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EasyTV: Easing the access of Europeans with disabilities to converging media and content.

D8.6 Public final activity report

EasyTV Project

H2020. ICT-19-2017 Media and content convergence. – IA Innovation action.

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Definitions, Acronyms and Abbreviations

ACRONYMS / ABBREVIATIONS	DESCRIPTION
CS	Companion Screen
DASH	Dynamic Adaptive Streaming over Http
HbbTV	Hybrid Broadcast Broadband TeleVlsion
NPS	Net Promoter Score
SUS	System Usability Scale

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Executive Summary

This report is the Public Final Activity Report of the project H2020 EasyTV (<https://easytvproject.eu/>) under grant agreement No. 761999 and it contains the public information that describes the work done during the lifetime of the project. In this regard, the document can be divided into the following main parts:

- Chapter 1 contains information about EasyTV main motivation and objectives.
- Chapter 2 presents the work structure followed during the project.
- Chapter 3 includes the information about the project implementation.
- Chapter 4 provides a summary of the main achievements
- Chapter 5 presents the project consortium
- Chapter 6 lists the project deliverables
- Chapter 7 provides information about the different dissemination activities performed during the project.

1. EASYTV OVERVIEW AND OVERALL OBJECTIVES

1.1. Project overview and purpose

Even in the poorest countries and societies, media has great importance because it provides the channels, networks, formats, and languages through which much of life takes place and finds meaning. So, it is of real concern that people with functional limitations may not have access to either the media or the information provided through specific channels (TV, movies, newspapers, magazines, the Internet and more). Ensuring a barrier-free life for people with disabilities and enabling access to the media and content for all, is crucially important in today's EU society with more than 80 million Europeans with disabilities.

On this basis, EasyTV's target is to foster wider availability of accessible media offerings to everybody and to provide equal access to audio-visual services for all users, especially for persons with various degrees of disabilities (focused to visual, hearing and mobility impaired). The project aims at developing media improved access services and making distribution of novel accessibility features with enhanced multimedia visual and sound experience more cost-efficient and yet more flexible to use, and also easier to use. Furthermore, and in order to offer easier access to converging media content to persons with disabilities by offering new mechanisms for content delivery, interaction and presentation, EasyTV is based on four main pillars:

- Universal multimedia access: EasyTV ensure improved access to multimedia content through the provision of different services that will enrich the visual and sound experience for all. To do so, it has been focused on providing new graphical interfaces adapted to users' needs, on performing an innovative audio processing for intelligibility improvement and finally on defining new tools for enhancing the image of the content, such as the services presented in this paper. EasyTV have also deployed efficient tools for universal interaction by means of multimedia devices.
- Novel technologies for breaking the sign language barriers: the project has been focused on the creation of a multilingual crowdsourcing platform for the sharing and generation of accessible content such as subtitles, the definition of an ontology for the link and translation of different sign language concepts and, finally, the advance in the capture and generation of sign language content by means of hyper realistic avatars.
- Personalization: EasyTV delve into an improved customization of the user experience thanks to the generation of adaptive menus and graphical interfaces, the provision of service recommendation tools and content based on user models and finally the access adaptation through MPEG-DASH (Dynamic Adaptive Streaming over Http) service provision.
- User centric approach: EasyTV propose a methodology based on a continuous user feedback for a clear idea of the existing needs (for user requirements gathering) and for a reliable opinion about the deployed services (for user validation). This has been an essential input for the definition of the services presented in this paper, as it is going to be explained later.

As can be seen, EasyTV is an ambitious and widespread project where new tools are going to be developed for improving the access to the contents of people with disabilities according to their own indications. Moreover, these tools will be integrated in a complete platform to be directly used by any broadcaster. Regarding the user requirements gathering, the performance of focus groups with final users is vital for our approach and helps us to understand what are the main demands in the real scenario

1.2. Main objectives

Considering that the prime motivation of EasyTV was to improve the access to mainstream multimedia products and services for people with different types and levels of disabilities, thus avoiding their marginalization from the Information Society, the specific objectives that the project has overcome are the following:

- **OBJ1:** To provide innovative improved access services for improved multimedia viewing and hearing.
- **OBJ2:** To provide an innovative hyper-personalisation of the content experience and interaction.
- **OBJ3:** To develop novel technologies for the interaction with content and users thus breaking the language barrier for people with disabilities.
- **OBJ4:** To implement a technical platform which is able to integrate different services aiming at allowing users with disabilities to access contents in a simple and intuitive manner via different terminals.
- **OBJ5:** To validate EasyTV resulting technologies with a relevant number of users and coherent methodology.
- **OBJ6:** To liaise with relevant European accessibility bodies and create needed impact.
- **OBJ7:** To create impact, especially among different European disability communities.

2. WORK STRUCTURE

Approaching the EasyTV main objective has required taking into account different aspects such as the end users participation for requirements gathering on the design phase, the technical implementation and finally the testing and validation of the results. For doing so, the work was organized considering different approaches. In this regard, EasyTV execution took 33 months and it has followed an iterative and incremental development composed of three phases as shown in Figure 1

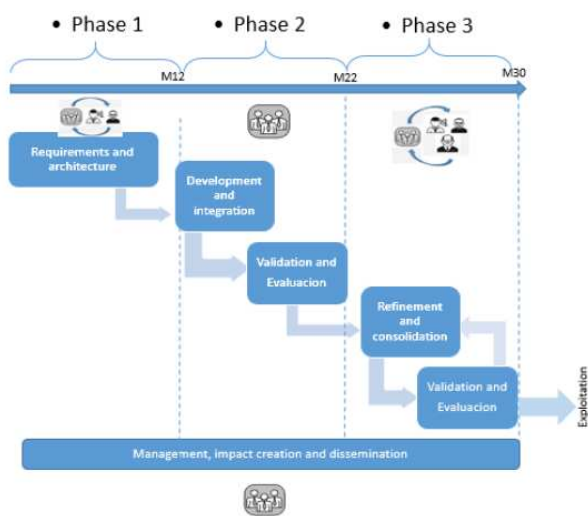


Figure 1. EasyTV 3-phased planning

-Phase 1 (M1-M12) focused on eliciting the user requirements and mapping them to technical specifications that were used for the definition of the EasyTV architecture. Moreover, during this phase the development of the different services also started.

-Phase 2 (M13-M24). During this phase a first version of the platform and the services were delivered. Following, the first testing wave was executed with the aim of obtaining users' feedback for improving the different solutions.

-Phase 3 (M24-M33) led the refinement of the different developments thanks to the obtained feedback and provided a second testing wave.

The following sections explain the three main approaches that composed the project.

2.1. End-user approach

EasyTV was defined as a user-centred project, where end-users organizations in the consortium divided their work in two main phases:

- To identify and provide users for the requirements gathering based on their own needs.
- To select and provide users for the two phases of the testing process of the developments, in order to obtain important feedback for the system refinement.

2.1.1. Methodology for user's requirements gathering

To gather users' needs we have established a specific methodology based on the use of "super end users" concept. This idea was adopted because we needed to find end users who, besides their

condition of regular users, also have some knowledge of the technologies that will be tested, since the objective was to advance their expectation to match the innovations. In this regard, the criteria for selecting this group of users was that they were experts within the EasyTV project targeted world of blind and deaf people, but with no need of being blind or deaf people. That is, they should know about the technologies to be used, but also about the user needs in depth through dealing with all different visual impairments and deaf disabilities every day, so they should be able to tell us, better than others, what the final users really need.

With regards to the type of method for obtaining the information that was applied, we selected the focus group methodology. A focus group is a discussion group over a particular topic of interest and it is commonly used at the beginning stages of a research group since it allows exploring when little is known about the questioned matter. Considering this, the two EasyTV initial focus groups were composed by several super end users for sharing and exchanging opinions about user needs in the multimedia scenario, one of five super end users for deaf people and one of six super end users for visual impaired people.

Once the focus groups were defined, we applied the following process to gather the required information:

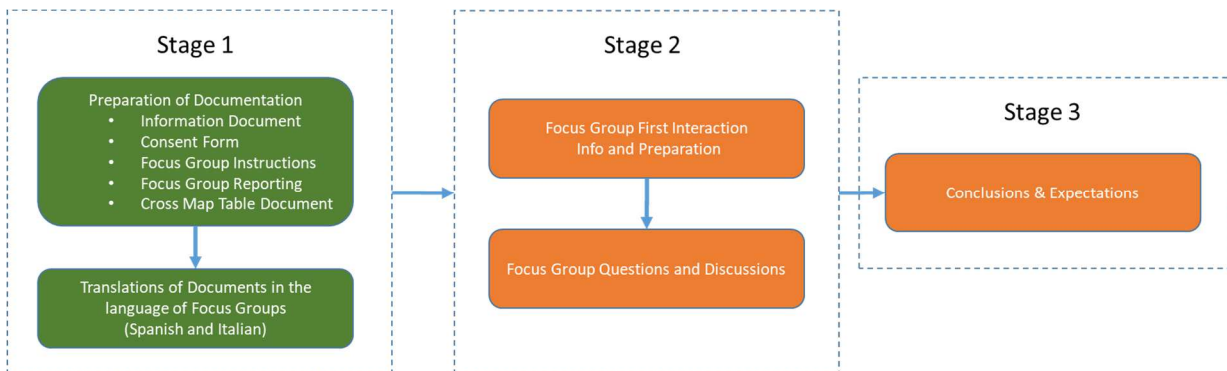


Figure 2. Process to gather information from super end user

Stage 1 focused on the preparation of documents and questionnaires in different languages. For doing so, an ethical committee was in charge of assuring that the information document and the consent form were ethical compliant, and they were offered in the same language of the users.

After that, Stage 2 was related to the interaction with the focus group. All the components to be developed were presented together with the description of the different interactions that the end users will have. Finally, a set of question and a discussion about each of these components took place.

Stage 3 was defined for obtaining the conclusions and expectations about all topics that were discussed. Once we had this information we were able to provide the user requirements and specifications to feed the different user scenarios and the technical architecture to be developed through a cross map table that included the related functionalities, sub functionalities, devices and features.

2.1.2. Methodology for users testing

The user testing process was composed by two different phases: an intermediate testing stage and a final testing stage. The first one was performed during the second period of the project, and its main aim was to obtain users' feedback for improving the different services. The users' opinion was also used to decide whether continue with a service or not, if it seems there is not enough interest for the end user. The second one was performed at the end of the project, and it provide us an important overview about the opinion of the users about the project. The obtained results are summarized on section 3.4.

Regarding the testing process, it was defined to have the same structure during both phases. Both face to face interviews and online tests were performed and regarding the test, they were composed by a questionnaire that contains the different parts:

- Two main questions about demographics, focused on the level of studies of the users and on the type of disability.
- A subset of questions from a System Usability Scale (SUS) typical test.
- A Net Promoter Score (NPS) for knowing the user' opinion about the services tested.

2.2. Technical approach

EasyTV project followed an iterative development approach in order to involve final users in its development, including the definition of users' requirements, the services initial implementation and their refinement based on users' feedback from intermediate tests and the final platform validation. Furthermore, a set of principles were followed during the project in order to let the obtained results to be adapted to future exploitations options:

- **Flexibility:** since several types and level of disabilities have been considered when implementing the project, EasyTV solutions have been designed to be flexible enough to enable cost-effective adaptation to other situations and scenarios.
- **Modularity:** EasyTV platform has been defined in a well-structured modular solution to facilitate the inclusion of new services or to connect with third party systems in a cost-effective way.
- **Usability:** EasyTV platform has followed a user-centric design and passed an iterative testing process for continuous improvement in order to maximize user experience.
- **Accessibility:** the main objective of EasyTV solutions is to improve the access to multimedia services so we have followed different standards and final users association advice.
- **Personalization:** EasyTV assures a personalised experience due to the advanced personalization technology that applies.

2.3. Innovation approach

With regards to the innovation activities, the method that has been followed is presented in next figure:

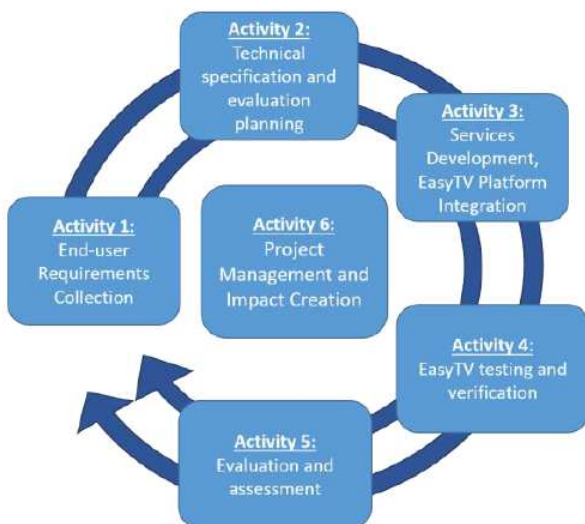


Figure 3. Innovation methodology

- o Definition of scenarios with functional and non-functional requirements.
 - o Definition of tests, including the demography, methodology and evaluation.
 - o Ethical permission and contact end user request.
- **Activity 2:** Technical specification and evaluation planning. The main aim of this activity was to establish the project foundation, including the EasyTV services, the technical platform and testing execution planning. Technical specification derived from the users' requirements
- **Activity 3:** EasyTV technical platform and services implementation and integration. As previously stated, EasyTV services can be divided into 3 categories: improved access

services, enhanced interaction and personalised services. For doing so, this activity incorporated the innovation activities together with the refinements of the EasyTV core components based on users' feedback.

- **Activity 4:** EasyTV testing and verification. This phase helps us to test all services with a varying population of impaired people. It is divided into two subphases: intermediate tests and final tests.
- **Activity 5:** Evaluation and assessment. Previous phase provided important feedback for system refinement, which is vital for the project evaluation and assessment.
- **Activity 6:** Project management and impact creation. This activity comprised of all the supporting activities of the project, namely administrative management ones that include the delivery of interim and periodic reports to the European Commission as well as activities related to the financial monitoring.

3. PROJECT IMPLEMENTATION

The project, with a final duration of 33 months, was divided into 8 work packages (WP) in order to better organize and follow the project activities and implementations:

- **WP1 Requirements, specification and technical architecture:** this WP was in charge of deriving technical requirements from the innovation needs gathering them from the final users. These technical requirements guided the system specification and the design of the technical platform for new access services delivery.
- **WP2 Improved access services for improved multimedia viewing and hearing and description.** This WP was responsible for developing different innovative services that have facilitated the achievement of the access for all objective.
- **WP3 Novel technologies for the interaction with content and users for breaking the language barrier for people with disabilities.** This WP was focused on two main objectives: on delivering a state of the art solution for sign language capturing together with a complete sign language ontology, and on providing an effective and easy interface for interaction activities by means of speech and gesture.
- **WP4 Improved personalisation,** that was focused on deriving technical adaptation of content and its presentation for enhancing the user experience.
- **WP5 EasyTV component based system** that performed the system integration for facilitating the access of users with disabilities to audio and video content, a multilingual crowdsourcing sign language platform and repository, a service and catalogue for allowing their presentation to the users and a SDK for facilitating the integration of new services.
- **WP6 Testing with users and feedback,** that was in charge of validating the entire system by means of an exhaustive analysis based on final users testing.
- **WP7 Dissemination and exploitation:** this WP was focused on the project impact creation that includes dissemination activities, clustering with other projects and defining the exploitation plan for future commercialization of the project's outcomes.
- **WP8 Project Management:** coordination and quality assurance of the EasyTV project.

WP had been organised as such with the aim of reaching the right balance between the technical implementations for achieving the expected impact and the idea of grouping similar activities and skills required to implement them. Moreover, they were carried out by a multidisciplinary consortium with a wide innovation experience.

3.1. EasyTV design

As explained before, EasyTV follows a user centered design strategy starting from the focus groups that provided information about users' need and expectations. After that, next stage was devoted to define precise scenarios with which to translate these results into a system of functional specifications to subsequently feed the technological and architectural features of the EasyTV platform. For doing so, different indicators provided in the methodology of the User Sensitive

Inclusive Design¹ were applied. In this regard, this approach has led designers to elaborate extremely holistic scenarios, finalizing each story in a framework that integrates different solutions from the beginning in a native way, without incurring successive overlapping operations that could only be addressed with the logic of additional components.

The needs emerged from the focus groups were collected and managed to achieve a set of “personas”, an archetype or character that represent a potential user of the system that will be developed, that helped the functional and non-functional requirements gathering later on. Next figures show the main information included for the different options:

Information
 Age: 31
 Nationality: Italian
 Disability: Blind since birth

"For me the access to audio description is"

due to Glaucoma

Occupation: Physiotherapist
 Language: Italian, English
 Technology: Laptop, Smartphone, Tablet, Google Home

Familiarity with technologies
 Low High

Watching TV habits

- **Device:** Smart TV (+Universal Remote Control), Smartphone (+earphones), Tablet (+earphones)
- **Where:** Everywhere
- **With:** Alone / Flatmate / Friends
- **What:** Cooking programs, TV series, Music channels
- **Needs:** Availability of audio description for all programs and access them easily

Information
 Age: 42
 Nationality: Italian
 Disability: Low vision

"I want to see beyond my disease"

due to Glaucoma

Occupation: Consultant
 Language: Italian, English
 Technology: PC Desktop, Smartphone, Tablet, Gaming console

Familiarity with technologies
 Low High

Watching TV habits

- **Device:** TV HbbTV, Tablet
- **Where:** At home
- **With:** Alone / Her son
- **What:** Talent show, Reality, Cartoon
- **Needs:** Be able to see more clearly everything on the Television screen

Information
 Age: 75
 Nationality: Greek
 Disability: Low vision

"My TV is my best friend"

due to cataract

Occupation: Retired
 Language: Greek
 Technology: PC Desktop(outdated); basic mobile phone

Familiarity with technologies
 Low High

Watching TV habits

- **Device:** TV HbbTV (+Universal Remote Control)
- **Where:** Home
- **With:** Alone / Her daughters, sons or grandchildren
- **What:** Film, TV series, Talk show
- **Needs:** Search easily her favourite channels and watch them as best as possible

Information
 Age: 38
 Nationality: Spanish
 Disability: No disabilities

"I am a teacher, but I want to learn something by my TV"

Occupation: Researcher & SL Teacher
 Language: Spanish, Catalan, English, French, German, LSE (Lengua de Signos Espanola)
 Technology: Laptop, Tablet, Smartphone

Familiarity with technologies
 Low High

Watching TV habits

- **Device:** TV (HbbTV), Tablet
- **Where:** During travel/At home
- **With:** Family
- **What:** Film, TV series, Talk show
- **Needs:** Watch TV programs subtitled in other languages

Information
 Age: 42
 Nationality: Spanish
 Disability: No disabilities

"I'd like that my company will deliver more access content for the TV"

Occupation: Broadcaster technical worker
 Language: Spanish, Catalan, English
 Technology: Laptop, Smartphone, Tablet

Familiarity with technologies
 Low High

Working on a broadcaster

- **Device:** laptop, PC
- **Where:** At work place
- **With:** Alone
- **What:** Multimedia content (series, films, news, etc.)
- **Needs:** To obtain more access content related to the delivered multimedia in a more efficient way

¹ Newell, A. F., Gregor, P., Morgan, M., Pullin, G., & Macaulay, C. (2011). User-sensitive inclusive design. *Universal Access in the Information Society*, 10(3), 235-243.

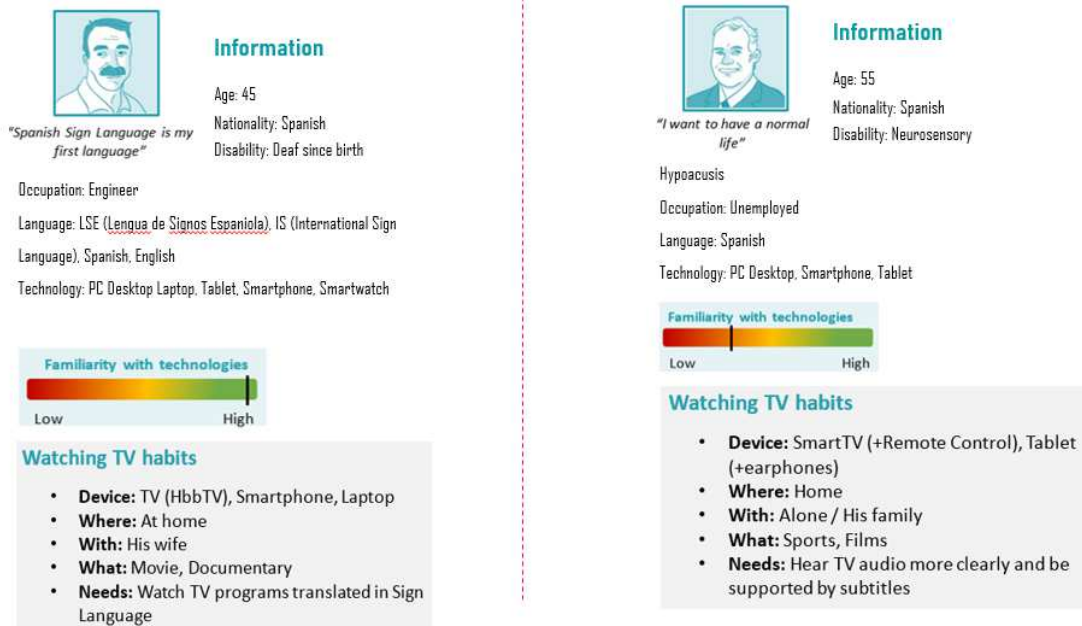


Figure 4. Personas defined for EasyTV based on focus group information

3.2. EasyTV general overview

The architecture of the EasyTV component-based system, derived from technical specifications, makes accessibility as a ubiquitous service a reality by delivering accessible content to different terminals. Figure 5 shows a general overview of the system.

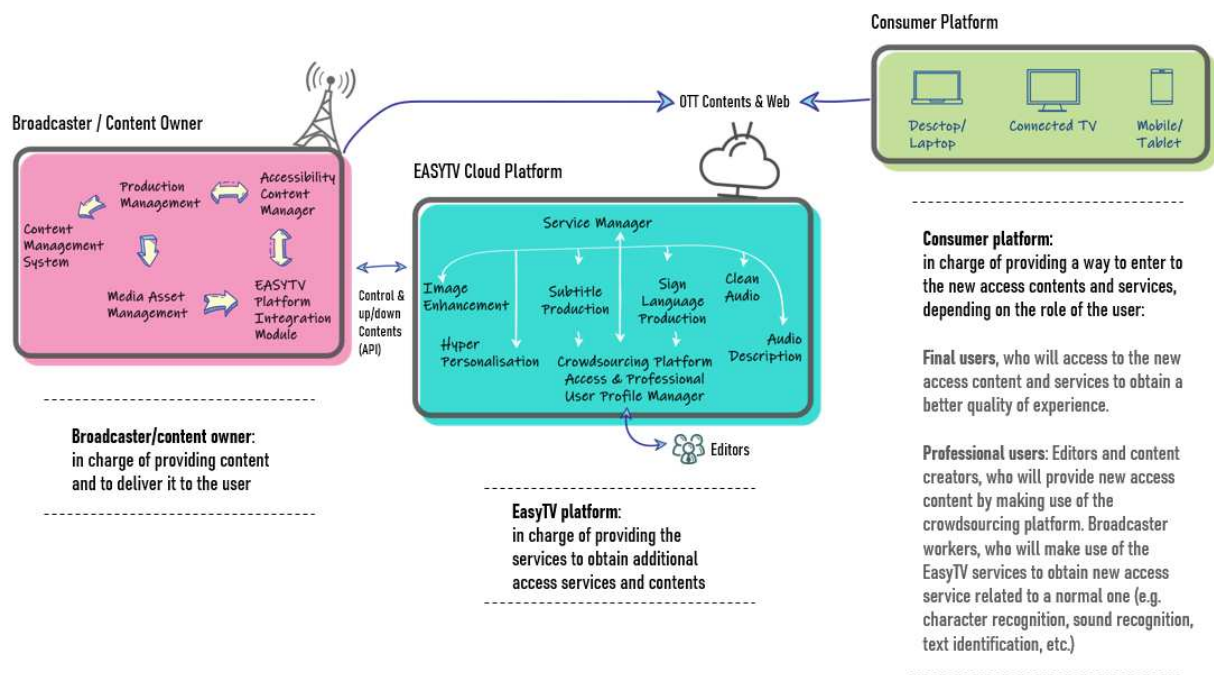


Figure 5. EasyTV system architecture overview

As can be seen, EasyTV structure can be divided into three main parts:

- Broadcaster/content owner premises: that are in charge of providing content and delivering it to the users, as well as of accessing EasyTV platform for obtaining additional access content.
- EasyTV cloud platform, in charge of providing different innovative tools that improve the accessibility level of the content and also of allowing new interaction methods for increasing the ease of use.

- Consumer platform, that includes the TV set and other additional solutions as the companion screen application for presenting additional access content to the users.

3.3. EasyTV access services

Regarding the different solutions implemented within the project, we can divide them according to the side they are included. In this way, as shown in Figure 6, we can find:

- EasyTV platform side: a set of core services have been implemented that allows a proper performance of the platform:
 - o Personalization and adaptation: a complete module for content personalization have been implemented. Moreover, a new proposal for including additional services over MPEG-DASH standard allows to extend its initial scope.
 - o Service manager, registry and catalogue, allow professional users to identify, access and orchestrate the EasyTV services.
 - o SDK for allowing 3rd parties to use and include additional services.

Together with these core services, the EasyTV platform include the different access services that have been defined. These services can be classified according to their own purpose:

- o Content improvement: these services enhance the content provision by improving or even including specific audio-visual characteristics:
 - Image enhancement: face magnification, custom magnification, character detection, colour subtitling, text detection, etc.
 - Audio processing and narratives: sound detection, personal equalization, etc.
 - Sign language avatar for different sign language captions creation.
 - o User interaction: new solutions for helping users to access the content and interact with it are included in this category: innovative tools for voice, gaze and gesture control and a new solution for text to speech that consider different languages.
 - o Crowdsourcing platform: a new platform for allowing content translations and sign language capturing for populating a specific EasyTV ontology.
- EasyTV client side: regarding this side, the main effort has been focused on providing a complete access tool based on the companion screen concept that allows accessing the additional content in an easy way through a personal user application.

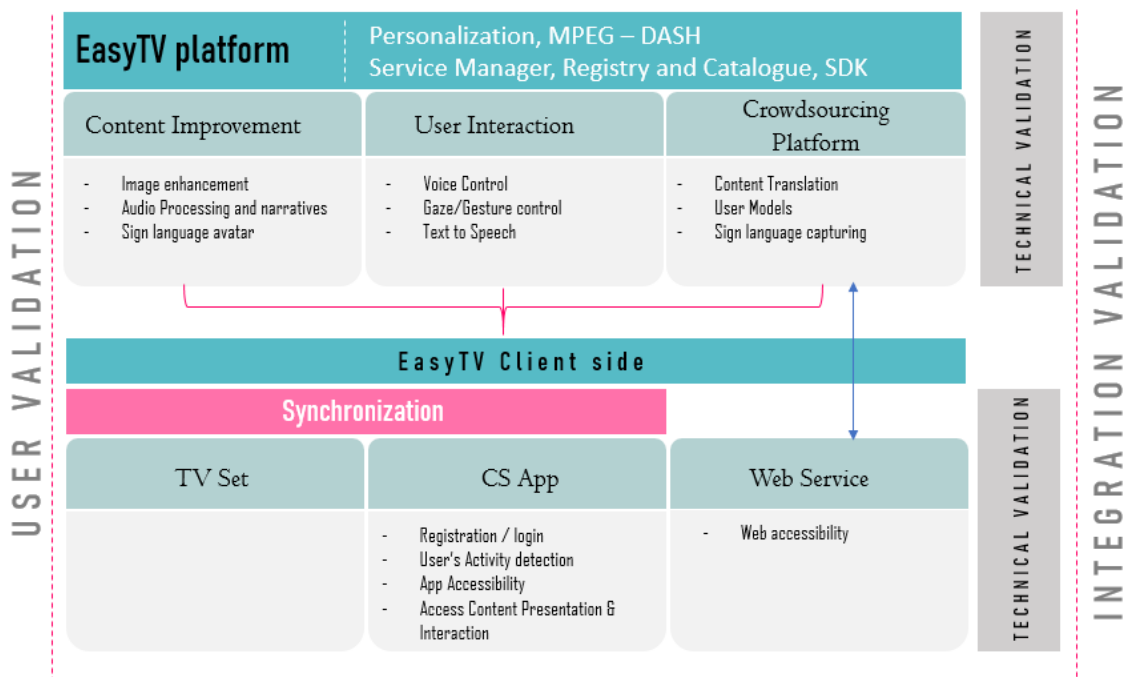


Figure 6. EasyTV services overview

3.4. EasyTV testing and results

As it has been said, two waves of tests have been performed during the project. First wave took place during March 2019, when a set of intermediate test were carried out. The following table presents a summary of the obtained results for each module (the entire analysis of the results can be found in D6.2).

Table 1. Summary of the intermediate tests

Service (test modality)	No. informants	SUS	NPS	Conclusions and further steps
Capturing module (online+live face to face)	12	57.92	-41.7	The results from the usability tests showed that a number of modifications are necessary concerning the current application user interface (UI), in order to make it even more simple and easy to use for the end users (i.e., expert signers).
Crowdsourcing platform (live face to face)	11	59.09	-18.2	Users' feedback indicates that platform's usability can be improved in certain aspects. In addition, the qualitative comments reveal that platform's scope can be more comprehensible to the contributing user. The main drawback recognized was that at its current stage of development the platform is not integrated with other EasyTV service, meaning that certain functionality is missing. Actions to be taken: workflow simplification of crowdsourcing tasks, enrichment of user-experience by integrating other EasyTV services
Gesture recognition control (live face to face)	5	77.5	40	Results from the usability tests are encouraging. Special attention will be paid towards a more intuitive interface and enhanced functionalities for users.
3D signing avatar (live face to face)	5	49.5	-80	In order to increase the realism of the avatar, more accurate data gathered through the recordings are needed along with additional pre-processing steps to achieve smoother movement. Furthermore, a refined questionnaire that will include questions for all levels of comprehension (i.e. face, fingers, words and phrases) will be provided. The new tests are expected to support at least 3 different languages with 6 testers each, in order to have better conclusions.
Speech platform (online+live face to face)	CA: 5	62.5	-80	Speech interaction (both Text to Speech and Speech Recognition) is essential for Blind and visually impaired users. The definition of the Voice User Interface of the applications and functionalities is a crucial task and very challenging. Looking at the comments and quantitative results of these intermediate tests we need to work constantly with end user organizations and fix the VUI time by time in order to reach an effective and efficient way of speech interaction. To do this we have to improve the Flexibility and effectiveness of the Dialog Flow, the interpretation of voice commands (NLP Module), simplify voice prompts and help messages and
	IT (Live): 12	88.33	75	
	IT (online): 48	67.71	53.2	

				finally add more and more services to the final product as requested by the users.
Colour-blind subtitles (live face to face)	9	78.33	0	Although the results were not bad. By not improving the readability or differentiation conflicts with of subtitle colours, in addition to the recommendation of the reviewers to concentrate efforts, we decided not to continue with this investigation.
Screen reader (live face to face)	5	80.5	80	Test Volunteers want the service in operation. The feedback received helped to improve the application with a new navigation solution. To add screen reader support also to the HbbTV launcher. Feedback after search results updated/rendered. Keyboard feedback while typing.
Text detection (online)	8	69.69	-12.5	Good results. Regarding the actions to be taken for service improvement according to the comments, we can mention: <ul style="list-style-type: none"> - To reduce the complexity of the functionality inside the CS app. - To include some voice control to make it more accessible.
Subtitles customization (online)	10	82.75	30	Good results.
Face detection (online)	5	73.50	0	Good results. Regarding the actions to be taken for service improvement, we can mention: <ul style="list-style-type: none"> - To improve the algorithms in order to reduce the constant movement of the image. - To analyse the possibility of including the service also in the TV screen
Custom magnification (online)	11	80.23	36.4	Very good results. Regarding the actions to be taken for service improvement according to the comments, we can mention: <ul style="list-style-type: none"> - To analyse the possibility of including the service also in the TV screen
Character detection (online)	6	77.04	16.7	Good results. There are no specific improvements derived from the comments to be included in this service.

After this, a phase of refinement was applied. Then, during May 2020 the final tests were carried out. Unfortunately, due to the COVID-19 outbreak, we were only able to perform online tests. However, before the restrictions, it had been possible to carry out a set of face to face interviews with blind and visual impaired people about the Speech Platform service. The following table presents a summary of the obtained results for each module (the entire analysis of the results can be found in D6.5).

Table 2. Summary of the final tests

Service (test modality)	No. informants	SUS	NPS	Conclusions and further steps
Capturing module (online)	15	43	-61.1	<ul style="list-style-type: none"> - While a number of targeted refinements and optimizations were made to this service according to expert signer instructions, we observe that results for both SUS and NPS declined from the intermediate tests, possibly due to the tests being performed online and not face-to-face. - Despite these results, most of the participants stated that research should be continued on this service - Significant research work has been performed by CERTH regarding video-based hand detection algorithms.
Crowdsourcing platform (online)	15	50	-33.3	<ul style="list-style-type: none"> - Most of the users believe that research and development should be carried on. - Due to the covid-19 emergency, tests were made online. Considering the results, this testing method highly affected the user understanding about the service
Gesture recognition control (live face to face)	6	87.92	66.7	<ul style="list-style-type: none"> - All users were positively inclined towards this service (The SUS score has been significantly improved from 77.5 in the intermediate tests to 87.92 in the final tests) - Most of them also stated that research should be continued
3D signing avatar (live face to face)	28	NA	NA	<ul style="list-style-type: none"> - There were both positive and negative remarks from the users, revealing that the avatar service is an open research area and there is still a lot of room for improvements, especially in the realism of the avatar. - The avatar realism can be improved by the research on novel hand detection algorithms performed by CERTH.
Speech platform (online+live face to face)	16 (live)	89,2	68,8	<ul style="list-style-type: none"> - Excellent results for both SUS and NPS scores. - Some aspects related to the interaction and customization based on the user profile or expertise can still be improved.
	91 (online)	77,9	34,1	
HbbTVScreen reader (live face to face)	3	52.50	-66.70	<ul style="list-style-type: none"> - Despite the results, conditioned by covid-19, we still believe on the results obtained on intermediate tests. Also, the HbbTV screen service provides a great help to blind and hard vision collectives. - We would like to continue with that service and expand the technique to the rest of smartTV TV3 broadcaster application - Text-to-speech do not interpret properly some acronyms, it should be revised.
Multilingual subtitles -	9	77.77	22.22	<ul style="list-style-type: none"> - EasyTV has developed the crowdsourcing platform to generate multi-language subtitle

content generation (online)				<p>services, and the outcome has been a great success</p> <ul style="list-style-type: none"> - For rich content, machine translation offered limited creativity. <p>Running the pilot, have demonstrated the third party integration with the platform, in that case a broadcaster, posting subtitling translation jobs. A volunteers' management by the crowdsourcing platform and the necessary editing tools to create the content.</p>
Multilingual subtitles - content consumption (online)	5	59.44	44.44	<ul style="list-style-type: none"> - The response from viewers has been an unexpected success <p>These results seem to indicate that there is a significant potential demand for this service</p>
Text detection (online)	15	73.3	13.3	<p>Based on the obtained results, and taking into account the comparative with the intermediate ones we can conclude that we have achieved a slight improvement of the service perception. Both the SUS score and the NPS score have increased thanks to the modifications that have been applied based on the comments given during the intermediate tests.</p>
Face detection (online)	38	63.9	-7.9	<p>According to these results, we can conclude that the perception of the users has decreased in comparison with the intermediate tests.</p>
Custom magnification (online)	24	68.8	-12.5	<p>Based on the obtained results, and taking into account the comparative with the intermediate ones, we can conclude that the perception of the users changed. In fact, the SUS score, although decreased, it is still in a good position but the NPS score has decreased a lot</p>
Character detection (online)	13	69.0	15.4	<p>Based on the obtained results, and taking into account the comparative with the intermediate ones, we can conclude that the perception of the users has been maintained. In fact, both SUS and NPS scores are similar although the number of users has increased</p>
Audio subtitles (online)	16	80	37.5	<p>This service has obtained good results both in SUS and NPS scores, so we can derive that it is interesting for the users</p>
Audio equalization (online)	15	41.1	-80	<p>Although most of the users are agree on continuing with the research of the service, due to the SUS and NPS punctuation it seems to be not so relevant or even interesting for them</p>
Sound detection (online)	15	67	-6.7	<p>Although most of the users are agree on continuing with the research of the service, according to the SUS and NPS results there is still room for improvement.</p>

4. CONCLUSIONS

During these 33 months, EasyTV project has obtained a complete platform for assuring and improving equal access to audio-visual services for all users, especially for persons with various degrees of disabilities. This EasyTV platform joins together services for content improvement, user interaction and crowdsourcing content creation and provision, together with a core set of architectural services for assuring the optimal performance of the entire structure. This platform can be considered as the main project result and it has been designed following a flexible approach to assure its adaptation to different market scenarios in order to approach future perspectives on the media market.

4.1. Main project results





As can be derived from the previous explanation, EasyTV platform includes a set of characteristics that are very relevant for exploitation. Moreover, the principles followed at the beginning of the definition such as personalization, flexibility, modularity, scalability and accessibility enables EasyTV assets to address exploitation better prepared since they can be adapted to market needs. In this regards, the available assets are:

- Image enhancement, that includes face and text detection and character recognition.
- Audio enhancement, that includes sound detection and persona equalization.
- Automatic Voice synthesis of subtitles.
- Text to speech service
- Service manager
- Subtitle production
- Sign language production, that includes sign language capturing, recognition and representation using a 3D avatar
- Hyper personalization module
- Crowdsourcing platform
- Multiterminal application.



4.2. Future perspectives

EasyTV project internal analysis reflects that end-users feedback in the 2 phased testing activity have been positive in most of the services, confirming the value proposal to the different stakeholders (broadcasters, content owner and final users, including both professional and non-professional ones). Nevertheless, media market has a wide diversity so it requires tailored approaches for exploitation in each specific situation, making the modularity and flexibility of the EasyTV solutions a vital key for its adoption. In this respect, EasyTV platform is prepared to provide adequate resources for effective commercialisation in future scenarios, while some other solutions have already been used for further research or as current services in real scenarios. Following this, media market will become more interesting when providing real content for all solutions, and EasyTV has made an important effort to support this idea.

5. EASYTV CONSORTIUM

Partner	Description and role
	<p>Description: Universidad Politécnica de Madrid (UPM) is the oldest and largest of the Spanish Technical Universities. UPM’s Schools cover most Engineering disciplines, and has a strong commitment to R&D and Innovation. Of a total annual budget of around 340 M€, UPM receives annually over 80 M€ support from external sources for research activities. The contribution of the university to knowledge creation through its scientific publications is also significant. As for the experience in FP7 research projects UPM participated in 200+, besides involved in the coordination of more than 30 projects, implying that the 20% of UPM participation are led by UPM.</p> <p>Role: UPM main role has been to coordinate EasyTV from a technical, organizational and administrative point of view. Moreover, UPM has lead the improved access solutions together with the creation of specific ontologies for the project. Finally, and due to its skills, UPM has lead the content adaptation based on DASH.</p>
	<p>Description: ENGINEERING Ingegneria Informatica S.p.A. is the head company of the ENGINEERING Group. Engineering was founded in 1980, and it is currently the first IT group in Italy, among the top 10 IT groups in Europe, 8,500 employees and 50 branch offices in Italy and abroad, with an established presence in Belgium, Norway, Republic of Serbia, Latin America and USA.</p> <p>Role: ENG main role has been the implementation and integration testing of the technological platform of EasyTV. Furthermore, ENG has been in charge of defining the business model together with leading the exploitation and dissemination of the project.</p>
	<p>Description: The Information Technologies Institute (ITI) was founded in 1998 as a non-profit organisation under the auspices of the General Secretariat for Research and Technology of the Greek Ministry of Development, with its head office located in Thessaloniki, Greece. Since 10/03/2000, it is a founding member of the Centre for Research and Technology Hellas (CERTH) also supervised by the General Secretariat for Research and Technology (GSRT). In 2008, CERTH was among the first Greek research organisations to undersign and accept the principles of the Charter and Code for researchers while at the same time CERTH representatives were members of the Greek delegation at the Steering Group for Human Resources and Mobility (SG HRM). Its latest achievement in the field of human resources is the “HR EXCELLENCE IN RESEARCH” logo awarded by the EC in April 2012 as a proof that CERTH is committed to offer the best possible working conditions, regardless the socioeconomic environment, and at the same time work towards the realisation of the European Research Area.</p> <p>Role: CERTH participation has been focused on several technical issues, mainly in leading the hyper-personalization process, the sign-language capturing and recognition solutions and the avatar presentation.</p>
	<p>Description: Mediavoice S.r.l. (MV) is an Italian SME founded in 2000 by professionals with extensive experience in the field of speech technology and innovation. MV core business is research and development of innovative solutions of assistive technologies for visually impaired people; its mission is to bridge the digital divide through voice technology solutions and revolutionize the human-machine interface, transforming the technology from a barrier into an opportunity thus allowing everybody to access information</p>

	<p>and digital services in the most natural way: through their voice. MV is very active in R&D and takes part in both National and International innovation projects with Italian and European academic partners.</p> <p>Role: MV has been mainly leading the interaction technologies based on speech recognition and interaction by means of oral information.</p>
	<p>Description: The Universitat Autònoma de Barcelona (UAB) plays a leading role in scientific research in Spain and it was selected in the top 5 universities to reach the label of Campus of International Excellence from the Spanish government. UAB is participating in 233 international founded projects. 141 in the 7PM: 67 in Cooperation (9 IPs, 30 Streps, 1 NoE, 7 CSA, 6 Eranet), 22 in Capacities, 7 in Ideas, 38 in People, and more from other pan-European programs (CIP, Interreg, Tenders, Eureka, Europe aid, etc.). UAB is acting as project coordinator in 16 from H2020 what shows its experience and support capabilities. Given the multidisciplinary nature of the project and the role played by UAB it will participate in the project via four departments: Translation, Psychology, Sociology and Economics, and also with a researcher from the neighboring university UPF expert in Media Studies. The UAB team is multidisciplinary and has a fully equipped state-of-the-art recently established perception laboratory: it has 5 eye-trackers and machinery to test physiological responses.</p> <p>Role: UAB participation in the project has been aimed to understand and analyse human reaction through both perception and cognition research. It has been also focused on performing tests and studies with end users and leading the standardization activities.</p>
	<p>Description: The Corporació Catalana de Mitjans Audiovisuals (CCMA, www.ccma.cat) is the leading communications group in Catalonia. It operates under the aegis of the Catalan Government and is financed through public funding and advertising revenue. The Corporació has been a member of FORTA (the Federation of Autonomous Area Radio and Television Organisations) since its founding, in April 1989. It also forms part of the European Broadcasting Union through Catalunya Música, which takes part in this organisation's musical exchange Euroradio, which brings together all the public bodies and the main private European radio and television companies.</p> <p>Role: CCMA has lead the technical architecture development together with the delivery of personalised services and content management for the testing.</p>
	<p>Description: ARX.NET SA (http://www.arx.net), founded in 2001, is Greek-based SME that is a mobile technology powerhouse that has remained in the forefront of European Value Added Services for more than 15 years, and consistently delivered some of the most innovative apps and services for some of the biggest brands in mobile. Its strategic partnerships with OTE/Cosmote (T-Mobile Group), Vodafone Group, Elisa, Huawei, Telefonica, Wind, Cyta, Samsung and other global brands led to the successful launch of a number of mobile applications, mobile services, mobile operator portals, service billing solutions, content delivery and content aggregation platforms. Today, ARX.NET SA is one of the global leaders in cross-platform TV application development and in next generation cloud-based services targeting specifically Mobile Network Operators. Having invested more than 5 years in R&D in the area of next generation cloud-based services, ARX.NET delivers a number of white label solutions for Mobile Operators that help them enrich their consumer and business propositions, differentiate from their competition, increase customer loyalty and get additional revenue streams.</p> <p>Role: ARX.net has been focused on leading the service development kit</p>

	<p>together with the analysis and performance of device interoperability and the multiterminal software development.</p>
	<p>Description: The CNSE Foundation for the Removal of Communication Barriers is a state-level entity with legal personality, non-profit and associated to the Spanish National Confederation of the Deaf (CNSE). CNSE Foundation has invested more than 10 years working to improve access for deaf people at all levels in society, and to promote the development of projects that improve the quality of life of this group. CNSE Foundation aims to carry out R+D in order to contribute to the development and strengthening of the competitiveness of enterprises, by improving the quality of life and social accessibility of deaf people.</p> <p>Role: As one of the final user association in the project, FCNSE has been mainly focused on the user requirements gathering as well as on providing users for the tests.</p>
	<p>Description: The Italian Union of the Blind and Visually Impaired, founded in 1920, (DPR 23 December 1978) is a non-profit organization that represent and protect blind and visually impaired people. In particular, the Italian Union of the Blind and Visually Impaired promotes the full realization of human rights, civil and social rights of the blind, the equality and inclusion in all spheres of civilian life, with reference to school integration, cultural training, vocational education, job placement, sports, playful-recreational, assistance given to multi-disabled, older people and those who are in situations of particular social exclusion.</p> <p>Role: As in the previous case, UICI has been mainly focused on the user requirements gathering as well as on providing users for the tests.</p>

6. DELIVERABLE REPORTS

EasyTV project provided several deliverables for each WP as shown below:

- **WP1 Requirements, specification and technical architecture:**
 - o D1.1 User scenario and requirements definition
 - o D1.2 EasyTV System requirements specification
 - o D1.3 First release of the EasyTV system architecture
 - o D1.4 Final release of the EasyTV system architecture
- **WP2 Improved access services for improved multimedia viewing and hearing and description:**
 - o D2.1 Sign language animation preliminary development and production
 - o D2.2 EasyTV tools for improvement of graphical interfaces
 - o D2.3 EasyTV descriptive narratives and object based sound engine implementation
 - o D2.4 Integration of new access services in the EasyTV platform
 - o D2.5 Sign language animation final implementation
- **WP3 Novel technologies for the interaction with content and users for breaking the language barrier for people with disabilities:**
 - o D3.1 Sign language capturing technology preliminary version
 - o D3.2 Enriched multilingual ontology with signs in different languages preliminary version
 - o D3.3 Remote control with gesture/gaze controls preliminary version
 - o D3.4 Remote control with speech recognition preliminary development
 - o D3.5 Enriched multilingual ontology with signs in different languages final version
 - o D3.6 Remote control with speech recognition final development
 - o D3.7 Sign language capturing technology final version

- D3.8 Remote control with gesture/gaze controls final version
- D3.9 Device interoperability initial solutions
- **WP4 Improved personalisation:**
 - D4.1 Content adaptation using DASH streaming services
 - D4.2 EasyTV self-learning system for improving personalization capabilities
 - D4.3 EasyTV user interface adaptation framework
 - D4.4 Content adaptation using DASH streaming services (revised version)
 - D4.5 EasyTV self-learning system for improving personalization capabilities (revised version).
- **WP5 EasyTV component based system:**
 - D5.1 Mid-term report on the set up and implementation of the EasyTV multi terminal technical platform
 - D5.2 Mid-term report on the set up and implementation of the EasyTV crowdsourcing sign language platform and repository
 - D5.3 Mid-term report on the set up and implementation of the EasyTV Service Registry and Catalogue
 - D5.4 First release of the EasyTV Service Development Kit
 - D5.5 Integration and technical testing plan mid-term report
 - D5.6 Final report on the set up and implementation of the EasyTV crowdsourcing sign language platform and repository
 - D5.7 Final report on the set up and implementation of the EasyTV multi terminal technical platform
 - D5.8 Final report on the set up and implementation of the EasyTV Service Registry and Catalogue
 - D5.9 Final release of the EasyTV Service Development Kit
 - D5.10 Integration and technical test plan final report
- **WP6 Testing with users and feedback:**
 - D6.1 Report on demographics for the tests
 - D6.2 Preliminary set of documents for ethical request, data protection and consent information
 - D6.3 List of end users with contact information and active contact address/mode of interaction
 - D6.4 Final set of documents for ethical request, data protection and consent information.
 - D6.5 Type of tests, results and final feedback.
- **WP7 Dissemination and exploitation:**
 - D7.1 Easy-stage market analysis and initial business model
 - D7.2 Report in identification of standardisation bodies
 - D7.3 Initial report on dissemination activities
 - D7.4 Final report on identification of standardisation bodies and contribution actions
 - D7.5 Final report on dissemination activities
 - D7.6 Consolidated market analysis and final business model
 - D7.7 Mid-term report on market analysis and business
- **WP8 Project Management:**
 - D8.1 Risk Identification and Management, Quality Assurance Plan and Data Management Plan
 - D8.2 Progress report 1
 - D8.3 Risk Identification and Management, Quality Assurance Plan and Data Management Plan v2
 - D8.4 Progress report 2
 - D8.5 Progress report 3
 - D8.6 Public Final activity report: report
 - D9.1 H-Requirements No.1

7. DISSEMINATION AND IMPACT CREATION

7.1. Scientific publications

All publications related to EasyTV for the entire project are listed below:

- Journals:
 1. Matamala, A. and Orero, P., “Standardising accessibility: Transferring knowledge to society,” *Journal of Audiovisual Translation*, 1(1), 139-154. 2018.
 2. Moreno, F., Uribe, S., Álvarez, F., & Menéndez, J. M. (2020). Extending Aspect-Oriented Programming for Dynamic User’s Activity Detection in Mobile App Analytics. *IEEE Consumer Electronics Magazine*, 9(2), 57-63. doi: 10.1109/MCE.2019.2953738.
 3. Uribe, S., Belmonte, A., Moreno, F., Llorente, Á, López, J., & Álvarez, F. (2019). New access services in HbbTV based on a deep learning approach for media content analysis. *Artificial Intelligence for Engineering Design, Analysis and Manufacturing*, 33(4), 399-415. doi:10.1017/S0890060419000350.
 4. Tor-Carroggio, I., & Orero, P. (2019). User profiling in audio description reception studies: questionnaires for all. *InTRAlinea. Online Translation Journal*, 21.
 5. Tor-Carroggio, I., Segura, D., & Soler-Vilageliu, O. (2019). Usability as a Premise of Quality. First steps towards the validation of the System Usability Scale (SUS) into Spanish. *Journal of Audiovisual Translation*, 2(2), 57-71.
 6. Bosch-Baliarda, M., Soler Vilageliu, O., & Orero, P. (2019). Toward a Sign Language-Friendly Questionnaire Design. *The Journal of Deaf Studies and Deaf Education*, 24(4), 333-345.
 7. López, J. P., Bosch-Baliarda, M., Martín, C. A., Menéndez, J. M., Orero, P., Soler, O., & Álvarez, F. (2019). Design and development of sign language questionnaires based on video and web interfaces. *Artificial Intelligence for Engineering Design, Analysis and Manufacturing AI-EDAM*, 33(4), 429-441.
 8. Bosch-Baliarda, M., Soler-Vilageliu, O., & Orero, P. (2020). Sign language interpreting on TV: a reception study of visual screen exploration in deaf signing users. *MonTI. Monografías de Traducción e Interpretación*, (12), 108-143.
- Conferences:
 1. Konstantinidis, D., Dimitropoulos, K. and Daras, P., “A Deep Learning Approach for Analyzing Video and Skeletal Features in Sign Language Recognition,” *IEEE IST, Krakow, Poland*, 16-18 October, 2018.
 2. Uribe, S., López, J.P, Llorente, Á., Moreno F., Álvarez, F., and Menéndez, J.M. “EasyTV: Mejorando la accesibilidad de los servicios audiovisuales en el ámbito de la televisión conectada”, *AMADIS, Madrid, Spain*, 8-9 October, 2018.
 3. Konstantinidis, D., Dimitropoulos, K. and Daras, P., “Skeleton-based Action Recognition Based on Deep Learning and Grassmannian Pyramids,” *EUSIPCO 2018, Rome, Italy*, 3-7 Sept. 2018.
 4. Konstantinidis, D., Dimitropoulos, K. and Daras, P., “Sign Language Recognition Based on Hand and Body Skeletal Data,” *3DTV Conference, IEEE, Stockholm, Helsinki*, 3-5 June 2018.
 5. Matamala, A., Orero, P., Rovira-Esteva, S., Casas-Tost, H., Morales, L.F., Soler-Vilageliu, O., Agulló, B., Fidyka, A., Segura, D. and Tor-Carroggio, I., “User-centric approaches in access services evaluation: profiling the end user,” *Language Resources and Evaluation Conference (LREC), Miyazaki (Japan)*, 7-12 May 2018.
 6. Konstantinidis, D., Dimitropoulos, K., Stefanidis, K., Kalvourtzis, T., Gannoum, S., Kaklanis, N., Votis, K., Daras, P., et al. (2020). Developing Accessibility Multimedia Services: The Case of EasyTV. *International Conference on Pervasive Technologies Related to Assistive Environments Conference (PETRA), Corfu, Greece*.
 7. Theodoridis, T., Chatzis, T., Solachidis, V., Dimitropoulos, K., & Daras, P. (2020). Cross-Modal Variational Alignment of Latent Spaces. In *Proceedings of the IEEE/CVF*

Conference on Computer Vision and Pattern Recognition Workshops, 960-961.

- Book chapters:
 1. Orero, P. and Tor-Carroggio, I. “*User Requirements When Designing Learning e-Content: Interaction for All*,” In E. Kapros y M. Koutsombogera (Eds.) *Designing for the User Experience in Learning Systems*, pp. 105-122, Cham: Springer Nature. 2018.
 2. Stefanidis, K., Konstantinidis, D., Kalvourtzis, A., Dimitropoulos, K., & Daras, P. (2020). 3D Technologies and Applications in Sign Language. In *Recent Advances in 3D Imaging, Modeling, and Reconstruction* (pp. 50-78). IGI Global.

7.2. Events

All events related to EasyTV for the entire project are listed below:

- Organization of events:
 1. Agent workshop at Petra 2019 conference (June 5th – 7th 2019, Rhodes, Greece)
 2. 7th TransMedia Catalonia International Meeting (October 25th, 2018, Barcelona, Spain)
 3. TransMedia Catalonia Open Day in Global Accessibility Awareness Day (May 17th, 2018, Barcelona, Spain)
 4. Colombia Digital TV sessions (May 10th, 2018, Barcelona, Spain)
 5. 6th TransMedia Catalonia International Meeting (March 21st, 2018, Barcelona, Spain)
 6. Focus group about future trends in accessibility (January 17th, 2018, Madrid, Spain)
 7. AGENT workshop in PETRA conference (June 30th-July 3rd, 2020, Virtual Conference)
 8. 9th Global Accessibility Awareness Day (GAAD) (May 21st, 2020, Online)
 9. ALMA network experts (January 30th, 2020, Barcelona, Spain)
 10. Barcelona Sc13nc3 Fest 2019 (October 26th-27th, 2019, Barcelona, Spain)
 11. H2020 Accessibility Cluster Workshop (February 5th, 2019, Brussels, Belgium)
 12. Annual Meeting of the territorial section of U.I.C.I. Roma (April 26th, 2019, Rome, Italy).
- Participation in events:
 1. ITU-EC Forum for Europe on “Accessible Europe: ICT for ALL” (December 13th, 2018, Vienna, Austria)
 2. MUTEI presentation event (November 23rd, 2018, Barcelona, Spain)
 3. European Disability Forum event (November 16th, 2018, Vienna, Austria)
 4. 7th HbbTV Symposium and Awards (November 14th-15th, 2018, Berlin, Germany)
 5. EBU Accessibility Services Experts Meeting (November 9th, 2018, Geneva, Switzerland)
 6. I Giornata d'Audiodescrizione (October 19th, 2018, Parma, Italy)
 7. International Conference on Imaging Systems and Techniques (IST 2018) (October 16th-18th, 2018, Krakow, Poland)
 8. ITU Intersector Rapporteur Group on Audiovisual Media Accessibility – 13th meeting (October 16th, 2018, Geneva, Switzerland)
 9. ASBU EBU Week of Technology (October 10th, 2018, Tunis, Tunisia)
 10. IX Conference Congress on audiovisual media accessibility for people with disabilities, AMADIS 2018 (October 8th-9th, 2018, Madrid, Spain)
 11. Languages and the Media (October 3rd-5th, 2018, Berlin, Germany)
 12. Terpsichore summer school in ICL 2018 conference (September 25th, 2018, Kos, Greece)
 13. 26th European Signal Processing conference (Eusipco 2018) (September 3rd-7th, 2018, Rome, Italy)
 14. ISO meeting (August 27th-31st, 2018, Okayama, Japan)
 15. 9th International Symposium For Young Researchers in Translation, Interpreting and East Asian Studies (June 29th, 2018, Barcelona, Spain)

16. 3DTV conference (June 3rd-5th, 2018, Stockholm, Sweden)
17. 25th NEM General Assembly (May 30th, 2018, Brussels, Belgium)
18. IRT Subtech 1 – Symposium on Subtitling Technology (May 24th-25th, 2018, Munich, Germany)
19. Bit Audiovisual (May 8th-10th, 2018, Madrid, Spain)
20. 11th Language Resources and Evaluation Conference (LREC 2018) (May 7th-12th, 2018, Miyazaki, Japan)
21. SIGHTCITY 2018 (April 26th-28th, 2018, Frankfurt, Germany)
22. Innovation and High Technology Fair (BIAT 2018) (Naples, Italy, April 19th-20th, 2018)
23. ITU Intersector Rapporteur Group on Audiovisual Media Accessibility – 12th meeting (April 17th, 2018, Geneva, Switzerland)
24. 9th Annual International Translation Conference (March 27th-28th, 2018, Doha, Qatar)
25. TV Innovation Forum Arqiva (March 6th, 2018, London, UK)
26. Jornades ACAPPS 17 (November 4th, 2017, Barcelona, Spain)
27. H2020 Media Projects Workshop (October 17th, 2017, Brussels, Belgium)
28. AI Move postgraduate program (December 9th-13th, 2019, Paris, France)
29. EBU/UICI TechFair during the 11th EBU General Assembly (November 27th-30th, 2019, Rome, Italy)
30. 8th HbbTV Symposium and Awards (November 21st-22nd, 2019, Athens, Greece)
31. 2019 EBU Access Services Experts Group (October 21st, 2019, Amsterdam, Netherlands)
32. International Conference on Sign Language (September 19th-20th, 2019, Madrid, Spain)
33. IBC 2019 Conference (September 12th-17th, 2019, Amsterdam, Netherlands)
34. XVIII World Congress of the WFD (July 23rd-27th, 2019, Paris, France)
35. ITU The Future of Television for Europe (June 10th, 2019, Geneva, Switzerland)
36. Translating in the 21st century and the challenge of sustainable development (Summer School) (June 7th, 2019, Venice, Italy)
37. International Exhibition SightCity (May 8th-10th, 2019, Frankfurt, Germany)