accessible on-screen composition

**Table 11.** Skeletal outline of the focus group.

The results from the focus groups with the end-users were consistent with the feedback reported by the interpreters. The most important on-screen feature to grant accessibility was considered by all participants to be the size of the interpreter. Most agreed that a taking about a third of a vertically split screen and using a MS/MLS would be the ideal.

Deaf users also considered colour contrast to be one of the most important characteristics. However, they did considered the possibility of interpreters wearing colours other than black a good way to prevent eye-fatigue and provide colour contrast. The participants also mentioned the fact that if programs other than news were to be accessible using SLI, clothing colours and the interpreter's dress-code would need to match the type of programs and their targeted audience. The suggested colours for the interpreter's clothing showed a wide range of preferences including light, dark, bright and the classic black. They all seemed to prefer plain colours (not patterned), though. Regarding the background colour, there was no agreement other than the fact that it had to contrast with the clothing and skin colour so that all the linguistic details could be perceived accurately and to prevent eye-fatigue. Regarding colour contrast and the screen composition, most of the participants considered that embedding the interpreter in a framed sub-screen, rather than using chroma, was a better way to guarantee contrast throughout the programmes. Some of the participants even mentioned that the contrast between the interpreter sub-screen and the screen should also be considered.

Deaf consumers also discussed about the overlaying (or even overlapping) of subtitling and DOG with interpreting on the screen. They all agreed overlapping should be completely avoided. Provided that subtitles are normally displayed at the bottom of the screen, most agreed that sign language sub-screen could be placed in a central position. However, there was no agreement regarding the right/left location. Interestingly, some said it was more comfortable to start looking the sign language on the right and then continue reading the subtitles and some argued the opposite.

When asked about the signing speed, most did not feel it was a feature possible to be changed and would not further elaborate. They seemed to accept news had this high speech pace and it was the interpreter's job to keep up with it, regardless of those deaf who could not keep up with it. They also all seemed to agree, though, that having the possibility to slow down the speed would make the contents accessible for more people.

All the other characteristics such as sex, age, appearance or position were considered irrelevant to accessibility. However they agreed that certain aesthetics are important to appear on TV and always stressed the fact that the most important characteristic of an interpreter on TV is their linguistic and interpreting skills as well as their cultural level and background.

## 8. Results

### 8.1. Task 6.1 progress

Objective	Progress
Compilation of current signing workflow and use cases	100 %
Definition of the business approach for the HBB4ALL signing workflow	80 %
Definition of the technical approach for the HBB4ALL signing workflow	75 %
Particularization of HBB4ALL signing workflow for technical implementations	50 %
Definition of HbbTV-based signing service pilot. Analysis of technological options.	90 %
Definition of IP/web-based signing service pilot	50%

**Table 12.** Task 6.1 Objectives progress.

### 8.2. Task 6.2 progress

Objective	Progress
RBB preliminary user tests	100 %
UAB preliminary user tests	80 %
Integration activities for HbbTV-based signing pilot	30 %
Integration activities for IP/Web-based signing pilot	0 %
Avatar signing service	60 %

**Table 13.** Task 6.2 Objectives progress.

### 8.3. Component progress

Objective	Progress
Signer HbbTV application	30 %
Avatar based signing component	60 %
HbbTV play-out system for tests	100 %

**Table 14.** Component progress.

## 9. Conclusions

Work Package 6 / Pilot D has advanced during this first project year and it fulfils the project plan for signing. Among the service pilots, the Portuguese sub-pilot (IP/web-based signing service) is less advanced due to the need of aligning the project and RTP strategy and available equipment.

The degree of accomplishment of the objectives for the initial two tasks of pilot D are summarised documented in detail in the previous sections of in this document.

No specific measures, actions or contingency plans are considered necessary at this stage. Operational phase is starting in August 2015 (M21).

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