

Deliverable

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D2.3-Platform Specification

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Authors: Francesc Mas (CCMA)

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Abstract:

This document describes the needed technical infrastructure of the ImAc platform, including production modules, delivery and end-user equipment, based on the results of WP2's user centered design and resulting requirements of tasks T2.1 and T2.2.

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Disclaimer

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EXECUTIVE SUMMARY

In two iterations, this document describes the needed technical infrastructure of the ImAc platform. This provides a specification for the functionality and basic architecture based on the results of WP2's user centered design and the resulting requirements established in T2.1 and T2.2. This document describes the overall ImAc technical system specification. This includes an initial functional description, leading to a detailed platform related specification for each ImAc services to be implemented, including production modules, delivery and end-user equipment.

ImAc follows a user centered design, where project developments are driven by real user needs. This is achieved by involving these users in each step of the design and implementation of the ImAc project. A range of professional users and end consumers were consulted in order to define the accessibility requirements needed as an integral and intuitive part of any immersive content. From these consultations, a detailed list of requirements was gathered and considered to define the ImAc platform which satisfies the required functionalities and define a basic architecture.

Chapter 1 provides an overview of this document, describing the objectives and scope of the deliverable. It also details how this work fits into the larger ImAc project.

Chapter 2 defines 'What to do'. This is the needed functionality of each component that will make up the production and distribution workflow for accessible content, based in professional user and end users requirements.

Chapter 3 defines 'How to do it'. This defines the basic structure of the ImAc platform, divided into different functional modules. Each of these modules is required in order to communicate and interchange information data with other platform modules.

The information in this document will be used as the basis for T3.1 and its deliverable D3.1. This will further define the technical architecture of the ImAc platform in order to allow the development tasks in WP3 & WP4 to commence.

Closed and open pilots in WP5 will allow testing and validation of the results from WP3 & WP4 and further refine these requirements, functionalities and architecture in a second iteration of the ImAc platform specification.

CONTRIBUTORS

First Name	Last Name	Company	e-Mail
Francesc	Mas	CCMA	fmas.z@ccma.cat
Enric	Torres	ANGLATECNIC	enric@anglatecnic.com
Romain	Bouqueau	MOTIONSPELL	romain.bouqueau@gpac-licensing.com
Marc	Brelot	MOTIONSPELL	marc.brelot@gpac-licensing.com
Sven	Glaser	RBB	sven.glaser@rbb-online.de
Doreen	Ritter	RBB	doreen.ritter@rbb-online.de
Peter	tho Pesch	IRT	thopesch@irt.de
Mario	Montagud	I2CAT	mario.montagud@i2cat.net
Chris	Hughes	USAL	c.j.hughes@salford.ac.uk
Themistoklis	Karavellas	i2CAT	t.karavellas@i2cat.net

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LIST OF ACRONYMS

Acronym	Description
GR	Generic Requirements
SR	Service Requirements
UR	User Requirements
SR	System Requirements
AD	Audio Description
AST	Audio Subtitles
ST	Subtitles
SL	Sign Language
HUR	Home User Requirement
PUR	Professional User Requirement
HMD	Head Mounted Display
FOV	Field Of View
HBBTV	Hybrid Broadcast Broadband TV

1. INTRODUCTION

1.1. Purpose of this document

ImAc project was born with the firm commitment to ease the production and distribution of accessibility services in new immersive audiovisual contents, exploring the integration in all the processes that add up to the overall workflow.

The WP2 activities are a vital part of the ImAc project. The aim of this deliverable is to document all activities and their results in the development of ImAc user scenarios, to provide detailed use cases and to act as a base for defining a system specification.

1.2. Scope of this document

The ImAc consortium has agreed to follow a user-centric approach from the very start of the project as the best option, with intensive user-centered design activities in order to produce valuable user scenarios that, once evaluated and analysed, derived the user and technical requirements.

These user and technical requirements, detailed in deliverable D2.2 of ImAc project, helped to define the ImAc platform specification.

As shown in previous European audiovisual accessibility related projects, users with different sensorial levels ask project teams to work together with them.

The sentence “Don’t work for us, work with us” is often found in Accessibility forums & conferences, as it was for example during the “Enabling accessibility in a connected world” Workshop on 26th February 2016, within the Hbb4All project. For these reason the ImAc project has dedicated 2/3 of the WP2 Tasks to gather and analyse the end-users and professional users’ requirements, through meetings in focus group.

The main objective of this deliverable is to define the main ImAc platform functionalities and specifications based in these user requirements, available in deliverables D2.1 & D2.2, that will be finally transformed in basic technical specifications to concrete the architecture of the new ImAc platform.

This document consists of two sections structuring its content:

- Chapter 2: System Requirements Specification
- Chapter 3: Technical architecture

The first section defines the **functionalities of the different blocks** that make up the production and distribution workflow for accessible contents, based in professional user and end users requirements, and the resulting accessible services from this workflow. (what to do)

The second section defines the basic structure of the ImAc platform, dividing this structure in different functional modules which will require communicating and interchanging information data with other platform modules. (how to do)

As an example, we could imagine that the module responsible for subtitling edition will need to interchange video data with the content manager module to allow the professional user to work with the edition of subtitles over the original video, and once the subtitles are ready, the module will need to send this subtitles data to the content manager. The same module will need to communicate and interchange data with the professional user, offering the needed tools and solutions for content production.

This structure definition is, at the same time, a compromise about what the project pretends to develop for the first phase of the project, as it will generate results that have to be tested during the first phase pilots.

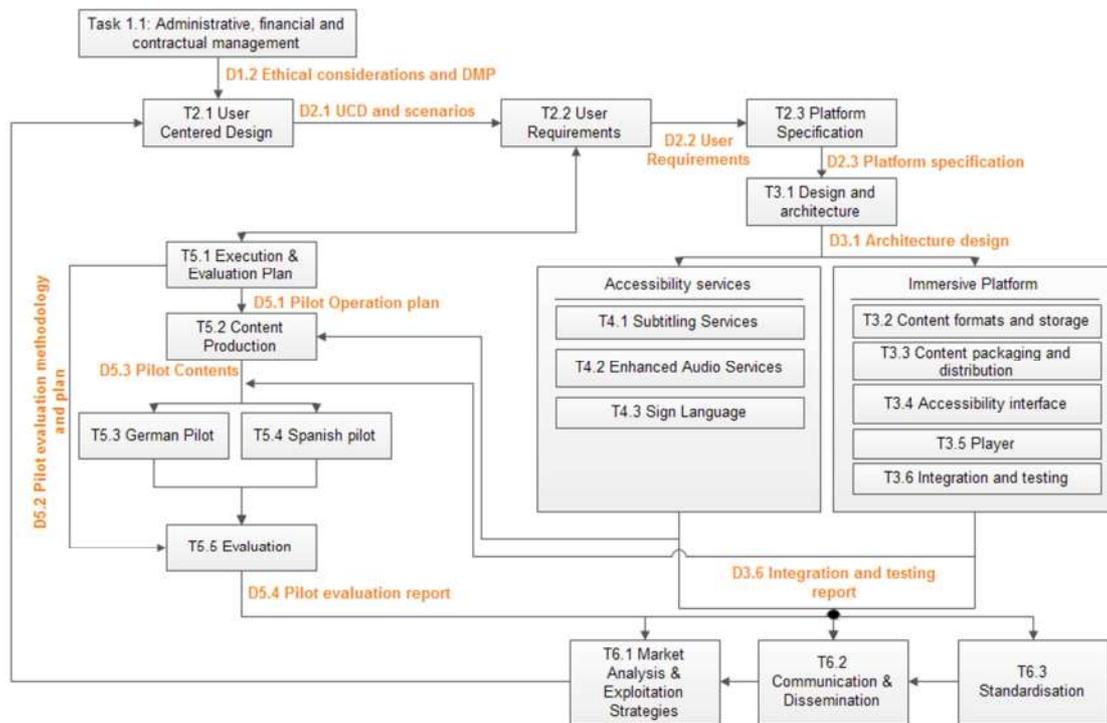
As we mentioned, in this document we'll define a basic structure of the ImAc platform, which will be introductory to the WP3 & WP4, where a deeper technical point of view will start.

1.3. Status of this document

This is the first version of D2.3 with delivery foreseen in M05. A revised version of this document will be delivered in M15. Modifications of this specification are expected due to the evaluation and findings of pilot 1.

1.4. Relation to other ImAc activities

In the diagram below we can see the dependencies between tasks and deliverables and examine the relation of D2.1 to other ImAc activities.



2. IMAC SYSTEM REQUIREMENTS SPECIFICATION

2.1. Basic elements of the System

In this chapter we will define the basic elements of the system, where production, distribution and consumer platform blocks will be also defined based in requirements. Every definition is referenced to a HUR (Home User Requirement) or PUR (Professional User Requirement) number from the "D2.2 User Requirements" document.

Figure 1 shows the logical layers of ImAc system environment: Content Production, Service Provider, Storage/Packaging/Distribution & Consumer Platform. The different green blocks in

the diagram represent high level functionalities of the ImAc system and show the envisaged end to end workflow.

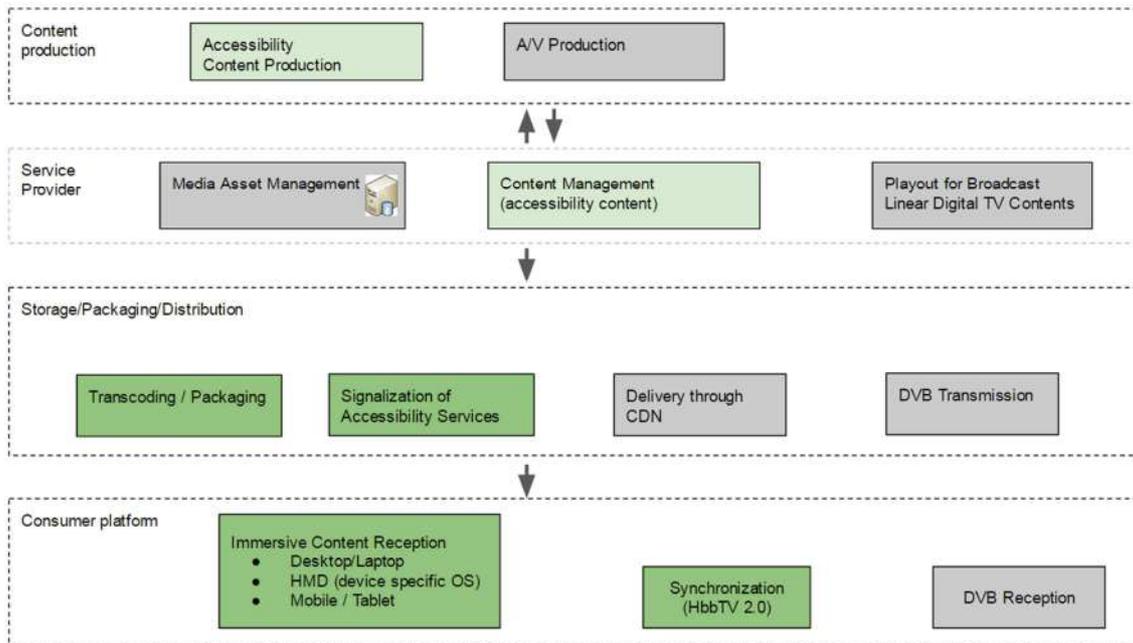


Figure 1- Basic Layers of ImAc system environment with functional blocks (green: relevant for ImAc project, grey: Not focus of ImAc)

Service provider (e.g. a Broadcaster or an OTT platform owner) will interact with the content production blocks to order jobs about accessibility content production, to manage, upload and download contents.

Consumer platform defines the platform where the end user will receive and consume the audiovisual content with accessibility services. This consumer platform will be based on the different platform possibilities, like for example desktop computer or smartphone.

Several blocks are highlighted in grey because they are not part of the ImAc platform but are relevant parts of the full workflow of production & distribution. ImAc does not focus on these parts, since ImAc's accessibility services don't require relevant changes of these system parts. We'll briefly define every one of these blocks before going in detail of ImAc blocks:

- **A/V Production** - refers to the content sent by the service provider to the ImAc platform for accessibility content production. For example, the service provider will sent a 360 Immersive short film and script to the ImAc platform with the aim to activate a job for the production of 360 subtitles and 360 audio description.
- **Media Asset Management** - MAM is closely linked to broadcast internal workflows, to allow the management of all contents, as for example importing, exporting, producing and storing contents.
- **Play Out** for Broadcast Linear TV - as we have two broadcast partners within the project, we have considered the possibility to consume immersive content on companion screen synchronously to non-immersive linear TV broadcasted content on SmartTV. The play out block is in charge of playing this linear TV.
- **DVB Transmission** - this block refers to the broadcast of digital terrestrial TV.
- **CDN Delivery** - as DVB Transmission broadcast linear TV, the Content Delivery Network is in charge of distributing IP streams through broadband in real-time (as linear TV) or as VoD. Usually this block is outsourced as a service.

- **DVB Reception** - Hybrid SmartTV, like those that are compatible with HbbTV standards, can receive audiovisual contents simultaneously or separately by both, broadband & broadcast channels. DVB Reception block refers to the Digital Terrestrial TV reception.

Let's summarize in the next section the main layer defined as basic elements of the ImAc system:

Content Production

The Content Production Layer is dedicated to production of all contents: Classic TV content, 360/VR content and accessibility content. In ImAc, the accessibility content will be produced and authored. The additional possibilities of a 360 or VR environment as well as the envisaged personalization options require an enriched accessibility content. The Content Production Layer addresses these aspects and all content, including the metadata to be provided to the next layer (Service Provider). The system requirements for Accessibility Content Production are described in section 2.2 (Content Production) in this document.

Service Provider

The Service Provider Layer is where the management of a program is handled, including asset management, linking of additional content to main TV programs and scheduling playout. Typically, this is a broadcaster's or content owner's area of responsibility.

Storage/Distribution

The Storage and Distribution Layer handles distribution via various channels. This covers content packaging, DVB transmission and IP distribution via Content Delivery Network (CDN). This layer provides all the data that is required by the large variety of consumer devices that can (co)-exist within the Consumer Platform Layer.

Consumer Platform

The Consumer Platform layer includes all required components for the presentation of the available ImAc contents, including traditional, immersive and accessibility contents, to end-users.

In ImAc, traditional TV contents will be played out on connected TVs. The 360° videos and the media accessibility assets will be played out on companion screens via a web-based player. The player will support different presentation modes and include customization options. Different interaction functionalities and modalities will be provided as well. These functionalities and features are detailed in Section 2.5 (Consumer Platform).

As indicated in the figure, ImAc will also provide synchronization solutions to ensure a time-aligned and consistent presentation of media contents across the involved devices. It will enable more immersive and engaging multi-screen experiences.

2.2. Content Production

This section specifies the definition of the system at the level of production of accessible content (subtitling, audio description and sign language).

The production requires the editors to have tools to produce the subtitling, audio description and sign language contents.

After analyzing the home end-user requirements and the professional end-user requirements obtained from the ImAc focus groups and described in delivery D2.2, we have prepared a list of specifications for each of the production tools. Also we have taken into consideration the expertise of some partners to include additional specifications that even not explicitly were required by end-users, we have considered that are necessary, being these additional specifications not against any of the end-user requirements.

The following subsections contain the list of specifications of each of the editors for the production of the subtitling, audio description and sign language contents.

2.2.1. Subtitling Editor

The list of specifications for the **Subtitling Editor** is the following:

- The editor will allow the professional user to edit subtitles in both 'vr-mode' and 'normal mode'. In 'vr-mode' the user can author relevant metadata for 360°/VR subtitling, while in 'normal-mode' the user can use the Subtitling Editor for classic video subtitling, without the 360/VR features.
- During the first iteration for the production of the pilot's accessibility contents, the video will be uploaded to the Accessibility Content Manager and the web editor prototype will select the required video from the Accessibility Content Manager. However there is foreseen to allow the professional user uploading the video directly from the computer hard drive, as a new feature that will be available on the second iteration.
- In the same way, during the first iteration, Accessibility Content Manager will be used for the management of subtitling files, but it is foreseen to allow directly loading and saving subtitling content files from the computer hard drive on the second iteration (PUR.01.07.0).
- A 360 preview player for the low-resolution video playback and monitoring will be embedded in the editor with the following characteristics:
 - The video will be able to be viewed either as Equirectangular or VR view (see Figure 2) (PUR.01.01.0).



Figure 2- From left to right, Equirectangular view (full 360°) and VR view (usually 90-105°)

- The editor will provide options to navigate through the video timeline by frame (PUR.01.04.0) and by media time (PUR.01.05.0). This allows the user to jump to specific video positions.
- The player will allow 360° video panning and zooming (PUR.01.03.0). The 360 player embedded in the editor will let the user move around the scene to find the speaker that has to be subtitled.
- For all video navigation options, shortcuts and input fields will be provided.
- The process of creation of a new subtitle will consist in (PUR.01.08.0):
 - Producing the text: The producer will have an input field to write the subtitle.

- Inserting icons: The producer will be able to select and input icons from a predefined library for the dramaturgically-significant sounds which are important for the plot.
- Introducing the vertical and horizontal position: The producer will be able to indicate a position for the subtitle on the screen.
- Introducing the styling: The producer will be able to select a predefined font setting (size, colour and other font attributes) with the purpose of identifying the speaker.
- Introduce the time codes: The producer will be able to indicate the points of entry and exit of the subtitle.
- Indicating the viewing angle: the producer can indicate the position of the speaker is in the scene.
- There will be a section for the management of the predefined icons that can be used in the editor.
- The editor will be able to show graphical elements that inform about the orientation of the current speaker, so the professional user can have a simulation of the result.
- The professional user will be able to check the complete result, in this case the subtitles will be previewed over the video during the video playback for real time checking.
- The final check of the complete result in high quality video can be done using HMD (PUR.01.02.0). Once the production has finished, the professional user will be able to watch the final result that will be available for end-users using a Head Mounted Display with high quality 360 video together with the 360 audio. The user will hear the 360° audio together with graphical elements that inform about the orientation of the speaker (PUR.01.06.0). The 360 audio will be further analysed during the second iteration as it is not essential for the production of the pilot's accessibility content during the first iteration.

2.2.2. Audio Description Editor

The list of specifications for the **Audio Description Editor** is the following:

- The editor will allow the professional user to edit audio description in both 'vr-mode' and 'normal mode'. In 'vr-mode', the user can author relevant metadata for 360°/VR audio description, while in 'normal-mode' the user can use the editor for classic video audio description, without the 360/VR features.
- During the first iteration for the production of the pilot's accessibility contents, the video will be uploaded to the Accessibility Content Manager and the web editor prototype will select the required video from the Accessibility Content Manager. However there is foreseen to allow the professional user uploading the video directly from the computer hard drive, as a new feature that will be available on the second iteration.
- In the same way, during the first iteration, Accessibility Content Manager will be used for the management of audio description files, but it is foreseen to allow directly loading and saving audio description content files from the computer hard drive on the second iteration (PUR.01.07.0).
- A 360 preview player for the low-resolution video playback will be embedded in the editor with the following characteristics:
 - The video will be able to be viewed either as Equirectangular or VR view (see Figure 2). (PUR.01.01.0).

- The editor will provide options to navigate through the video timeline by frame (PUR.01.04.0) and by media time (PUR.01.05.0). This allows the user to jump to specific video positions.
- The player will allow 360° video panning and zooming. The 360 player embedded in the editor will let the user move around the scene to facilitate the search of the speaker.
- For all video navigation options, shortcuts and input fields will be provided.
- The creation of a new audio description segment will consist in:
 - Writing the script for the audio description segment. A script can be imported (PUR.01.10.0).
 - Introduce a comment: The producer can indicate how this audio description script has to be recorded, for instance the tone of voice.
 - Add information regarding the role of an audio description segment. For example to differentiate between main action and secondary actions.
 - Recording of the audio description segment: The producer will read out loud the corresponding script. Different voices can be used for different actions, for instance main action and secondary actions. An audio file can be uploaded (PUR.01.11.0).
 - Assigning the time codes for the audio description segment, so the producer can decide the exact point of the video where the playback of audio description will start.
 - Indicating the viewing angle: the producer can indicate where the audio description is happening (PUR.01.13.0).
 - Check the audio description segment with the preview video and the corresponding audio mixing.
- The professional user will be able to check the complete result, so the professional user can playback the video with a simulation of the audio description mixed with the programme audio (PUR.01.12.0).
- Final result check of the complete audio description in high quality video can be done using a HMD (PUR.01.02.0). Once the production has finished, the producer will be able to watch the final result that will be available for end-users using a Head Mounted Device with high quality 360 video together with the 360 audio. The producer will hear the 360° audio together with graphical elements that informs about the orientation of the speaker (PUR.01.06.0). The 360 audio will be further analysed during the second iteration as it is not essential for the production of the pilot's accessibility content during the first iteration.

2.2.3. Sign Language Editor

The list of specifications for the **Sign Language Editor** is the following:

- During the first iteration for the production of the pilot's accessibility contents, the video will be uploaded to the Accessibility Content Manager and the web editor prototype will select the required video from the Accessibility Content Manager. However there is foreseen to allow the professional user uploading the video directly from the computer hard drive, as a new feature that will be available on the second iteration.
- In the same way, during the first iteration, Accessibility Content Manager will be used for the management of SL files, but it is foreseen to allow directly loading and saving SL files from the computer hard drive on the second iteration (PUR.01.07.0).

- A 360 preview player for the low-resolution video playback will be embedded in the editor with the following characteristics:
 - The video will be able to be viewed either as Equirectangular or VR view (see Figure 2). (PUR.01.01.0).
 - The editor will provide options to navigate through the video timeline by frame (PUR.01.04.0) and by media time (PUR.01.05.0). This allows the user to jump to specific video positions.
 - The player will allow 360° video panning and zooming. The 360 player embedded in the editor will let the user move around the scene to facilitate the search of the speaker.
 - For all video navigation options, shortcuts and input fields will be provided.
- The creation of a new sign language segment will consist in (PUR.01.09.0):
 - Recording a video with the sign language interpreter using the webcam.
 - Cutting the specific sign language clip from the video.
 - Defining vertical and horizontal position of the sign language video if necessary.
 - Defining the dimensions of sign language video.
 - Introduce the time codes, the producer will indicate the points of entry and exit of the sign language video.
 - Indicating the viewing angle, so the producer can indicate where the speaker is in the scene.
 - Assigning the sign language segment to a video time code and a video angle (there can be simultaneous sign language segments to different sections of the visual scene).
- The sign language video segment will be previewed alongside the video for real time checking, so the producer can have an instant simulation of the result. The main video playback will be in the preview player and the sign language video segment playback with the interpreter will be in a separate window next to the player.
- The editor will be able to show graphical elements that inform about the orientation of the current speaker, so the professional user can have a simulation of the result.
- The professional user will be able to check the final result. In this case the sign language video segment will be played in a window next to the preview player in a synchronized manner.
- The final check of the complete result in high quality video can be done using HMD (PUR.01.02.0). Once the production has finished, the professional user will be able to watch the final result that will be available for end-users using a Head Mounted Display with high quality 360 video together with the 360 audio. The user will hear the 360° audio together with graphical elements that inform about the orientation of the speaker (PUR.01.06.0). The 360 audio will be further analysed during the second iteration as it is not essential for the production of the pilot's accessibility content during the first iteration.

2.3. Service Provider

This subsection contains the list of specifications of the Accessibility Content Manager:

- A web interface will allow the professional user to upload and download the subtitling, audio description and sign language files to the platform (PUR.03.01.0).

- The web interface will let the professional user to upload the low resolution video that the prototype web editors need for the production of the pilot's accessible content (PUR.03.01.0).
- Once the file has been uploaded, metadata can be edited such as the IDs that identify the corresponding media of one or several media asset management systems (PUR.03.03.0).
- The professional user will be able to search accessibility content by file name, content type, integrity and assignment (PUR.03.02.0).
- From the web interface the professional user will be able to trigger the packaging of subtitling, audio description and sign language once all the necessary files are ready (PUR.03.04.0) and also the settings such as forward the packaging result as local retrieval (PUR.03.06.0) or to a different IP resource (PUR.03.07.0).
- There will be a section for general parameters required for the packaging and distribution modules (PUR.03.08.0).
- From the web interface it will also be possible to monitor the state of the packaging (PUR.03.05.0).

2.4. Storage / Packaging / Distribution

This section will specify the definition of the system at the level of packaging and distribution of accessible content (subtitling, audio description and sign language stream distribution) with audiovisual contents.

The previous paragraph focused on the production tools of the accessibility contents and management of the content including audiovisual assets and associated accessibility contents. The content manager will allow the user to pilot the production, the packaging and the distribution of contents through a user interface. The Storage/Packaging/Distribution Layer will allow to prepare the contents for the end user visualization through:

- The packaging of subtitling, audio description and sign language within the corresponding audiovisual contents.
- The distribution of the packaged contents to the client players.

The packaging process will have to insert the proper metadata to ensure synchronization between each individual content and especially between the original audiovisual content and the additional accessible content.

The content packaging and distribution module will also allow two types of distribution:

1. **VoD:** the content will be prepared as files on CDN storage ready to be distributed on a video on demand request.
2. **VoD for TV linear program:** the content will be distributed to be consumed through companion screen synchronously to a linear TV content.

The content packaging and distribution module will take into account the devices targeted and validated by the ImAc consortium.

2.5. Consumer Platform

This section describes the functionalities and options of the media player for the presentation of omnidirectional video in combination with the accessibility contents considered in ImAc, namely: subtitles, audio description and sign language videos.

2.5.1. Media Playback Control

The ImAc player will include the proper functionalities to control the media playback of the considered media contents (including omnidirectional and accessibility contents). This includes “play”, “stop”, “pause”, “resume”, “forward” and “rewind”, as well as “volume” setting, options (HUR.02.06.0).

Spoken feedback to the execution of these commands will also be provided (HUR.02.10.0), e.g. by using a “screenreader”.

2.5.2. User Interface

A key aspect of the ImAc player is the User Interface (UI) to be designed and adopted. This UI needs to take into account the sensorial capacities of the target users, and the requirements and preferences identified in the focus groups, which are listed and described in this document. In addition, the UI to be designed will take into account the particularities of each platform and physical limitation of each screen. This will determine various relevant aspects regarding the presentation of the (immersive and accessibility) contents, such as the “safe area”, the comfortable FoV, the objects’ size and position, etc.

The UI will be modern, intuitive and efficiently interpreted/used by all users, regardless of their sensorial abilities. Besides, the recommendations provided in different accessibility standards (e.g. W3C WCAG <https://www.w3.org/TR/WCAG20/>) will be taken into account in order to provide an accessible player. It may also involve that multiple pathways for media control and interaction need to be provided.

The provided mockups for the presentation modes give an initial idea of the approach to be followed for the design of the UI.

In the following passages, the identified requirements regarding the visual menus, voice control interaction, and the personalisation options to be provided are listed. These requirements will also be considered as starting points for the design of the UI.

Visual Menus:

The UI will include visual menus to provide access to the subtitles (HUR.02.01.00), audio subtitling (HUR.02.05.00), signer (HUR.02.02.00) and audio description (HUR.02.03.00). Therefore, the proper controls will be added in order to enable:

Switch on/off signer	(HUR.02.16.0)
Switch on/off subtitles	(HUR.02.24.0)
Switch on/off audio description and audio subtitles	(HUR.02.36.0)

The player will also enable zoom and enlargement functionalities for visual menus and/or controls (HUR.02.04.00). Spoken feedback of playback controls (play, pause, skip forward, skip backward and stop) and of main volume and audio description volume controls (HUR.02.10.00) will be also provided.

The player will also support different personalization options to be set via a menu (HUR.02.17.00, HUR.02.26.00). These options are detailed in the next sub-section.

Voice Control:

Apart from graphical menus and controls, voice control is also a very useful mechanism for media accessibility and will be provided for controlling the media player (HUR.02.11.00). Accessibility users are familiar with voice control and these days voice control is becoming an expected interface in accessibility services. The following table provides a list of the voice commands that will be supported:

Voice Command	Action	State
<i>Library</i>	Switches to library mode	From any mode
<i>Player</i>	Switches to player mode	From any mode
<i>Previous</i>	Previous (Item or Chapter)	With content playing
<i>Next</i>	Next (Item or Chapter)	With content playing
<i>Show Menu</i>	Toggle menu bar in library	In any mode
<i>Play / Pause</i>	Play/Pause Toggle	With content queued up
<i>Stop</i>	Stops Playback	With content playing
<i>Seek back 10</i>	Skip Backward 10s	With content playing
<i>Seek back 20</i>	Skip Backward 20s	With content playing
<i>Seek back 30</i>	Skip Backward 30s	With content playing
<i>Seek forward 10</i>	Skip Forward 10s	With content playing
<i>Seek forward 20</i>	Skip Forward 20s	With content playing
<i>Seek forward 30</i>	Skip Forward 30s	With content playing
<i>Subtitle on/off</i>	Subtitle On/Off Toggle	Playing content which has subtitles
<i>Audio Subtitling on/off</i>	Subtitling On/Off Toggle	Playing content which has subtitles
<i>Audio description on/off</i>	AD On/Off Toggle	Playing content which has AD
<i>Signer on/off</i>	Signer On/Off Toggle	Playing content which has signer
<i>Speed normal</i>	Play Speed Normal	With content playing
<i>Speed Slow</i>	Play Speed Slow	With content playing
<i>Speed Fast</i>	Play Speed Fast	With content playing
<i>Fullscreen</i>	Switch Fullscreen	With content playing
<i>Mute</i>	Mutes sound	In any mode
<i>Volume Up</i>	Increases sound volume	In any mode
<i>Volume Down</i>	Decrease sound volume	In any mode
<i>Menu</i>	Context menu shortcut	In any mode
<i>Personalization Options</i>	Context menu shortcut	In any mode

Table 1- Voice commands to be supported within ImAc Media Player solutions

All voice commands will be acknowledged with an audible response.

2.5.3. Synchronization Functionalities

The player will support the integrated presentation of the different accessibility contents in a synchronized manner. Synchronization across devices will be provided as well. It will guarantee a time-aligned presentation of the traditional contents on the main TV and the immersive and accessibility contents on the companion devices, for each target platform.

2.5.4. Target Platforms

As shown in the Consumer Platform block of the ImAc block diagram (Figure 1), different types of consumer devices will be supported in the project. These include PCs (desktops and laptops), mobile devices (tablets and smartphones) and HMDs. It means that the player needs to be integrated within these different devices, for a variety of platforms and Operating Systems. The use of web-based components for the development of the player is an advantage in that sense, as cross-platform support is easier to achieve, although taking into account the specific particularities of the different devices and platforms.

2.5.5. Presentation of Accessibility Contents

This section specifies how the different accessibility contents will be presented to end-users via the ImAc player. At this stage of the project, the considered presentation modes for these contents are provided as a series of mockups. The full accessibility interface for the ImAc player (for each target consumer platform) to enable/disable the presentation of these contents and to set the considered personalization options will be carefully designed in a later stage of the project.

2.5.5.1. Presentation of Subtitles

According to the focus group tests, four different presentation modes and five personalisation options were identified, which mainly rely on existing concepts available for subtitle services. Additional requirements for the interface were introduced, which again are based on existing usage concepts.

Approved subtitle characteristics:

- **Colours to distinguish between different speakers:** The same colours will be used as per broadcaster's guidelines (3-4 colours). The use of specific colour palettes for colour-blind people will also be considered.
- **Maximum amount of text for one subtitle:** The TV broadcast subtitle services are still based on the teletext limitations as well as on viewer behaviour, including their reading speed. That implies that the number of characters is limited to about 37 characters per line and it is suggested to use not more than 2 lines for a subtitle.

In order to derive the specifications for the ImAc platform from the requirements, we had a look at existing subtitle services and research results from previous EU projects like HBB4ALL and DTV4ALL, covering TV and VoD services.

Concerning the web player for tablets and smartphones to be used without VR glasses, we assumed the same ratio (16:9) and the safe area for interactive elements defined by the EBU guideline EBU R95 (<https://tech.ebu.ch/docs/r/r095.pdf>) in a HD format.

The head mounted displays have different maximum visual fields defined as FoV (Field of View). In ImAc we need to define the "user's comfortable visual field" to properly position the accessibility contents and controls. The comfortable save areas for subtitle placement on different display devices will be evaluated in ImAc pilots and introduced to the ImAc player at a later stage.

In order to get a better understanding of the requirements we started to visualise the different presentation modes in six comfortable viewing field levels ranging from 30% to 80% of the absolute field of view in a head mounted display.

The subtitles were positioned centered, bottom left, bottom right, top left and top right to show the limits of the comfortable field of view. The default presentation of RBB's HbbTV subtitles in a medium size (40px according to HD resolution of 720px height) with an adapted black background (80% opacity), a maximum of two lines and 37 characters per line was used as a starting point. It was obvious that the font size needs to be adapted according to the comfortable field of view to avoid additional line breaks.

The different pre-defined approaches to guide the user with an arrow or a compass to the speaker were also visualised in mock-ups.

Main concept for the presentation

The subtitles will be always presented on the same device on which the omnidirectional video is being presented. The use of additional screens for exclusively presenting subtitles is not an option desired by end-users (HUR.02.08.0). In addition, subtitles will be always visible in the basic presentation mode (centered in the defined field of view), regardless of whether the related scenes/objects in the 360° area are visible or not (HUR.03.05.0).

Personalisation options

In case that multiple subtitle tracks are available, users will be able to select between them (HUR.02.25.00). This will include multiple languages, and normal vs easy-to-read subtitles.

Different font sizes (e.g. small, medium and large) for the presentation of subtitles will be available (HUR.02.29.00). In addition, the users will be able to select between different backgrounds: 1) semi-transparent box (80% opacity); 2) outline (2px for each font size); and 3) adding the subtitles below a scaled down video area (HUR.02.30.0). Regarding their position, subtitles are typically visible in the user's field of view in the middle slightly below eye line, two-lined (see Figure 3). The ImAc player will follow this approach (HUR.02.27.0), but it will allow dynamically setting different positions, as also required by users during the conducted focus groups. The most appropriate vertical position for subtitles depends on the user device (i.e. viewing environment) and/or on the user. Therefore, personalization options will be provided and some tests will be conducted in that sense in order to find out the most comfortable consumption experience.



Figure 3- Traditional centered subtitles placed within a defined Comfortable Field of View in HMD

Presentation Modes

Different presentation modes are envisaged in ImAc. When the active speaker/s is/are not within the FoV of the end-users, different strategies will be considered to inform them about the position of the speaker/s:

- a) Adding arrows (see Figure 4);
- b) Using sided text (see Figure 5);
- c) Adding a compass or wind rose (see Figure 6).

These multiple options will be used for testing the end-users' preferences. Then, the most adequate ones will be included in the final version of the player.



Figure 4- Arrows next to the subtitles to inform about the position of the speaker



Figure 5- Sided subtitles to inform about the position of the speaker



Figure 6- Compass next to the subtitles to inform about the position of the speaker

Appropriate and intuitive controls to set the mentioned presentation functionalities and modes will be provided in the player.

Presentation of visual notifications for sounds

The player will also provide visual notifications, as icons (see Figure 7), when relevant sound-related events are being presented, enabling their interpretation by the hearing-impaired users.



Figure 7- Subtitles and sound icons

2.5.5.2. Presentation of Audio Description (AD)

The following aspects have been considered regarding the presentation of audio and Audio Description for visually impaired people:

- Presentation of immersive/spatial/3D audio in general
- Location of the AD speaker in the audio scene
- Directional AD
- Level of AD track in relation to the main audio
- Audible cues to help users to orientate themselves

As a matter of course, all media assets (video, the main audio mix and Audio Description) are played back synchronized to the user (HUR.02.09.00).

Presentation of immersive/spatial audio in general

Various terms are used in that context, mainly “immersive audio”, “3D audio”, “spatial audio”. All of them mean more or less the same: That the listener feels like he/she is located within the presented (audio) scene and that listener can locate sound sources in different directions.

Focus group test results lead to the finding that an immersive audio scene will improve the user experience significantly for visually impaired people. Immersive audio helps them to orientate themselves in a 360 environment. And this is exactly one of the key aspects to make 360 and VR presentations accessible for this user group. Other surveys came to similar results [Portillo, C., (2017) Films Unseen: Approaching sound design alternatives to enhance perception and mental imagery models among audio description audiences on Sci-fi films].

ImAc envisages full support of immersive audio (HUR.2.38.0).

One effect has to be mentioned here, that occurs when headphones are used for playback: Since headphones are “attached” to the head, they follow head movements. That means the audio scene moves as well. Rotation is the most critical movement that will break the impression of being within the audio scene. The effect can be compensated by tracking the head movement of the listener and apply an appropriate audio processing. When this is done, or when a loudspeaker system is used, the audio scene will not follow head movements but stays fixed in relation to the room. In the following, we will speak of a “spatially stable audio scene” in that case. A spatially stable audio scene is desired in ImAc.

Resulting functionalities for the ImAc user platform:

- Rendering of audio formats that are suitable for immersive audio will be supported (HUR.3.6.0).
- Head tracking will be supported and processed in order to provide a “spatially stable audio scene”.
- Rendering of traditional audio formats as a fallback solution when immersive audio was not produced, is not supported by the user’s hardware or is not available for other reasons.

Locations of AD speaker in the audio scene

In traditional AD services that are usually provided for Stereo or 5.1 systems, the AD track is mixed in such a way that it is located in the center position (i.e. in the center of the stereo panorama or to the center speaker of a 5.1 system). As described previously, ImAc will support immersive audio that allows for additional options regarding the location of the AD speaker.

ImAc will evaluate what AD speaker location will be most comfortable to the user. Three different options will be tested:

- 1) AD centered in the scene (Voice of God)
- 2) AD anchored in the scene (Friend on Sofa).
- 3) AD anchored on the event/object being described. (AD on action)

Depending on the evaluation results, ImAc will offer different options that a user can choose from.

The first two options for AD speaker locations described above are fixed locations. In addition to these options, ImAc will test an “action related positioning” of the AD speaker (HUR.2.42.0). That means that the user will hear the AD speaker from the same direction where the described action takes place. It is unclear yet if that is a reasonable option or if it leads to confusion. The user will be able to choose this presentation option (when available) instead of a fixed AD speaker location.

Resulting functionalities for the ImAc user platform:

- An appropriate way for selecting from different AD options will be provided (refer to section 2.5.6 user preferences).
- Simultaneous rendering and mixing of multiple audio tracks will be supported.

Directional AD

A secondary AD can be provided for the user FoV (HUR.2.44.0), which will describe the action or details happening within the current user view, and avoiding the description of actions or details out of this view or already described in main AD track.

Users will also have access to a main AD track describing the main action, but if secondary AD tracks for additional actions are available, their selection will be also possible (HUR.2.43.0). In this context, the main action can be identified by setting a higher volume to it (HUR.2.46.0) or using different voices for the main and secondary actions (HUR.3.7.0).

Level of AD track in relation to the main audio

It was considered that user preferences might differ regarding the relation of the AD volume to the main audio volume. Thus, the user will be able to set the AD volume independently.

Resulting functionalities for the ImAc user platform:

- Simultaneous rendering and mixing of multiple audio tracks will be supported.
- An appropriate way for setting the volume for the AD speaker will be provided (refer to section 2.5.6 user preferences).

Audible cues to help users to orientate themselves

If the user choose the ‘guide me’ option, then he/she will also be guided through the main action with a sound effect (“beep”) which will indicate the position of main action. (HUR.2.45.0).

2.5.5.3. Presentation of Sign Language (SL)

Similar to the approach used for subtitles, we also started to analyse existing research results concerning the presentation of signer videos.

An outcome of the EU project HBB4ALL was among other things the recommendation for three different sizes of the sign language video. The medium size was adapted to the ratio of the head mounted display and mock-ups were created to have a visualisation of the service.

Basic presentation mode

The player will also enable the presentation of Sign Language (SL) videos in a synchronized manner with the related contents. A “basic presentation mode” for the signer will be always available on any device. In this mode, the signer video has a fixed position on the bottom right area of the comfortable FoV and the user decides what direction he/she wants to look (HUR.02.18.00).

Personalisation options

In this “basic presentation mode”, users will be able to select between a predefined set of different horizontal and vertical positions for the signer (HUR.02.19.00). They will be also able to select between a predefined set of sizes for the signer (HUR.02.20.00).

Presentation modes to guide the user to the speaker

The signer will appear within the user’s FoV, according to the personalisation settings. An arrow under the signer window and/or the name or description of the speaker will indicate the position of the actual speaker (see Figure 8). This way, these visual instructions will help end-users to turn around towards the speaker (HUR.02.21.00).



Figure 8- Presentation of Sign Language Videos within the Comfortable FoV plus Arrows informing about the position of the speaker

Apart from the “basic presentation mode” for the accessibility contents, the player will provide support for a “forced perspective” mode. It consists of automatically changing the current end-user’s FoV to the one in which the involved speakers are visible and the conversation is active. Afterwards, the user can change the direction he/she wants to look (HUR.02.22.00). For the signer, a third “angular-based positioning” presentation mode will be considered. In this mode, the signer will be dynamically presented at the position on the FoV that is closest to the object that is associated with it. For example, if the signer represents a person that is to the left of the user’s viewing direction and outside of the FoV, the signer video would be presented at the left

edge of the field of view (HUR.02.23.00). These different presentation modes will be tested and, according to their appropriateness, they will be adopted or not in the final player.

2.5.6. User Preferences

In the focus groups, the need to provide different personalisation option regarding the presentations of the accessibility contents was also identified. This will enable end-users to set their preferences, based on their likings or comfort levels, or on their sensorial capacities.

The customization options that will be provided in ImAc are listed in the table below. The specific UI and controls to enable the presentation of these contents and to set the available options will be designed in a later stage of the project. Besides, the user preferences options to be provided might depend on the target consumer device to be used. It will be analysed and determined in the first (pre-)tests.

Font size of subtitles (HUR.02.28.0)	Users will be able to select between different font sizes for subtitles: - Small (30 pixel* (i.e. 1/24 of viewing field height)) - Medium (40 pixel (i.e. 1/18 of viewing field height)) - Large (50 pixel (i.e. 1/14.4 of viewing field height)) *Sizes calculated according to a TV screen dimension 1280 x 720
Position of subtitles (HUR.02.28.0)	Users will be able to select between a pre-defined set of positions in the viewing field: - Bottom  - Top 
Background	Users will be able to select between different backgrounds for the presentation of subtitles: 1) semi-transparent box (80% opacity) 2) outline (2px for each font size) 3) adding the subtitles below a scaled down video area (HUR.02.30.0).
Selection of subtitle tracks	If different subtitle tracks are available, users will be able to select between them. This will include: - Multiple languages. - Normal vs easy-to-read subtitles.
Position of icons (HUR.02.32.0)	Customization regarding the position of icons or indication elements for the accessibility contents will also be provided
Position of the signer (HUR.02.19.00)	Users will be able to select between a predefined set of horizontal and vertical positions for the signer: - Bottom right (traditional position, see Figure 8) - Top right - Bottom left - Top left

Size of the signer (HUR.02.20.00)	Users will be able to select between a predefined set of sizes for the signer: - Small (400 x 400 px) - Medium (450 x 450 px) - Big (500 x 500 px) (Sizes calculated according to a TV screen dimension 1280 x 720)
Access to several AD tracks	Users will have access to a main AD track describing the main action, but if other secondary AD tracks for additional angle-based actions are available, their selection will be also possible.
Adjust audio level of AD and main audio separately	The user will be able to adjust the level of the AD track in relation to the main audio.
“Guide Me” option	If users enable this option, they will be guided through the main action.

Table 2- Customization options to be provided by the ImAc player

Users can save preferences and customization options for every device, so future content consumption on that device will be automatically adapted to user preferences.

3. TECHNICAL ARCHITECTURE OF THE IMAC PLATFORM

Chapter 2 has been dedicated to describe the multiple functionalities foreseen to be implemented in ImAc platform.

Based on these functionalities it was imperative to design an optimal architecture that must allow the production of accessibility content by professional users, and at the same time must ease the consumption to end users by offering the best user experience for all citizens.

The next sections draft this architecture, which has been divided in modules and grouped in four main areas, with the aim to offer a first high-level view of the full platform.

This architecture will feed the upcoming deliverable D3.1, where a deeper technical implementation of the architecture will be studied before starting the real development of the ImAc platform with the aim to obtain the best results.

3.1. Logical Architecture

This section will introduce the chosen architecture to realize the ImAc platform. A platform, that takes into account the professional and end user requirements and the specifications derived from these requirements, is drawn in the form of a logical architecture (see Figure 9) that contains different modules that interact with each other to execute the necessary processes for the creation, management and distribution of audiovisual content and accessible services.

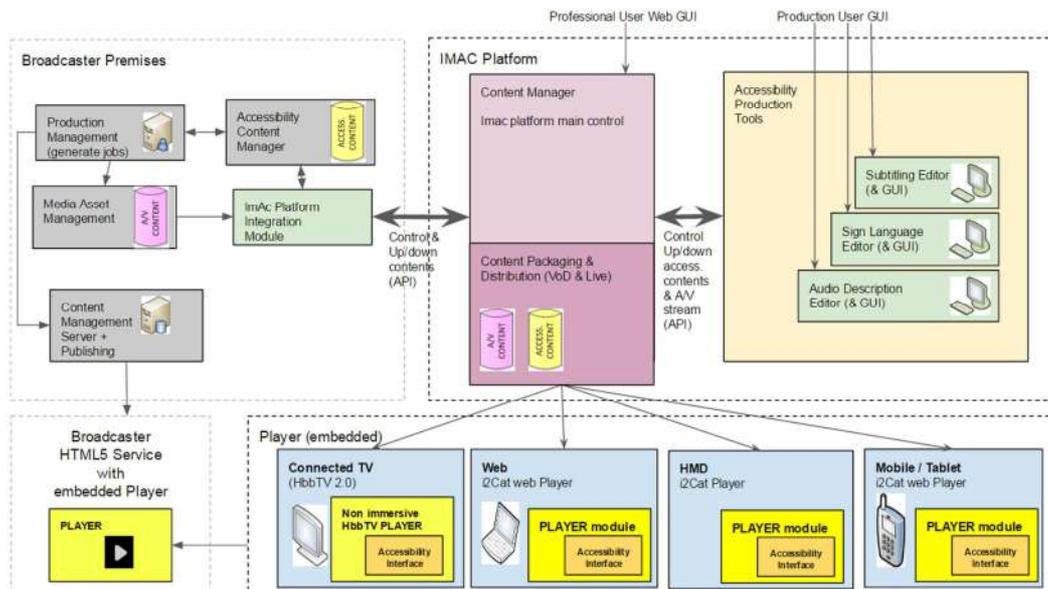


Figure 9- ImAc platform architecture

The architecture is divided in 3 main areas:

- Broadcast Premises - this area could be also represented by an OTT platform owner or any content owner with the requirement to produce accessibility content for its audiovisual immersive content. A general overview of internal broadcaster workflows is shown, with the following modules:
 - Production Management module from where the different works of accessible content production are requested.
 - Accessibility Content Manager module to manage and store the ImAc produced contents.
 - Media Asset Management platform manages broadcaster media workflows, systems and assets throughout the multimedia production & distribution chain.
 - Content Management System + Publishing module allows the management, packaging and publishing to Internet of broadcast contents.
 - ImAc Platform Integration Module will be in charge to interconnect broadcaster workflows with ImAc platform and will allow all the necessary communication to execute all required processes through a pre-defined API (Application Programming Interface).
- Player (embedded) - The ImAc media player will be developed within the ImAc project ready to play all immersive accessible services and with an accessibility interface to ease the access to end users. This ImAc media player will be embedded in the web service of the broadcaster or OTT platform owner.
- ImAc Platform - this area brings together all the main modules for the management, production, packaging and distribution of accessible contents and will be detailed in next sections.

3.2. Accessibility Production Tools Module

The professional user will use the corresponding editor for the production of the accessibility contents. For that it requires the low-resolution video and upload the result to the Accessibility Content Manager. So there's a strong relation between the editors and the accessibility

content manager module.

For the prototype web editors of the first iteration:

- The professional user will access the accessibility content manager, search the asset with the video and execute the production of the corresponding accessibility content.
- The corresponding web editor (subtitling, audio description or sign language) will open with the asset's video and the asset's corresponding accessibility content. If no accessibility content existed for the asset, a new empty one will be created.
- The professional user will use the corresponding web GUI editor for the production of the subtitles, audio description segments or sign language segments. The result will be saved in the server and accessed via the same asset from the accessibility content manager web interface.

For the professional editors of the second iteration:

- The professional user will execute the editor in a Windows operating system, select the video file and the accessibility content file (subtitling, audio description or sign language) from the hard drive.
- The resulting file will be saved onto the hard drive and then uploaded to the Accessibility Content Manager via the web user interface.
- Once the file is in the Content Manager, the professional user can assign general metadata via the web interface and execute the edition of the file.
- In case the professional user executes the edition of accessibility content from the accessibility content manager, the corresponding professional editor will be executed with the file without the need of saving the file into the hard drive first. In this case the professional user will also have to select the video file from the hard drive.
- If the professional user is editing a file from the accessibility content manager with one professional editor, the recording will be automatically uploaded to the content manager without the need of previously saving the file into the hard drive.

3.3. Accessibility Content Manager

Once the accessibility files are uploaded to the content manager, the professional user will be able to use its user interface for:

- Assign metadata to the asset with the accessibility contents, such as the ID needed to match the asset with external asset management systems.
- Prepare the final files for the packager using the asset's contents, such as a new mixed audio file created from the audio description file and the video file.
- Trigger the packaging by validating all the files required.

The accessibility content manager web service will be used by the content packaging and distribution module to initiate and notify its processes.

3.4. Content Packaging & Distribution

The content packaging and distribution system takes the input given by the content manager (described in 3.3) and make it playable by the player modules (described in 3.5). The distribution system will be able to transcode the audiovisual initial content to adapt it to the distribution constraints (like network bandwidth) or target devices.

This module will match four main required functionalities:

- Firstly, it will encode the content (compress the audio and video).
- Secondly, it will package the content inside a suitable container for delivery, and it will ensure that the content is segmented appropriately.
- Thirdly, this module will ensure a proper delivery that includes the signalling of the metadata according the editors' wishes.
- Finally, it will push the content to the appropriate network (whether using streaming protocols or file-based caching infrastructures).

The distribution system will leverage the state-of-the art technology to deliver the best possible quality to all users depending on their capabilities. These technologies may be developed in the framework of the ImAc project. The wish of the ImAc consortium is to rely on standard technologies which means that our technological advances will be pushed to standardization bodies (such as MPEG or others) and industry consortiums (such as DVB or others).

As a consequence, this module will communicate with the Content Manager in a close way. The ImAc project will define a protocol to ensure communications between the modules following the best practices of the industry.

3.5. Player Module

End-users will make use of several consumer devices to access the traditional, immersive and accessibility contents considered in ImAc, provided via the Content Packaging & Distribution module (see Figure 9).

ImAc considers different types of consumer devices, ranging from desktops/laptops, mobile devices (e.g. tablets, smartphones...) and HMDs. This implies that the interaction and presentation features of the player need to be adapted to the characteristics of the target devices. The use of web-based technologies and components for the development of the player will be an advantage in these aspects.

In general terms, the ImAc player will be able to play out the immersive contents (i.e., omnidirectional media), but most interestingly, it will integrate an **accessibility module/interface** to be able to present the accessibility contents in an easy way and to dynamically set the considered personalization options.

An objective of ImAc is also to provide support for multi-screen scenarios, so that different devices in a local scenario can be discovered, associated, play out the same or related contents in a synchronized manner, and even support interaction features. An example is the consumption of a director-controlled view of an event on a main TV augmented with the consumption of alternative 360° views and accessibility contents on companion screens.

The availability of commercial devices supporting the latest version of Hybrid Broadcast Broadband TV (HbbTV) 2.0 standard, at the time pilots need to be prepared (which is scheduled), will be of a great help in this aspect. It is due to the fact that it would allow leveraging of the features provided by HbbTV 2.0 regarding the mentioned targeted functionalities. It would also allow considering broadcast linear (although not live) TV contents to be played out on main (connected) TVs in the pilots. In such a case, the main TV will be able to process metadata inserted into the broadcast stream(s), signaling the existence of accessibility services. It will also include the proper modules for service and device discovery, and for app launching. Inter-device synchronization capabilities are also provided by HbbTV 2.0 thanks to the adoption of the DVB-CSS (DVB Companion Screens and Streams) protocols. If HbbTV 2.0 devices are not yet available at the time pilots need to be prepared, all these multi-

screen functionalities will be provided in web-based scenarios, as they are not supported in the current commercial version of HbbTV, v 1.5.

4. CONCLUSIONS

The first tasks of the ImAc project have involved the survey and understanding of the requirements for both professional users and end users. This is important when consuming accessibility content in an immersive environment which is unfamiliar.

Within this new Immersive environment, little is currently understood about the user requirements and behaviours making these first critical steps to discover and learn from the users themselves essential. The thorough work carried out so far in task 2.3, has enabled a precise definition of the specifications for the ImAc platform. It has led to the development of a platform architecture which aims to facilitate an optimal development process to satisfy the user's needs.

This will ensure successful results which will be demonstrated and tested in WP5, through the participation of both professional and end users through a process of closed and open pilots. It will also allow to further refine the platform during the second phase of the ImAc project.