Deliverable

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D4.5 Accessibility Service Tools Report

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Abstract:

This deliverable documents the latest progress made in the ImAc project regarding the development of access services production tools.

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Statement of originality:

This document contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

EXECUTIVE SUMMARY

This deliverable acts as a comprehensive report destined to description of the progress made in this work package (WP4 – Accessibility Service Tools), especially the final developments in the matter of access services production tools up to the moment of their submission.

The main objective is to present all the achievements in a concrete manner in order to make it easy for the reader to follow up the ImAc WP4 progress.

The objective of ImAc WP4 is to develop the technological basis required for access service production. The developed tools have derived their specifications from user requirements defined in previous work packages and introduce new results in the field of access service production in immersive media.

In first iteration the relevant research has been conducted and prototyped version of tools have been developed. In the second iteration the tools have migrated to an exploitation version of themselves while fulfilling the user requirements.

The deliverable addresses the developed tools, improvements in their iterations, use-cases, user requirements achievement, aimed stakeholders and conclusion.

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Acronym	Description
ACM	Accessibility Content Manager
AD	Audio Definition
ADM	Audio Description Model
AST	Audio Subtitle
CM	Content Manager interface
CPS	Character per Second
EBU	European Broadcasting Union
ED	Editor Interface
FOA	First Order Ambisonics
HOA	Higher Order Ambisonics
HUR	Home User Requirements
IMSC	Internet & Media Subtitle and Caption
LQ	Low Quality
OBA	Object-based Audio
PUR	Professional User Requirements
SCF	Subtitle Conversion Framework
SL	Sign Language
SM	System Manager interface
ST	Subtitling
STL	Standard Template Library
T	Task
TC	Time Code
TTML	Timed Text Markup Language
WP	Word per Minute
WPM	Work Package

1. Introduction

1.1. Purpose of this document

This document reports on the progress and final result obtained in WP4 of ImAc. The work package includes three separate tasks dedicated to developing production tools belonging to three main access services (ST, AD, SL) respectively. This document follows the same structure as well, in addressing the issues above.

Access service production tools have been realised in WP4 and have been explained individually in D4.1[i], D4.2[ii] and D4.3[iii]. In WP4 and specifically during the first iteration, the technological basis for the content production for access services in ImAc is developed. This comprised a comprehensive research on the access service file formats, investigations of existing tools and libraries, extending existing tools and the development of new production tools, handling existing and new file formats and convert between them and rendering access services.

This document elaborates and aggregates the results and progress made in WP4.

1.2. Scope of this document

This deliverable is meant to be a comprehensive report of the progress made in the second iteration of the ImAc in all of the WP4 tasks. Each task of work package is specified to a chapter and each chapter is divided into different sub-chapters specified to different tools addressing the developed tools, improvements in iterations, use-cases, user requirements achievement, aimed stakeholders and conclusion.

1.3. Status of this document

This is an iterative document that depicts the progress made during the second development phase. The first version of the document was submitted in November 2018.

This is the final version to be submitted with due date in M24.

1.4. Relation with other ImAc works

Illustration 1 shows the relation between this deliverable with other ImAc activities. As seen, specifications and architecture design are extracted from D2.3[iv] and D3.1[v] respectively. These helped WP4 which focused on access services production tools. WP4 tools feed into T5.2 (content production for pilots). Findings that were made during the development also feed into standardisation activities, where appropriate (T6.2).
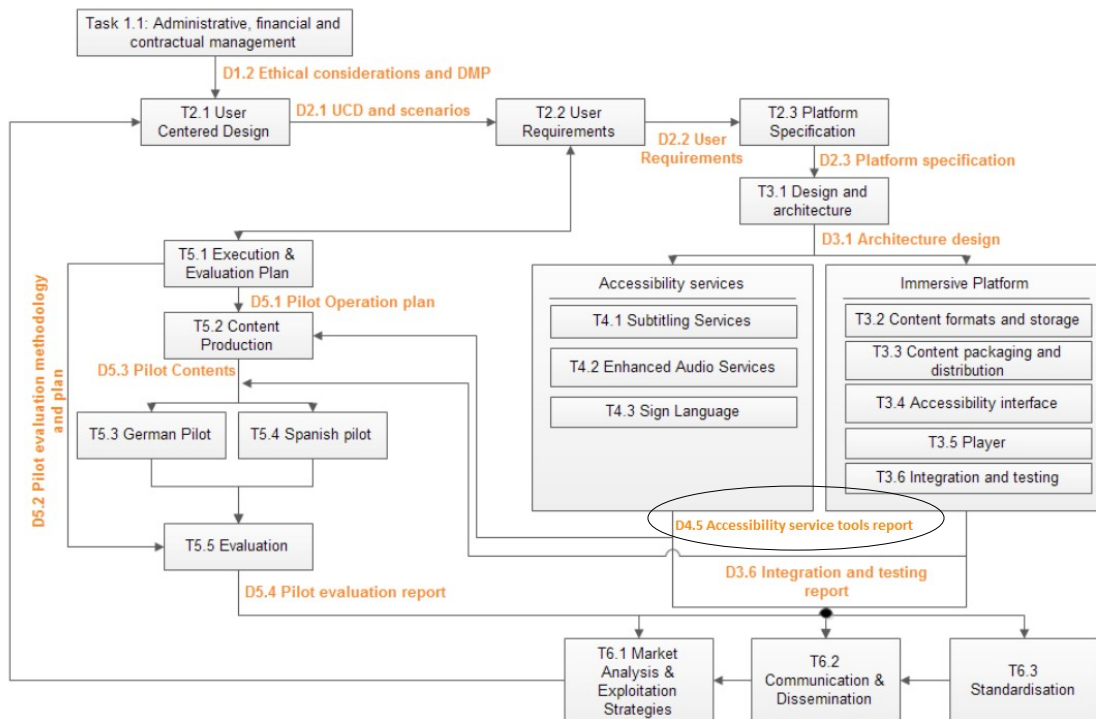
Illustration 1: Pert diagram showing relation between deliverables

1.5. POSITION OF PRODUCTION TOOLS IN IMAC WORKFLOW

Illustration 2 shows the workflow ImAc uses for procedure of access services production for 360º video in broadcasting industry.

The various components of this illustration are clearly described in their corresponding deliverable. However, this chapter aims to highlight the role of access services production tools and their accompanying tools in this procedure. As seen in the illustration, PROVIDERS require "EDITOR INTERFACE" and "ONLINE EDITORS" in order to produce/edit access services content that are assigned to them by "ACCESSIBILITY DEPARTMENT" which is then received by "QUALITY DEPARTMENT" for verification when completed. In the next sub-chapter, the stakeholders terms are described in order.
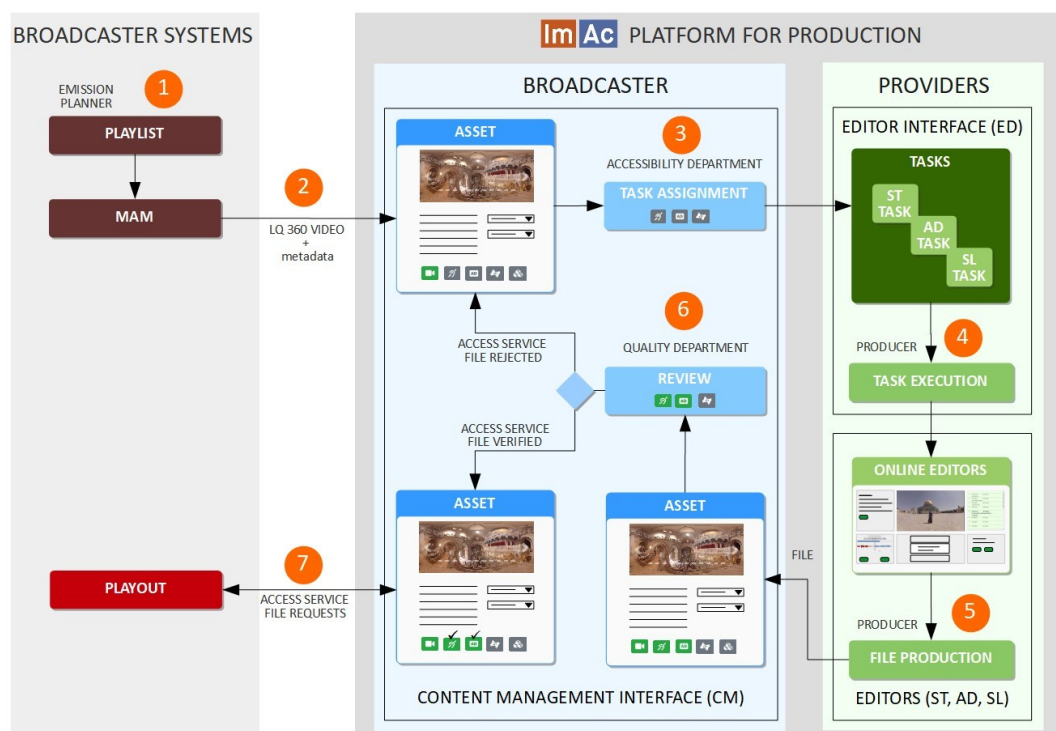
Illustration 2: Steps for the production of content for 360º media access services

1.6. STAKEHOLDERS

It is necessary to recognise the professional users who are potential consumers to the tools developed in WP4. Illustration 2, displays the potential professional users as below:

- **Broadcasters:** It refers to classic broadcasters who wish to offer 360º media to their audience and they need access services for the programmes. Typically broadcasting stations are comprised of numerous departments related to access services such as:

  ○ **Accessibility department:** A department in charge for managing the production of the access services for the programmes. For that they need to deliver the necessary videos and data to producers and catalogue the access service files that have been produced.

  ○ **Quality department:** This department verifies the accuracy and correctness of the completed access services files received by the provider which is done in the step 5 of the illustration.

- **Producers:** The term refers to certified professional people who are certified to produce access service files for programmes such as: subtitlers, audio describers and sign interpreters. Producers can be part of the broadcasting station as a whole department or an external entity.

2. T4.1 – SUBTITLE PRODUCTION TOOLS

The first task to be described is T4.1 which deals with subtitle production tools.

The objective of the task is defined to be development of technological basis for subtitling and also investigation of subtitles access service formats and conversion tools with following goals:

- Provide production tools, suitable for producing and reviewing 360° subtitles

- Investigate tools for converting existing subtitle formats into 360° subtitle and check file quality

- Investigating open source tools usage on subtitle production for 360°

- Mapping the specifications from T2.3 to a suitable TTML-based subtitle format

- Investigate various rendering strategies for subtitles in 360º environment

In this chapter, in each sub-chapter the results are described according to the developed tool.

2.1.   TOOL – WEB ST EDITOR

This tool is a cloud-based edition tool aimed to subtitles called "Web ST Editor" with improvements in second iteration. This chapter merely reports the tool; more detailed technical information is presented in D4.1.

2.1.1. General description

The Editor interface is a place in which the professional users can check and navigate the tasks that have been assigned to them previously from the Content Manager interface. More details on how this interface works can be found in D3.2[vi]. This interface grants an access to Web ST editor.
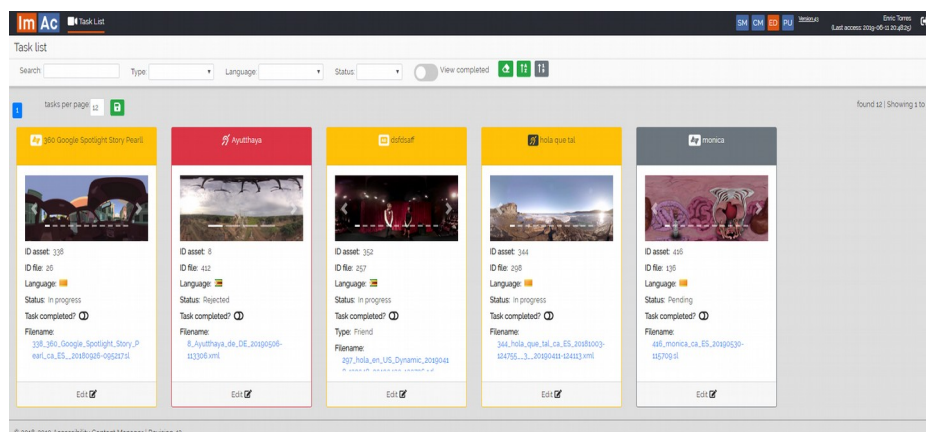
Illustration 3: Editor interface

The Web ST Editor is the tool that allows the professional user to produce/edit the ST task assigned to them.
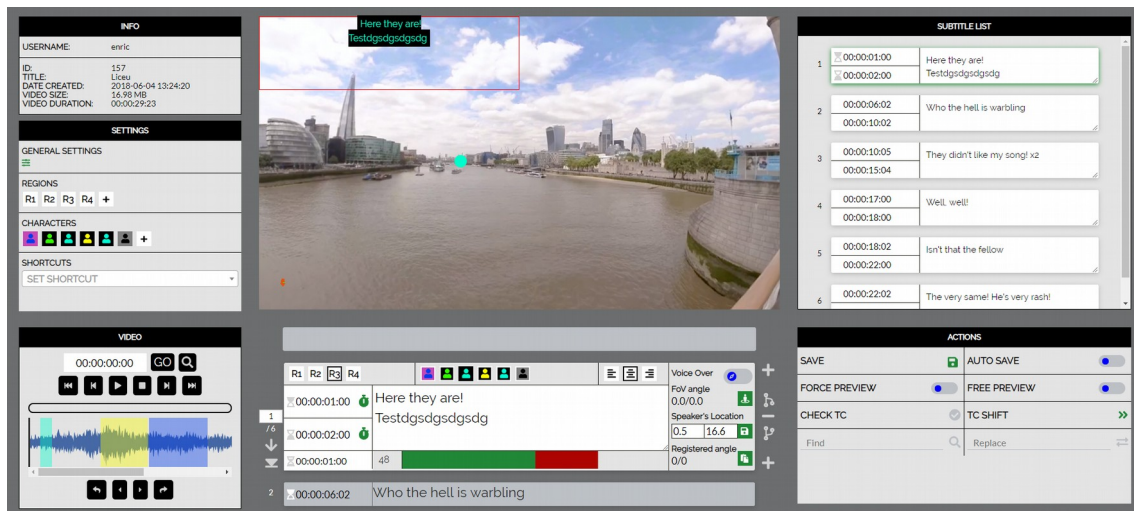
Illustration 4: Web ST Editor

In the second iteration of ImAc the Web ST Editor has been improved according to the user requirements. This editor lets the user produce/edit subtitles for 360º media (LQ videos transcoded on ACM). The editor mainly relies on existing concepts available for subtitle services, however new features have been added to it according to the specifications derived from previous work packages (WP2 and WP3). In 2.1.2 the main objectives and user requirements for this editor are presented, while in 2.1.3 the obtained result according to user requirements are available. Finally, a comparison between the first and second iteration is presented to highlight the improvements from first to second iteration.

2.1.2. Objectives

ImAc is a user-centric project which has extracted its specifications from user scenarios and focus groups. According to these previous work packages, objectives were defined to look into at the moment of user requirements definition phase. It is important to note that this document pays special attention to PURs because the result of WP4 mainly interacts with professional users. The specifications are divided into two sub-categories:

1. General goals addressed in D2.3 (referenced earlier) document as objectives.

2. Specific requirements addressed in D2.2[vii] professional user requirements.

The work done is based on these two sub-categories.

1. **General goals addressed in D2.3:**

    •   **Subtitle characteristics:** 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.

    •   **Colours for distinguishing different characters:** it is considered that at minimum 4 colours are used for different characters. Also colour palettes for colour-blinded people should be determined.

- **Subtitle position:** it is necessary to define positions for the text. The subtitles were positioned centred, 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.

- **Subtitle 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. In addition, subtitles will be always visible in the basic presentation mode (centred in the defined field of view), regardless of whether the related scenes/objects in the 360° area are visible or not.

- **Presentation of visual notifications for sounds:** the player will also provide visual notifications, as icons, when relevant sound related events are being presented, enabling their interpretation by the hearing-impaired users.

2. Specific PURs addressed in D2.2 with their specifications:

Typee	Sys. Reference	Numberr	versions	Title	Description	Prioritization
PUR	1	1	0	Watch low-res preview content	The user must be able to watch the preview content in low quality as flat folded view.	MUST
PUR	1	1	1	Watch high-res preview content	The user must be able to watch the preview content in high quality as HMD view.	SHOULD (Due to the need of using HMD libraries from partners for this item, it has been jointly decided to face this item just after the pilots)
PUR	1	2	0	Watch hi-res preview content	The user is able to watch the preview content in high quality as HMD view	MUST (Due to the need of using HMD libraries from partners for this item, it has been jointly

Typee	Sys. Reference	Numberr	versions	Title	Description	Prioritization
						decided to face this item just after the pilots)
PUR	1	3	0	Navigate preview content by angle	The user must be able to watch content and to navigate it with the help of keyboard shortcuts, scroll wheel and input fields by angle.	MUST
PUR	1	4	0	Navigate preview content by frame	The user must be able to watch content and to navigate it with the help of keyboard shortcuts, scroll wheel and input fields by frame number.	MUST
PUR	1	5	0	Navigate preview content by time	The user must be able to watch content and to navigate it with the help of keyboard shortcuts, scroll wheel and input fields by time code.	MUST
PUR	1	5	1	Navigate preview content by time	The user can add and subtract a given amount of time to the input field for time-code	MUST
PUR	1	16	0	Edit shortcuts	The user can change the shortcut used in the editor tools for the ImAc content	SHOULD
PUR	1	17	0	Edit and preview mode for ImAc files	There are two different modes for editing and previewing ImAc content. The preview mode allows a few editing options	MUST
PUR	1	22	0	Navigate preview content by defined number of frames	The user is able to navigate content by customizable amount of frames for forward/backward jump	SHOULD

Typee	Sys. Reference	Numberr	versions	Title	Description	Prioritization
PUR	**1**	**23**	**0**	Listen to audio content while navigating by frame	The user is able to listen to the main audio content while navigating the video content frame by frame	COULD (This PUR is not implemented in this version due to the fact that the current browser player does not reproduce audio when in slow speed backwards)
PUR	1	24	0	Visual display of audio content	The user can monitor the main audio via a visual display of the sound-wave	MUST
PUR	3	10	0	Defining speaker location indicator options	The user is able to define the speaker location indicator options which are offered to the home user	SHOULD
PUR	1	8	0	File operations	The user is able to produce subtitle texts by (1) inserting text with keyboard, (2) symbols from a library and adding it all to the video with the following ordered steps: 1) defining vertical and horizontal position and font size 2) defining time-code and duration 3) defining font colour 4) defining viewing angle position of speaker (given as horizontal angle)	MUST

Typee	Sys. Reference	Numberr	versions	Title	Description	Prioritization
PUR	1	8	1	Add subtitle text	The user is able to create ST frames that are not related to specific angle.	MUST
PUR	1	8	2	Add subtitle text	The user is able to define the width of a "security angle" that covers a speaker. The speaker location indicators only disappear once the center of the FoV is within the security angle. The center of this security angle is the position of the speaker defined as the viewing angle.	SHOULD (It is still not clear If the Player will need this metadata)
PUR	1	8	3	Add subtitle text	The user is able to add missing spatial information to legacy subtitles, which were imported.	MUST
PUR	1	8	5	Add subtitle text	The user is able to define the relative depth of each speaker.	COULD (It is still not clear If the Player will need this metadata)
PUR	1	18	0	Add subtitle text	The user can format single words in a subtitle frame.	COULD (It is not necessary at the moment)
PUR	1	19	0	Add subtitle text	The user can monitor the reading speed via numeric display.	MUST
PUR	1	20	0	Add subtitle text	The user can monitor the number of characters per line via numeric display.	MUST

Typee	Sys. Reference	Numberr	versions	Title	Description	Prioritization
PUR	1	21	0	Add subtitle text	The user has the option to activate an automatic separation of subtitle frames by a defined amount of video frames.	SHOULD
PUR	1	25	0	Add subtitle text	The user can create subtitle frames with overlapping time-codes.	MUST
PUR	3	11	0	Speaker introduction	Each speaker is introduced in the subtitles (e.g. by name or "man"/"woman") when speaking for the first time.	MUST

Table 1: ST production tool Professional User Requirements

It is required to mention that, not yet implemented PURs are highlighted in a different colour in table 1 with some explanation in the last column.

What mainly done in WP4 first task is observing I and II sections, consortium and potential users consultations then developing the tools. Section 2.1.3. explains the result obtained based on these actions.

2.1.3. Results and user requirements achievements

In this chapter only a theoretical description will be presented, for more detailed information and for test purposes, the user manual of the Web ST Editor and the access to its interface can be found in D4.1. Since D4.1 includes code installation guide, comprehensive user manual with images, user centric scenarios which help the reader understand the tool better, these points are skipped and the result is only reported. This section presents the resulting implementation according to PURs provided in the previous chapter:

Result achievement based on PURs

1	A simple display of main information of the access service file required by the user. This information includes:
	• The active username
	• File ID and creation date
	• Title
	• Programme ID
	• Language
	• Video Type (360º or ordinary)
	• Video duration
2	General settings permits a more personalised working environment to the user. These items are configurable inside this dialogue:
	• Default duration time for subtitles
	• Default time separation between subtitles
	• Minimum time duration for subtitles
	• Minimum time separation between subtitles
	• Reading speed (CPS or WPM)
	• Video jump
	• Don´t prompt me again
	• Max characters for subtitles
	• Use auto-break
3	Regions and characters settings let the user configure the styling of subtitle texts as they wish and also add new ones up to a limit
4	Subtitle shortcut buttons are defined in this section. There is a list of default buttons but they are changeable if the user wishes to.
5	**Video navigation buttons:** the classic video navigation buttons that can be found in players.

Result achievement based on PURs	
6	Video duration and display of the video sound-wave in time. The transparent colours along the sound-wave symbolize the subtitle characters defined by the user during the video.
7	Buttons specifically for moving through the video by FoV (Field of View).
8	**Video preview:** the useful information found by the user in this area: • Video itself • current region of subtitle • subtitle text and its style inside the region • current FoV • the coloured dot displays the current subtitle angle in 360º spherical space
9	Basically this area is reserved for subtitle edition purposes with the following possibilities: • Text entering • Time codes defining • Checking subtitle duration • Checking reading speed at the bottom • Choosing current subtitle character, region and alignment • Buttons designed to navigate through segments and edit their sequence at the left and right the editing area
10	This area is specifically designed for angle position determination. As the user is working in 360º environment, existence of such section in edition area is essential with following possibilities: • Choosing FoV, current subtitle angle and a registered angle • Copy and paste angles • Voice over option for cases in which the subtitle is not bound to any special angle in 360 sphere space
11	An area for displaying the full subtitles texts and their timings

Result achievement based on PURs	

12	A set of common actions for the editor such as:
	• Saving/auto saving
	• Preview modes:
	
	    ○ **Free preview:** this mode is used for the verification of the subtitling. Subtitles are bound to the video time code, but angle is not. It means that navigating through the video using the "Video control" buttons you can also move angle (it is not fixed to the speaker), so it makes the verification process more real as if playing back the video with subtitles using HMD.
	
	    ○ **Forced preview:** this mode is used for the verification of the subtitling. This verification mode makes it easier for the subtitler as the video will change angle when needed during the playback of the video. Subtitles and angle are bound with the video. It means that navigating through the video using the "Video control" buttons, the angle of the field of view will change automatically to the speaker location to ease the verification process.
	
	• Import script text files from PC
	
	• Find/replace
	
	• Check TC
	
	• TC shift

Table 2: Web ST Editor characteristics

Table 2, reflects the degree of which the PURs have come into reality. More technical information on the editor is found D4.1 and also tests result of pilots based on this editor is found in deliverables of WP5.

2.1.4. Work done in second iteration

After ImAc first phase pilots, the consortium has processed the results for going forward with the tools in second iteration. In the case Web ST Editor, improvements have been introduced and also a comprehensive debugging has been done.

Table 3 shows an iterative comparison of the Web ST Editor in its first and second iteration. It is essential to mention that table 3 only reflects the characteristics that have been introduced in the second iteration and does not display the editor's full characteristics.
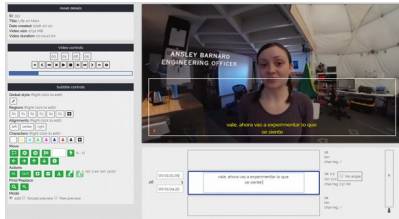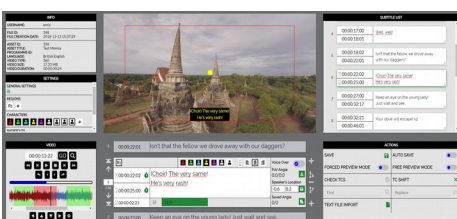
First iteration vs. second iteration		
Feature title		
User friendly environment	No	Yes
Prototype vs. exploitation	Prototype	Exploitation
Video sound-wave in time	No	Yes
Shortcut keyboard buttons	No	Yes
Time cue syntax check	No	Yes
User personalised settings	No	Yes
Copy and paste angles	No	Yes
Join and split subtitle text	No	Yes
Character style customization	No	Yes
Subtitle region customization	No	Yes
Graphical subtitle demonstration in time	No	Yes
Text file import from PC	No	Yes
Subtitle angle index in video preview	No	Yes

Table 3: Iterative improvement of Web ST Editor

2.2. Tool – Subtitle Conversion Framework

2.2.1. General description

The Subtitling Conversion Framework (SCF) is a set of modules for converting XML-based subtitle formats. The tool includes conversion between the current standard subtitle format in Broadcast (EBU STL) and EBU-TT, which is very closely related with IMSC, the TTML-based subtitle format that is used as a basis in ImAc.

SCF is published under the Apache 2.0 license on github.com (see Table 4).

Description	Link
SCF (documentation & source code)	https://github.com/Irt-Open-Source/scfhttps://github.com/Irt-Open-Source/scf
TTML standard	https://www.w3.org/TR/ttml2/
EBU-TT standard family	https://tech.ebu.ch/subtitlinghttps://tech.ebu.ch/subtitling
IMSC standard	https://www.w3.org/TR/ttml-imsc1.0.1/

Table 4: List of links relevant to SCF

2.2.2. Objectives

Main target of the SCF is to build up a flexible and extensible transformation pipeline to convert EBU STL formats and EBU-TT subtitle formats.

In ImAc, the SCF is used to allow a better integration of ImAc subtitle production into existing subtitle workflows. Especially that means, that the subtitle format used in ImAc shall be supported by the SCF, such that:

- Subtitles that were produced in EBU STL can be used as a basis in ImAc (module "STLXML2EBU-TT"),

- Subtitles that were produced in the ImAc subtitle format can be converted into EBU STL or EBU-TT (module "EBU-TT2STLXML" – ImAc extensions will be dropped or mapped in this process) and

- The helper modules in SCF can be used for ImAc subtitle files (for example the module "TT-edit-list", that can apply an edit list to a subtitle file and automatically adjust all timecode values).

2.2.3. Results

During the first iteration of ImAc only two additional attributes were added to IMSC: latitude and longitude values that describe a direction in 3D space.

Since these extensions are not critical for the conversion process, no ImAc related implementation work has been done for the SCF during the first iteration.

A short test has been conducted to check the compatibility of ImAc subtitle files with the SCF. The result of this test was positive.

2.2.4. Work done in second iteration

No updates have been made during the second iteration.

Specific modifications of SCF towards ImAc requirements were not required in the project. The tool was used several times to convert subtitle files for the preparation of content for the pre-pilot tests.

2.3.   TOOL – EXPERIMENTAL IMSC_VR AUTHORING TOOL

2.3.1. General description

The IMSC_VR Authoring Tool is an experimental software component, that accompanies the work on defining an IMSC-based subtitle format. As such, it includes features to test different subtitle presentation modes. Additionally, it implements the ImAc subtitle format for 360° media.

2.3.2. Objectives

The objectives of this tool are:

- Providing an experimental 360° subtitle rendering implementation for demonstrating and testing the rendering concept for subtitles in 360° and VR.

- Providing an open source reference implementation for a standardized IMSC-based data model for subtitles in 360° and VR.

2.3.3. Results and user requirements achievement

In the first iteration of ImAc, subtitle presentation options have been implemented as described in D4.1. Early feedback from pre-pilot user tests were considered during this process.

Additionally, the work on this topic revealed several issues regarding the definition of a 360°/VR subtitle format.

During the first phase of ImAc, the requirement for a subtitle format extension regarding positioning was determined. The most basic requirement is to connect a subtitle with a position in the VR/360° environment.

2.3.4. Work done in second iteration

During the second iteration, the tool was extended by an additional presentation mode, where subtitles are fixed to the video instead of being fixed to the screen.

As presented by Sylvia Rothe at TVX2018[viii], viewers find it more comfortable when subtitles are positioned next to the speaking person rather than at a static position in the field of view. As a drawback, the viewer might miss subtitles when looking around the scene.

Different features have been prototyped to compensate for the fact that the subtitle may be located outside of the viewing field:

- Subtitles follow head movements by a certain amount (the amount can be modified) such that they stay within the user's view longer when turning away from the speaker.

- A "navigation aid" can be added that supports the viewer in finding a conversation in a scene. In addition to the main subtitle, a smaller subtitle is drawn onto the screen when the speaker is outside the viewport. The subtitle is complemented by an arrow pointing towards the speaker.

- A "navigation aid" can be added as described in the previous bullet point, except that this time the subtitle text is not replicated and only the arrow is shown.

A sample of these implementations can be seen at the following website: **http://subtitling.irt.de/vr_edit/foxfinder_sample/**

The project partners have decided to test the presentation mode including the last of the above-mentioned options with users. The feature has then been ported into the ImAc player for the tests.

2.4.   TOOL – RESPONSIVE SUBTITLING

2.4.1. General description

In previous work[ix] the advantages of adopting a subtitling approach that adopts techniques used in responsive web site design was demonstrated. The traditional approach to formatting subtitles uses fixed size blocks of text (generally 2 lines, ~30 characters) which although is sufficient for a standard television set up, is far from ideal for immersive displays.

The ImAc responsive approach enables the subtitles to be formatted in the device to fit the display capabilities. It also provides the flexibility to respond to both changes made by the user to personalize the subtitles to fit their own requirements and other graphics within the display. This is achieved by 'atomizing' the subtitles in the player, and interpolating timings and formatting for each word from the original subtitle. The 'atomized' words can then be reconstructed into subtitles of any length, as required during playback.

This means that the block formatting can take account of the device characteristics and user preferences to provide a tailored and completely custom user experience. This approach is particularly effective when adapting content from traditional television displays into an immersive environment, such as rendering the subtitle as speech bubbles attached to a character, or for instance if the user wishes to reduce the width of the subtitles in order to make room for graphics as demonstrated in illustration 5.
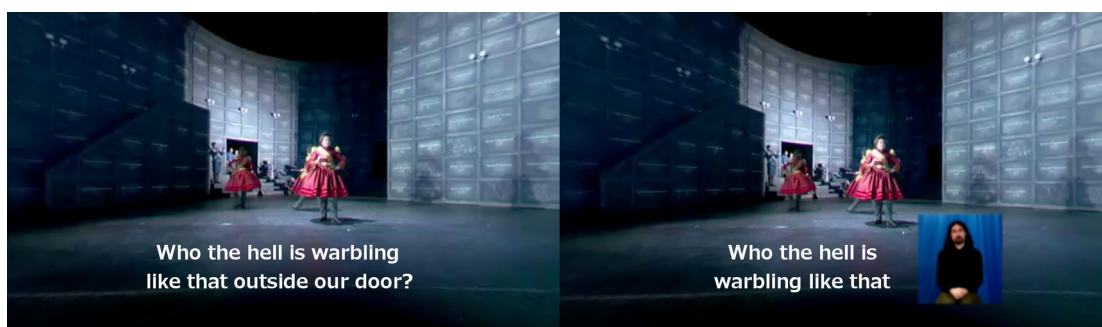
Illustration 5: Responsive subtitles allow the rendering area to be dynamically changed to make space for graphics, or other accessibility services such as a signer

2.4.2. Objectives

In the world of web design, the challenge of providing web content to many different types of device has been met by an approach called Responsive Web Design also sometimes called Mobile First. Responsive web sites respond to the device size and capability using a fluid approach to text layout where space is limited, whilst going to fixed column widths where there is plenty of space on the screen. This approach overcomes the problem of needing different versions of a web site for each new device, and it is the approach we have adopted to provide a more appropriate way of displaying subtitles, across a range of display devices.

ImAc has followed practices used in responsive web design to provide a framework for responsive subtitles. This adopts the principles of text flow and line length informed by semantic markup along with style sheets to control the final rendering. The subtitle file can also include rendering information to provide recommended areas of the display in which to display the subtitle so that the subtitle does not occlude faces or graphics. The key difference from the traditional approach is that the words are formed into blocks in the client and so the number of words in the subtitle blocks will vary depending on the space available in the display.

Once the decision has been taken to render the subtitle layout in the client this opens the possibility of taking into account the user preferences at the point where the subtitle blocks are rendered. Although personalization of video captions if not a new concept (YouTube and Netflix for example, allow a choice of font, size and colour) our mechanism allows the subtitles to be restructured on demand, creating new subtitle blocks that best fit the display based on the user preferences. In this way the user could increase the size of the font to make the text more readable and the client would then be able to form subtitle blocks with fewer words in order to prevent the subtitles from obscuring too much of the video.

User options can thus be accommodated for a choice of font to meet cognitive issues such as dyslexia and font size to cope with varying visual. Colour is used for speaker identification for TV subtitles and the choice of the four colours could be re-mapped to accommodate the user's colour vision. The text background could also be varied according to the user preferences for an opaque or semi-transparent background, or even no background with outlined text.

2.4.3. Implementation

As part of the ImAc project we have developed a prototype a JavaScript library for generating responsive subtitles. This adopts the principles of text flow and line length informed by

semantic mark-up along with styles to control the final rendering. The library provides an extension to IMSC.js (a JavaScript library for rendering IMSC1 Text and Image Profile documents to HTML5) where IMSC documents can be loaded into a TT-object.

The responsive subtitle library developed in ImAc restructures a TT-object based on line character width and line count as shown in illustration 6. (a) IMSC.js converts the TTML document into a TT Object. (b) The responsive library atomizes the TT object into words, preserving an interpolated time and style for each word. (c) The words are reconstructed into phrases split by a pause in the dialogue or a change of speaker. (d) The phrases are subdivided using a best-fit algorithm to meet the line length requirements. (e) a new TT objet is generated with IMSC.js.
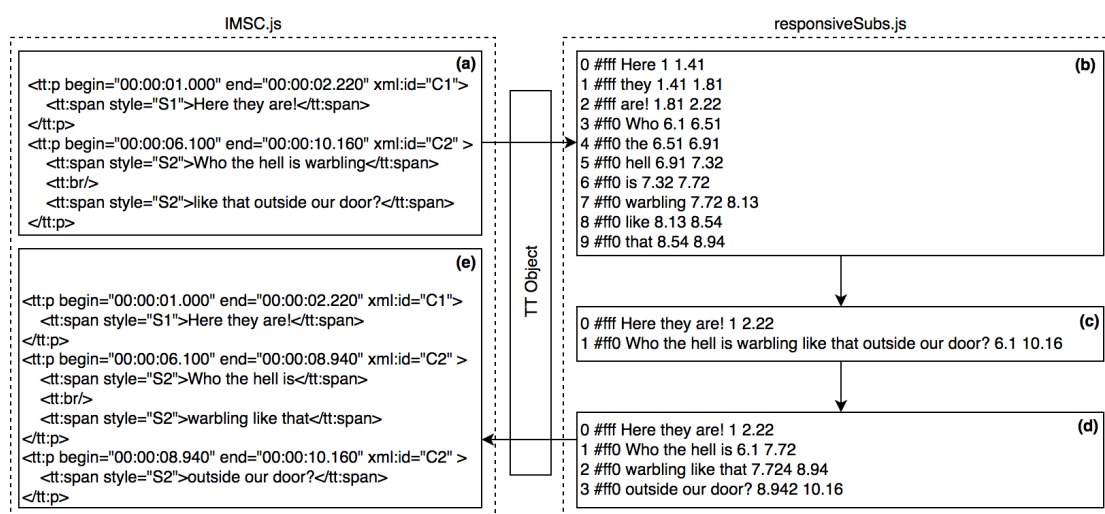

Illustration 6: Restructuring a subtitle file with responsiveSubs.js

By working directly with TT-objects allows this library to be simply connected to any application which already uses the standard IMSC.js implementation allowing customization controls to be retrofitted, such as font size as shown in illustration 7.

Subtitles are re-blocked by adhering to the number of characters that can fit into the display container at the chosen font size. Firstly, 'paragraphs' are constructed recombined, based on identifying a distinct segment of the text. The end of each segment is identified, either by a change of speaker or when there is a gap of more than two seconds between subtitles.

A best-fit algorithm then breaks each paragraph up to individual captions in order to fit the container. Due to the nature of the changing font size this may provide more or less captions than the original subtitles, however as the number of words is remains the same the reading speed never changes. As words are evenly distributed it also avoids leaving orphaned words.

Illustration 7: Responsive subtitles re-blocked based on consumers font size requirements. The subtitles are presented differently when the user chooses a font size of 50%, 100%, 125% and 150%.

The library can also be used in non-linear VR applications, such as a high contrast reproduction of a 360º video. The responsive subtitle library has automatically identified each unique character in the scene and represented each character as a clear cylinder in the VR scene, as shown in illustration 8.
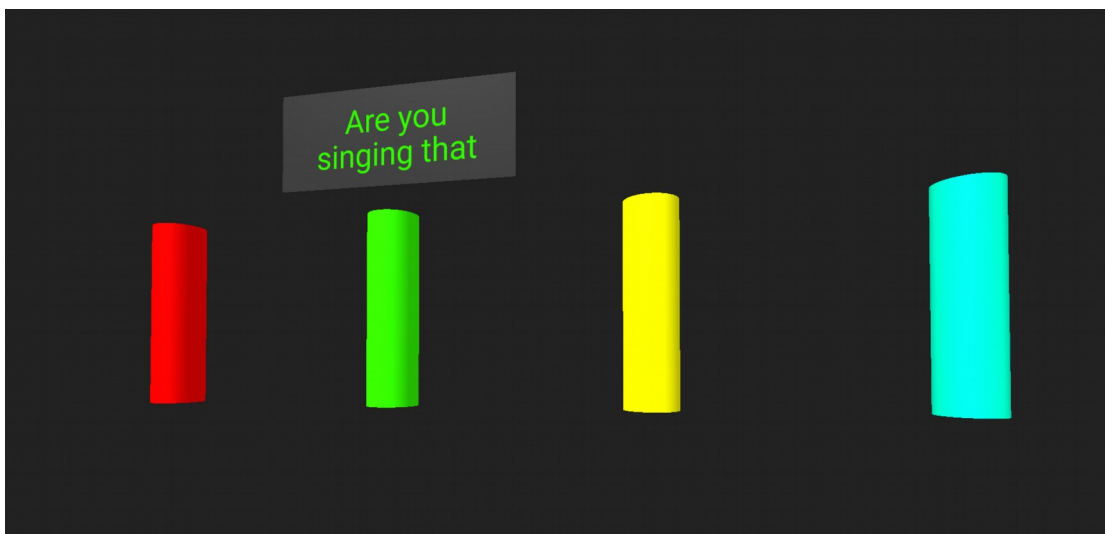

Illustration 8: Responsive subtitles can also be used in non-linear VR applications

3. T4.2 – ENHANCED AUDIO SERVICES PROGRESS

The second task of WP4 (T4.2) focuses on audio services. The objective of T4.2 is development of technological basis for audio services production in immersive environments and also investigation of AD access services formats and conversion tools with following goals:

- Evolution of current audio access services tools

- Investigate technical solutions and suitable formats for preparing and delivering 3D audio with AD to target devices and platforms, following user requirements from T2.2.

- Provide production and editing tools following the results from the preceding bullet point.

Illustration 9, shows the ImAc audio description work-flow. This work-flow consists of a number of tools developed under the project work-frame. The details of the work-flow concept is addressed in D4.2.
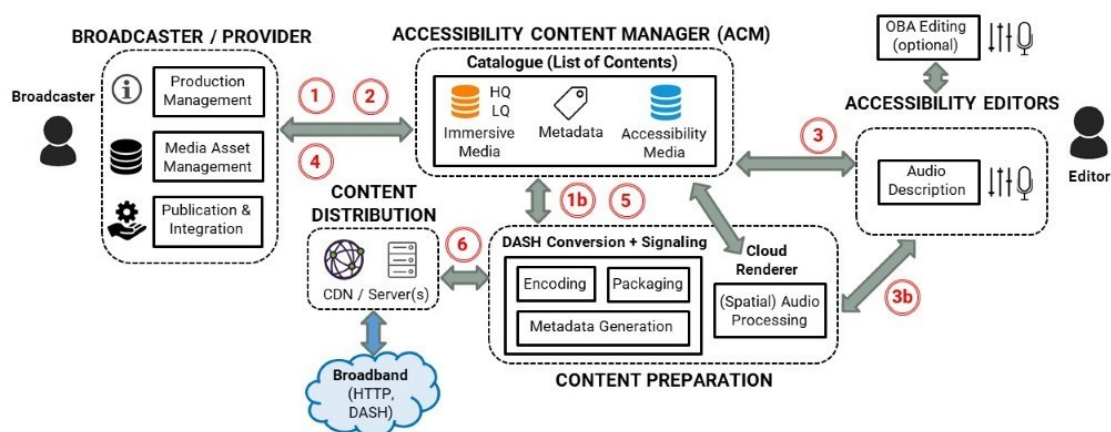
Illustration 9: Audio description workflow

3.1. TOOL – WEB AD EDITOR

For the second iteration the Editor interface (see illustration 2) and a Web AD Editor (see illustration 10) have been developed.

The Editor interface is a place in which the professional users can see and navigate the tasks that have been assigned to them previously from the Content Manager interface. These tasks can be either a ST, AD or SL. In this sub-chapter we deal with AD tasks which are performed by the integrated Web AD Editor. Illustration 10 shows the Web AD Editor environment.

Illustration 10: Web AD Editor

3.1.1. General description

The current audio description editor tools was extended to add support for 360° video and to edit enhanced metadata elements. As seen before the user requirements are extracted from D2.2 and the specifications are from D2.3. It is very important for this tool to maintain its compatibility to the current audio description tools.

3.1.2. Objectives

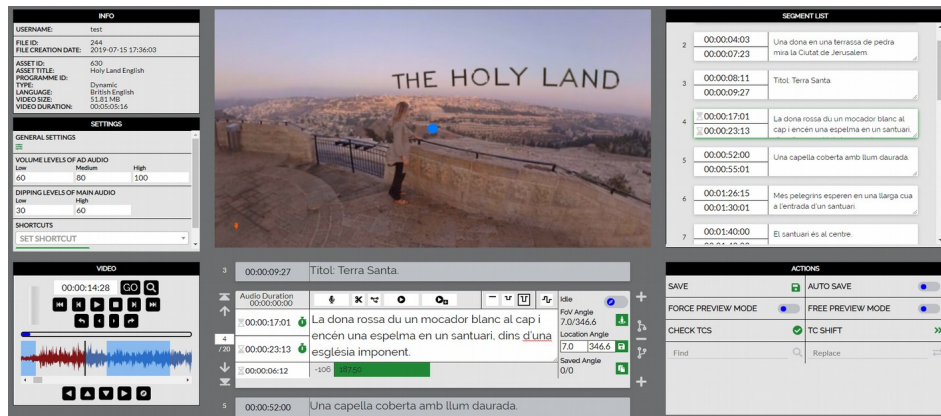Similar to 2.1.2. the general specifications needed for the tool are presented and then the Professional User Requirements are presented as objectives of this development as two sub-categories:

1. General goals addressed in D2.3 document.

2. Specific requirements addressed in D2.2 with their specifications.

1. **General goals addressed in D2.3 (concerning tools for professional users):**

   ○ **Presentation of immersive/spatial audio in general:** the principal objective of this task is that the user feels like he/she is located within the presented (audio) scene and that listener can locate sound sources in different directions. According to the past projects and also the focus groups test results a spatially stable audio scene is desired in ImAc.

   ○ **Locations of AD speaker in the audio scene:** 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 centred in the scene (Classic).

     2. AD anchored in the scene (static).

     3. AD anchored on the event/object being described (Dynamic)**.**

2. **Specific PURs addressed in D2.2 with their specifications:**

The below table displays the specifications related to AD Editor. As a matter of fact, the items from PUR.1.1.0 to PUR1.8.0 from table 1 make sense in this editor as well but are skipped in this table for convenience.

Type	Sys. Reference	Number	versions	Title	Description	Prioritization
PUR	1	6	0	Navigate preview content by audio	The user is able to hear 360º audio.	MUST (Due to the need of using HMD libraries from partners for this item, it has been jointly decided to face this item just after the pilots)
PUR	1	10	0	Create AD preview content	The user is able to feed a written AD script and start a text-to-speech process.	MUST
PUR	1	11	0	Add AD preview audio to video	The user is able to add a text-to-speech AD result to a video as additional audio asset.	MUST
PUR	1	12	0	Preview video and AD audio	The user is able to preview the video together with the added speech-to-text AD asset.	MUST
PUR	1	13	0	Add audio description	The user is able to add a number of simultaneous audio descriptions to different sections of the visual scene.	MUST (Pending the results of second phase pilots before implementing it)
PUR	1	14	0	Pre-listen 3D audio content	The user is able to pre-listen immersive audio content together with immersive AD.	SHOULD (Due to the need of using HMD libraries from partners for this item, it has been jointly decided to face this item just after the pilots)
PUR	1	26	0	Edit audio description script	The user can split and merge AD script files.	MUST

Type	Sys. Reference	Number	versions	Title	Description	Prioritization
PUR	1	27	0	Edit audio description script	The user can split and merge AD audio files.	COULD
PUR	1	28	0	Display of AD assets in space and time	The user monitor where in space and time he/she added AD assets to the video content.	COULD
PUR	1	29	0	Monitor recording of AD	The user gets a visual feedback on the start and stop of the recording of an audio file.	MUST
PUR	1	30	0	Define fading level of main audio	The user can choose between several levels of fading for the main audio.	MUST
PUR	3	15	0	Export AD scripts as text file	The user is able to export an AD script as text file.	SHOULD (Low priority but in to-do list)

Table 5: AD production tool Professional User Requirements

Table 5 displays these requirements, with highlighted different colour and some explanation in the last column are the PURs which are not implemented to the date of submission of the deliverable.

3.1.3. Results and user requirements achievement

In this chapter only a general description is presented on how the Web AD Editor covers professional the user requirements, for more detailed information and for test purposes, the user manual of the Web AD Editor and the access to its interface can be found in D4.2. This deliverable contains clear user manual, a manual on how to install the tool, scenarios and images on how a user can work with Web AD Editor.

Table 6 shows the editor characteristics to ensure the fulfillment of PURs.

Result achievement based on PURs

1	A simple display of main information of the access service file required by the user. This information includes: • The active username • File ID and creation date • Title • Programme ID • AD Type (static, dynamic or classic) • Language • Video Type (360º or 2D) • Video duration
2	General settings permits a more personalised working environment to the user. This settings dialogue contains options such as: 1. Default time duration for audio segments 2. Default time separation between audio segments 3. Minimum time duration for audio segments 4. Minimum time separation between audio segments 5. Reeding speed (WPM or CPS) 6. Video frame jump 7. Don't prompt me again 8. Waiting recording time 9. Short test time 10. Long test time

Result achievement based on PURs	
3	Audio segments specified settings such as: **Volume levels of AD audio:** This setting is only available when dealing with a Classic and Static AD types, as in these cases it is necessary to indicate where the AD will be anchored in the 360º sphere. These setting are save in the AD file. **Dipping levels of main audio:** These settings are the dipping levels that can be used in the segments. When a segment with a dipping level is run, the main audio volume is lowered during the AD segment. These settings are saved in the AD file.
4	Editor shortcut buttons are defined in this section. There is a list of default buttons but they are changeable if the user wishes to. For most commonly used editor functions a set of shortcut buttons is predicted for user convenience.
5	**Video navigation buttons:** the classic video navigation buttons that can be found in players.
6	Video duration and display of the video sound-wave in time. The transparent colours along the wave are: **Blue:** corresponds to the TCs window (from TCin to TCout), that is the time that is assigned to this segment during the script production. **Yellow**: corresponds to the recorded audio window (from TCin to TCin + audio duration). **Green:** corresponds to the area where blue and yellow overlaps. The ideal case is that only this colour is displayed meaning that the duration of the recorded audio is the same as the time assigned to this segment during the script production. **Blue** displayed after green means that the TCs window is longer than the recorded audio window. **Yellow** displayed after green means that the recorded audio window is longer than the TCs window.
7	Buttons specifically for moving through the video by FoV in spherical space (Field of View).
8	Video preview area where the video is pre viewed in LQ and also a blue dot showing the current action occurrence position in spherical space in dynamic mode.
9	**Edition area:** this edition is purely reserved for edition AD segments. Operations such as text entering, keeping dipping of the main audio, setting AD gain, recording and testing audio, splitting and cutting segments and timings are available in this box.

Result achievement based on PURs	
10	This area is specifically designed for angle position determination. As the user is working in 360º environment, existence of such section in edition area is essential with following possibilities: • Choosing FoV, current audio segment angle location and a registered angle • Copy and paste angles • Idle option for cases in which the audio segment is not bound to any special angle in 360º sphere space
11	This space is reserved for displaying AD segments text and sequence with their time-codes.

12	A set of common actions for the editor such as:
	• Saving/auto saving
	• Preview modes:
	
	    ○ **Free preview:** this mode is used for the verification of the audio describing. Segments are bound to the video time code, but angle is not. It means that navigating through the video using the "Video control" buttons you can also move angle (it is not fixed to the point of interest location), so it makes the verification process more real as if playing back the video with segments using HMD.
	
	    ○ **Forced preview:** this mode is used for the verification of the audio describing. This verification mode makes it easier for the audio describer as the video will change angle when needed during the playback of the video. Segments and angle are bound with the video. It means that navigating through the video using the "Video control" buttons, the angle of the field of view will change automatically to the point of interest location to ease the verification process.
	
	• Import script text files from PC
	
	• Find/replace
	
	• Check TC
	
	• TC shift

13	A set of buttons next to edition area destined to edit the segments sequence, number, join or split them.

Table 6: Web AD Editor characteristics

3.1.4. Work done in second iteration

After the first phase pilots, the tools have moved forward with new characteristics introduced in the second iteration.

This chapter compares the Web AD Editor in its first and second iteration to depict the progress of the tool in the period of time between first and second submission of this deliverable. It is

noteworthy that table 7 only displays the new characteristics introduced in the first iteration and it does not reflect the full list of the editor's features. D4.2 contains full characteristics of the Web AD Editor.
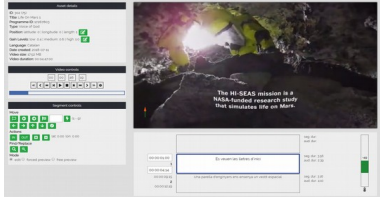
First iteration vs. second iteration		
Feature title		
User friendly environment	No	Yes
Prototype vs. exploitation	Prototype	Exploitation
Video sound-wave in time	No	Yes
Shortcut keyboard buttons	No	Yes
Time cue syntax check	No	Yes
User personalised settings	No	Yes
Copy and paste angles	No	Yes
Join and split segments text	No	Yes
Graphical segment demonstration in time	No	Yes
Text file import from PC	No	Yes
segment angle index in video preview	No	Yes

Table 7: Iterative improvement of Web AD Editor

3.2. TOOL – CLOUD RENDERER

3.2.1. General description

The Cloud Renderer is a software settled in a serverless architecture and works as "Software as a Service" (SaaS) in the cloud. It is a service to attach interactive audio content to an audio scene or a channel-based audio (OBA) production. In the domain of ImAc, interactive audio content means Audio Description segments, which can be placed in a 360º scene and which can be leveled interactively by the customer. The pre-processed audio variants can be rendered into a number of common audio formats (like wav or AAC). The software pre-renders different versions of the immersive content and uploads the results to a defined web space.

In the ImAc workflow, the Cloud Renderer downloads all the files it needs (Audio Description segments and the configuration file, and/or an ADM file) from a defined URL, merges the Audio Description into the object-based audio scene, renders different variants of the AD and the audio scene and uploads the results to the specified web destination. Further details on the Cloud Renderer can be found in D4.2.

3.2.2. Objectives

The main objectives of this tool are:

- Support for the ADM metadata format: The rendering algorithm and the API must be made capable for processing the ADM standard (as of ITU-R BS.2076, Audio Definition Model[x]). ADM is an open and standardized production format for OBA. As such, it allows an interoperable exchange of these production files between different systems (See D4.2).

- Support additional AD parameters: For the ImAc use cases, two OBA parameters were defined to be variable. The position of an AD sequence within the 3D audio space is adjustable – the user may select from different options later. Three different positions are suggested in ImAc – Classic, Static and "dynamic" position. The specification of different gain levels (of the AD compared to the main audio mix) is the second parameter, which has to be addressed. Hereby, the AD editor may define different volume levels for AD (e.g. high, medium, low) within a range between 0 and 1. The renderer must be able to process these parameters as a list of options.

- ImAc API: the cloud renderer software should meet the requirements of the API and the web API gateway as defined in ImAc.

3.2.3. Results and user requirements achievement

In the first iteration of ImAc, two additional parameters for AD tracks were defined and implemented in a (proprietary) ImAc-format. This format describes AD tracks as OBA assets/objects in order to either add them to an OBA scene (in case the main audio production was done object-based) or to mix them with a channel-based production (stereo, FOA, …). Support for mixing AD objects into channel-based production was added to support the creation of content for ImAc user tests. The renderer is able to process the ImAc AD-files together with a channel-based main mix into the formats First Order Ambisonics (FOA), stereo and static binaural.

3.2.4. Work done in second iteration

The API of the cloud renderer has been finalized during the second year. Additionally, some adaptations were done in the rendering engine. Most relevant changes were:

- A specific audio treatment was implemented for the AD mode "classic" where the AD audio comes from no specific direction (omnidirectional). It was found, that a better quality was reached, when the source is not placed above the listeners head (in the virtual audio scene), but instead, the AD asset added to the channel of Ambisonics that contains the omnidirectional portion of the audio signal.

- A dipping feature has been added, such that the main audio is dipped within the renderer whenever an AD asset is active. The amount of dipping can be controlled using the renderer's API.

3.3.   TOOL – OBJECT-BASED AUDIO EDITOR

3.3.1. General description

The object-based editor with graphical user interface was developed by IRT. It allows users to create and author object-based audio scenes, control the object positions but also other metadata, such as gain. It also controls the signal processing/rendering and can be synchronized to any DAW via MTC (Midi Time Code) and MMC (Midi Machine Control).

Object-based audio is the future standard for audio production in broadcast environments, therefore the development of this editor is important for ImAc to be state of the art.

Object-based audio provides a simple way to integrate barrier-free services and provide all kind of barrier-free content. Immersive sound can be provided easily to the users, the audio mix is custom-made for any sound-system and is therefore in a better quality and with more possibilities of usability. AD can be used more flexible and with a lot more possibilities than in standard formats. Separate gain adjustments for the AD and different kinds of AD mixes can be easily provided.

The Audio Definition Model (ADM), is a metadata model to describe all sorts of audio contents and formats. Besides traditional channel-based audio it also supports scene-based audio like Higher Order Ambisonic (HOA) and object-based audio. For audio description purposes, the ADM element *audioContent* is particularly interesting. It describes the content of one component of a program (e.g. dialog), and references one or more *audioObject* elements to tie the content to its format. To further describe the content it provides sub-elements to indicate whether it consists of *dialog, non-dialog* or a *mix* of both. For the dialog kind, it is additionally possible to explicitly state, that the content only contains *audio description* or dialog for the *visually impaired*. The mixed content kind can be moreover specified as content for the hearing impaired.

3.3.2. Objectives

The main objectives of this tool are:

- Integration of the ADM standard in the object-based audio editor.

- It is important for the ImAc project to implement the ADM standard in the object-based audio editor because this is the future format for audio production in broadcast environments. To be up to date and ready for all future developments AD should already be considered in developments with this standard.

- Integrate ImAc requirements for AD into ADM, where needed. That may result in a proposal for ADM extensions.

3.3.3. Results and user requirements achievement

In the first iteration of ImAc, the integration of ADM has started but had not been completed yet. ADM supports a wide range of parameters which need to be supported by the audio processor in order to render a correct representation of the ADM scene. Additionally, the present implementation of the editor does not suit the requirements of the ADM yet. During iteration 1, the tool had been prepared for a standard compliant import and export of a basic ADM feature set.

3.3.4. Work done in second iteration

The work on the OBA editor "Eddie" has been finalized in the second project year. The software is not publicly available, it is a lab tool developed for internal usage.

Additionally, the representation of audio description assets within the ADM format has been described. Detailed information can be found in Deliverable D4.2, section 5.3.

additionally, the representation of audio description assets within the ADM format has been described.

- Detailed information can be found in D4.3, section 5.3.

4. T4.3 – SIGN LANGUAGE EDITOR

The objective of T4.3 is the development of technological basis for sign language files edition/production in immersive environments and also the investigation of SL accessibility content formats as below:

- Development of an editing tool for SL video assets enrichment with metadata for a 360° environment

- Easy to user GUI interface

- Ensure compatibility between main video and SL video

In this section, the progress in the SL production tools, obtained result and finally a comparison of the editor in the first and second iteration of the project are presented.

4.1. TOOL – WEB SL EDITOR

4.1.1. General description

ImAc Web SL Editor is an online editor destined to professional users who wish to produce sign language files on a video in 360º environment. The developed editor lets the user work with angles in 360º sphere space and also to edit the SL video as they wish. In the upcoming chapters, the objectives and user requirements behind this editor are discussed and then the result coming from these requirements is described.

4.1.2. Objectives

Similar to 2.1.2. the specifications needed for the tool are addressed and then the PURs are presented as objectives of this development as two sub-categories:

1. General goals addressed in D2.3 document as objectives.

2. Specific requirements addressed in D2.2 with their specifications as user requirements.

1. **General goals addressed in D2.3 (concerning professional users):**

   - 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 SL Editor prototype will select the required video from the Accessibility Content Manager

   - 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

   - A 360° preview player for the low-resolution video playback will be embedded in the editor

   - The creation of a new sign language segment with characteristics mentioned in D2.3

- 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

2. **Specific PURs addressed in D2.2 with their specifications and priorizations:**

The below table 8 displays the professional user requirements related to SL Editor. As a matter of fact, the items from PUR.1.1.0 to PUR1.8.0 from table 1 are relevant in this editor as well but are skipped in this table for convenience.

Typee	Sys. Reference	Numberr	versions	Title	Description	Prioritization
PUR	1	9	0	Add sign language video	The user is able to add sign language video with the following ordered steps: 1. separating specific SL segments if necessary 2. time code definition 3. defining position of speaker (given as horizontal angle)	MUST
PUR	1	9	1	Add sign language video	The user is able to create SL segments that are not related to a specific angle.	MUST
PUR	1	9	2	Add sign language video	The user is able to define the width of a "security angle" that covers a speaker. The speaker location indicators only disappear once the center of the FoV is within the security angle. The center of this security angle is the position of the speaker defined as the	SHOULD (It is still not clear If the Player will need this metadata)

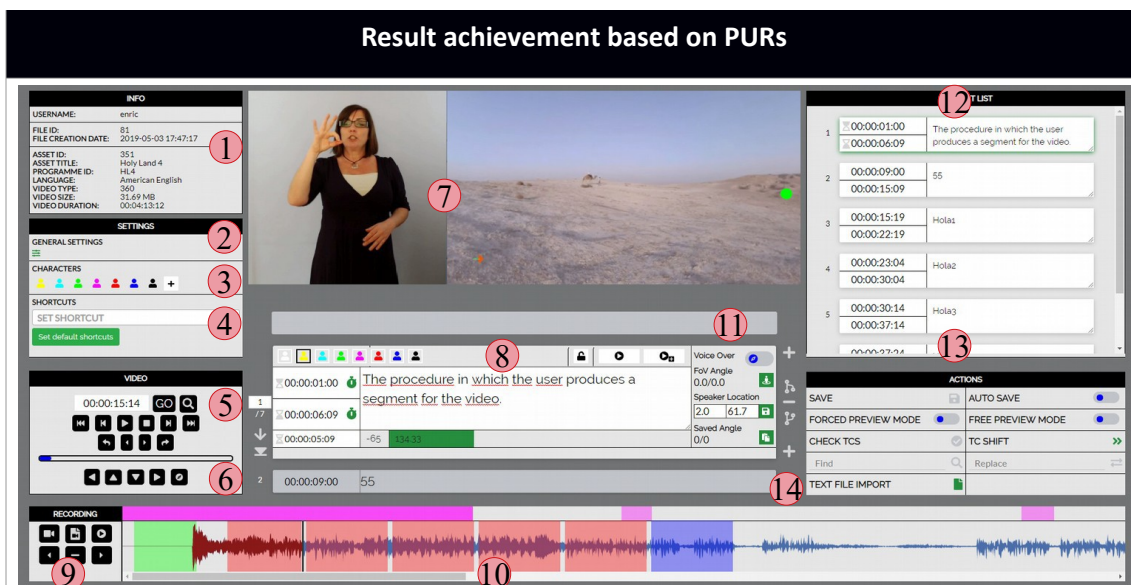| Typee	Sys. Reference	Numberr	versions	Title	Description	Prioritization
					viewing angle.	
PUR	1	9	3	Add sign language video	The user is able to add missing spatial information to legacy SL videos, which were imported	MUST
PUR	1	9	4	Add sign language video	The user is able to define the frames in which the automatic speaker location indicator will change the field of view (this is typically done when a new scene starts or a speaker changes his/her position).	MUST
PUR	1	9	5	Add sign language video	The user is able to define the relative depth of each speaker.	COULD (It is still not clear If the Player will need this metadata
PUR	1	31	0	Set in/out points for non-continuous display	The user is able to define the time-code for in- and out- points of the signer video to enable a non-continuous display of the video in the player.	MUST
PUR	1	32	0	Speaker identification	The user is able to define the names of the speakers that are translated in the signer video	MUST

Tabla 8: SL production tools Professional User Requirements

It is required to mention that, not yet implemented PURs are highlighted in a different colour in table 8 with some explanation in the last column.

4.1.3. Results and user requirements achievement

At the end of first iteration, no result was presented due to justified reasons. At that time, the other tools (CM, Web ST Editor and Web AD Editor) had the main priority In the second iteration, the comprehensive Web SL Editor was developed and presented.

Table 9, shows how the result is obtained according to the user requirements in 4.1.2.

Result achievement based on PURs

1	A simple display of main information of the access service file required by the user. This information includes:
	• The active username
	• File ID and creation date
	• Title
	• Programme ID
	• Language
	• Video Type (360º or ordinary)
	• Video duration
2	General settings permits a more personalised working environment to the user. This settings dialogue contains options such as:
	1. Default time duration for video segments
	2. Default time separation between video segments
	3. Minimum time duration for video segments
	4. Minimum time separation between video segments
	5. Sign interpretation speed (WPM or CPS)
	6. Video frame jump
	7. Don't prompt me again
	8. Waiting recording time
	9. Short test time
	10. Long test time
	11. Recorded video alignment (left or right)
	12. Text over video (deaf or hard of hearing considerations)
	13. Recording layout (default, expanded, full screen)
	[when being in full screen mode, the user may only work with keyboard shortcut buttons]
3	Characters styling and edition/deletion options

Result achievement based on PURs	
4	Editor shortcut buttons are defined in this section. There is a list of default buttons but they are changeable if the user wishes to. For most commonly used editor functions a set of shortcut buttons is predicted for user convenience.
5	**Video navigation buttons:** the classic video navigation buttons that can be found in players.
6	Buttons specifically for moving through the video by FoV in spherical space (Field of View).
7	This section, the main and the sign language video are previewed in LQ. The alignment is changeable by the user. The green dot displays the current segment "Speaker's location".
8	**Edition area:** this area is where the user is able to enter the segment text, specify time-codes and also perform below actions: • A short test of the sign language video • A long test of the sign language video • Keep the sign language video of the previous segment in this segment as well • Choosing character for the video segment
9	**Recording actions:** these buttons are aimed to operations on the SL videos: • Recording • Import a video from PC • Preview selected recorded video • Move selected recorded video to left in time • Move selected recorded video to right in time • Delete selected recorded video
10	Video duration and display of the video sound-wave in time. The transparent colours along the wave are the characters colour of each video segment in time. The pink area shows the SL videos in time which are moveable and selectable with mouse left button.
11	This area is specifically designed for angle position determination. As the user is working in 360º environment, existence of such section in edition area is essential with following possibilities: • Choosing FoV, current video segment angle and a registered angle • Copy and paste angles • Voice over option for cases in which the video segment is not bound to any special angle in 360 sphere space
12	An area specified to data segment texts entered by the user while recording along time-codes and their numbers in sequence.

Result achievement based on PURs	

13	A set of common actions for the editor such as:
	
	• Saving/auto saving
	• Preview modes:
	
	   ○ **Forced preview:** this mode is used for the verification of the sign interpretation. This verification mode makes it easier for the producer as the video will change angle when needed during the playback of the video. Segments and angle are bound with the video. It means that navigating through the video using the "Video control" buttons, the angle of the field of view will change automatically to the speaker location to ease the verification process.
	
	   ○ **Free preview:** this mode is used for the verification of the sign interpretation. Segments are bound to the video time code, but angle is not. It means that navigating through the video using the "Video control" buttons you can also move angle (it is not fixed to the speaker's location), so it makes the verification process more real as if playing back the video with segments using HMD.
	
	• Import script text files from PC
	
	• Find/replace
	
	• Check TC
	
	• TC shift
	
	• Show/hide recording camera

14	A set of buttons next to edition area destined to edit the segments sequence, number, join or split them.

Table 9: Web SL Editor characteristics

4.1.4. Work done in second iteration

In this document's first iteration version, basically no apparent result was presented due to the decision made on putting main focus of the project on finishing the development of the CM and Web ST and AD Editors on the first due date of this deliverable which was M10. Hence, The development of the Web SL Editor did not start in the first iteration.

In the second iteration development, implementation and testing of Web SL Editor started and terminated.

In this second iteration the Web SL Editor was presented as the tool resulting from third task of WP4 (T4.3). More detailed technical information of the editor is found in D4.3. This document only reports the user requirements achievement, main innovative characteristics on theoretical level.

5. Conclusion

This document reports the main ImAc achievements on access service production tools (as shown in Illustration 11) destined to professional users in broadcasting industry. These tools include:

- Web ST Editor

- Subtitle Conversion Framework

- Experimental IMSC_VR Authoring Tool

- Responsive Subtitling

- Web AD Editor

- Cloud Renderer

- Object-based Audio Editor

- Web SL Editor

The deliverable has had goals to familiarize the reader with professional tools developed under ImAc framework that help extensively the production of access services for 360º media. These tools are essential in order to have an integrated environment displayed in illustration 2 and also to fulfill the principal objective of ImAc which is making 360º media type more accessible for audience with special needs.

The document demonstrates that the user requirements of the project are met with a high degree of success. The result of pilots and tests are reported in WP5 deliverables[xi].

Illustration 11: WP4 – Tools

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