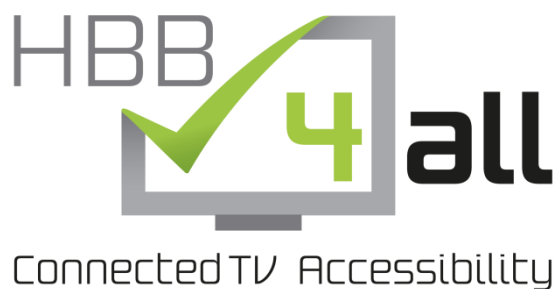


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# D5.1 – Pilot-C Progress Report

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D5.1 v1.5

Project no. 621014

**HBB4ALL**

Hybrid Broadcast Broadband for All

CIP- Pilot actions

Competitiveness and innovation framework programme 2007-2013

## D5.1 – Pilot-C Progress Report

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## Executive Summary

This deliverable describes the progress of Work Package 5/Pilot C “Automatic UI adaptation” of the HBB4ALL project within the first project year. It gives an overview on its refined objectives, the partners’ activities as well as the main achievements within this period.

The general strategy for Pilot-C is the realization of a unified UI adaptation service that allows the provision of personalized accessibility on PC, mobile and HbbTV platforms. The online service is based on the UI adaptation framework that was developed in the EU project GUIDE “Gentle UIs for elderly people” by Vsonix together with other partners and which is now further maintained as an open source project under the Apache license.

The service includes APIs and functions for user management, the necessary mechanisms for UI and subtitle (in collaboration with Pilot-A) adaptation as well as an online screen-reader service. It also includes an application for user profile generation and storage called AccessGUIDE. This application will be a redesign of an existing “user initialization application” that was developed in the GUIDE project. The AccessGUIDE application will be available for PC and mobile platforms (by Vsonix) as well as for HbbTV platform (PPG). It will transfer the existing application from a local application to an online service while refining it in terms of its usability and accessibility aspects taking into account the guidelines of the W3C-WAI initiative. The adaptation parameters provided by the service will include e.g. font size, type and colour, optimized colour schemes for people with different kinds of visual impairments, as well as screen reader functionality.

The online accessibility service including AccessGUIDE will be integrated by three different Pilots realized by Vsonix, SCREEN and PPG. Those include an online video learning course (“MOOC”) on media accessibility, on which Vsonix has already worked in this period in collaboration UAB and which is planned to be provided as a service for interested parties in Europe in English including German and Spanish subtitles. The MOOC showcase will act as a cross-pilot showcase addressing Pilot-C and Pilot-A, where the GUIDE based online accessibility service will be used for personalized subtitle rendering. Besides the MOOC, Pilot-C will work on a media-on-demand service provided by SCREEN as well as a HBBTV showcase based on an application of the Netherland public broadcaster NPO, which is provided by PPG. Both will integrate the UI adaptation framework provided by Vsonix. All Pilots have been started to be tested and will be further tested in the second year of the project. The aim is to further refine the requirements for the UI adaptation service, the user profile generation application (AccessGUIDE) as well as for the pilot applications following a user centred design approach.

Within this period the overall strategy and objectives for Pilot-C have been refined by the partners:

The realisation of an online accessibility service based on the GUIDE framework providing functions for user management and profiling as well as a web based API (JavaScript).

Provision of an online screen reader service as part of the overall service.

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

Provision of a user testing and profiling application (AccessGUIDE) as part of the UI adaptation service. This application will be an essential part of the accessibility service and will allow determining user requirements and preferences based on a number of accessibility tests. It will be provided by Vsonix for PC and mobile platforms. In addition PPG works on a HbbTV version of the service.

The realisation of a MOOC addressing topics related to media accessibility as a webcast service for PC based and mobile platforms by Vsonix targeting Europe (using content from UAB) as main region. The course will be provided in English, German and Spanish.

The realisation of media on demand service provided by SCREEN for HbbTV 1.5 using the UI adaptation framework

The realisation of an HBBTV showcase by PPG based on an existing application of NPO.

Expert group discussions and early user trials (from second half of 2014) by Vsonix and UAB in order to acquire refine the user requirements for the UI adaptation framework as well as for the MOOC application.

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

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

The main achievements of Pilot-C within this period have been:

- The definition of requirements for the Online UI framework
- The specification of the online UI adaptation API
- The definition of requirements for AccessGUIDE application on PC, mobile and HbbTV platforms
- The definition of requirements for online learning platform (MOOC) as well as the Identification of MOOC content by UAB
- Identification and definition of additional pilot services by Screen and PPG
- The realisation of expert group discussions on AccessGUIDE
- Preparation of early user tests as well as the planning of the usability tests
- First version of the HBB4ALL online service for UI adaptation and personalised subtitle based on GUIDE framework
- First version of the online text to speech service





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- Conceptualisation and prototype implementation of the AccessGUIDE application for PC, mobile and HbbTV platforms
  - First version of the MOOC application based on existing technologies as well as preparation of the MOOC content

## 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 aim Pilot-C is the realization of an online UI adaptation and personalization service that allows the provision of personalized accessibility features for web and HbbTV based media services. The online accessibility service is based on the UI framework that was developed in the EU project GUIDE “Gentle UIs for elderly people” by Vsonix together with other partners and which is now further maintained as an open source project. The Software as a Service (SaaS) platform provided by Vsonix will include APIs and functions for user management as well as the necessary mechanisms for UI adaptation. It will further include an application for the standardized definition of user accessibility profiles on PC, mobile and HbbTV platforms. The UI personalization service will be integrated and trialed in an online video learning application (“MOOC”), which is planned to be provided as a webcast service for interested parties in Europe on PCs and mobile devices. It will further be integrated and trialed in two additional HbbTV showcases provided by PPG and SCREEN.

### 1.1. Purpose of the document

This document constitutes a report on the progress of Pilot-C, as part of the HBB4ALL project, funded under the Competitiveness and Innovation framework Programme 2007-2013 (CIP). Pilot C 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 C is reported in this document up to the end of month 12 of the project timeline. 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 C or the terminology.

Chapter 3 summarises the results of some previous projects being useful in HBB4ALL and the current state of the art in UI adaptation for accessibility on SmartTV, PC and mobile platforms. This also includes the description of the UI adaptation framework provided by the European project GUIDE (Gentle UIs for elderly people), which founds the technical basis for this sub project.

Chapter 4 explains current challenges in UI adaptation from a user perspective and some existing technologies for the deployment of the service pilots. Chapter 5 revises the four service pilots, which will be provided in Pilot-C using the UI adaptation framework provided. It includes information about the current state of development and future steps. The overall roadmap for the Pilot is summarised in chapter 6. Chapter

7 explains the service components that are considered in this Pilot, according to the 2.3.X deliverables including their current state. Chapter 8 explains the user tests that are being carried out. Chapter 9 and 10 are dedicated to results and conclusions.

## 1.2. Summary of Pilot-C objectives

The refined objectives of the Pilot can be summarized as:

Objectives		VSX	UAB	IRT	SCREEN	PPG
C1	<p>The realisation of an online accessibility service based on the GUIDE framework providing functions for user management and profiling as well as a web based API (javascript). Extension of the GUIDE user profiles by Vsonix in collaboration with UAB and Screen to support additional parameters for UI adaptation.</p> <p>Extension of the GUIDE UI adaptation framework to include additional features such as an online screen reader.</p>	x	x		x	
C2	<p>Provision of a user testing and profiling application (AccessGUIDE) as part of the web based UI adaptation service. This application will be an essential part of the accessibility service and will allow determining user requirements and preferences based on a number of accessibility tests.</p> <p>It will be provided by Vsonix for PC and mobile platforms. In addition PPG works on an HbbTV version of the service.</p>	x				x
C3	<p>The realisation of a MOOC addressing topics related to media accessibility as a webcast service for PC based and mobile platforms by Vsonix targeting Europe (using content from UAB) as main region. The course will be provided in English, German and Spanish.</p> <p>The realisation of media on demand service provided by SCREEN for HbbTV 1.5 using the UI adaptation framework for the provision of personalized accessibility features as well as for personalized content adaptation.</p> <p>The realisation of an HbbTV showcase by PPG based on an existing application of NPO (Netherlands Public Broadcasting).</p> <p>The accessibility features of these services will benefit from the UI adaptation service targeted in the Pilot.</p>	x	x	x	x	x
C4	The preparation of expert group discussions and early user trials (from	x	x		x	x

	<p>second half of 2014) by Vsonix and UAB in order to acquire refine the user requirements for the UI adaptation framework as well as for the MOOC application.</p> <p>User experience testing of different end user related aspects of UI adaptation in webcast and HbbTV applications based on the integrated UI adaptation framework (Mid – End 2015) involving users from Germany (Vsonix) and Spain (UAB) .</p> <p>A final (online) user evaluation of the MOOC and the Access GUIDE based on online questionnaires.</p>					
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**Table 1.** Overview of Pilot-C objectives.

### 1.3.Summary of Task 5.1

In the following we will describe the content of the two different tasks that we have worked on in the first year of the project. In comparison to the original task descriptions that have been provided in the DoW only minor changes / adaptations have been made to the goals of task 5.1 and 5.2.

Task 5.1 “Definition and Preparation of Operation Phase”:

This task covers the definition of requirements and preparation needed for the pilot services targeted in T5.3, that will integrate the web-based UI adaptation and personalisation service provided by Vsonix and is based on the UI adaptation capabilities of the GUIDE framework. The online UI personalisation service can be used by media service providers on PC, mobile and HbbTV platforms to provide personalized accessible user interfaces adapted to the needs of the individual users into their applications. As a precondition the status quo of the available technologies including the GUIDE framework (see chapter 3.4) was analysed to determine necessary adaptations and improvements to be made during the first two years of the project. This mainly includes the transition of the GUIDE framework from a local service running on Set-Top Boxes to become an online service that could be used by web developers on all relevant media platforms for the project including PCs, mobile devices and HbbTV enabled. The UI personalisation features will include means for font size adaptation, fonts positioning, contrasts and colours as well as an online screen reader service. The task shapes the strategy for the operational phase of the HbbTV and web based services operated in T5.3 (see chapter 5). It defines which service components (see chapter 6) will be implemented, integrated and trialled (see chapter 7) in T5.2. In addition we will plan the large scale pilot for the Operation Phase.

### 1.4.Summary of Task 5.2

Task 5.2 “Solution Integration and Trials”:

This task includes the refinement and integration of the web-based accessible UI adaptation and personalization service by Vsonix based on relevant parts of the GUIDE UI adaptation framework as well as a number of media services for PC, mobile and HbbTV platforms that integrate the UI personalisation

features of the service. One important part of the task was the transition of the GUIDE framework from a local service to become an online service for all relevant platforms. It includes also the re-design of user initialisation application of GUIDE (see chapter 4.3.2) that was designed to determine the UI preferences of the individual users in order to integrate all the accessibility features of the Pilot as well as personalized subtitling. This will be done in a new application called “AccessGUIDE” (see chapter 4.4), which will be available for PC, mobile and HbbTV platforms. One important aim here is to improve the user experience by increasing the accessibility as well as usability aspects of the application.

The service provided by Vsonix will be used by SCREEN, PPG and Vsonix to integrate accessibility features into their media services (see chapter 5.3 and 5.4). This will include a MOOC (massive open online course) for PC and mobile on media accessibility provided by Vsonix in collaboration with UAB, which is responsible for the content of the course (see chapter 5.2). The course that will provide accessibility on the UI (through UI adaptations) but also on the content level (through personalized subtitles) will target interested people of all ages. Moreover SCREEN will provide an accessible media on demand service based on their existing HbbTV application platform (see chapter 4.3.6), whereas PPG has started to work on an HbbTV version of AccessGUIDE and will integrate the UI personalisation service in one sample EPG application for HbbTV platforms. Focus group discussions and different early trials are conducted in Task 5.2 in order to examine the usability and accessibility aspects of the AccessGUIDE application as well as for all other services provide by the Pilot. This includes also the nature of the adaptation parameters and their range for changes. It will further involve trials to test the services before launching it in the operational phase.

## 1.5. Reference documents

The following documents are relevant to Pilot C:

TS 102 796 - V1.2.1 - Hybrid Broadcast Broadband TV
TS 102 796 - V1.1.1 - Hybrid Broadcast Broadband TV
User Interaction & Application Requirements, Deliverable D2.1 - GUIDE – Gentle User Interfaces for Elderly People.
Initial User Tests and Model Project, Deliverable 7.1 - GUIDE – Gentle User Interfaces for Elderly People.
D2.3.1 Common Technical Components (I) document (CIP-IST-PSP-621014)

Table 2. 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. Abbreviations and acronyms are introduced in brackets in the text after the corresponding full text version.

## 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.

**Accessibility, Linguistic:** The degree to the language of an audio-visual work can be understood by as many persons as possible in the target audience.

**Audio-visual Content:** All kinds of time-based content consisting of images and sounds

**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.

**Captioning (North America):** See Subtitling, Intra-lingual. A form of subtitles primarily intended as an access service for viewers with hearing impairments. Captions not only display words as the textual equivalent of spoken dialogue or narration, but they may include speaker identification, sound effects, and music description. Captioning aims to include as much of the original language as possible. However, altering the original transcription may be necessary to provide time for the caption to be read and for it to be in synchronization with the audio.

**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, but may also be achieved via a Personal Video Recorder (PVR) on which the viewer has chosen to record the program, or through a push Video On Demand (VOD) subscription where the viewer receives the program via the Internet, his Set-Top Box (STB) or his PVR.

**Control, Remote** is also known as a remote, controller or sometimes channel changer. It is an electronic device used for the remote operation of a machine (television set, set-top-box or PVR) over very short distances within the home. The design of such devices needs to consider their usability and accessibility. Blind and partially sighted persons and those with other disabilities often encounter difficulties with remote controls that render them inaccessible.

**Dubbing** is the post-production process of recording and replacing voices on a motion picture or television soundtrack subsequent to the original shooting.

**DVB –Digital Video Broadcasting** a set of technical guidelines, standards and specifications to benefit and advance digital media markets world-wide. It was originally European but today is a worldwide alliance of 250-300 companies.

**DVB subtitles** – bit-map or text captions on digital television using DVB specifications.

**EBU:** European Broadcasting Union

**HbbTV:** Hybrid Broadcast Broadband TV 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.

**Impairment, age-related** is a collection of sensory and cognitive impairments. In the general sense, it covers matters such as the deterioration of sight and hearing, memory impairment or memory loss. In the report, we look not only at persons who are elderly but also at the challenges facing children whose intellectual maturity has an impact on their ability to read subtitles. In principle, there can be other impairments that are related to stages in the person's life.

**Impairment, cognitive** affects the individual's ability to think, concentrate, formulate ideas, reason and remember.

**Impairment, dexterity** is reduced function of arms and hands that makes activities related to moving, turning or pressing objects difficult or impossible. This does not influence speech communication itself but makes it hard to make a phone call or use a wide range of other equipment.

**Impairment, hearing** is a generic term including both deaf and hard of hearing which refers to persons with any type or degree of hearing loss that causes difficulty working in a traditional way. It can affect the whole range or only part of the auditory spectrum which, for speech perception, the important region is between 250 and 4,000 Hz. The term deaf is used to describe people with profound hearing loss such that they cannot benefit from amplification, while hard of hearing is used for those with mild to severe hearing loss but who can benefit from amplification.

**Impairment, visual** Visual impairment (or vision impairment) is vision loss (of a person) to such a degree as to qualify as an additional support need through a significant limitation of visual capability resulting from either disease, trauma, or congenital or degenerative conditions that cannot be corrected by conventional means, such as refractive correction, medication, or surgery. The loss may cover visual acuity, significant central or peripheral field defects or reduced contrast sensitivity.

**Internet Protocol Television, IPTV** is a system through which Internet television services are delivered using the architecture and networking methods of the Internet Protocol Suite over a packet-switched network infrastructure, e.g., the Internet and broadband Internet access networks.

**Language condensation Captioning** is rarely a verbatim transcription of what is said in the soundtrack, but an edited version to convey the original sense of what was said while making sure that the viewer is comfortable reading the final result. As a result, the difference between the verbatim transcription and the final result involves language condensation.

**Metadata** is data about data, in this case information about television programs. This can be in the form of program listings or guides, or technical data delivered with the program to accomplish an access service.

**Metric** is a criterion or measure of success in reaching a particular objective or goal.

**Metric, Quality** is a measure of the perceived quality of a television picture or sound or associated service.

**MOOC a Massively Online Open Course;** a course of study made available over the Internet without charge to a very large number of people.

**Multiplex or mux** is also called a virtual sub-channel in the United States and Canada, and Bouquet in France. It is a group of TV channels that are mixed together (multiplexed) for broadcast over a digital TV channel and separated out again (de-multiplexed) by the receiver.

**Over-the-top TV** Over the top Television allows you to view content that is available over the Internet. It is delivered via your broadband connection to your flat panel display or computer screen and so bypasses the traditional broadcast or IPTV providers of TV services - hence the term —over-the-top.

**Personal video recorder, PVR** is a consumer electronics device or application software that records video in a digital format to a disk drive, USB flash drive, SD memory card or other local or networked mass storage device.

**Play-out centre** A play-out centre is the location from which a broadcaster dispatches a television channel either directly to a transmitter network or indirectly through a contribution system to one or more transmission networks.

**Program Guide, Electronic, (EPG)** an interactive program guide to provide users of television, radio, and other media applications with continuously updated menus displaying scheduling information for current and upcoming programming.

**Program Guide, On-screen** as distinct from program listings and guides on other platforms such as the Web, mobile phones and in print media.

**Re-speaking** is a means to provide real-time captioning for live events including television programs. It involves a captioner / subtitler re-speaking or dictating the captions that are transcribed using speech recognition trained to the specific re-speaker's voice and automatically formatted for display.

**Set-top box** is a device that enables a television set to receive and decode digital television broadcasts.

**Short-form video** is video in bite-sized chunks, unlike long-form video such as television programs and motion pictures.

**Simulcast** Simultaneous broadcast of a program on two or more distribution networks



**Smart phone** is a mobile phone that offers more advanced computing ability and connectivity than a contemporary feature phone.

**SMPTE** The Society of Motion Picture and Television Engineers, SMPTE is a technical society for the motion imaging industry.

**Spotting** The offline determination of subtitle timing (i.e. when subtitles need to appear) using a proxy or copy of the associated video content.

**Stakeholder** is a person, group, organization, or system who affects or can be affected by an organization's actions. In the case of television accessibility, the stakeholders are all those who have an impact on, or are influenced by the planning, production, exchange, delivery, use and enjoyment of television.

**Subtitling** is a generic term for the production of text as an alternative form of the audio content of Audio-visual Content. The term 'subtitling' is often interpreted as the process of translating the dialogue component of audio-visual content into text and displaying the text on the screen overlaid on the video image. [See also Captioning and Subtitling, Intra-lingual].

**Synthesis, Speech** is a means by which human speech can be created synthetically, rather than have to use recordings. It is used for car navigation systems, point-of-information kiosks and is being introduced as a means of offering Audio Captioning.

**Tablet or Tablet PC** is a device equipped with a touchscreen as the primary input device and designed for personal use.

**Teletext** is a television information retrieval service developed in the United Kingdom in the early 1970s. It offers a range of text-based information including closed subtitles and closed captioning. This service is typically available on page 888, but the actual page number depends on the broadcaster and country.

**Terrestrial Television** is a mode of television broadcasting which does not involve satellite transmission or cables — typically using radio waves through transmitting and receiving antennas or aerials. The term is more common in Europe, while in the United States it is referred to as broadcast television or sometimes over-the-air television.

**Transcription** is the representation of the sound track of a TV program in written form.

**Transcription, Verbatim** is a word-for-word representation of the sound track of a TV program in written form.

**Translation Subtitles** see Subtitling, Inter-lingual

**Vertical Blanking Interval**, (VBI) also known as the vertical interval or VBLANK, is the time difference between the last line of one frame or field of a raster display, and the beginning of the first line of the next frame. It is present in analogue television and can be used for data casting (to carry digital data), since

nothing sent during the VBI is displayed on the screen; various test signals, time codes, closed captioning, teletext, CGMS-A copy-protection indicators, and other digital data can be sent during this time period.

**Work, Derivative** according to US Copyright law is a work based upon one or more pre-existing works, such as a translation, musical arrangement, dramatization, fictionalization, motion picture version, sound recording, art reproduction, abridgment, condensation, or any other form in which a work may be recast, transformed, or adapted. In the case of subtitles and captions, both of these services can be regarded as derivative works. The question about their use or re-use by third parties or in new contexts is whether the original agreement contemplates such exchange and use of access services.

**World Wide Web Consortium, (W3C)** is an international community that develops standards to ensure the long-term growth of the Web.

## 2. State of the Art and Results from Past Projects

The following chapter gives an overview on the actual state of the art for UI accessibility on different platforms on an operating system as well as on a web browser level. In addition we will give a brief summary on the web accessibility guidelines from W3C (WAI), which have been used as a conceptual basis for the UI designs of the services and applications targeted in this Pilot. It also gives an introduction to the GUIDE UI adaptation framework, which in this Pilot is used as the basis for an online UI adaptation and personalisation service.

### 2.1. Existing UI customisation approaches

#### 2.1.1. Browser Add-Ons

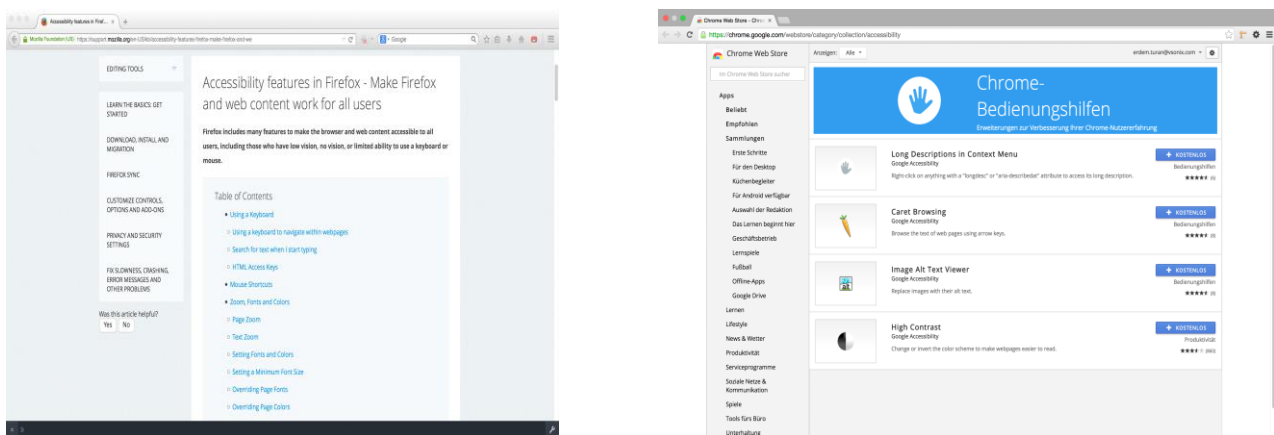


Figure 1. Accessibility features in Chrome.

In the current state of web accessibility the browser plays a major role. Almost all of the most popular browsers support the option to change the text size of the web content for example. They utilize different features like increased contrast mode, font selection and zoom options to increase the accessibility of the

content. Among these browsers, Firefox is the most advanced by adding options for contrast optimization, color settings and the highest compatibility with different accessibility APIs. Thereby Firefox is able to adopt the settings used by the Operating System. Mozilla is also anxious about increasing the amount of additional tools in the form of add-ons. There are some to increase button and size, reader and magnifier. Chrome on the other hand provides a different approach to the add-ons. There are for example developer tools, which can help designing and developing accessible web pages.

Both Safari and Internet explorer are designed to work with the accessibility tools provided by the respective OS. Whereat Internet Explorer there is a noteworthy add on for Internet Explorer. Microsoft provides to download an additional tool, which is able to analyze the interface and the web content to display all the interaction options by little numbers. The user is thus able to speak the numbers to navigate the website. This is protracted, but useful. The only problem is again to access the accessibility features, since impaired users do have problems to enable these tools.

## 2.1.2. OS specific accessibility functions

### 2.1.2.1. Android

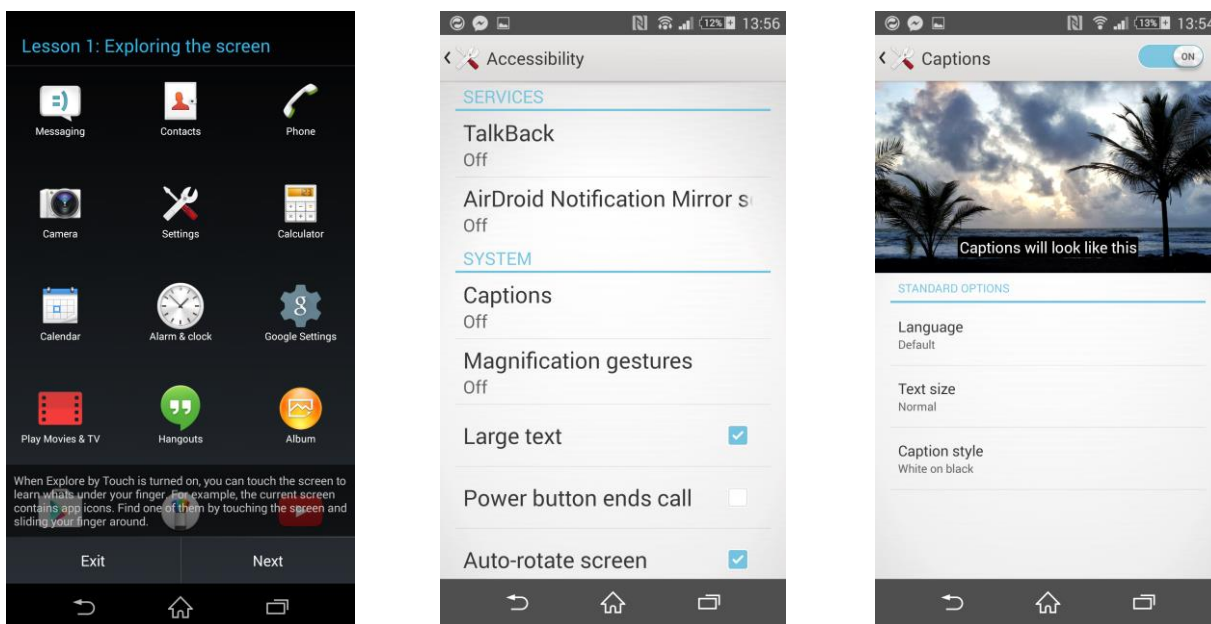


Figure 2. Accessibility features in Android.

The Android platform is because of its ability to fully customize the only platform which is completely adaptable for the user. It is possible to download launcher and special icons. The user can add features and change interaction methods. It is even possible to change the complete UI to the preferences of the user. Google also allows third party companies to make changes in the UI. Android also offers screen reading functionalities for blind and braille support. In theory, this is the best condition for an accessible UI, but unfortunately it is not enough in the real usecase. All these options are available hidden in the settings and in

the store. Activating the screen reader for example requires to complete a guide with very small text on semitransparent backgrounds floating above the interface.

### 2.1.2.2. Windows

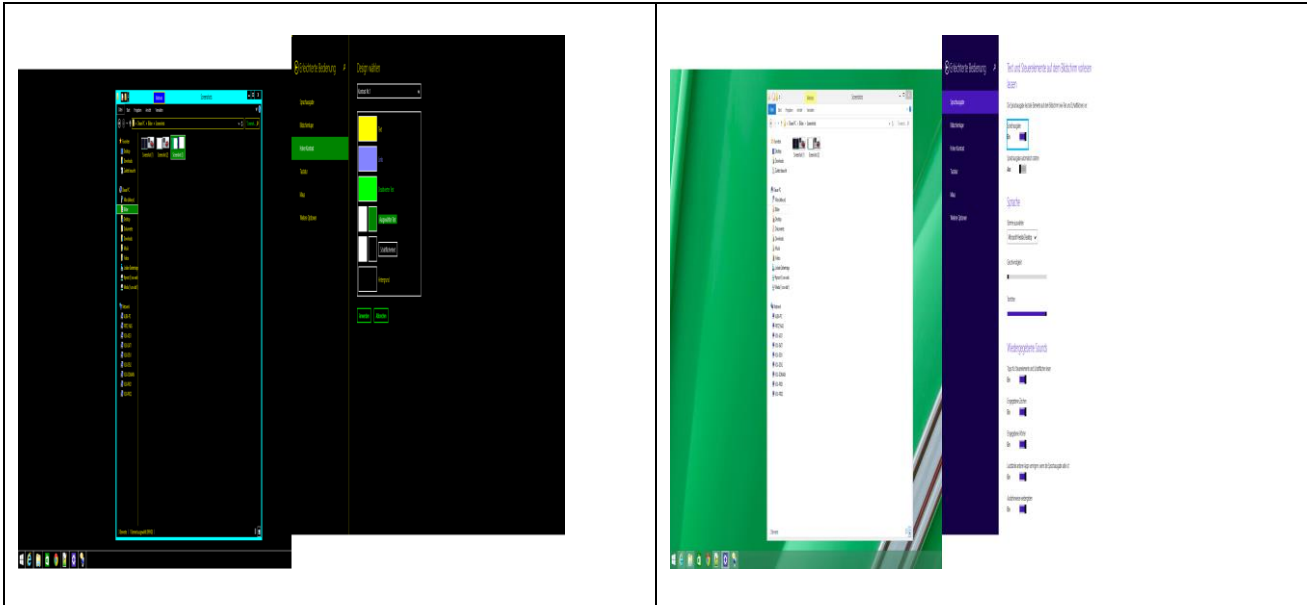


Figure 3. Accessibility features in Windows.

The most recent 8th version of Windows provides also a variety of accessibility features. The main focus is the adjustable screenreader. The User is able to select a voice, which appeals him best and is also able to change the speed and voice pitch. By navigating via mouse or the keyboard, the user gets detailed information about the selected item and further options.

Microsoft also provides a very interesting solution for voice controlled interfaces. This is an additional software MS offers for free. The software places an overlay on the screen and displays numbers for every interactive element on the screen. The overlay is displayed in regular intervals. The user is now able to navigate by speaking the associated numbers. Unfortunately Microsoft only provides this additional software for the Internet Explorer and thereby the users are forced to use Microsoft's proprietary systems and solutions.

### 2.1.2.3. iOS

Apple's mobile operating system provides a few more accessibility features. Contrary to the OS X there is an option to increase the font size, which is very necessary for visually impaired people, since the UI font is again Helvetica Neue. iOS also provides an Option to set the font to bold. Analogous to OS X, there are options to increase Contrast, reduce transparency and miscellaneous other options for Subtitles and media accessibility features such as audio description. Especially the ability to design own subtitles might seem very accessible at the first sight.

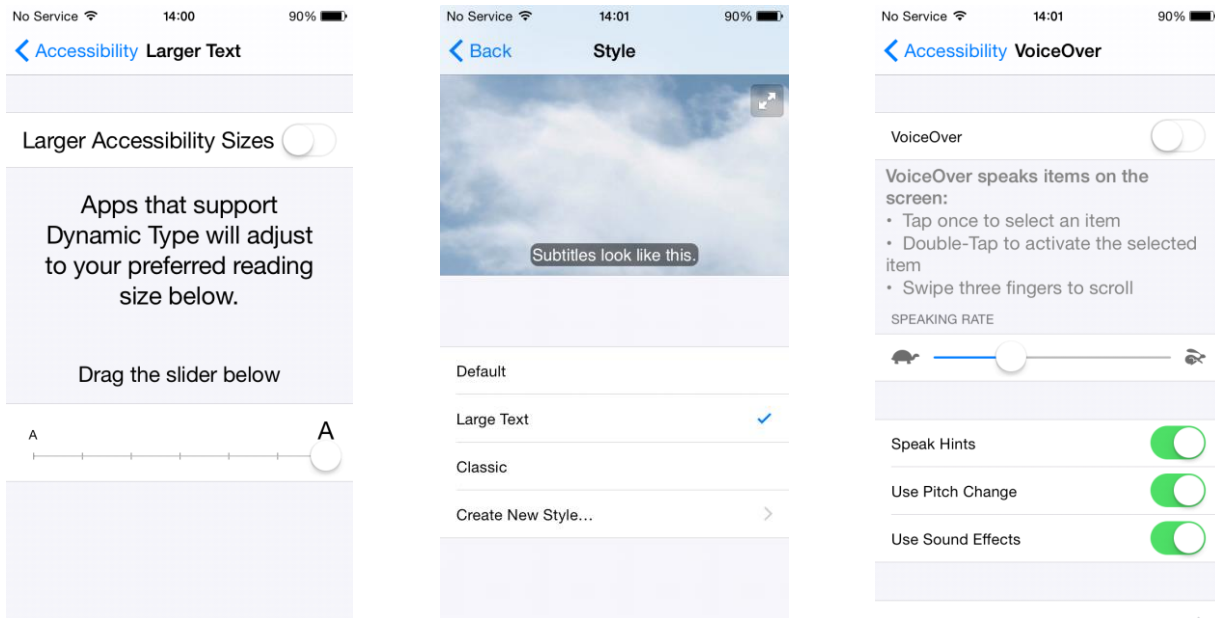


Figure 4. Accessibility features in iOS.

### 2.1.2.4. MacOS

Mac OS provides accessibility tools like inverting colors, a magnifier and a tool to explain selected UI elements in text or in spoken language. It's very sophisticated in some parts and assists users with different disabilities in their everyday digital life. But there are also very profound accessibility issues like the UI font. With the upgrade to Yosemite Apple redesigned big parts of their UI and changed the font from Lucida Grande to Helvetica Neue. The new font is pretty to look at but provides less legibility and contrast, especially in small sizes. OS X also does not offer an option to change the font size, which is a big issue for visually impaired people. There is only one possible solution to display the font bigger. The user is able to select a larger scaled interface with bigger fonts and bigger window decoration. In return the user gets less space to work on his desktop and the viewport of the Browser decreases.

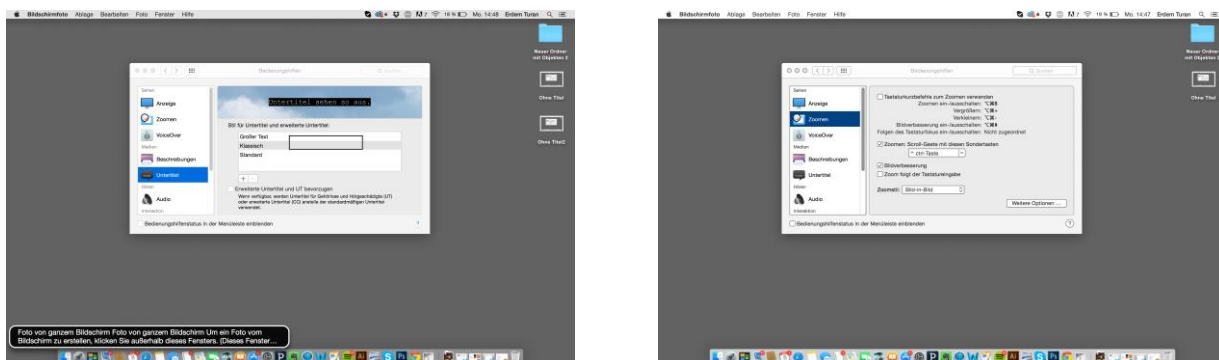


Figure 5. Accessibility features in MacOS.

## 2.2.W3C – WAI standard

### W3C - WAI Accessible Website

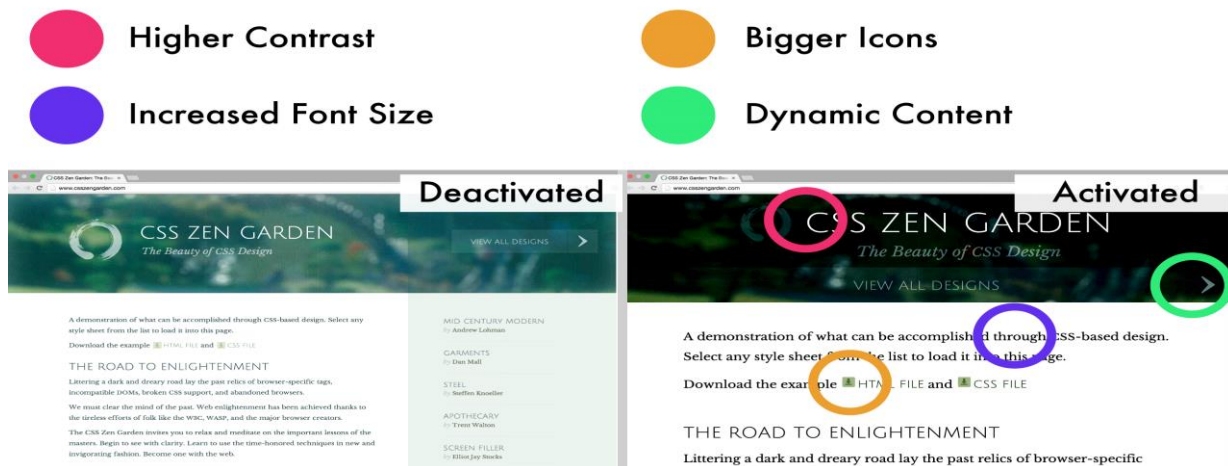


Figure 6. W3C-WAI conform accessible website.

The W3C accessibility standards aim is to make the web accessible and universal regardless of the disability under the premise that accessibility means social inclusion. The Web Accessibility Initiative (WAI) emerges for that proposes with the intention of presenting a standard that includes all the components on web development as such as: the content itself; Web browsers, media players, and other "user agents"; assistive technology; users' knowledge, experience; developers; authoring tools; and the evaluation tools.

One of the guidelines from W3C-WAI that are relevant for the HBB4All project are the WCAG 2.0 Guidelines. They intend to provide a single shared standard for web content accessibility that meets the needs of individuals, organizations, and governments internationally. The WCAG documents explain how to make web content more accessible to people with disabilities. Web "content" generally refers to the information in a web page or web application, including natural information such as text, images, and sounds as well as code or markup that defines structure, presentation. The guidelines are organized in 4 principles, which are that web content needs to be:

- **Perceivable:** This includes the provision of text alternatives for non-text content as well as captions and other alternatives for multimedia. It also includes that content can be presented in different ways without losing meaning as well as to make it easier for users to see and hear content.
- **Operable:** Here the guidelines recommend to make all functionality available from a keyboard as well as to give users enough time to read and use content.
- **Understandable:** Text shall be readable and understandable, whereas content should always appear and operate in predictable ways.

- **Robust:** This shall be achieved by maximizing the compatibility with current and future user tools.

### 2.3.Limitations of existing accessibility approaches

The availability of accessible, personalisable user interfaces, being capable to adapt to the specific needs and requirements of users, is still very limited. As depicted in this chapter there are numerous APIs available for various operating systems or application platforms (e.g. in Web browsers) that allow developers to provide accessibility features within their applications. Further there are of course many assistive devices and technologies available, especially for people with specific impairments/disabilities (e.g. brail code rendering, screen readers, etc.). However there are several limitations as all solutions are restricted to a single browser or system, whereas the user profiles that are storing the parameters from one solution to the other are not interchangeable between browsers and systems. This leads to the point that users need to adjust their setting on all systems and browsers that they are using. Also, web applications are not capable to get information about the user requirements in a unified way in order to adapt their UI to be suitable for the user, without e.g. destroying the application’s UI layout.

For example, both iOS and OS X provides in theory a good mix of accessibility features. However they are useless in terms of web content. The very sophisticated options for subtitles for example are not applicable for HBB content, online Media Libraries, or VOD services. Most of the features work only for proprietary content from the iTunes store and local saved media. Even though the accessibility features are manifold they are useless if they only work in the Apple universe.

The overall concept of this Pilot based on the UI adaptation framework provided by GUIDE (see next chapter) on the other hand delivers the option to enable all accessibility features for content and interfaces from a variety of sources. The idea is to make the content and UIs accessible in all applications and content that use the framework independent from the manufacturer, OS or browser provider.

### 2.4.GUIDE UI framework

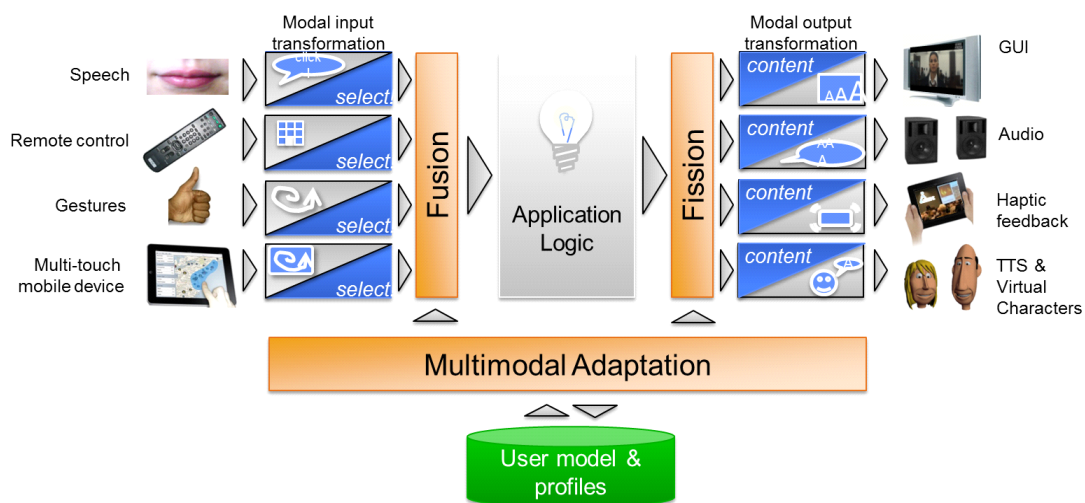


Figure 7. GUIDE Framework overview.

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).

The GUIDE adaptation framework serves as the foundation for the GUIDE API service developed in HBB4All. 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 (see chapter 4.4). AccessGUIDE will store collected user information through the GUIDE API in its online



database storage (see chapter 7.3). Furthermore, the existing accessibility features of the User Initialisation Application will be improved in accordance with existing accessibility standards such as W3C WAI recommendations.

### 3. Challenges, Technologies and Concepts

The main objective in Pilot-C is the realization of an UI adaptation and personalisation service that allows the unified provision of personalized accessibility for HbbTV applications as well as services for PC and mobile applications. The adaptation service will be based on the UI adaptation framework that was developed in the EU project GUIDE “Gentle UIs for elderly people” by Fraunhofer IGD together with Vsonix and other partners and which is now further maintained as an open source project under the Apache License. The UI adaptation framework in GUIDE was implemented as a local service to run as a stand-alone UI middleware being an add-on of the Set-Top Box’ operating system.

In order to provide UI personalisation on different devices and browsers in unified way, the transition for the GUIDE framework has to be made within this Pilot from a local service to an online service (see chapter 7.3), accessible by all web (in our case HTML 5) based applications. From a technical point of view, this transition from a local UI service to an online service that is accessible and usable by any web based application is the main challenge that we address in this Pilot.

The online service provided by Vsonix includes APIs and functions for user management, profiling as well as the mechanisms needed for UI personalisation and adaptation. The adaptation parameters provided by the service include e.g. font size, type and colour, optimized colour schemes as well as an online screen reader service for people with visual impairments. It will further include means for personalised subtitle rendering (as part of Pilot-A) for people with hearing problems.

Whereas GUIDE was originally intended to address the needs of elderly people with typical age related visual and hearing impairments, the concept now includes users of all ages with mild to moderate hearing and visual impairments. To determine the adaptation parameters for the individual, the Software as a Service (SaaS) platform of Vsonix will include an application that allows to determine the UI adaptation parameters for individual users in a compelling and interactive way.

The main challenge to be addressed in the conceptualisation of this application is that it needs to be accessible and usable for all people within the target group. It has the need for a truly inclusive design, whereas it acts as a first entry point for the users, when they access the service that is integrating the UI adaptation framework. The application will allow the adjustment of UI parameters on a default as well as on an application level.

This chapter gives an overview on the main challenges of the Pilot faces from a conceptual as well as from a technical point of view. It will provide information about available technologies that have acted as a starting point for this Pilot as well as about the concept of the AccessGUIDE application that will be one of the main technical outcomes of the Pilot beside the online UI adaptation service.

### 3.1. Challenges of UI personalisation/ adaptation

Pilot C addresses UI personalisation and adaptation from a user perspective. It targets the provision of a unified framework for the integration of accessibility features for people with mild to moderate hearing and visual impairments. The features to be included by the Pilot are analysed through the focus groups as well as through the user tests in the pilot. The aim of the trials are to test the different features of the UI adaptation framework from accessibility as well as from usability aspects (see chapter 7). This includes standard parameters for the UI adaptation part as font types or colour schemes, advanced parameters such as different types of audio feedback, e.g. while browsing through the content, screen reader parameters such as voice type, speed of speech output, latency aspects, e.g. between user interaction and speech output. Regarding the personalized subtitling features of the MOOC application, aspects such as subtitle position, font types, colour and sizes, types of background, as well as synchronized second screen rendering will be tested.

### 3.2. Challenges of integration in software development workflows

The provision of accessible user interfaces is still expensive and risky for application developers, as they need special experience and effort for user tests. Many implementations simply neglect the needs of users with age related impairments locking out a large portion of their potential users. Nowadays, there are few service providers on the market, for example with services for elderly people, who provide some basic means of manual adaptation (e.g. text size, colour scheme or voice control). Instead, these features have to be manually integrated, since they do not provide automatic or guided personalisation, and they cannot be re-used or shared among services or different market participants.

### 3.3. Available technologies

In the following we will describe existing technologies available from the different partners of this Pilot and how they will be used, respectively adapted in the course of the project.

#### 3.3.1. *GUIDE framework*

The GUIDE UI adaptation framework focuses on adaptations to the user interface such as changes in font size, colour scheme, and user language in order to overcome limitations in the user's capabilities to interact with applications due to age-related restrictions. Furthermore the framework provides additional means of inputs to the user such as speech input in order to overcome limitations imposed on users with physical disabilities that do not allow them to perform input actions on conventional input devices.

In HBB4ALL we transition the user interface adaptations supported by the framework from the local domain (set top boxes) to a public online service including the necessary user management and profile storage solutions, so that HbbTV application may easily include the functionality offered by the framework without requiring the installation of software or browser extensions (as was the case in GUIDE).

### 3.3.2. GUIDE User initialisation application

The GUIDE user initialisation application is a substantial part of the GUIDE framework. It is used for making relevant user information accessible to the framework. By performing a series of simple tests with the user at the very first system execution, this one-time process establishes a user profile that correctly reflects their impairments. The user initialisation application serves as the starting point for new users because it also introduces them to the range of available input and output modalities such as speech recognition, gesture recognition, avatars, and remote control.

In HBB4All the user initialisation application will be transitioned from a local application installed on a set top box or connected TV to an online application that may simply be included in any web based application or service . The user initialisation application will be rebranded “AccessGUIDE” to better reflect its use in the HBB4All project and its user interface will be restructured to further increase its usability.

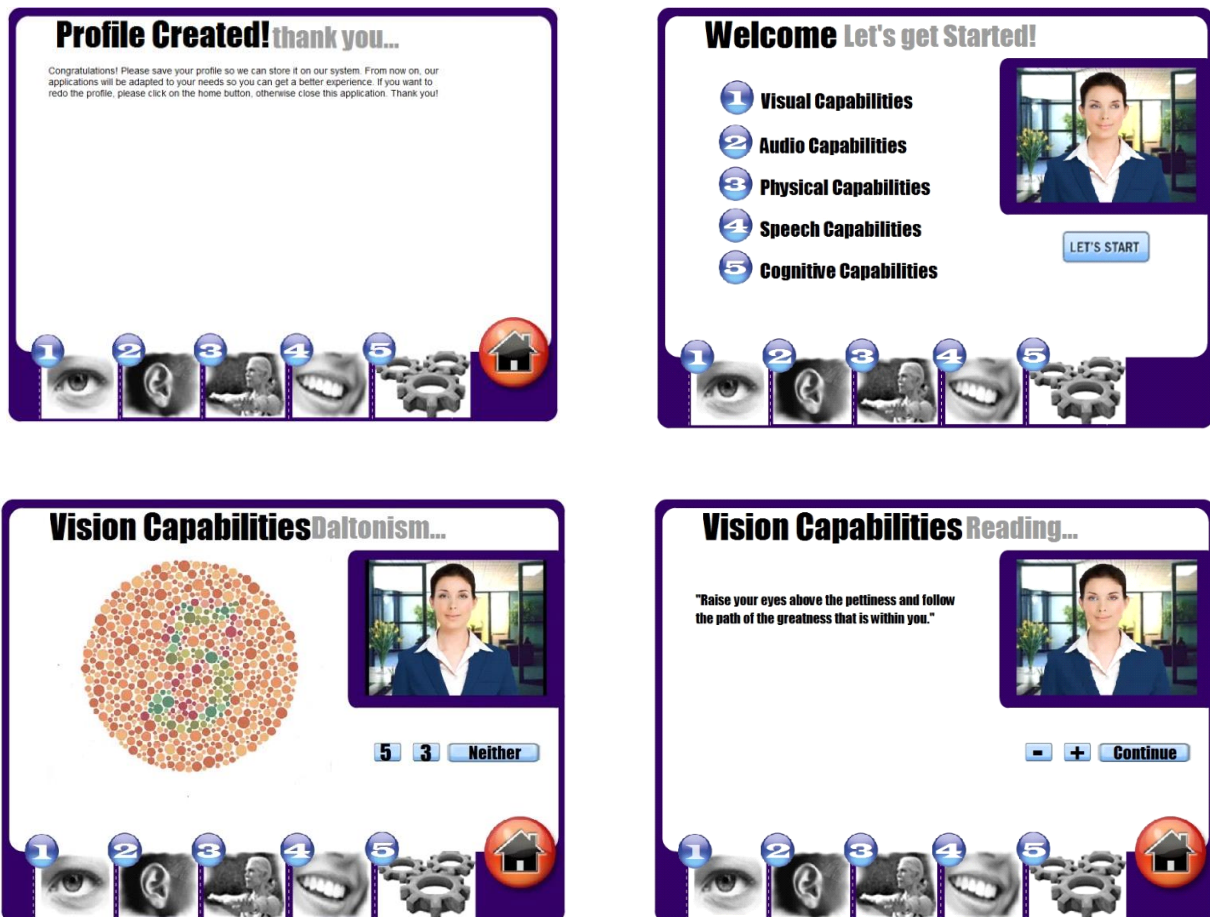
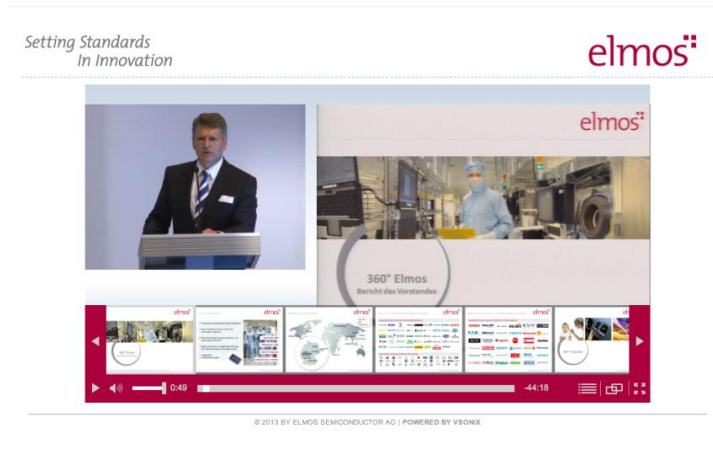


Figure 8. Sample Screens of the existing User initialisation application from GUIDE.

### 3.3.3. vPlayer



**Figure 9.** Sample Screen of the vPlayer.

vPlayer is a powerful tool to present webcast content over the internet. It is a rich media player that can be seamlessly integrated into any web page. By offering both an Adobe Flash based as well as an HTML5 based version it enjoys a wide compatibility and acceptance across all desktop operating systems including Windows, Linux and MacOS X and mobile platforms (iOS, Android, Windows Phone).

One of its key features is the synchronized playback of video, slide and text content, which is combined with various intuitive search and navigation features: In particular, end-users can choose between navigation via video timeline, via slides (based on titles and thumbnails) or via a full-text search field. When interactively working through presentation content, these utilities complement each other. The front-end of vPlayer and its navigation features are depicted in the figure above.

In Pilot-C of HBB4All, vPlayer will be used as the media playback component of the MOOC service for media accessibility (see chapter 5.2) in order to playback the lecture content of the online courses on PCs and mobile devices.

### 3.3.4. vManager

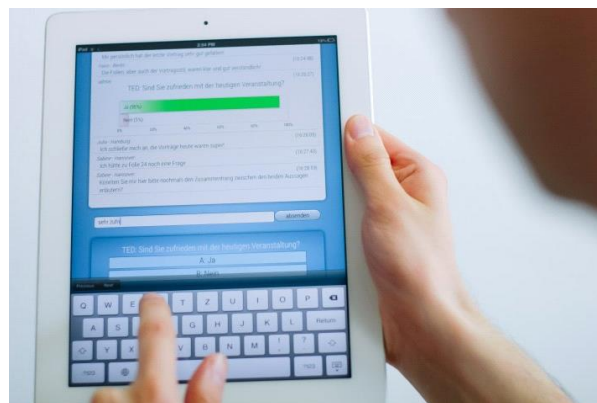


**Figure 10.** Sample Screen of the vManager.

vManager is an integrated solution for editing, managing and analyzing webcast content. It serves as an authoring and post-production tool for video content and includes functions for automatic video annotation, basic video and audio editing functionality, annotation of video with additional information as slides, text, video and images as well as webcast rendering to different platforms. Additionally, state-of-the-art video analysis tools provide an automatic indexing of presentation slides to achieve chapter navigation using our vPlayer. Since it is accessible via a web front-end, it is platform independent supporting all major desktop and mobile platforms.

In Pilot-C of HBB4All, vManager will be used as the content management component of the MOOC service for media accessibility (see chapter 5.2) in order to playback the lecture content of the online courses on PCs and mobile devices.

### 3.3.5. *vInteract*



**Figure 11.** Sample Screens of the vInteract.

vInteract serves as a connector between viewers of a live stream and speakers as it enables the direct communication between all participants. It is accessible from all major desktop and mobile platforms and can serve as a second screen application during an event.

By offering a chat module, viewers can discuss topics during a presentation or ask questions. Since this happens in real-time, speakers can directly approach these questions and thus answer them immediately. Furthermore a TED functionality amplifies this interactive experience by integrating viewers directly into a talk or presentation. Since it is accessible from mobile devices vInteract could be used as a stand-alone-application serving as a second screen for on-site participants.

### 3.3.6. *PPG - TV AppBox*

The PPG – TV AppBox is a result of years of experience in developing TV apps for different platforms and standards. The TV AppBox has bundled all unique features and knowledge into a framework.

With the TV AppBox PPG can build the TV app for the project only once and deliver it cross-platform, supporting all major SmartTV platforms as well as the interactive TV standard “HbbTV”.

The TV AppBox consists of 5 intelligent engines and cloud-scaled services that enable us to tackle every aspect of development.

- ScreenSync Engine
- MediaPlayer Engine
- Content Engine
- Payment Engine
- Template Engine

### 3.3.7. SCREEN-HbbTV Interactive Application publishing system



Figure 12. Sample Screen of SCREEN HBBTV interactive application.

Plasma Gold from Screen is a well-established, mature system for publishing interactive content on a variety of platforms, predominantly Digital TV platforms such as MHEG, MHP, OpenTV and HbbTV, but also to Teletext, Mobile Phones and Desktop browsers. It is in active use by broadcasters in Europe as well around the world to supply information services to viewers.

Plasma Gold simplifies the publishing of the same content to multiple platforms based on platform-specific templates that tailor the content to the capabilities of the target devices. The Plasma Gold software can receive or request data from various sources such as news feeds, weather information and sports results, and transform them into displayable content and publish the changes in real-time.

The Plasma Gold software uses editor defined templates to adapt the same content across all platforms, and content can also be manually created or edited directly within the system. The system can also export content

to other publishing systems (e.g. as an XML feed). The software organises the information within a structured hierarchy and supports multiple links between ‘pages’ of content.

Within Pilot C SCREEN will adapt the existing HbbTV output mechanisms within Plasma Gold to integrate the UI adaptation concept from the GUIDE project, allowing a user of the information services to tailor the appearance according to their preferences or needs. The user will be able to select a previously created GUIDE user profile, which will be used to adapt the presentation of content to the viewer. The adaptations planned to be supported include font size, font foreground and font background colour, simple navigation, and high contrast highlighting of the currently selected on screen object. The adaptation of Plasma Gold to support simple screen reader functionality (using Text To Speech) will also be investigated.

To support certain axis of adaptation (e.g. font size that affects page layout) the Plasma Gold system may automatically generate parallel copies of content pages – i.e. ‘server side’ adaptation. Other adaptations will be implemented actively in the client device (in effect in the HbbTV browser, using script that modifies the styling of the content dynamically in line with the viewer’s profiled preferences or requirements). It is planned that the viewer will have access to controls that enable specific adaptations directly on the displayed page of content, allowing them to temporarily override any stored profile preferences if desired (or to adapt specific pages as necessary).

### **3.4. AccessGUIDE concept**

An essential part of the UI personalisation framework is the user profiling application (AccessGUIDE) that will be used to determine the UI customisation parameters for the individual users. In HBB4All the UI adaptation framework as well as the AccessGUIDE application already includes customisation capabilities for subtitling as well as for the user interface itself. The UI adaptation framework was conceived to be expandable also to other interface modalities as those targeted in Pilot-A (subtitling) and Pilot-C (GUI). Therefore also the design of the AccessGUIDE application is realized in a way that it could also include other modalities with personalisation parameters such as the clean audio approach targeted in Pilot B as well as the sign language interpreters from Pilot-D. The application is designed in a “one fits all” manner, with very low accessibility barriers for the whole target group as it will be used as an initial step to determine the individual user needs.

#### ***3.4.1. Pre-conditions***

Vsonix commenced the project with a comprehensive analysis of the GUIDE framework and its user initialisation application. Based on the insights gained from the GUIDE project Vsonix has started to design and develop the AccessGUIDE for PC and mobile applications, whereas PPG has started to transfer the initial design of the application to be used on HbbTV platforms. Since GUIDE was more focused on various different input methods, there had to be changes made for the AccessGUIDE application, because mobile and computer interfaces do not provide the same input methods like the ones used in GUIDE. The application design will focus on various aspects including:

The transition of the GUIDE user initialisation application to become a unified expandable online service for personalised accessibility .

The redesign of the application in a one fits all manner with low entry barriers taking into account accessibility and usability aspects of the users in cooperation with UAB. This will be based on the focus group discussions and early user tests conducted in the Pilot (see chapter 7).

The integration of the accessibility aspects provided in Pilot-A and Pilot-C into the application.

The provision of the application for PCs and mobile devices by Vsonix as well as for HbbTV platforms by PPG.

In cooperation with UAB, the core functionalities were selected to optimize the user experience. The outcome was that these features are included in the concept of AccessGUIDE:

- Interface text size
- Interface text-background contrast
- Interface background transparency
- Colour options
- Subtitle size
- Subtitle position
- Subtitle colour options
- Subtitle background transparency
- Screen reader availability
- Screen reader voice selection
- Screen reader volume and speed

As a first result of our user research (see chapter 7), UAB demanded for additional support for audio description, narrated subtitle options and therefor a language selection for the subtitles. These features were also added to the feature set. Subsequently Vsonix and PPG carved out the conceptual differences in the design for the TV, which is developed by PPG.

Design features for accessibility needs sensitiveness, because it is difficult to find the right balance between the amount of help and paternalism. Impaired people want to be able to use the internet and digital media without any problems like unimpaired people. What they surely do not want is to be treated like helpless children. Consequently the goal is to provide specialized assist to impaired people without the feeling of being treated specially. Therefore, we conceived the UX more like an open, friendly personalization tool, which can be used from everyone, who set his preferences. This approach offers a trustful, pleasant



environment to let the user reflect about his own needs from the media and makes him able to apply his preferences without any efforts.

### **3.4.2. User flow**

The first time the user visits an application that integrates the GUIDE UI adaptation framework such as those services targeted in this pilot, the system informs the user with a restrained modal dialog about the ability to set preferences for the user interface. The user is now able to refuse or to start AccessGUIDE directly. By no reaction from the user, the system starts a countdown from ten and starts the application automatically.

The process begins with asking the user, if there is any need for a screen reader. Most blind people, who uses the internet are surely also using screen readers for orientation, but since a lot of the media libraries are using flash, the screen readers are not working. And the screen reader is also not working with subtitles. To fill this gap, the UI adaptation framework provides an online screen reader service. The user is able to activate the screen reader already in the beginning. In the next step the user is able to add a profile. Here, the user can select an Avatar from a variety of unique and stylized avatars for his profile for later identification. Both the web and the mobile versions also include a step for the user in which he can give his profile a name.

By completing this, the user gets an explanation of what he can do in AccessGUIDE and how he can do it. The instructions will be provided as texts or as video, which will be based on the results from the usability tests for the AccessGUIDE targeted in January 2015.

The main adjustable options are arranged in three categories. UI text options, contrast options along with colour options are grouped in the display options. Subtitle options are also summarized as well as audio options like voice speed and gender. The user is able to navigate to these options by using the side bar or by clicking on the "OK" button, which applies the changes and leads to the next step. After the user runs through the options he wants to adjust, he gets an overview of the changes he made. This overview will be displayed like a dashboard and be always the main landing page if the user starts AccessGUIDE the next time. From here, he is directly capable to jump to the settings he wants to correct or save his changes, close AccessGUIDE and get back to the application. Every change he made should be already applied to the interface of the media library in the background.

To improve the user experience, the "AccessGUIDE"-setup is designed to be used as less as possible, since the user is more interested in the media content as in personalizing the interface. The user is able to restart Access Guides main setup with the button provided by the broadcaster on his page. By clicking on this button the first set-up begins automatically, if there is no profile already. A user who already created a profile is presented within the Quick Access Menu. The Quick Access allows to make content based changes, a fast option to switch between profiles and a button to go back to the AccessGUIDE main system. The content based options are a necessity, since some options are completely dependent from the content, like the position of the subtitles. To provide an option for changing some settings on the go, without being distracted from the actual media content. The Quick Access delivers a variety of settings, which include Interface text size, based on the different broadcaster, subtitle position and options for enabling audio description. Also there is the option to start the main AccessGUIDE software.

### 3.4.3. UI Concept of AccessGUIDE for PCs

AccessGUIDE first introduces the user and explains the following steps:



**Figure 13.** Access GUIDE Welcome Screen. In the next step AccessGUIDE offers to enable an assistive audio guide, which includes a screenreader for blind people. Thereafter the user is encouraged to create his profile by choosing an avatar and entering a profile name.



**Figure 14.** Access GUIDE User Profile Screen.

This is followed by the Settings for the display, subtitles and audio.

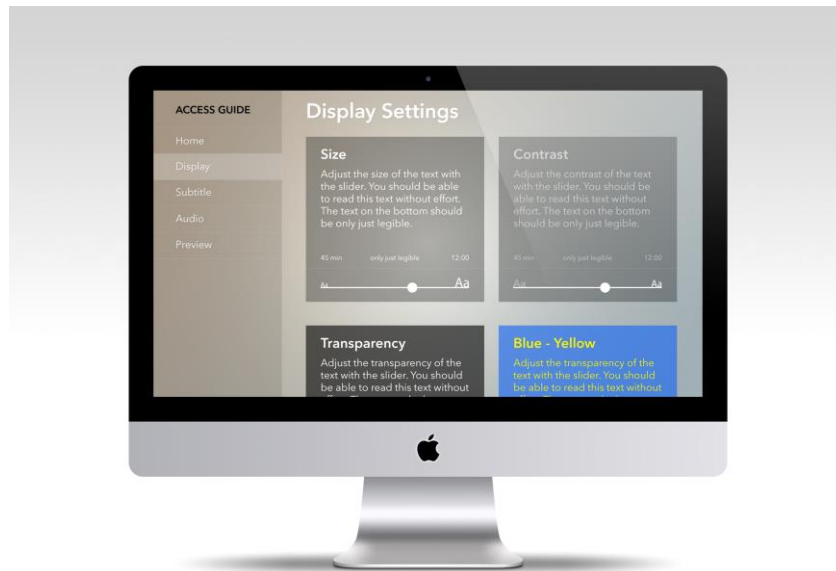


Figure 15. Access GUIDE Display settings menu.

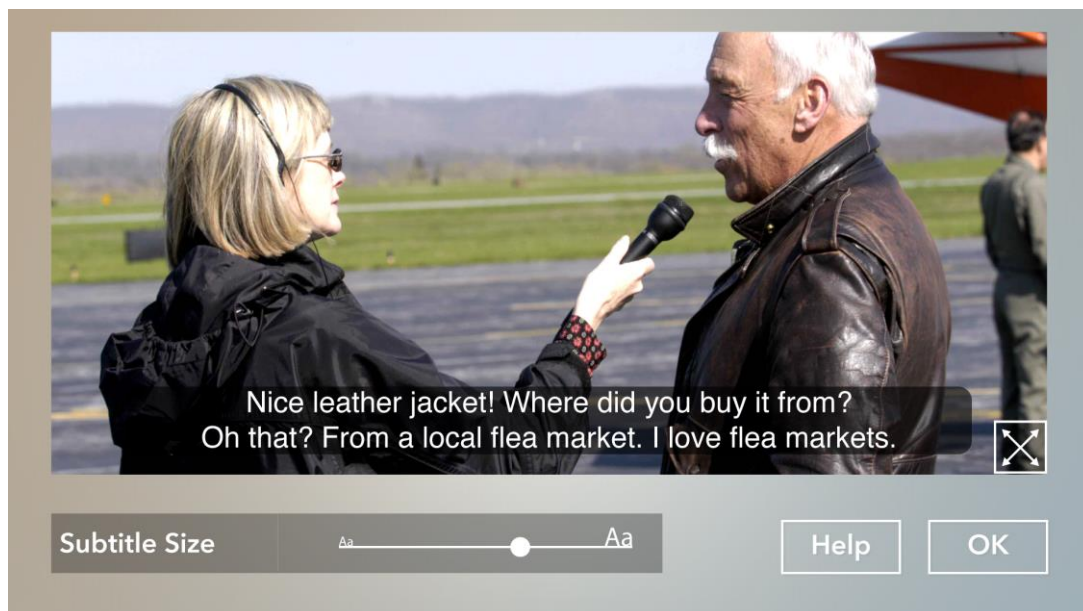
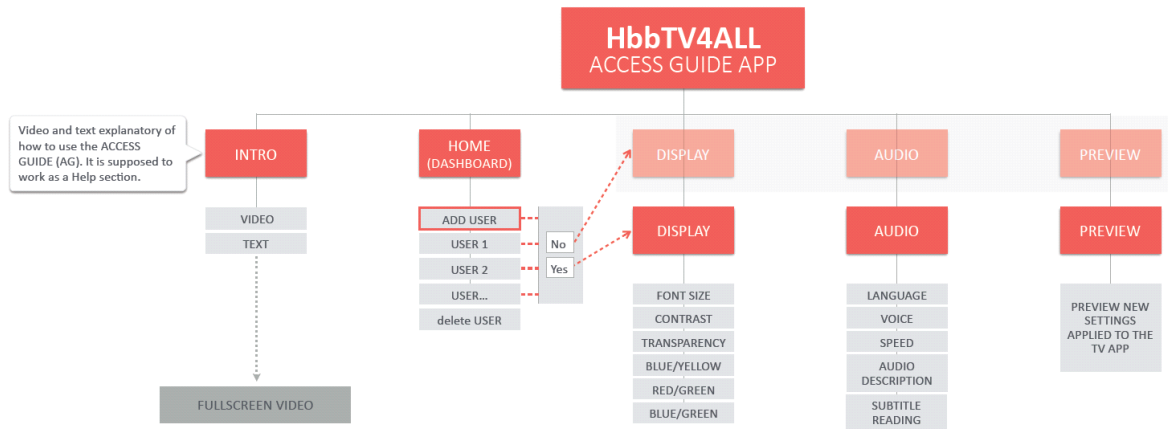


Figure 16. Access GUIDE Subtitles menu.

Access Guide finally provides an overview of the changes and the user is then able to save his changes and go back to the content. Meanwhile AccessGUIDE applies the changes to the interface and provides the option to have peek at the changes with the preview feature.

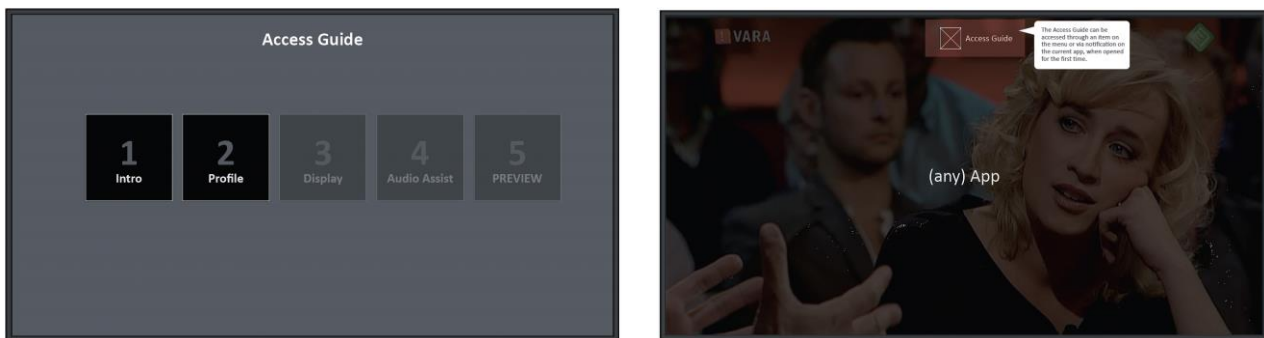
### 3.4.4. AccessGUIDE for Smart TV



**Figure 17.** Access GUIDE for HBBTV Function Overview.

The AccessGUIDE for Smart TV in the Netherlands will be integrated to the Catch-up TV application of the Dutch Public Broadcaster (NPO). The Access Guide for Smart TV will take the remote control in consideration when adjusting the settings. Therefore the settings are positioned differently from the online AccessGUIDE. The illustration below provides an overview on the available functionality for the HbbTV version.

In the following we will present the wireframes of the UI design as it is realized for the HbbTV version. This includes the first time access to the application: as well as the Home Screen.



**Figure 18.** Access GUIDE for HBBTV UI design.

Below we present the wireframes designed for the user profile organisation, the display as well as the audio settings:

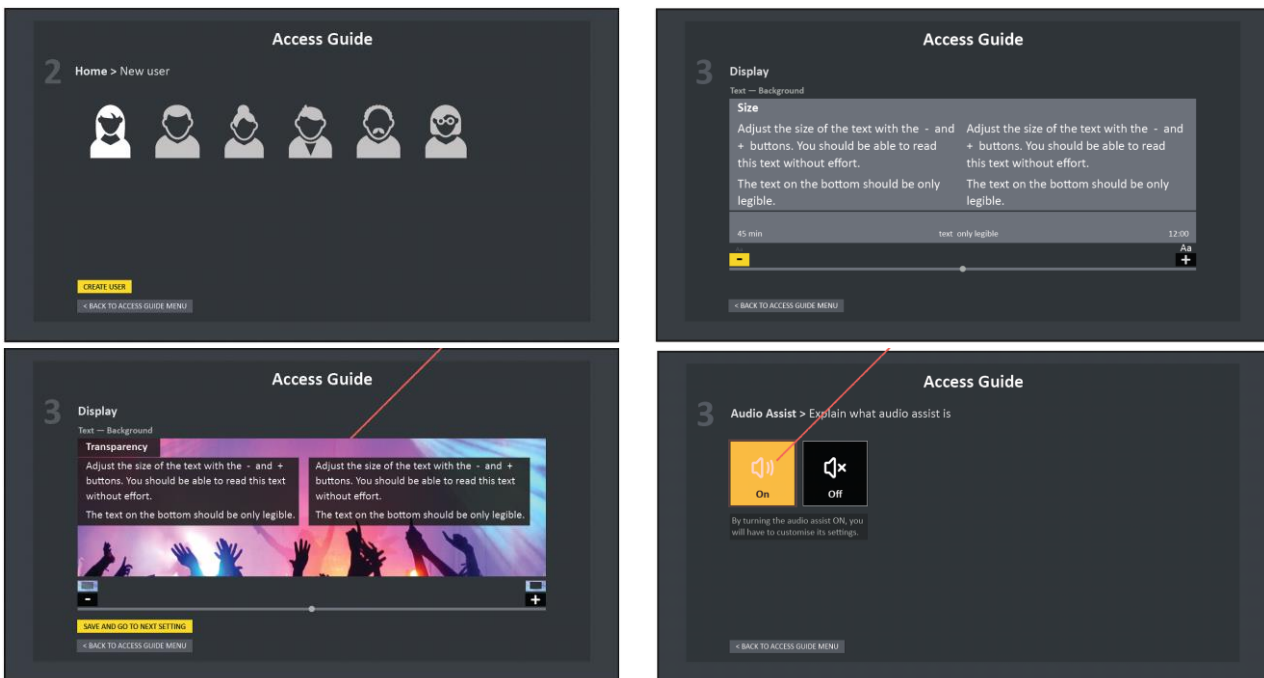


Figure 19. Access GUIDE for HBBTV Sample Screens.

## 4. Service pilots for Pilot-C

In the following we will give an overview on the service pilots targeted in the Pilot-C subproject, on which we have already started to work in the first year of the project. Those pilots include the AccessGUIDE, which usability and accessibility aspects are examined in various focus group discussions and user tests (see chapter 7). Those either have been conducted or will take place mainly in the first half of the second project year. The AccessGUIDE will be implemented as PC and mobile version by Vsonix as well as a version for HbbTV platforms by PPG.

The GUIDE based online service and its personalized accessibility features are integrated in different Pilots realized by Vsonix, SCREEN and PPG in collaboration with UAB and IRT. In cooperation with UAB, Vsonix works on a MOOC (“Massive open online course”) on media accessibility, which is planned to be provided as a webcast service for users in Europe in English with German and Spanish subtitles for PCs and mobile devices. The MOOC showcase will act as a cross-pilot showcase addressing Pilot-C and Pilot-A, where the GUIDE based online service will be used for personalized subtitle rendering. Beside the MOOC, PPG works on a showcase for HbbTV with content from NPO using the framework. SCREEN will integrate the accessibility features within a prototypical media on demand service based on their HbbTV publishing system.

## 4.1. AccessGUIDE – Germany, Netherlands, Spain, UK

### 4.1.1. General Setup

As described in chapter 4.4, the AccessGUIDE will replace the user initialization application from GUIDE as an essential part of the UI adaptation framework. It was re-designed taking into account the accessibility and usability aspects of the target group, which are people with mild to moderate hearing and visual impairments. The application provides a number of standard-tests to determine the user's preferences / needs related to UI personalisation including parameters like font size, font type, UI contrast and color as well as screen reader parameters such as voice gender or speed of speech output, etc.

The AccessGUIDE is intended to be a standard online application for UI personalization on PCs, mobile and SmartTV platforms. It can be used by application developers as part of the UI adaption service provided by this pilot in order to determine the accessibility needs / UI preferences of their individual users for the user interface of an application (as in this pilot) and for subtitles (as targeted in Pilot A). In principal the concept of the AccessGUIDE can be extended to other modalities as those targeted in the project such as personalized audio rendering (Pilot-B) and signing (Pilot-D).

The AccessGUIDE will be itself an important component to be tested by users from the target groups in terms of accessibility and usability. As such it will act as an integrated pilot to be used in conjunction with the other service pilots.

### 4.1.2. Status of Work at M12

The concept of AccessGUIDE is fully developed and the interface design is prepared for the mobile (e.g. tablets) and web versions. Vsonix has also worked on a clickable prototype to test the application with UAB. The design changes, which have to be made for the TV version are developed with PPG and will be further refined by PPG. A first focus group discussion has been made to refine the requirements of the application. Vsonix and UAB are now preparing the user tests, which will be conducted in the first months of the second project year to find usability problems and needs for improvements in the concept.

### 4.1.3. Timeframe

Access GUIDE is planned to be available as a clickable prototype until mid-January 2015 for early usability tests. This is followed up by an evaluation phase of the test and a correction of the found usability issues, which is going to be finished until April/May 2015. In May UAB is going to execute an in-depth usability testing followed by detailed analysis of the results. The second amendment of Access Guide will finish until end of 2015 and therefore released to the public audience subsequently in December 2015.

Early 2014 – End of 2014	Specification/UI Design for AccessGUIDE for PC/mobile and HbbTV
End of 2014 – Mid 2015	Implementation of AccessGUIDE for PCs and mobile Platforms
End of 2014 – Mid 2015	User tests to test usability and accessibility aspects and to refine requirements in

	partnership with UAB
Beg 2015 – Mid 2015	Implementation of AccessGUIDE for HbbTV platforms
Mid 2015 – End 2015	Refinement of Accessibility GUIDE
Early 2016 – Mid 2016	Deployment of AccessGUIDE in large scale MOOC Pilot

**Table 3.** Planned AccessGUIDE timeframe.

#### **4.1.4. User tests**

Vsonix and UAB started the testing with an Expert Group discussion in Barcelona. Based on the results changes were made for the visual interface. Both Vsonix and UAB are going to make tests in the upcoming year to improve the application. Vsonix also seeks for cooperation with University of Applied Sciences Darmstadt to have a local partner for usability testing.

Regarding the HbbTV version of the application, PPG will work with UAB on usability and accessibility tests (see chapter 8.4) In addition, this contains an option to presents new ideas to an already existing test panel, with which PPG has worked in former projects with NPO. This test panel consists of around 40 households. These households contain families, singles and elderly.

#### **4.1.5. Validation Method**

For validation, UAB is going to prepare questionnaires, specific usability tests, including eyetracking methods and thinking aloud methods under the watch of Vsonix. The release version will include direct feedback methods to collect user sentiments.

### **4.2. MOOC – Germany, Spain**

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

Vsonix actually works on a video based learning application (“MOOC”), which is planned to be provided as webcast (online) service for Europe in German, English and Spanish. The MOOC will act as a cross-pilot showcase addressing Pilot-C and Pilot-A, where the online UI adaptation service targeted in Pilot-C based on GUIDE (see chapter 2.5) will be extended to also support user profiles for personalized subtitle rendering. The MOOC service will be available for PCs and mobile devices. It integrates a variety of functions including lecture content playback, user access and profiles, functions for social communication including messaging boards and chat as well as functions for learning assessment. Regarding its accessibility aspects it will include all the features of the GUIDE based online service including personalized font size, colour schemes, screen reader functionality as well as personalized subtitles|

The content of the MOOC showcase for Spain is developed by UAB. The goal is to provide an online course for media accessibility. The course will consist of a number of lectures addressing different aspects of media accessibility and interactive functions for learning assessment and feedback provision.

The MOOC service is actually integrated using software components developed by Vsonix including vPlayer, a Flash and HTML5-based webcast player that is capable to playback lecture and presentation content as well as vInteract, a software component that provides functions for social interaction including messaging, chat and voting functions. The MOOC will be hosted via Vsonix' content delivery network (CDN). The subtitle implementation for the vPlayer is based on common standards such as EBU-TT-D using the W3C Standard TTML for implementation.

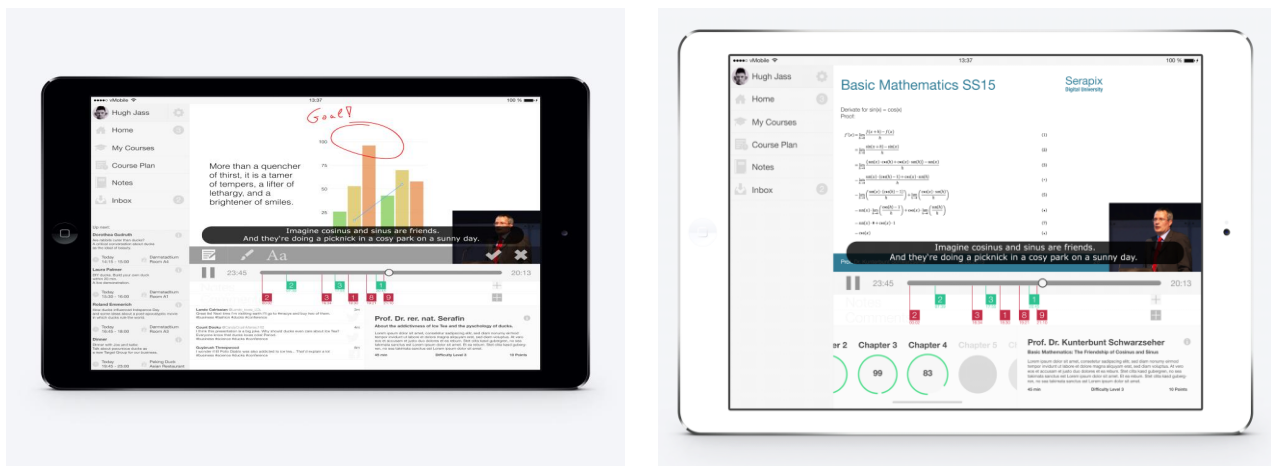


Figure 20. UI design for the MOOC application.

From a content perspective, UAB has prepared a series of lectures that have been and will be further recorded by UAB and Vsonix to be used in the MOOC. The course will introduce students to the principal systems ensuring accessibility to these content and services. On one hand, the linguistic accessibility, aimed at those who do not understand the original language will be through techniques such as dubbing, subtitling and voice-overs, traditionally studied in the context of audiovisual translation. On the other hand accessibility will be explained and how captioning for the deaf, audio description or audio subtitling allows people with hearing or visual disabilities to access audiovisual content and services. Content and media services are becoming increasingly important in our society, whether in traditional settings such as television or film or in environments such as the Internet. The MOOC will try to address this importance by proving an overview on the current state of the art in media accessibility for all interested parties including service providers and application developers.

#### 4.2.2. Status of Work at M12

During the first 12 months of the project Vsonix has worked on a variety of aspects for the MOOC showcase including the UI adaptation framework that will be used for UI as well as for subtitle personalisation. Vsonix has worked on the MOOC concept including its different aspects for lecture playback, interaction and assessment. A first integrated prototype of the MOOC is actually implemented that will be used in the upcoming user tests planned at the beginning of 2015. Regarding the integration of the subtitle features for the MOOC showcase Vsonix has already worked on different aspects of the technical implementation: This includes the preparation of Vsonix' vPlayer software for the integration of a subtitle rendering engine.



Further we have started to integrate subtitle rendering based on common web technologies using XHTML, JavaScript as well as CSS. Vsonix will collaborate / exchange ideas with UPM on the further realization of the subtitle rendering engine, whereas Vsonix will further concentrate on the customization part.

First implementation and integration work has been done on the GUIDE UI adaptation / personalization framework to become an online based service for personalized accessibility. This includes the provision of the UI adaptation API, which has been completely defined as well as the implementation of the necessary backend services, which we have already started to integrate.

### ***4.2.3. Timeframe***

The integration, adaptation work on the MOOC, AccessGUIDE and UI adaptation framework has already started in the first 12 months of the project, whereas a first prototype of e.g. the AccessGUIDE is already available for early user trials (January 2015). An integrated version of the MOOC application for PC and mobile, integrating subtitling using EBU-TT as well as TTML is planned to be tested in the first half of 2015. An advanced version of the MOOC application is planned for the second half of 2015 / beginning of 2016 integrating personalized subtitle features using the GUIDE based UI adaptation service.

Early 2014 – Mid 2014	Specification of MOOC application for PC/mobile and HbbTV
Mid of 2014 – Mid 2015	Implementation of MOOC for PCs and mobile Platforms
End of 2014 – Mid 2015	User tests to test usability and accessibility aspects and to refine requirements in partnership with UAB
Mid 2015 – End 2015	Refinement of MOOC
Early 2016 – Mid 2016	Deployment of large scale MOOC Pilot

**Table 4.** Planned MOOC timeframe.

### ***4.2.4. User tests***

All user tests will be made with 20 users from the target group, which will be mainly elderly users (50+) with an interest in online video applications and with mild to moderate visual and hearing impairments. In addition we will include users of all generations from the deaf and hard of hearing group.

### ***4.2.5. Validation Method***

Within the tests Vsonix will focus on usability and accessibility aspects of the MOOC as well as of the AccessGUIDE application. The customisation aspects of subtitling to be tested will include subtitle position, font size, colour, background, timing, etc. The validation will be made based on questionnaires and interviews.

### 4.3. Media on Demand Service Showcase– UK



Figure 21. Sample Screen for the MoD showcase.

The Media Service showcase is based on SCREEN existing Plasma Gold demonstration system that can show news, weather, sport and financial information on HbbTV, modified to take the end-user’s adaptation preferences from AccessGUIDE into account to alter the display of content. As previously described, it is planned that the viewer will be able to select a predefined profile when entering the service. It is planned that the showcase will be able to utilise ‘cookies’ stored on the client device to automatically use a selected profile on subsequent access to the service. An ‘adaptation button’ (which may be an on-screen button or a dedicated colour button on the remote control) will be used to allow the viewer to change the selected adaptation profile (e.g. between different users of the device) or to temporarily override the adaptations set by the profile.

#### 4.3.1. General Set-Up

The Media Showcase will use the existing Plasma Gold product from Screen, with adaptation to use the GUIDE profiles. A complete system will be deployed at UAB to facilitate tests with users. It is planned that early user tests will actively influence the integration of the GUIDE user adaptation framework in Plasma Gold.

#### 4.3.2. Status of Work at M12

The SCREEN media on demand showcase has been specified in the first year of the project as well as the planning of the integration of Access GUIDE into the existing infrastructure has been made.

#### 4.3.3. Timeframe

Mid 2014 – End of 2014	Specification/Definition of SCREEN media on demand service
Early 2015 – Mid 2015	First Integration of UI adaptation framework in Plasma Gold
Mid 2015 – End 2015	User tests to test usability and accessibility aspects and to refine requirements in partnership with UAB  Technical refinement of UI adaptation framework
Early 2016 – Mid 2016	Deployment of SCREEN application possible to partners for wider testing as

	necessary
Mid 2016 – End of Project	Final user tests and analysis

Table 5. Planned MoD timeframe.

### 4.3.4. User tests

Testing with selected users who require or prefer adaptations will be performed by UAB with the direct support of Screen. In addition, Screen will perform local testing of the adaptation integration by testing the implementation against accepted guidelines for accessibility of web-sites (using the W3C Web Content Accessibility Guidelines (WCAG)). These tests will be designed to check if the W3C-WAI can be achieved within an HbbTV framework for access to content

## 4.4.HbbTV Programme Guide Service showcase– Netherlands

The Public Dutch broadcaster NPO has created an HbbTV portal and provided a service that is currently limited to Canal + (Satellite) users and some smaller Cable companies. NPO has exploited a CatchUp TV service called 'Uitzending Gemist' which is by far Holland's biggest and most successful CatchUp TV service.

### 4.4.1. General Set-Up

For the Pilot-C showcase PPG will re-use parts of its existing NPO's application in order to integrate the functionality of the accessibility service including the AccessGUIDE application.

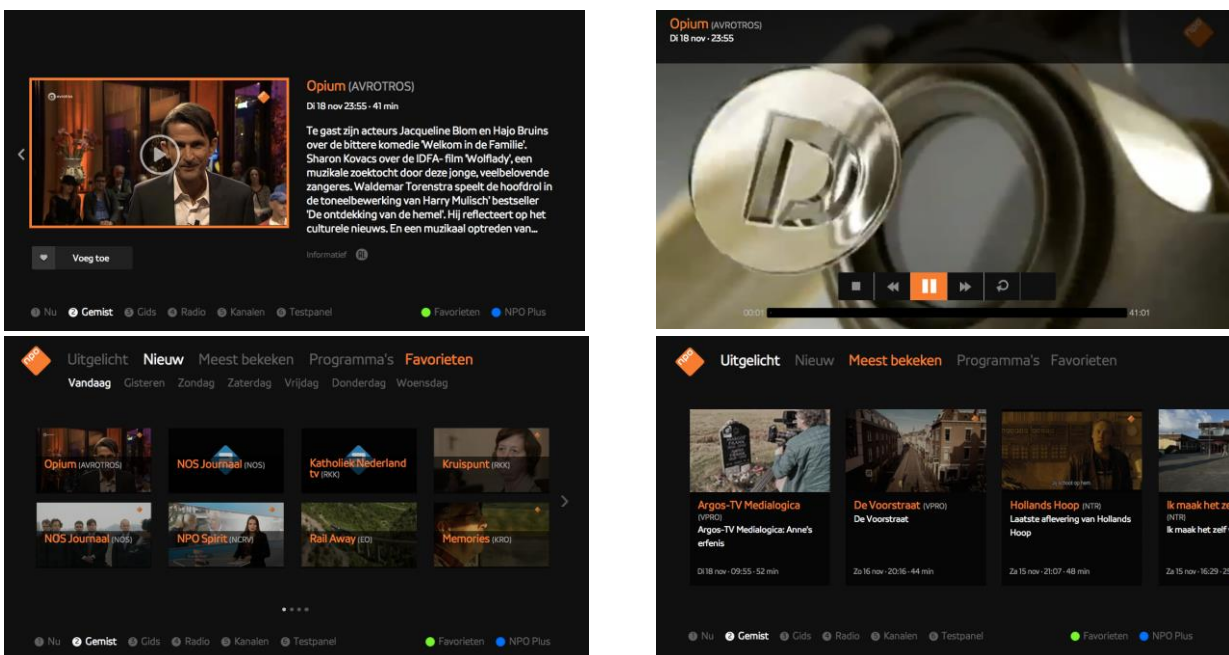


Figure 22. NPO application used for the showcase.

The output of the Access GUIDE will be implemented in the “Uitgelicht” and “Nieuw” section and its detail screen. The quick Access GUIDE could appear during a video play out together with the player options.

#### **4.4.2. Status of Work at M12**

We are currently in the concept phase for the HbbTV based version of the AccessGUIDE application integrated in the NPO application, whereas the focus is on wireframes, UI and visual designing.

#### **4.4.3. Timeframe**

Mid 2014 – End of 2014	Wireframes and UI concepts of Access GUIDE for Smart TV integrated to NPO framework
Early 2015 – Mid 2015	Visual Design of Access GUIDE for Smart TV integrated to NPO framework
	First Integration of UI adaptation in NPO framework
Mid 2015 – End 2015	Final Integration of Access GUIDE to the NPO framework

**Table 6.** Planned HBBTV programme guide service timeframe.

#### **4.4.4. User tests**

As the AccessGUIDE for HbbTV, the NPO showcase will be part of the user tests (see chapter 8) that Vsonix and UAB have planned for Mid 2015. In addition PPG plans to do additional tests with an existing test panel that PPG works on in another project with NPO. This test panel consists of around 40 households. These households contain families, singles and elderly.

## 5. Pilot-C Roadmap

The following chapter will give an overview on the overall roadmap defined for Pilot-C including all technical developments and user trials planned.

Within the first year of the project the partners involved have worked on the detailed specification of the planned Pilots including the definition of content, addressed user groups as well as the accessibility features to be included, which will also define the requirements for the online accessibility service. Vsonix will prepare some first early prototypes for the second half of 2015 that will be used by UAB in user trials to examine the advanced accessibility aspects provided by the framework. Moreover Vsonix has already started the technical work including the identification of relevant parts of GUIDE as well as the migration of parts of the existing UI adaptation framework to become an online based service. A first version of the online service API was already defined in August 2014.

From the beginning of the second year a first version of the online accessibility service will be ready to be used by Vsonix, SCREEN and PPG within their applications. The aim is to use a first version of the MOOC application as a basis for additional user trials conducted by Vsonix in collaboration with UAB. Further testing and integration work will be performed before Pilots of the online learning as well as HbbTV applications will be deployed at the end of the second year. The roadmap can be summarized as:

When	What	Who
Early 2014 – Mid 2014	Specification of MOOC, definition of content, addressed user groups as well as the accessibility features to be included	Vsonix, UAB
	First definition of requirements for online accessibility service.	Vsonix
	Starting integration / migration work on UI adaptation framework	
	Definition of user test plan	
	Re-design of GUIDE user initialization application to become Access GUIDE	
Mid 2014 – End of 2014	Preparation of prototypes for early user trials by Vsonix for the refinement UI adaptation framework requirements	Vsonix, UAB
	UI Design for AccessGUIDE on PCs, mobile and HbbTV platforms	Vsonix, PPG
	Specification/Definition of SCREEN media on demand service	SCREEN
	Specification/Definition of NPO showcase by PPG	PPG
	Definition of UI adaptation API	Vsonix

	Continuing migration of UI adaptation framework as online service	
	Implementation of Online Screen Reader Service	Vsonix
	Early version of MOOC application	Vsonix
	Expert group discussion on AccessGUIDE	UAB, Vsonix
	Preparation of early user trials	UAB, Vsonix
Early 2015 – Mid 2015	First Integration of UI adaptation framework in pilot MOOC application	Vsonix
	First Integration of UI adaptation framework in Plasma Gold	SCREEN
	Implementation of AccessGUIDE for PCs and mobile Platforms	Vsonix
	Implementation of AccessGUIDE for HbbTV platforms	PPG
	User tests to test usability and accessibility aspects and to refine requirements in partnership with UAB	SCREEN
	First Integration of UI adaptation in NPO framework	PPG
Mid 2015 – End 2015	Additional user tests based on integrated Pilots to test usability and accessibility aspects and to refine requirements	Vsonix, SCREEN, UAB, PPG
	Technical refinement of UI adaptation framework, and applications before large scale roll out	SCREEN, VSONIX, PPG
	Final Integration of Access GUIDE to the NPO framework	PPG
	Final Integration of UI adaptation framework in Plasma Gold	SCREEN
Early 2016 – Mid 2016	Deployment of MOOC service in Europe for PC and mobile platforms.	VSX, UAB
	Deployment of PPG application	PPG
	Deployment of SCREEN application	SCREEN
Mid 2016 – End of Project	Final user evaluation	VSX, UAB, SCREEN, PPG

Table 7. Pilot C Roadmap.

## 6. Service Components to be adapted, integrated and trialled

### 6.1. Introduction

In the following we will describe the different technologies and standards used for the realisation of the pilots including all prototypes and its related components and services. This includes the GUIDE framework based UI adaptation service consisting of the GUIDE API and its backend service, the redesigned user initialisation application – AccessGUIDE- , which will be realised by Vsonix for PC and mobile and by PPG for HbbTV platforms to create the user profiles, an online text to speech screen-reader service as well as services for user management and access.

The UI adaptation service will be integrated by various pilot services (see chapter 5) including the MOOC application that is realized based on existing software developed by Vsonix, the NPO showcase by PPG as well as the Media on Demand service provided by SCREEN. SCREEN will use the features of the GUIDE service within its HbbTV publishing system for a demo application.

### 6.2. UI adaptation service API

The UI adaptation service is accessible through a JavaScript based application programming interface (API). The API provides easy access to all of the functions that are derived from the GUIDE project, but instead of operating locally on a set-top box the API provides a cloud-based service interface. Access to the API is protected through an authentication token stored on the client in a cookie, whereas a token is created for each user for each device. The API communicates with the backend using AJAX and passes the backend response to developer-provided JavaScript callback functions while abstracting away certain details such as the user authentication process or setting up asynchronous connections to the backend.

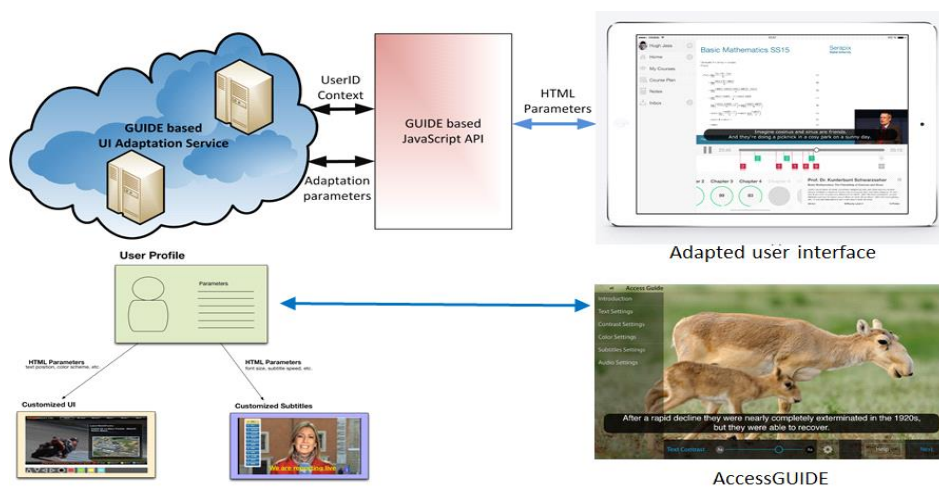


Figure 23. UI adaptation mechanism provided by the GUIDE framework.

The following two table list the actual Javascript functions provided by the online service and its related functionality as well as the adaption parameters that are provided so far:

Initialize()	Initializes the GUIDE API. After this function has been called the API is capable of providing the application developer with adaptation values that are associated with the current user and machine.
logout()	Deauthenticates the current user against the GUIDE API. After this function has been called, getRequirementValue() will no longer provide adaptation values and the GUIDE API is no longer associated to any user profile.
getRequirementValue(requirement)	Retrieves adaptation values targeted towards the current user for the given adaptation criteria. This function will return values only when the user successfully authenticated against the GUIDE API. The available adaptation criteria may be queried by getAvailableRequirements() or isRequirementAvailable().
getAvailableRequirements()	Retrieves all available adaptation criteria that may be used as arguments in various functions of the GUIDE API. The values returned by this function include common adaptation criteria provided by GUIDE as well as extensions provided by the respective application. This function does not rely on any user being authenticated and thus should not be used to predict the availability of adaptation values according to any user profile. In order to verify the presence of an adaptation value for a specific criteria call getUiRequirement() instead.
isRequirementAvailable(requirement)	Checks if an adaptation criterion belongs to the set of criteria that may be queried through the GUIDE API. This function will look up the given criterion in GUIDE's set of predefined adaptation criteria as well as in the set of criteria specified by the application. This function does not indicate whether a given criterion is set in a user profile, it only checks if that criterion is generally known to GUIDE.
describeRequirement(requirement)	Provides meta information for an adaptation requirement. This function is useful in combination with getRequirementValue() because it allows the developer to gain information regarding the expected data type and range of values among others.



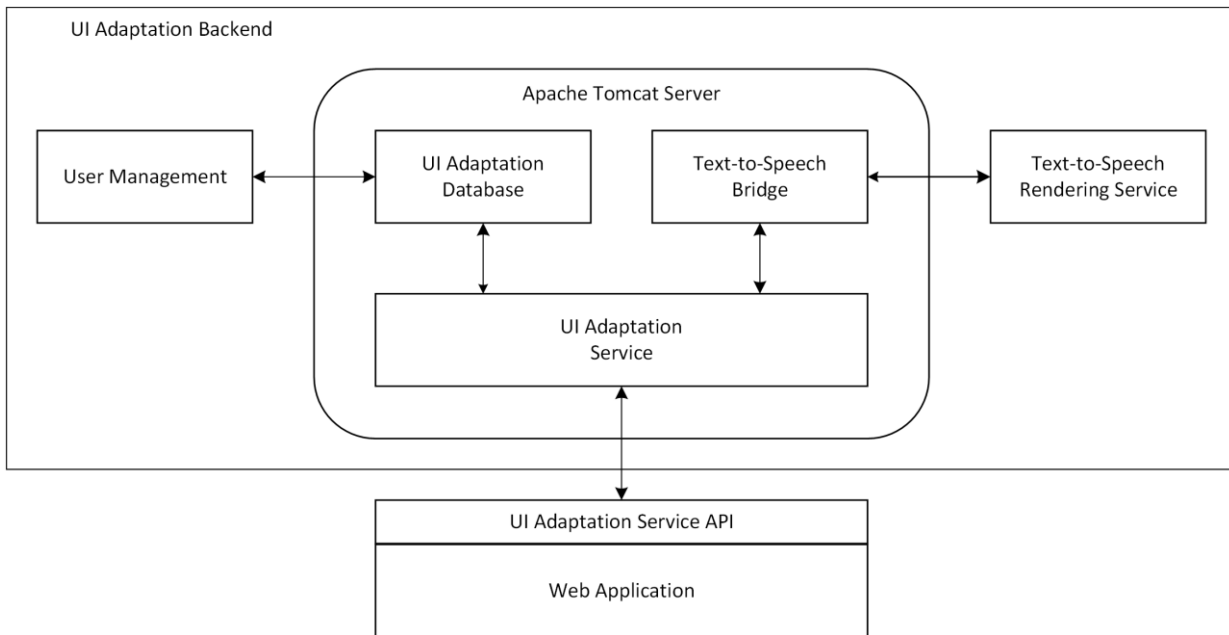
MinimumFontSize	<Integer>
Smallest font size which the user is capable of reading. The value returned by this function is to be interpreted in Pixels.	
ColourScheme	“Normal”, “BlackWhite”, “YellowBlue”, “BlueYellow”
Combination of colours which is best suited for the user to operate the UI.	
Language	“English”, “German”, “Spanish”
Native Language of the user.	
SubtitlePosition	“top”, “bottom”
User’s preference regarding subtitle position. “top” refers to the top of the screen, while “bottom” references the bottom of the screen.	
SubtitleBackground	“transparent”, “semi”, “opaque”
Specifies how subtitles should be rendered. “none” specifies that subtitles should not have any background and may be rendered directly on top of the video. “semi” specifies that subtitles should be rendered on top of a semi-opaque background (transparency set to 50%), and “opaque” specifies a background without any transparency.	
SpeechSpeed	“slow”, “normal”, “fast”
Specifies the maximum speed of spoken word which the user is able to follow. The TTS system will adapt to this setting.	
SpeechGender	“male”, “female”
Specifies the gender of the speaker that the user prefers for spoken word.	
SpeechVolume	<Integer> [0 – 100]
Specifies the volume of the speaker for the TTS system.	

**Table 8.** Available Adaptation Parameters of the GUIDE API.

### 6.3. UI adaptation backend

The UI adaptation backend comprises a set of components which are grouped within a Servlet and run on an Apache Tomcat Server, as can be seen in the figure below. The backend provides an interface to access the UI adaptation service and (through a bridging component) the Text to Speech (TTS) service. The user management service receives user profile data from the user management service and populates the received profile in UI adaptation database. Each of these components will be briefly outlined in the following sections.

### 6.3.1. UI adaptation service



**Figure 24.** UI adaptation framework

The UI adaptation service is an extension of the service provided by the GUIDE project, running in a cloud-related environment. The original adaptation service has been ported to Java in order to bring it to the cloud, which required a paradigm change from procedural programming to object oriented code. At the same time the adaptation service has been extended to increase the set of supported adaptation requirements and in general allow introducing additional requirements at any time with only little effort. Interface code of the service is now shifted towards the UI adaptation backend component in order to clearly separate business logic from interface code.

### 6.3.2. User management/profiling service

The user management service allows the administrator to easily manipulate any user profile or the data associated with it. Besides these maintenance operations the user manager is responsible for creating user profiles based on the information collected by the AccessGUIDEservice. AccessGUIDE therefore contacts the user management service and transmits the required profile data over a well-defined interface. The user management service writes the profile data to the database storage, making it available to the GUIDE API. Upon creation the user profile is associated with an authentication token stored in a cookie. The profile will then be available only to clients in possession of the cookie (and hence, the token).

### **6.3.3. UI adaptation database**

The UI adaptation database represents the central data storage entity where user tokens, user profile information and requirement information is stored and associated with each other. Serialization mechanisms allow for easy profile serialization and storage in traditional relational database systems, while abstractions allows for easy switching of the underlying database system, if ever required. The database will be modified by the user management service (for instance, if a new profile shall be generated it will be stored in the database by the user management service) and accessed read-only by the GUIDE API (for instance if an application requests information regarding a specific user profile through one of its API functions).

### **6.3.4. Service extensions**

The GUIDE API aims to be easily extensible towards additional adaptation requirements, since not all necessary adaptation requirements may be addressed adequately by the predefined set of requirements. Extensions usually are per-application, since there is no way that applications can know about the presence of other applications (or their adaptation requirement extensions).

The GUIDE API may be extended by creating a well-defined and valid (according to a custom XML schema) XML file, which will then be translated into its respective relational representation, stored in the database, any finally be made available through the GUIDE API functions. There exist mechanisms to check for the presence of any adaptation requirement, so each application is easily able to determine whether an extension is available or not, so that each application may gracefully handle the absence or presence of any requirement.

## **6.4. Text-to-speech rendering service**

The text-to-speech rendering service allows for easy integration of common TTS services into any application which makes use of the GUIDE API. The text-to-speech service is very tightly integrated into the GUIDE API to the point where no additional component needs to be included in the web application and a single API function call makes the spoken equivalent of any text fragment available to the application, so that it can be used for various use cases ad hoc. The text-to-speech service is implemented as a standalone component that is connected to the UI adaptation backend via a custom bridge component which makes it possible to control it from within the Java Servlet container.

Delivery of the speech renderings may take place using either pre-rendered audio files that are played on-demand by suitable HTML5-based mechanisms or using just-in-time renderings that are streamed to the application using experimental HTML5 methodologies such as WebRTC. Currently, technical prototypes for either method exist in order to perform evaluations regarding which methods to finally make available to the application developers – if not both.

## **6.5. AccessGUIDE (PC / mobile version)**

AccessGUIDE establishes based on both the current user and the current device a profile which measures the user's impairments and preferences and communicates them to the GUIDE API. This is a one-time

initialization process that needs to be done only on the first time the user works with a device; afterwards the profile will be readily available directly through the GUIDE API (of course it is the user's choice to recreate or update or extend their profile at any time). Access GUIDE uses modern input controls and measurement methods to establish the optimal user settings and is extensible to include tests for preferences that are defined by individual applications.

## 6.6. AccessGUIDE (Smart TV version)

For the Smart TV version of the Access Guide PPG will use their TV AppBox platform as a tool to connect the API that Vsonix is delivering with the NPO application that will be used for this project. This TV AppBox tool is supporting the HbbTV standard 1.5 and consists of:

- JavaScript based framework, delivering cross-platform compatibility
- HTML5/SASS based framework templates
- HTML5/native Multimedia player (photo, audio and video including DRM)
- Integrated Analytics hooks (ComScore, Google Analytics)
- Abstracted API hooks in order to integrate with all common API-services (JSON-P)

## 6.7. MOOC service components

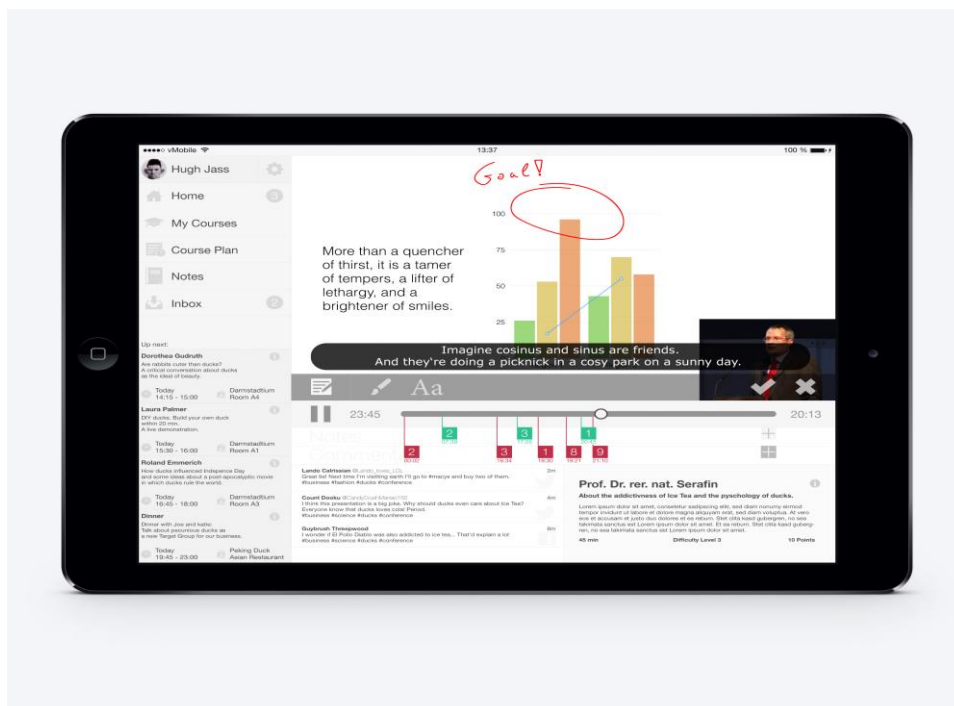


Figure 25. UI design for the integrated MOOC application.

The MOOC service has been started to be realized as an integrated service for PC mobile platforms. It is integrated based on components provided by Vsonix. This includes vPlayer, a rich media player for presentation content playback on PC and mobile platforms as well as vManager, a content management system for webcast content. It further includes means for social interaction based on vInteract, a social media tool by Vsonix that provides chat, media communication and TED functionality. Another interactive element of the application is the online assessment component that provide multiple choice questions as well as gap text. The figure below shows the actual UI design for the MOOC application running on mobile devices.

### 6.7.1. vManager/vPlayer

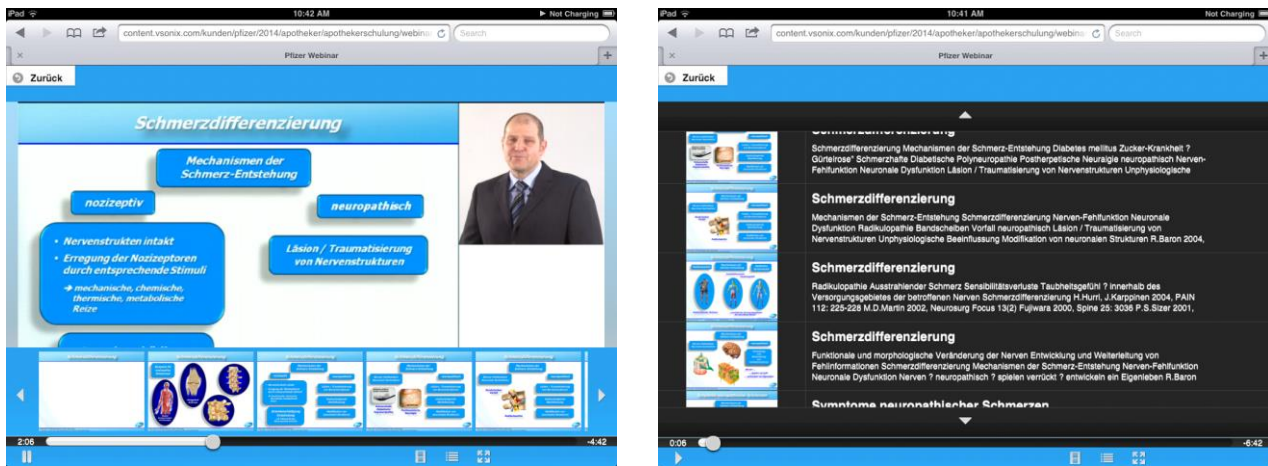


Figure 26. vManager and vPlayer.

As described in chapter 4.3.3 and 4.3.4, vManager and vPlayer are technologies developed by Vsonix and used for video content organisation and playback. vManager is the content manager solution provided by Vsonix that allows to dynamically control the way webcast content such as event videos, event metadata, interaction modules, and video playlists are presented to the user. vManager is a cross-platform compatible tool, enabling actions such as index-based search, time based video annotations and chapter navigation. In HBB4All vManager will be used as the content management system for the MOOC Pilot to provide structured access to the individual course materials and provide functions such as a user authentication mechanism, video annotation, and course-based navigation functions.

vPlayer is an advanced webcast video playback solution that allows synchronization of multiple media channels simultaneously, provides convenient chapter-based navigation, index-based search functionality and dynamic viewport switching. Based on state-of-the-art HTML5 techniques, it is supported by all major web browsers. Intelligent fallback mechanisms allow to gracefully handle legacy browsers, so that vPlayer is able to retain compatible to all major environments. In HBB4All vPlayer is used by vManager for lecture content and presentation playback for the MOOC pilot.

## 7. User tests

This chapter gives an overview on all ongoing and planned user tests within Pilot-C.

### 7.1. Overall Planning of user tests

The user tests in Pilot-C support the user centred design approach that we follow for the redesign of the AccessGUIDE application, as well as for the preparation of the MOOC Pilot and the two additional showcases provided by SCREEN and PPG that are planned to be launched for the operational phase of the project. The tests will look at the showcase

The aim of the user tests is to examine the user interaction designs of the Pilot-C applications in respect to its usability and accessibility aspects and directly feed back to the further application design process. We have started the user tests with an expert group discussion (see chapter 8.2) for the AccessGUIDE application, which are followed by early user trials (see chapter 8.3) with clickable prototypes of the AccessGUIDE and the MOOC application. Based on this we will further develop both applications before we do the final usability and accessibility tests (see chapter 8.4) on AccessGUIDE, the MOOC pilot as well as on the two additional showcases provided by SCREEN and PPG, whose results are used for the final refinements to be made before the operational phase. The final evaluation will be done while the AccessGUIDE and MOOC application is online. This will be done using online questionnaires. For the user tests itself we use the following test methodologies:

**Expert Groups:** This test is used in the starting point of research, implementation or development. It helps the researcher to focalise into the relevant issues, problems or concrete elements that have to be addressed to improve the application performance, usability or experience.

**Interviews:** using interviews posterior to the use or presentation of the application or software, the researcher is able to gather more in-depth information about the thoughts of the participants about all kind of relevant issues.

**Talk aloud:** the talk aloud methodology is a well know usability test. This method consists in the presentation of the software to be tested to a number of participants. Those participants have to use it while explaining the reasoning they are doing while using. This method allows the researcher to gather inputs on usability, design and user experience.

**Eye Tracker:** the Eye Tracker metrics and results are used to have an objective measure to compare to the subjective data gathered with the other methodologies. Moreover, this tool allows us to improve concrete aspects of the application design as such as salience, positioning, legibility, among others.

## 7.2. Expert Group Discussion - Access GUIDE (October 2014)

### 7.2.1. Objectives

The first phase of the user tests aimed to provide an analysis and to develop theories about possible usability problems. Therefore we decided to organize an expert group discussion with participants from different fields of studies in the 28th of November 2014. By using this approach, we were able to provide a more scientifically accurate usability test, based on the theories developed by the experts. Another advantage was, that we could reduce the number of the test participants to six, without losing meticulousness. [Nielsen, 1993]. The experts examined the UML and the interaction procedure in wireframes step by step. Subsequently they discussed possible usability issues for impaired people.

### 7.2.2. Methodology

We proceeded with an expert group set up. Including 8 experts as follow:

- 1 User Interaction expert
- 1 Audio Description expert
- 1 Text to speech, AD and machine related accessibility services expert
- 1 Cognitive Psychologist
- 1 Engineer working in the development of accessibility applications
- 1 Subtitling expert



Figure 27. Expert group setup at UAB.

A presentation of the different personalisation steps and features as well as wireframes of the different steps were presented to the experts and then discussed based on the advantages and disadvantages that they saw.

### **7.2.3. Conclusion**

The outcome of the analysis and the discussion related mostly to the information architecture and conceptual ambiguities:

- A revision on the order and classification of the different steps has to be done for making the process quicker and taking into consideration only the aspects that the users found useful for them.
- The text to speech option has to be switched on or off easily from the beginning to avoid overlapping with other services the user may have activated.
- For the desktop and tablet / mobile version of the application the inclusion of blind users as a target is not of use because they already have other services that perform across media. Either way, this target group must be considered in the application development for the television sets.
- The subtitle positioning is normally a content-based parameter; as so, it will be part of a quick access menu that will allow users to quickly change that option depending on the content they are watching.
- The use by different users of the same devices makes necessary the deployment of the possibility to save different profiles.
- Given this necessity of having access to quick options and the profiling, a quick access button is absolutely necessary for the comfort and usability of the application.
- Finally, we talked about the methodology for the next user test and made terms about the following changes and the next steps.

## **7.3. Early User Test – Access GUIDE prototype (December 2014)**

### **7.3.1. Objectives**

After completion of the design changes, basing on the expert group discussion, we are planning to perform a user test. In this test our aim is to identify all serious usability issues in the concept to prevent making unreasonable steps in developing the project.

### **7.3.2. Methodology**

Based on the results of the expert group discussion we will prepare a questionnaire. This questionnaire is conceived to get answers to constitute reasonable design decisions.

The test participants are going to be individually interviewed and thereafter they are presented with the updated wireframes and a simulation of the user interaction flow. The participant is free to comment and



review the current version of the application, followed by an open discussion with all the participants about the problematic parts of the application.

The interviews will be performed in the UAB. Six participants (viable participants excluding possible drops or sampling errors) of the following groups will be interviewed:

- 6 Visually impaired people from age 16 – 36
- 6 Visually impaired people from age 36 - 66
- 6 Hearing impaired people from age 16 - 36
- 6 Hearing impaired people from age 36 – 66

All the data will be summarised and delivered to the developers to process and implement. The estimated Timeframe for the testing is from December until January.

## **7.4. Usability test on integrated AccessGUIDE and MOOC prototype (Mid 2015)**

### ***7.4.1. Objectives***

Once compiled the results of the prior tests. The outcome is going to be incorporated into the concept and a fully operational alpha version will be prepared. The alpha version will be applied to a prototype MOOC platform. Thus giving us the possibility of performing more accurate tests about the user – app interaction. The aim of this test will be to locate minor usability issues in the layout or the application interface. The main goal is to improve the user experience and the application usability. We target to find solutions for the issues, which only cause minor changes in the concept to ease out development work.

### ***7.4.2. Methodology***

The setup of the test will be constituted of two different methods used simultaneously. First, the thinking aloud method in which the tester is encouraged to speak his/her thoughts, expectations and feelings loud while interacting with the working application.

At the same time, a registration of the eye movement of the participants will be done to determine which elements on the UI draw more attention than others. This will allow us to determine if there are any design changes to be done in order to facilitate the use of all the functionalities of the application.

This test will be held at UAB. The recording will be done with a Tobii X20 Eye Tracker and a mobile device and a computer. The number of participants will be 20 users of the target group.

## 7.5. Final evaluation on integrated Access GUIDE and MOOC prototype

### 7.5.1. Objectives

The last test of the project is taking place with the release of the application to a wider audience. Therefore the fully developed version will be released online and the users will get access to the software. The aim of the large trials is to determine the correct implementation of all features, access user satisfaction and fix possible bugs appeared during the final steps to implementation.

### 7.5.2. Methodology

An online questionnaire will be implemented at the end of the application use. This questionnaire will consist in a one-click question that will deploy different alternative options if the user reports problems with the application. In case of optional solutions developed from the prior tests an A-B test will be implemented as well. In this test phase every user is encouraged to participate. The estimated time frame starts in August 2015 to December 2015.

## 8. Results

This chapter will contain a table of activities and a percentage of execution per activity. It will be a way to check the progress of the WP. The following subsections contain a table to check the progress of each activity.

### 8.1. Task 5.1 progress

In task 5.1 we have finished most of our activities, whereas we are still working on the definition of requirements for the AccessGUIDE as well as for the MOOC application. This will be based on the results we derive from the early user tests as well as from the usability and accessibility tests planned for mid 2015.

Objective	Progress
Definition of requirements for Online UI framework	100 %
Definition of requirements for AccessGUIDE application on PC and mobile	60 %
Definition of requirements for AccessGUIDE application on HbbTV platforms	60 %
Definition of requirements for online learning platform (MOOC)	60 %
Identification of MOOC content by UAB	100 %
Identification and definition of additional pilot service Screen – Media on Demand Service by Screen	100 %
Identification and definition of additional pilot service NPO Showcase– PPG	100 %

Table 9. Task 5.1 Objectives progress.

## 8.2. Task 5.2 progress

In task 5.2 we have worked on the user tests, whereas the focus group discussions have been finished and the early user tests have been prepared. This includes the provision of early prototypes to be tested. We have also already started to prepare the usability tests and also started to define the goals and methodologies for the final user evaluation. Most of the work has been spent on the transition of the GUIDE framework to become an online service as well as on the redesign of the AccessGUIDE application.

Objective	Progress
Focus group discussions on AccessGUIDE	100 %
Preparation and realisation of early user tests	50 %
Planning and realisation of usability tests	30 %
Preparation of final user tests	10 %
Transition of GUIDE framework to become online service	50 %
Re-design of GUIDE User initialisation application (UIA) to become AccessGUIDE for PC and mobile	50 %
Re-design of GUIDE UIA to become AccessGUIDE for HbbTV	40 %
Provision of AccessGUIDE and MOOC prototypes	30 %
Media on demand service prototype by SCREEN using UI framework	10%
NPO showcase by PPG	10%
Preparation of MOOC content	20%

**Table 10.** Task 5.2 Objectives progress.

## 8.3. Component progress

The following progress have been made in respect to the service components to be realized for the preparation of the different Pilots. This includes the preparation of the AccessGUIDE application, the provision of the GUIDE online API as well as the realisation of the UI adaption service backend and the online text to speech service. Moreover, we have already worked on the integration of the MOOC platform based on existing technologies from Vsonix.

Objective	Progress
AccessGUIDE application	20 %
GUIDE online API	100 %
HBB4ALL online service for UI adaptation and personalised subtitle based on GUIDE framework	50 %
Online text to speech service	50 %
MOOC application	50 %

**Table 11.** Component progress.

## 9. Conclusions

Concluding we can point out that Work Package 5 / Pilot C has advanced during the first project year according to the project plan. The objectives of the Pilot have been well achieved including the specification of the UI adaptation framework and its related services, the definition of the different service pilots including a concrete implementation roadmap as well as the planning and realisation of the Pilot's user tests.

From a technical implementation perspective the Pilot is well advanced, whereas first prototypes of the UI adaptation service, the AccessGUIDE application as well as the MOOC service are already available. The degree of accomplishment of the objectives for the initial two tasks of pilot C 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. The operational phase is starting in August 2015 (M21).

## 10. References

ABASCAL, J. / ARRUE, M. / FAJARDO, I. / GARAY, N. / TOMÁS, J.: The use of guidelines to automatically verify Web accessibility, Springer-Verlag, March 2004.

AccessABILiTY.psu - HTML and Web Page Accessibility, <http://accessibility.psu.edu/byhtmltag>, 01.12.2014.

Accessibility Android Developer, <https://developer.android.com/guide/topics/ui/accessibility/index.html>, 28.11.2014.

Apple Accessibility, <http://www.apple.com/accessibility>, 01.12.2014.

iOS, <http://www.apple.com/accessibility/ios>, 01.12.2014.

OSX, <http://www.apple.com/accessibility/osx>, 01.12.2014

Apple Developer, <https://developer.apple.com/accessibility>, 01.12.2014

CHIANG, M.F. / COLE, R.G. / GUPTA, S. / KAISER, G.E. / STARREN, J.B.: Computer and World Wide Web Accessibility by Visually Disabled Patients: Problems and Solutions, Elsevier Inc., August 2005

GREGOR, P. / NEWELL, A.F.: Designing for dynamic diversity: making accessible interfaces for older people, ACM Digital Library, 2001

HANSON, V.L. / RICHARDS, J.T.: A web accessibility service: update and findings, ACM Digital Library, January 2004

LAZAR, J. / DUDLEY-SPONAUGLE, A. / GREENIDGE, K.: Computers in Human Behavior, Elsevier Science Ltd., March 2004.

LIU, J.: Color Blindness & Web Design, <http://www.usability.gov/get-involved/blog/2010/02/color-blindness.html>, 01.12.2014.

MCGOVERN, G., The vital importance of the first click, <http://www.gerrymcgovern.com/new-thinking/vital-importance-first-click>, 01.12.2014.

NEWELL, A.F. / GREGOR, P.: Accessibility and interfaces for older people – a unique, but many faceted problem, Department of Applied Computing, University of Dundee, Scotland - [http://automatix.inesc.pt/wuau01/procs/pdfs/newell\\_final.pdf](http://automatix.inesc.pt/wuau01/procs/pdfs/newell_final.pdf), 15.12.2014

Nielsen, Jakob, and Landauer, Thomas K.: "A mathematical model of the finding of usability problems," Proceedings of ACM INTERCHI'93 Conference (Amsterdam, The Netherlands, 24-29 April 1993), pp. 206-21

OBRENOVIĆ, Ž. / OSSENBRUGGEN, J.: Web browser accessibility using open source software, ACM Digital Library, 2007.

PACIELLO, M.G.: Web Accessibility for People with Disabilities, C M P Books ©2000.

WALKER, W.: Designers Explain Why Apple's New OS X Typeface Is a Strange Choice, <http://gizmodo.com/designers-explain-why-apples-new-os-x-typeface-is-a-str-1585123982>, 01.12.2014

WebAIM - Implementing Web Accessibility, <http://webaim.org/intro/#implementing>, 28.11.2014

-Principles of Accessible Design, <http://webaim.org/intro/#principles>, 28.11.2014.

Windows Development - Accessibility, <http://msdn.microsoft.com/en-us/library/windows/desktop/bb735024.aspx>, 01.12.2014.