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1 Executive summary

This document describes the overall methodology followed to validate and evaluate BRIDGET tools during the project's lifetime, and a summary of the main findings. As such, this document is an incremental update of D2.3 – User Validation – Version A. This is done in order to present the results of all user validation activities in a coherent and self-standing form. Detailed considerations and analyses can be found in Deliverables D8.5 and D8.10, respectively reporting data and the results of the first and second validation cycles.

During validation design, the approach applied was that of distinguishing between the two main usage domains, namely the professional and the end-user domains. Both domains have been contextualised in terms of functionalities tested in the trials, and linked to the set of requirements that have been put under test. Therefore, detailed exercises were defined and proposed to users to validate the Professional Authoring Tool and the BRIDGET Player Application in the context of dedicated focus groups. In addition, during the second cycle of validation, a field trial session has been organised at some of the partners' headquarters.

2 Introduction

This document is Version B of the deliverable produced by the BRIDGET project describing methodologies adopted to test the developed tools and to present feedback elements and factors derived from different trial sessions. As such, this document should be considered as an incremental update of D2.3 – user Validation - Version A [6].

The document is organised as follows: Section 3 presents the trial methodology referencing in Appendix A the list of trialled requirements and presenting the exercises performed during trials sessions to test the developed tools; Section 4 describes feedback elements and factors for each trial modality and summarises the key findings obtained by the validation activity.

3 Validation Strategy

3.1 Approach and Planning of Validation Activities

Figure 1 illustrates compactly the overall approach and planning of user validation adopted in the project, as well as the validation activities' inter-relations. Validation activities are represented in three time-aligned layers: a) Scenarios & Requirements (managed by WP2); b) Design & Execution (managed by WP8); and c) Implementation (managed by WP7). In general, we had two validation cycles, one starting at M5 with the definition of Version A of the PoC Specification [1], the second starting at M27 with the definition of Version B of the PoC [7]. These two starting points have been defined based on the outcomes of the First Workshop and Version A of Requirements (respectively [4] and [2]) and of the Second Workshop and Version B of the Requirements (respectively [9] and [8]).

The PoC specifications gave input to the two system implementation cycles, carried out by WP4,5,6,7 and resulting in Version A and B of the BRIDGET system. The system tools were then integrated in Version A and Version B of the PoC, and documented in the Validation Framework deliverables (respectively [5] and [12]). The validation frameworks constituted the actual infrastructure on which to execute the User Trials runs, which took place in two cycles: between M21 and M22 and between M34 and M35. At the end of each trial cycle the analysis of results produced two main outputs, namely a public summary and a confidential analysis report (respectively [6] and [3] for the first cycle, and this document and [10] for the second one).

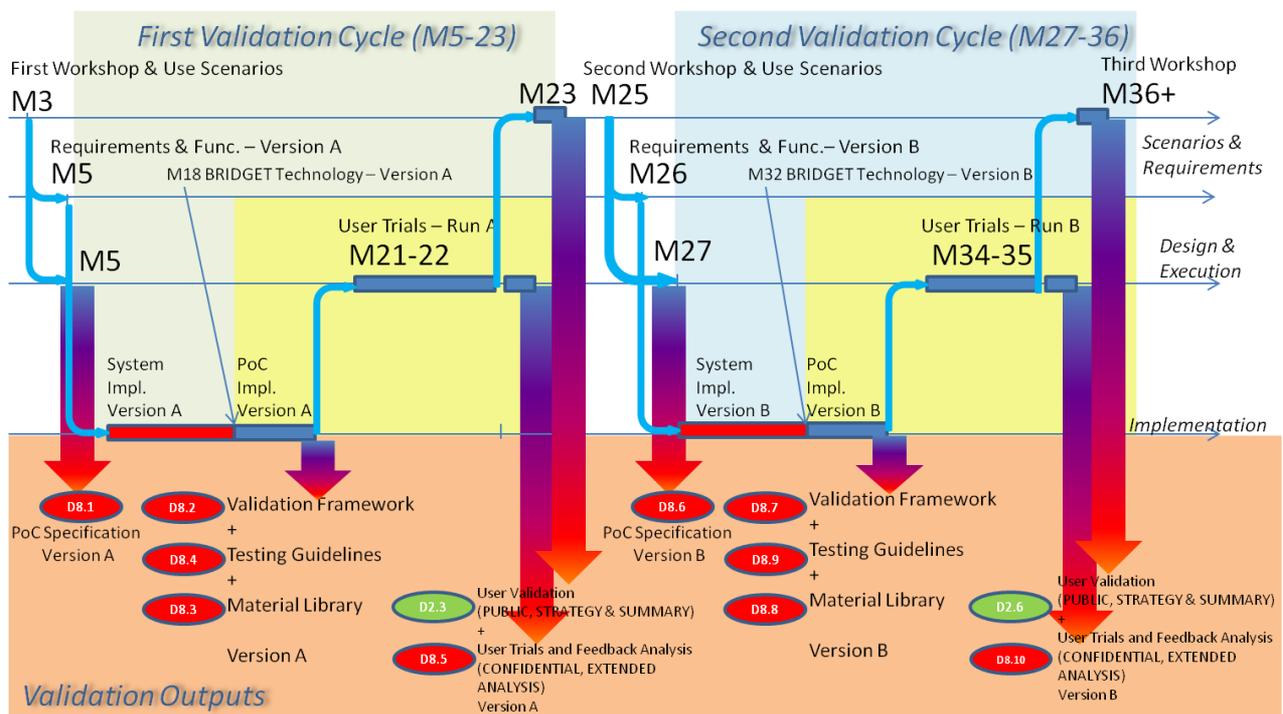


Figure 1. Overall planning and inter-relation of validation activities.

To validate results of each of the two system implementation cycles, only a subset of the complete functionalities have been considered and implemented in the PoC, namely those forming a relevant part of the Proof of Concept scenarios analysis (see Section 3.2.2). This high level decomposition is mapped to a selection of the complete system requirements (see Section 3.3), which have been put under test during the trials of the project, both in the professional production domain and in the end-user consumption domain.

While during the first validation cycle the PoC included most of the high level functionalities defined for it, the second cycle of work was more focussed on testing functionalities derived from the analysis of new scenarios on the one hand, and on testing the results of the 3D Media Tools integrated in the Professional Authoring Tool on the other hand. Therefore, while the first round of validation tested the large part of the defined PoC functionalities, and as a consequence also accounted for most part of the tested requirements, the second part was dedicated to few additional, but yet crucial, functionalities implemented or integrated in the second phase of the project.

Before formalising the detailed definition of each validation cycle's practical plan, a relevant set of audiovisual material has been collected and documented in [13] and [14].

In each of the two validation cycles a couple of practical exercises reflecting the requirements and scenarios under test have been identified to test the developed systems (see Section 3.4) against them. The production domain exercises (Section 3.4.1) have been proposed to professional users to put under test the Professional Authoring Tool, while the end user domain exercises (Section 3.4.1.2) have been proposed to test the BRIDGET Player Application during two focus groups organised with real end-users and during a final Filed Trial session organised at some partners' homes or offices (namely Madrid, Guildford and Paris) – this was done to enlarge the panel of users in terms of age, cultural background and profession.

Both professional users and end-users involved in each of the two cycles of trials gave substantive feedback about the experience they had with the tools by means of questionnaires and face to face interviews. The results of the first round of trials have been useful to redefine some of the tools functionalities, while the results of the second cycle can be seen as a further indication of what aspects should be improved and what are the strengths of the developed solutions from the perspective of a real service.

All the collected feedback has been analysed by the consortium in order to highlight eventual deficiencies of the provided tools and decide on how to proceed with further developments of the tools (see Section 3.4.2.2). The detailed analysis of feedback data is presented in [3] and [10].

3.2 Proof-of-Concept Functionalities

In the first part of this Section a high level functional breakdown of the scenarios described in [1], and the overall activity flows on the production side and in the end-user domain are presented. These two domains are the contexts in which the validation took place in the two cycles.

The second part of this Section shows the subset of the Proof-of-concept functionalities taken into account to validate results of the first and second cycle of work.

3.2.1 Use Cases Breakdown Analysis

Error! Reference source not found.Figure 2 and Figure 3 **Error! Reference source not found.** show the UML use-case representation of the two domains of usage of BRIDGET technologies: the production domain and the end-user domain. These descriptions have been derived by analysing in further detail the scenarios proposed in [4] and [9] and putting those high-level user experiences in the context of a possible back-end (authoring and production) and front-end (user experience) workflows. This activity allowed to derive a consistent set of high-level functionalities which have to be realised and supported by the technologies developed or integrated by the project, and to define trials exercises (see Section 3.4). The two figures include some relevant use cases which haven't been tested (red rimmed oval), some which have been simulated (orange rimmed oval) and some which haven't been tested but considered

irrelevant (grey rimmed oval). Overall, in the production domain the excluded functionalities were those connected with the online correction, done by the Authoring Tool user, of the content analysis subsystem's results and of the visual search subsystem's results. In the end-user domain the excluded functionalities were those connected with the contribution of content by the user, visual search by the user, and the switch of configuration of the application. Furthermore, in the end-user domain we didn't approach the problem of embedding user-created bridglets in the broadcasted programme. In the second validation cycle we instead simulated the condition of a live bridgletted programme in which an operator manually activates and deactivates bridglets during a live show.

3.2.1.1 Production Domain Use Case

In the production domain we identified the following main functional areas, depicted in **Error! Reference source not found.** different colours in Figure 2:

- Content repository area, i.e. the functionalities connected to the search and retrieval of content and metadata
- Content analysis and 3D reconstruction area, i.e. the functionalities provided by the content analysis and 3D reconstruction subsystems
- Editorial staff area, i.e. the functionalities available to the editorial staff of the broadcaster
- Content provider area, i.e. the functionalities provided by the content providers
- Indexing and search area, i.e. the functionalities exposed by the visual search-based and metadata-based indexes

3.2.1.2 End user Domain Use Case

In the end user domain we identified the following main functional areas, depicted in different colours in Figure 3:

- End user area, i.e. the functionalities available for direct usage to the end user
- Bridglet application area, i.e. the functionalities provided by the second screen application used to consume bridglets
- Bridglet repository area, i.e. the functionalities provided by the broadcaster back-end to access and retrieve information related to bridglets
- Content repository area (in common with the production domain), i.e. the functionalities connected to the search and retrieval of content and metadata
- Content provider area, (in common with the production domain), i.e. the functionalities provided by the content providers
- TV set area, i.e. the functionalities provided by the main screen device
- Broadcast service area, i.e. the functionalities provided by the broadcasting service

3.2.2 Trials Exercises Breakdown Analysis

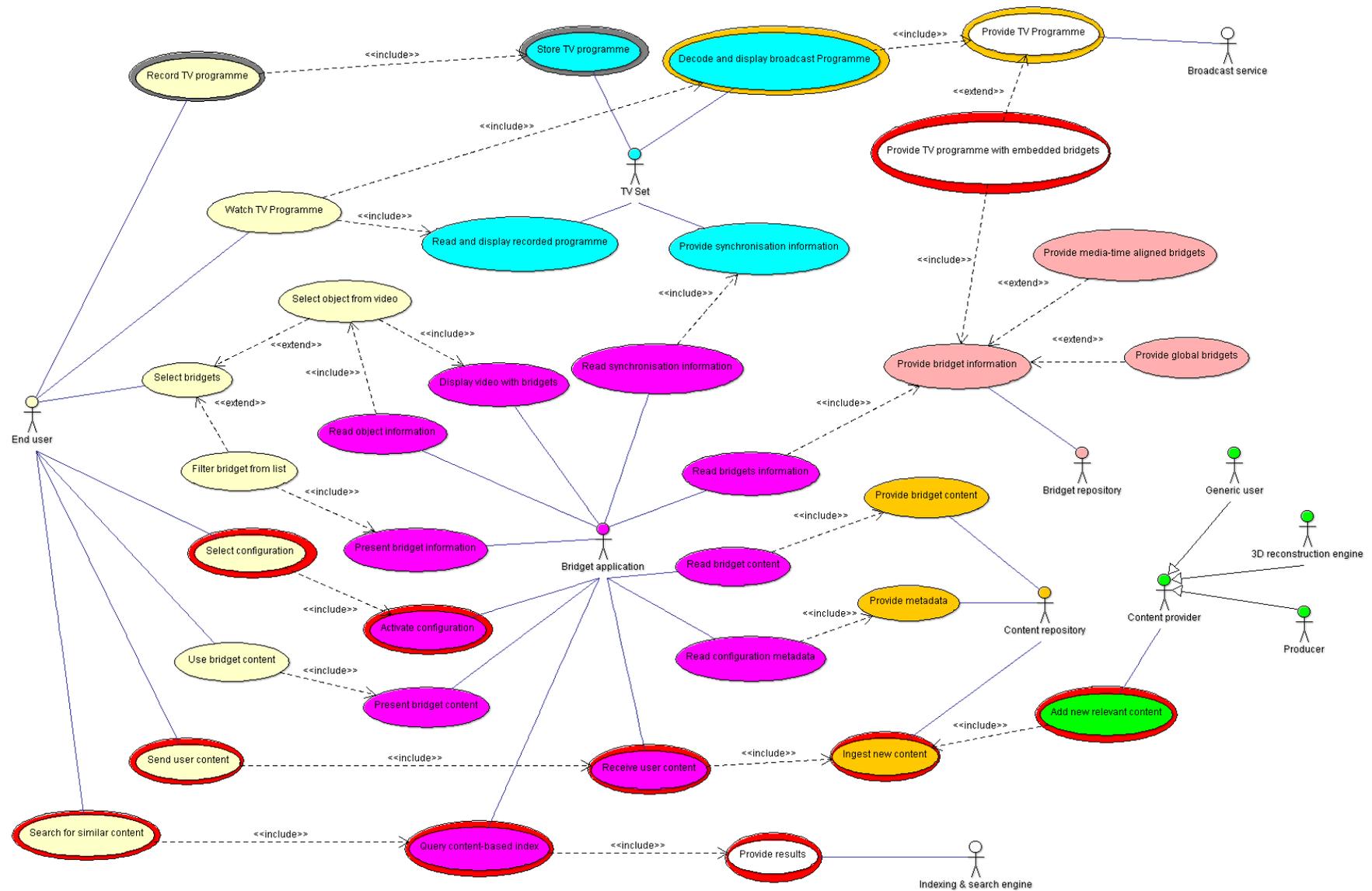


Figure 3. UML use case diagram for the end user domain – trials context.

3.3 Trialled requirements

Appendix A provides the lists of detailed requirements for the BRIDGET tools (i.e. the Professional Authoring Tool and the BRIDGET Player Application) that have been developed during the entire lifetime of the Project (and culminating in Version B) and trialled during the two editions of the user trials. For further information please refer to [2] and [8]. It should be stressed that the top-down validation approach adopted by the project (i.e., the definition of a PoC close to a selection of relevant usage scenarios) forcibly implies that, by definition, the developed Proof-of-Concept can employ only a reduced subset of all possible functionalities that a complex system like the BRIDGET system can utilise. As a result, the number of tested requirements (i.e., the requirements indirectly solicited by the execution of the user exercises) is appropriately reduced.

3.4 User Trials Exercises

In order to validate the BRIDGET technologies and tools for each of the two cycles of trials several user-trial exercises have been defined to involve users in the experience of the BRIDGET Professional Authoring Tool developed for the production domain and the end user's BRIDGET Player Application developed for the end user domain.

In the following sub-sections a textual description of each exercise is presented. Where appropriate, in brackets, the correspondent UML use case diagram functionalities (referred in **Error! Reference source not found.** Figure 2 and Figure 3**Error! Reference source not found.**) involved in each specific step of the exercise are also mentioned.

In the following example the text in bold identifies an action in the exercise workflow, while text in italic refers to use case functionalities**Error! Reference source not found.** involved in the action:

- **The user loads a content from the library** (*Select source material, Select pre-existent material, Provide content*)

3.4.1 Production Domain

3.4.1.1 First Validation Cycle

The exercise proposed to test the Professional Authoring Tool is as follows:

- The BRIDGET Professional Authoring Tool is running, the home page is displayed
- The user accesses the Programmes Repository and adds a new Source Programme (*Add new content, Ingest new content*)
- After the content upload phase the shot detector and the CDVS extractor tools run automatically one after the other (*Invoke content analysis, Run content analysis, Provide content analyses results*)
- The user loads a content from the library (*Select source material, Select pre-existent material, Provide content*)
- Using the following workflow the user can add new time-aligned bridgets to different shots or global bridgets to the whole programme
 - The user can navigate the video and have an easy access to segments (shots) for augmentation (*Provide content analyses results, Provide bridget points, Select & filter bridget points*)
 - The user selects a shot (*Select specific segments*)
 - The user starts the new bridget's creation workflow for the selected shot
 - The user adds info to the new bridget metadata structure (*Ingest new metadata*)
 - The user adds an icon from the local disk to represent the new bridget (*Add new content, Ingest new content, Ingest new metadata*)

- The user searches for content similar to those pertaining to the selected shot using metadata (*Search by content*)
- The user selects several content from the list of retrieved destination contents and adds them to the new bridget (*Provide content, Provide metadata, Link content through bridgets*)
- The user edits Bridget Layout and saves his choices (*Consolidation and rendering*)
- The user stores the newly created bridget (*Store consolidated bridget*)
- Using the following workflow the user is able to reuse existing bridgets in the same source programme
 - The user selects a shot (*Select specific segments*)
 - The user searches for a specific bridget among the stored ones using bridget's metadata and selects one bridget from the returned list of bridgets (*Provide metadata, Load metadata about bridget points, Select & filter bridget points*)
 - The user modifies some metadata and destination content of the reused bridget (*Link content through bridgets, Consolidation and Rendering*)
 - The user runs visual search to add further pictures to the reused bridget (*Search by content, Provide visual search results, Metadata-based indexing, Content-based indexing, Provide content updates*)
 - The user confirms the selection for further pictures to be added to the reused bridget (*Link content through bridget*)
 - The user stores the modified reused bridget (*Store consolidated bridget*)
- Using the following workflow the user is able to have a rough preview of the bridgeted programme and apply possible modifications
 - The user consolidates the bridgeted programme, i.e. the output MP4 is created (*Consolidation and rendering*)
 - The user sees a preview of the bridgeted programme in the AT environment (*Consolidation and Rendering*)
 - The user decides to modify a bridget of the programme (*Link content through bridgets*)
 - The user selects the bridget and makes the desired modifications, e.g. modifies a time-aligned bridget into a global bridget, changes some destination content (*Provide metadata, Load metadata about bridget points, Select & filter bridget points, Link content through bridgets*)
 - The user stores the modified bridget (*Store consolidated bridget*)
 - The user re-consolidates the modified bridgeted programme (*Consolidation and rendering*)
 - The user sees a preview of the modified bridgeted programme in the AT environment (*Consolidation and Rendering*)

3.4.1.2 Second Validation Cycle

The following exercises have been performed with selected users to test the BRIDGET Professional Authoring environment in the second validation cycle.

Exercise about bridgets' publication during live programmes:

- The BRIDGET Professional Authoring Tool is running, the home page is displayed;
- The user accesses the Live Programmes Repository;
- The user selects the live programme of interest;

- The list of already created bridgets is presented to the user;
- The user fills in or modify the field about the Lifetime of each bridget;
- The user drags & drops bridgets to create the desired running order of bridgets;
- The user, while watching the live programme on the main screen, activates each bridget at the proper time following events happening during the live programme;
- The user chooses whether to manually deactivate one or more bridgets or to leave them active for their whole Lifetime period.

Exercise about 3D reconstruction:

- Task 1: Show different reconstructed 3D models
 - The goal is to show the final 3D reconstruction results for different real-world objects (buildings and statues).
- Task 2: Show different 3D model reconstruction types
 - The goal is to show different kinds of reconstructed 3D models of the same real-world object with different approximation degrees, e.g., based on point clouds vs. meshes.
- Task 3: Simulate gradual 3D model refinement
 - Task 3.1: Gradual processing of pictures
 - The goal is to show a gradual refinement of the reconstructed 3D model thanks to additional sets of input (still) pictures.
 - Task 3.2: Gradual video processing
 - The goal is to show how video processing is enabled, allowing the creation of 3D models in form of point cloud.
- Task 4: Gradual processing of stereo videos
 - The goal is to show how stereo video processing is enabled, allowing the real-time creation of dense 3D.

3.4.2 End user Domain

3.4.2.1 First Validation Cycle

The exercise proposed to test the BRIDGET Player Application is:

- The user selects and watches a recorded TV Programme (*Watch TV Programme, Read and display recorded Programme*);
- The BRIDGET Application recognises the Programme. The objective is to start synchronisation. This is done through the Synchroniser (*Read synchronisation information, Provide synchronisation information*);
- The BRIDGET Application downloads the associated content (*Read bridget content, Provide bridget content, Provide metadata, Read configuration metadata*);
- The BRIDGET Application records the audio track, extracts audio signatures and matches them with the ones that are related to the associated content available locally or remotely. The objective is to keep synchronisation to ensure a timely presentation of bridget information and related destination content. This is done through the Synchroniser (*Read synchronisation information, Provide synchronisation information*);
- The Bridget Player displays notifications whenever a match is confirmed, thus presenting bridgets. This is done through the Synchroniser (*Display video with bridgets, Present bridget information, Read bridget information, Provide bridget information, Provide global bridget, Provide media-time aligned bridgets*);

- The user interacts with the bridget content (i.e. the bridgets and presentation information) (*Select bridgets, Filter bridget from list, Select object from video, Read object information*);
- The user consumes some destination content (*Use bridget content, Present bridget content, Read bridget content*);
- Once the programme finishes, the user is presented with the list of all the programme's bridgets so that he can enjoy any missed destination content of interest (*Provide bridget information, Provide global bridget, Provide media-time aligned bridgets, Provide bridget content, Provide metadata, Select bridgets, Filter bridget from list, Use bridget content, Present bridget content, Present bridget information, Read bridgets information, Read bridget content.*)

3.4.2.2 Second Validation Cycle

The test of the End-user Environment in the second validation cycle consisted of two distinct sub-exercises, which are described in detail in the following two subsections.

3.4.2.2.1 Simulated Live Bridget Experience

The first one of the two sub-exercises tested the functionalities implemented in the Player on a pre-selected programme, namely a portion of the second semi-final of the Eurovision Song Contest 2015, and simulating a Live broadcast case. The exercise execution is therefore supported by a staff person (the Bridget Publisher) in charge of controlling the timing of the appearance and disappearance of the relevant bridgets according to a predefined broadcast schedule. More in detail, in the exercise:

- The user launches the BRIDGET Application;
- The user selects and watches a Live TV Programme (Eurovision Song Contest 2015 - Semifinal) from the available live shows;
- The BRIDGET Application periodically polls the Bridget server to acquire knowledge about which bridgets are active;
- The Bridget Publisher activates the appropriate bridgets at the right time of the show, following a pre-defined schedule;
- The BRIDGET Application displays notifications whenever a new bridget is activated by the Bridget Publisher, and presents the related icon;
- The user interacts with the bridget content (i.e. the bridgets and presentation information);
- The user consumes some destination content;
- Once the programme finishes, the user is presented with the list of all programme's bridgets so that he can enjoy any missed destination content that may be of interest, after the main programme.

3.4.2.2.2 Navigation in the 3D model

The second sub-exercise tested the navigation of the reconstructed 3D model of Palazzo Carignano, in the context of a touristic application. In this case, the classical fingerprint-based synchronisation mechanism was used to trigger the synchronisation between a video clip depicting Turin monuments and an interactive map of the city where each bridget represented one monument. More specifically:

- The user selects and watches a recorded TV Programme;
- The BRIDGET Application recognises the Programme. The objective is to start synchronisation. This is done through the Synchroniser;
- The BRIDGET Application downloads the associated content;
- The BRIDGET Application records the audio track, extracts audio signatures and matches with the ones that are related to the associated content available locally or remotely. The objective is to keep synchronisation to ensure a timely presentation of bridget information and related destination content. This is done through the Synchroniser;

- The Bridget Player displays notifications whenever a match is confirmed, thus presenting bridgets. This is done through the Synchroniser;
- The user interacts with the bridget content (i.e. the bridgets and presentation information);
- The user consumes some destination content until the bridget depicting Palazzo Carignano is notified;
- The user opens the bridget depicting Palazzo Carignano, selects the corresponding 3D model and starts experiencing it;
- Once the programme finishes, the user is presented with the list of all programme bridgets so that he can enjoy any missed destination content of interest.

3.4.2.2.3 Free experience

Field trials in Madrid, Paris and Guildford were basically free hands-on trials of the application followed by an online questionnaire. During each session of the trials, users were watching the main programme (Eurovision Song Contest 2015 – second semi-final), for the first few minutes and at the same time using the BRIDGET application freely exploring all available functionalities.

4 Feedback elements and factors

To test the Professional Authoring Tool, in both validation cycles, focus groups made up of different professionals involved in media production were selected, spanning in a number of different roles, all relevant to the objectives of the project. The approach to select the testers was based on an analysis of the professional skills needed to realise the final product (i.e., the second screen experience of the end-user environment) in the tested cases.

Professionals who tested the Professional Authoring Tool belonged to the following roles:

- Executive Producers
- Programme directors
- Assistant programme directors
- Assistant to programmes
- Graphic designers
- 3D Technology Experts
- Production Technology Experts

Feedback collected during the focus group formed as described above are summarised in Section 4.1 of this deliverable, with an in-depth analysis performed and reported in [3] and [10].

As to the BRIDGET Player Application a crucial step was first to understand the effectiveness of the mobile application provided to final end-users.

To accomplish this task, the mobile application, in both Version A and Version B, has been preliminarily tested by a team of experts, looking for major issues requiring modifications before being submitted to groups' participants.

The choice of which participant groups were most relevant for evaluating a new bridget service and the mobile app was based on the evidence concerning audiences most interested in the scenarios being tested by each focus group:

- Validation Cycle 1: Enhanced News and Crowd Journalism. For this case a group of retired workers (approximately aged 65) was selected;
- Validation Cycle 1: Edutainment. For this case a group of young parents (approximately aged 35) was selected;
- Validation Cycle 2: Simulated Live bridget experience and Navigation in 3D model. For this case a group of young students (approximately aged 18-20) and a group of adults (approximately 55-65).

All related scenarios are detailed in [4] and [9].

In both validation cycles two different focus group sessions took place separately, one for each group of participants; after these, feedback have been collected by consortium experts via individual interviews, providing the final report collecting the trends and the final qualitative assessment of the participants.

A summary of this feedback is presented in Section 4.2 of this deliverable and deeply reported and analysed in [3] and [10].

Finally, in the second validation cycle we also engaged in the experiment a real field trial, i.e. a distributed session in which users from different nations played with the application and gave their feedback through a simplified online questionnaire.

Table 1 summarises the number of users involved in each of the two validation cycles and per each trial modality.

Table 1. Summary of involved users.

| | First Validation Cycle | Second Validation Cycle | Total |
|----------------------------------|-------------------------------|--------------------------------|--------------|
| Professional Focus groups | 14 | 12 | 26 |
| End-user focus groups | 13 | 11 | 24 |
| Field trials | - | 86 | 86 |
| TOTAL | 27 | 109 | 136 |

4.1 Summary of Authoring tool feedback analyses

Concerning the Professional Authoring Tool trial, we can conclude that the functionalities presented in both validation cycles have been well received and considered generally well designed to fulfil the requirements of a hypothetical bridget creation workflow, in both the cases of pre-planned and live programmes. However, improvements are required in terms of content organisation, graphic layout and integration with existing enterprise services before thinking of an actual production phase. From the strategic perspective of utilisation of the tool in the context of a media company business process, although the idea of such a service has been acknowledged as valid, there is a clear indication that further study of the impact on existing production flows in terms of resources and integration of personnel skills needs to be carried out before service introduction.

Professionals expressed hesitation about the applicability of 3D reconstructions in production. While some of them acknowledge that this kind of media represents an interesting enrichment for some genres, others think that the achieved quality of the automated reconstructions is not yet sufficiently high to support real production work-flows, especially when compared with the current state of the art in gaming and virtual reality. Furthermore, the evaluation of individual reconstructions achieved by the two available reconstruction pipelines led to diverging results between the editorial and technical staff, indicating that the evaluation criteria and expectations of these two profiles are based on different considerations.

4.2 Summary of Player feedback analyses

4.2.1 Heuristic evaluation

The team of experts that pre-tested the Player application before user trials, with the focus to detect and remove deficiencies of the proposed solutions, gave also positive feedback. Indeed, from the functional point of view, the application achieves the task of accurately recognising the audio in the TV programme to deliver good bridget synchronisation, minimizing failures. However, from the interaction point of view

different issues have been raised and solved before the focus groups sessions of each of the two validation cycles. In particular, a shared framework for “bridged” programmes was initially missing a clear indications allowing users to understand how they can interact with the bridgeds.

Navigation issues were also identified together with the indication for the necessity to build specific and unified behaviours between programmes and to use more user-friendly feedback.

The amount of feedback received from the experts in the first validation cycle was considerably higher than the amount received in the second validation cycle, when the most critical issues in terms of interaction had been already solved. Nevertheless some specific improvements have been pointed out also in the second validation cycle, in the area of clarity of some interaction metaphors (buttons and navigation bars), user self-orientation in the application screens, and completeness of presented information.

4.2.2 Focus Groups

Once the BRIDGET Player Application has been improved, following the results of the heuristic evaluation phase for each of the two validation cycles, a couple of focus group sessions were organised. The general objective of these focus groups, shared across the two cycles, was to collect information about:

- how much the bridged¹ concept is perceived as useful, pleasant and could it satisfy users expectations in a real-life everyday use,
- what is the efficiency of the proposed solution, which aspects of the prototypes are easy to use and intuitive and which are not sufficiently clear for good user experience
- is the application perceived as innovative, and any suggestions of improvements that could help the application to better meet the users expectations

During both focus group sessions main characteristics of the bridged concept were presented and all application functionalities were analysed in detail from the real user’s point of view in order to get feedback and suggestions on the “ideal” BRIDGET Player Application.

To better evaluate the different solutions proposed by the project in each cycle, appropriate types of target groups have been involved. For example, the first focus group of the first validation cycle was carried out with parents of teenagers, and focussed on the Gulp Girl content, the second one with people aged over 60, on the TG1 and Porta a Porta content.

The first focus group of the second validation cycle was carried out with young students between 18 and 20, while the second one was carried out with elder adults beyond 55. This choice was guided by the measured age distribution for the audience for the selected content type (Eurovision Song Contest). Refer to [5] and [11] for an extended description of these cases.

4.2.2.1 First Validation Cycle

4.2.2.1.1 Parents of teenagers target

This focus group generated useful feedback and many interesting suggestions. The discussion about the behaviour and the interaction with the application led to the conclusion that the mechanism of audio-based programme recognition is considered a value, because of the innovative way of interaction but it is not displayed in an intuitive and clear manner. Participants would have desired different level of control on the activation of the application. The same lack of clarity has been identified in the bridged bubbles behaviour. Although if it was graphically appreciated, it was considered not completely clear and the group suggested to redefine its contextualization with the audio-based synchronisation mechanism.

Having different types of content as enrichments was appreciated, because these are graphically attractive and allow users to go deeply into the topic of the TV programme. Nevertheless in many cases displayed content has to be redefined both to avoid redundancy and for the way of interaction that

¹ Here and hereafter with *bridged* we intend the notion developed by the project of a link from a source content to a destination content.

sometimes is not completely clear. A lot of interest was noticed on the opportunities offered by the integration of the application with social pages, with specifics depending on the target and type of TV programme under augmentation.

Users involved in this focus group highlighted the importance of such a service in particular for the edutainment scenario, seen as something inspiring fruitful discussions and allowing people to share their opinions; for example the viewers could share receipts, solutions to problems or tips improving the depth of understanding of the TV programme is talking about.

According to this focus group the tested prototype performs well, the navigation is easy and the layout is nice.

In general, the feedback was positive and a shared feeling was that the concept of this application could be extended to many types of TV programmes and to different target groups, in particular scenarios related to educational TV programmes, shows containing manual activities and programmes with a lot of interaction with users such as quiz and game shows.

4.2.2.1.2 Retired workers target

The second focus group session involved similar analysis on two different kinds of programmes, namely TG1 and Porta a Porta.

The feedback about behaviour and interaction with the TG1 application revealed that the mechanism of audio-based recognition is considered of value, because it allows to activate the application quickly, that is what users actually mostly care about. From the graphical point of view, news the behaviour of new “bars” is appreciated and clear, because this metaphor is similar to the news caption. However the users note that there are some superfluous elements, for example too many “back” icons.

Users involved in the trail said that having enhanced content in such a programme is useful, also having different type of additional content like images is an attractive point, but they also suggested to have more content and more readable (e.g., wider fonts and higher contrast), with customizable graphic elements.

As to the Porta a Porta programme, users feedback about behaviour and interaction was that the bridget bubbles behaviour is graphically appreciated, but it is not completely clear, especially the availability of the bubbles at any particular moment in time - that needs to be more graphically diversified; indeed, during the session it was highlighted that the use of bridget bubbles on the right side of a content view was not clear to some participants.

Having varied types of augmentation content was really appreciated here, because it is graphically attractive and their presence allows the user to go deeply into the topic of the TV programme, but in many cases content has to be refined to avoid redundancy and to make the interaction available clear.

Users showed a lot of interest about social pages and external links, and thought the mode of interaction should be, based on the target audience and type of the TV programme.

4.2.2.2 Second Validation Cycle

During the second validation cycle in focus groups we decided to present the same exercise to the two different target audiences, young students and mature adults, in order to measure possible differences in the feedback from these two groups.

The expected dimensions underlying the differentiation were:

- to see if there were differences in the app evaluation between the two groups leaving unchanged the proposed stimuli;
- to understand if the UI was simple and effective for both young and adult groups;
- to collect some suggestions about the app and its evolution from people with different lifestyles and experiences.

However, the analysis of the resulting material (written comments, meeting interaction, oral feedback) gave indication that only few minor differences have been observed between the two groups, their feedback and evaluation of the app was very similar. In summary:

- most of the participants of the two focus groups considered the app concept very interesting and virtually useful in the daily life;
- most of the participants of the two focus groups detected some usability issues that should be solved in the final version of the app;
- some contents and some sections of the app were most successful than others.

Table 2 summarises the key findings. More analytics are presented in [10] .

Table 2. Summary of focus groups key findings.

| | Concept | Features | Usability | Layout |
|--|--|---|--|---|
| Simulated Live Bridget Experience | People like this concept | <p>People like to have a second screen app on this kind of content</p> <p>People like the synchronization mechanism</p> | Some usability issues have been detected | The layouts of the app aren't all well structured |
| Navigation in 3D model | People like very much this concept but this 3D applications could distract people from the TV show | People like very much the 3D feature | Some usability issues have been detected | Some graphic issues have been detected |

All the participants thought that this kind of application is appropriate in some types of tv shows, such as reality shows, contests and talk shows while is less appropriate for movies and TV series. Furthermore the app should show less intrusive types of information, but let people go deeper if and when they wished, maybe with external links to all types of multimedia content available.

The app presents a lot of strength points such as: a) synchronization with the TV show; type of presented contents; the bridgets feature. However, before a market launch it is mandatory to solve some serious usability issues, such as: a) clarity of buttons, labels, titles and captions; b) the screens layout; and c) the appearance of graphics.

4.2.2.2.1 Field trials testers

As planned, during the second validation cycle a field trial session has been organised and run across Europe at some of the partners' offices, namely in Madrid, Paris and Guildford. The idea was to enlarge the panel of users to cover a wider variety of nationalities, and thus to sample a more diverse cultural background of testers, as well as to increment the number of young testers, nominally the main target of a BRIDGET-like service. The analysis conducted on the gathered data allows to conclude that:

- The testers generally appreciated the application and are very interested in this kind of services;
- The application is considered useful and entertaining and help better understand and contextualise the main programme;
- Some technical issues and the graphical design of the application have a negative impact on the evaluation, regardless the attractiveness and relevance of presented content;
- The fundamental idea of synchronisation between the main and the second screen content is highly appreciated, however some testers would prefer bridgets to remain always active even after their planned scope.

Table 3 reports the age distribution of the 86 testers. Figure 4 reports the distribution of professions. Figure 5 reports the distribution of the overall appreciation of the app. More in-depth analyses are reported in [10].

Table 3. Distribution of age for the field trials testers.

| Under 18 | 18-25 | 26-35 | 36-55 | Over 56 |
|----------|-------|-------|-------|---------|
| 1 | 45 | 30 | 9 | 1 |

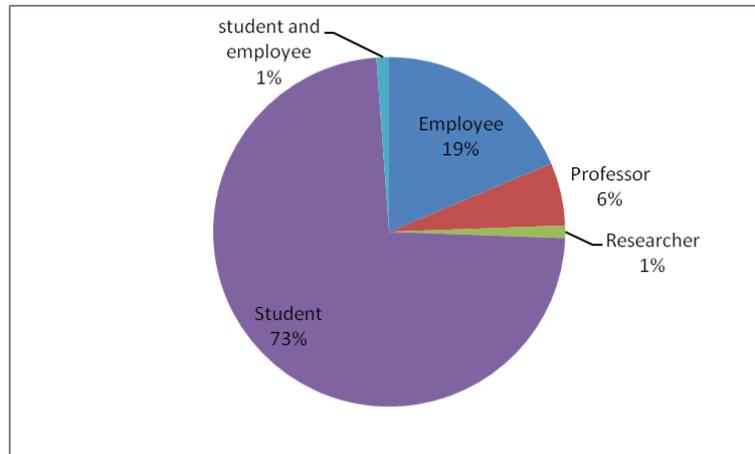


Figure 4. Testers profession.

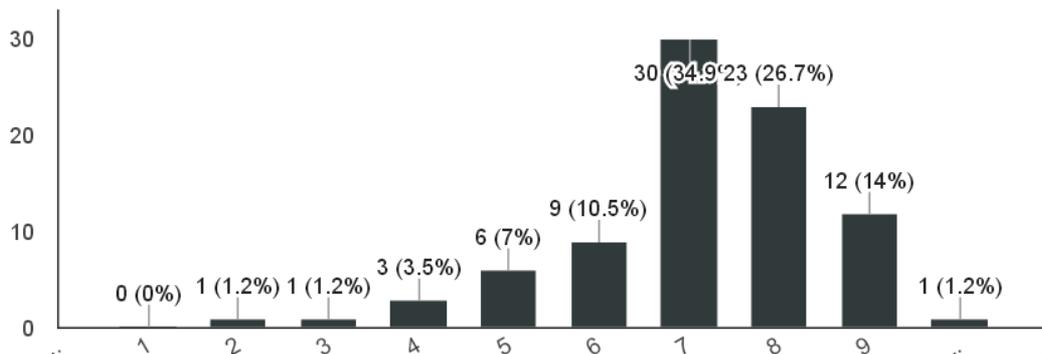


Figure 5. Distribution of appreciation score ("I like the app").

4.3 Extracted design guidelines

Taking into account users' feedback on the Professional Authoring Tool and the BRIDGET Player Application side, presented in depth in [3] and [10], a list of design guidelines was extracted and is presented in the following subsections. The purpose of these guidelines was initially to provide a parallel input from the point of view of users to the second cycle design of the applications. As a final output of the validation work, these guidelines present suggestions on how to further improve the functionality of the two applications, under the assumption of setting up a real service.

4.3.1 Professional Authoring Tool

The following guidelines were derived from the analysis of the Professional Authoring Tool feedback:

- Improve integration with enterprise content management systems, even if at an experimental stage
- Improve the organisation of content available to the authoring tool user
- Include the possibility to refer to segments of ingested programmes as potential destination content for other source programmes
- Include the possibility to reuse bridglets across programmes (e.g., episodes of a series)
- Improve the number and quality of layout options (layout templates) and add all relevant content parametrisation options (e.g., how/if to scale images)
- Define and implement a full layered model in the tool, by which users with different roles and authorisation level interact in a typical production workflow
- Include some level of rights clearance functionality for destination content
- Enlarge the content types available as destination content selectable and configurable from the authoring tool, e.g. text areas, interactive elements, links
- Improve the control of live bridglet publication by including more levels of authorisation before the actual publication

4.3.2 BRIDGET Player Application

The following guidelines were derived from the analysis of the BRIDGET Player Application feedback:

- Redesign the logic of the application start by:
 - Include the possibility for the user to configure the behaviour of the engagement depending on the specific programme/series
 - Consider embedding the BRIDGET app in the main broadcaster mobile application and not as a separate and independent app
- Graphically redesign the different statuses of bridglet content, based on the bubbles (or news bars) metaphor, in order to differentiate between content active in a specific moment of the TV programme but not yet visited and content already visited
- Regarding content not yet available, it is better not to display it to users or to show it with an advise that this content will be available soon
- Design an app with some educational content associated linked to a how-to-do-what TV programme types, and test with end user (e.g. young target)
- Design a different architecture and navigation for news content, based on design requirements specific to elderly people
- Try to explore different scenarios involving users in design sessions
- Reconsider the possibility to make bridglets available for browsing after their temporal scope expired
- Take much care about the quality and completeness of presented enrichment content and of the graphical corresponding representation
- Stick with existing reference paradigms for the interaction objects (buttons, navigation bars, links to social media)
- Consider user profile in the design of the presentation and in the features of imagery and textual content, especially for what concerns readability and visual contrast.

5 Conclusions

This deliverable presented a high level global description of the methodology used to design and execute the user validation trials of the technologies and tools developed by the project and a summary of the main findings. With a general project organisation subdivided into two consecutive validation cycles during the project lifetime, the approach started from the breakdown analysis of the domain use cases (authoring and end user) and the selection of the functionalities to test, followed by the assessment of which requirements from the complete list have been actually trialled. The trials have been organised in form of guided exercises, which have been executed by appropriate panels of users, and of a final field trial session. The results of the trials can be considered satisfactory for the project's objectives and scale.

From the output of the first validation cycle it was possible to derive a first set of guidelines for both usage domains for the development of the second cycle. The output of the second validation cycle, integrated with the former output, represents a comprehensive feedback, from the user's perspective, of how the resulting BRIDGET system should evolve beyond the lifetime of the project to meet the requirements of a real service.

6 References

- [1] BRIDGET Deliverable D8.1 – “Proof-of-Concept Prototypes Specification – Version A”, March 2014.
- [2] BRIDGET Deliverable D2.2.1 Rev0.3 – “Requirements and Functionalities - Version A (revised version)”, January 2015.
- [3] BRIDGET Deliverable D8.5 – “User Trials and Feedback Analysis - Version A”, November 2015.
- [4] BRIDGET Deliverable D2.1 – “First BRIDGET workshop and use scenarios – Version A”, January 2014.
- [5] BRIDGET Deliverable D8.2, “Validation Framework - Version A”, June 2015.
- [6] BRIDGET Deliverable D2.3. "User Validation – Version A", September 2015.
- [7] BRIDGET Deliverable D8.6, "Proof of Concept Prototype Specification – Version B", January 2016.
- [8] BRIDGET Deliverable D2.5, "Requirements and Functionalities – Version B", December 2015.
- [9] BRIDGET Deliverable D2.4, "Second BRIDGET Workshop and Usage Scenarios", November 2015.
- [10] BRIDGET Deliverable D8.10 – "User Trials and Feedback Analysis – Version B", October 2016.
- [11] BRIDGET Deliverable D8.9, "Testing Guidelines – Version B", September 2016.
- [12] BRIDGET Deliverable D8.7, "Validation Framework – Version B", July 2016.
- [13] BRIDGET Deliverable D8.3, "Material Library and Ground truth – Version A", June 2015.
- [14] BRUDGET Deliverable, D8.8, "Material Library and Ground Truth – Version B", June 2016.

7 Acknowledgements

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Appendix A. Analysis of trialled requirements

User requirements

Notice: in this section the word “user” indicates the appropriate type of BRIDGET user for each scenario: bridget editor or end user playing bridgets and/or destination content. Green background rows indicate requirements that have been considered in the second cycle of validation. The Level column in all tables indicates if the corresponding requirement has been fully tested (F), partially tested (P), only integrated in the trials PoC but not tested (I), or not integrated in the trials PoC (N).

Italic and normal face fonts in the requirements row have the same meaning as in [8] , i.e. requirements expressed in normal font have been implemented in a basic form in the PoC, while requirements in *italic font* are considered mandatory for a commercial service but are not implemented in BRIDGET.

I. Bridget Creation

This section collects requirements on how users create bridgets.

Table 4 - Bridget creation user requirements

| Req. ID | Name | Description | Level |
|---------|------------------------------------|---|-------|
| UBC1 | Content link | The user shall be able to create a bridget linking destination content to a programme. | F |
| UBC1.1 | Live content link | The user shall be able to create bridgets linking destination content to a live programme before its actual broadcast | P |
| UBC2 | Stored content | The user shall be able to create bridgets for stored programmes. | F |
| UBC3 | Live content | The user shall be able to create bridgets for live programmes. | I |
| UBC3.1 | Live bridget authoring | The user shall be able to associate an authoring status to a bridget associated to a live programme. Examples of authoring status are: draft, inactive, active, authorised, published | P |
| UBC3.2 | Live bridget publication | The user shall be able to enable / disable bridget and to modify their order, duration and start point during a live programme | F |
| UBC4 | Bridget association – time-aligned | The user shall be able to associate one or more bridgets to a defined interval in the timeline of the programme (time-aligned bridget). | F |
| UBC5 | Bridget association – global | The user shall be able to associate one or more bridgets to the entire duration of the programme (global bridget). | F |
| UBC6 | Bridget made global | The user shall be able to transform, media time-aligned bridgets into global bridgets. | F |
| UBC7 | Bridget reuse | The user shall be able to store, retrieve and reuse the bridgets previously associated to a different programme. | N |

| Req. ID | Name | Description | Level |
|---------|--|--|-------|
| UBC8 | Time-aligned bridget points candidates | The user shall be able to retrieve a list of manually and automatically generated candidate media time/space points or segments for bridget insertion. | F |
| UBC9 | Destination content candidates | The user shall be able to retrieve a list of manually and automatically generated candidate destination content for a programme segment. | F |
| UBC10 | Destination content | The user shall be able to create a bridget whose destination content is a 2D audiovisual content or a 3D model of a scene including 3D visual objects, 3D Audio objects or both. | P |
| UBC11 | Bridget information creation | The user shall be able to edit a bridget, following a defined bridget representation structure. | I |

II. Bridget Access

This section collects requirements on how users access bridgets.

Table 5 - Bridget access user requirements

| Req. ID | Name | Description | Level |
|---------|------------------------------------|--|-------|
| UBA1 | Devices for bridget access | The user shall be able to access bridgets and corresponding content using a device (e.g. a companion screen device). | F |
| UBA2 | Bridget retrieval | The user shall be able to retrieve bridgets based on the identification of the programme and of the media time point being watched on the main screen. | F |
| UBA3 | Retrieval of remote bridgets | The user shall be able to retrieve bridgets from the Internet. | F |
| UBA4 | Synchronised access & presentation | The user shall be able to access and present bridgets synchronised with the programme displayed on the main screen. | F |
| UBA5 | Synchronisation independence | The user shall be able to access synchronised bridgets independently from the broadcast network (e.g. DVB-T/S/C or the internet) used to receive the programme | F |
| UBA6 | Recording support | The user may be able to access synchronised bridgets from a programme previously recorded using a PVR or Network PVR. | F |

III. Bridget Search

This section collects requirements on how users search bridgets and related content

Table 6 - Bridget search user requirements

| Req. ID | Name | Description | Level |
|---------|---------------------------------|---|-------|
| UBS1 | Bridget Search | The user shall be able to search and retrieve bridgets using metadata. | F |
| UBS2 | Content Search – production | The user shall be able to search and retrieve media content similar or related to a segment of the programme. | F |
| UBS5 | Content search – metadata | The user shall be able to search for similar or related content using metadata. | F |
| UBS6 | Content search – visual queries | The user shall be able to search for similar content through visual queries. | N |

IV. Bridget Presentation

This section includes requirements on how bridgets are presented to users for navigation and selection.

Table 7 - Bridget presentation user requirements

| Req. ID | Name | Description | Level |
|---------|--|---|-------|
| UBP1 | Presentation of in scope time-aligned bridgets | The user shall be able to view a presentation of the bridgets according to their temporal scope on the media time interval of the programme. | F |
| UBP2 | Presentation of out of scope time-aligned bridgets | The user may be able to view a presentation of associated time-aligned bridgets after their temporal scope of the media time interval of the programme. | F |
| UBP3 | Presentation of bridgets or groups of bridgets | The user shall be able to decide the visual presentation of bridgets or groups of bridgets. | P |
| UBP4 | Presentation of global bridgets | The user shall be able to view a presentation of global bridgets associated with a programme. | F |
| UBP5 | Bridget presentation resources | The user shall be able to define how to notify the availability of bridgets using different media resources such as icons, images, text, video, and audio for appropriate presentation. | P |
| UBP6 | Bridget notification | The user shall be able to enable and disable the notification of available active bridgets on the second screen at any time (for both media-time aligned and global bridgets). | N |
| UBP7 | Multiple bridget notifications | The user shall be able to receive notifications of more than one available bridget at the same time. | F |

| | | | |
|-------|--------------------------------|---|---|
| UBP8 | Filter & Selection – manual | The user shall be able to filter and select presented bridgets manually. | F |
| UBP9 | Presentation preferences | The user shall be able to set and update preferences concerning bridgets presentation (e.g. preferred kind of content: 2D video, 3D model, etc...). | N |
| UBP10 | Filter & Selection – automatic | The user may be able to filter and select presented bridgets automatically based on preferences. | N |

V. Bridget Consumption

This section includes requirements on how users consume bridgets.

Table 8 - Bridget consumption user requirements

| Req. ID | Name | Description | Level |
|---------|----------------------------|---|-------|
| UBU1 | Bridget consumption | The user shall be able to consume available bridgets (i.e. bridget presented to the user) and corresponding destination content on the second screen. | F |
| UBU2 | Global bridget consumption | The user shall be able to consume a global bridget and corresponding destination content at any time during the associated programme. | F |
| UBU3 | Independent consumption | The user shall be able consume bridgets and corresponding destination content without interrupting the programme on the main screen. | F |

VI. 3D Object Creation

This section collects requirements on how users create 3D objects.

Table 9 - 3D object creation user requirements

| Req. ID | Name | Description | Level |
|---------|---|--|-------|
| U3C1 | 3D reconstruction | The user shall be able to create a 3D model representation reconstructed from a set of videos or images. | F |
| U3C2 | Candidate selection for reconstruction. | The user shall be able to enable manual and automatic selection of content items for 3D reconstruction. | N |
| U3C3 | Initial 3D reconstruction | The user shall be able to request the 3D reconstruction engine to generate a coarse 3D scene geometry. | F |
| U3C4 | 3D reconstruction | The user shall be able to request the 3D reconstruction engine to refine the 3D scene | I |

| Req. ID | Name | Description | Level |
|---------|------------------|---|-------|
| | refinement | geometry with new images and videos of the scene. | |
| U3C5 | 3D input content | The user shall be able to provide 3D content to the 3D reconstruction engine in order to either generate a coarse, initial 3D model of a real scene or refine an already existing 3D model. | N |

VII. 3D Object presentation

This section includes requirements on how 2D views from 3D objects are presented to users

Table 10 - 3D object presentation user requirements

| Req. ID | Name | Description | Level |
|---------|--------------------------|--|-------|
| U3P1 | Viewpoint rendering | The user shall be able to request 2D views from the reconstructed 3D scene model at original viewing positions. | N |
| U3P2 | Viewpoint navigation | The user shall be able to request 2D views from the reconstructed 3D scene model at intermediate viewing positions, to allow navigation inside/around the model | N |
| U3P3 | Device independence | The user shall be able to view [almost] identical 2D images on devices with different capabilities, e.g. HW-based acceleration for 3D graphics, although the result may be obtained with very different response times or frame rates. | I |
| U3P4 | 3D audio rendering | The user shall be able to listen to 3D spatial audio through headphones. | N |
| U3P5 | 3D audio navigation | The user shall be able to listen to 3D spatial audio adapted to the virtual position selected through the user interface. | N |
| U3P6 | 3D audio/video rendering | The user shall be able to view 2D views at intermediate viewpoints synchronised with the spatial audio rendered according to the corresponding position. | N |

Requirements of Applications

This section provides the detailed functionalities required by the BRIDGET Professional Authoring Tool and by the Player that have been developed during the entire lifetime of the Project (and culminating in Version B), and that have been considered in the trials.

VIII. Professional Authoring Tool

Table 11 - Professional Authoring Tool functional requirements

| Professional | Description | Level |
|--------------|-------------|-------|
|--------------|-------------|-------|

| | Authoring Tool functionalities | | |
|-------|--|--|---|
| | Bridget Representation | | |
| FBR3 | Bridget source programme | The bridget format shall allow specification of the associated source programme. | I |
| FBR5 | Bridget types | The bridget format shall allow specification of whether the bridget is associated to a specific time interval of the programme (time-aligned) or to the entire programme (global). | I |
| FBR6 | Bridget destination content | The bridget format shall allow specification of one destination content item. | I |
| FBR7 | Bridget destination content types | The bridget format shall allow specification of audiovisual, audio, 3D video, 3D audio, or 3D video/audio scenes as destination content. | I |
| FBR8 | Bridget extended destination content types | The bridget format may allow specification of any kind of media or combination thereof as destination content (e.g. images, text, web pages, etc...). | I |
| FBR9 | Bridget destination content description | The bridget format shall support inclusion of descriptions related to the destination content (e.g. content type, media duration, MIME type, file size, etc...). | I |
| FBR10 | Bridget multiple sources for destination content | The bridget format shall support inclusion of a list of alternative sources for the destination content. | I |
| FBR11 | Bridget default icon | The bridget format shall allow the definition of a default icon or image that can be used to visually present the bridget to the user. | I |
| FBR15 | Bridget modifications | The bridget format shall allow modification of all its representation data values excluding those related to identification. | I |
| | Content and Bridget Management | | |
| FCM1 | Content ingestion | The content management system shall allow media content ingestion and storage in content repositories. | I |
| FCM2 | Content types | The content management system shall support the following media types: images, audiovisual content, audio content, and 3D models. | I |
| FCM3 | Content | The content management system shall allow storage of | I |

| | | | |
|------|--|--|---|
| | metadata | metadata and annotations related to content. | |
| FCM4 | Content removal | The content management system shall allow deletion of content and related metadata and annotations from a content repository. | I |
| FCM5 | Content publishing | The content management system shall allow publication of content available on a content repository to the Internet. | I |
| FCM7 | Indexed Content | The content repository shall maintain a list of indexed content. | |
| | Synchronisation | | |
| FSY1 | Synchronisation presentation delay | The synchronisation tool shall allow bridget presentation, synchronised to a point in the media timeline of a programme, with a maximum delay of 5s. | P |
| FSY2 | Detection accuracy | The synchronisation tool shall be able to identify the programme watched and the relative point in the media timeline with a temporal detection accuracy comparable to the average length of the visual shots. | P |
| FSY3 | Bridget identification | The synchronisation tool shall be able to identify the bridgets to retrieve and present at specific points in the media timeline of a programme. | F |
| FSY4 | Programme media time identification | The synchronisation tool shall be able to retrieve the media time from the main programme at specific points in time. | F |
| FSY5 | Independence from main screen interactions | The synchronisation tool shall be able to synchronise the presentation of a bridget to a programme without any interaction with the main screen (e.g. using audio and/or video fingerprinting mechanisms). | F |
| FSY6 | Automatic synchronisation | The synchronisation tool shall be able to identify and retrieve synchronisation information automatically from the programme stream (i.e. without the intervention of the user). | F |
| FSY7 | Synchronisation information production | The synchronisation tool shall be able to create synchronisation information from a segment of a programme. | F |
| | Content Access | | |
| FCA1 | Content delivery | The content access system shall support access to content delivered through HTTP <i>and HTTP adaptive streaming</i> . | F |
| FCA3 | CDN | The content access system shall be able to access content delivered through a Content Delivery Network (CDN). | N |

| | | | |
|-------|--|--|---|
| FCA4 | Bridget delivery | The content access system shall support access to bridgets delivered through HTTP. | F |
| | Media Analysis Tools | | |
| FMA1 | Multiple content types | The media analysis tools shall be able to process audiovisual content comprising images and/or video and/or <i>audio</i> . | I |
| FMA2 | Coding independence | The media analysis tools shall be able to process audiovisual content independently of the content coding format. | I |
| FMA3 | Coding awareness | The media analysis tools may be able to process audiovisual content according to specific content coding formats, but shall produce comparable results to the media analysis tools which are able to process audiovisual content independently of the content coding format. | I |
| FMA4 | Content duration independence | The media analysis tools shall be able to process audiovisual content of arbitrary duration. | I |
| FMA5 | Content modification robustness | The media analysis tools shall be robust to audiovisual content modifications comprising temporal resampling, spatial resampling, spatial aspect ratio changes, A/D conversion, and I/P conversion. | I |
| FMA6 | Content description self-containment | The media analysis tools shall provide audiovisual content descriptions which are self-contained, in that their use does not require the audiovisual content from which they were generated. | I |
| FMA7 | Content non-alteration | The media analysis tools shall leave the audiovisual content on which they operate unaltered. | I |
| FMA8 | Real-time content description extraction | The media analysis tools shall be able to generate audiovisual content descriptions in real time or near-real-time. | P |
| FMA9 | Faster than real-time content description extraction | The media analysis tools may be able to generate audiovisual content descriptions at very high speeds, far exceeding real time, but shall produce comparable results to the media analysis tools which are able to generate audiovisual content descriptions in real time. | P |
| FMA10 | On-the-fly content description extraction | The media analysis tools may be able to generate audiovisual content descriptions on the fly, processing video and audio only in a small temporal window around the current media time. | I |
| FMA11 | Low-level structural segmentation | The media structure analysis tools shall be able to provide a shot-level temporal segmentation and keyframe representation of audiovisual content. | F |

| | | | |
|-----------|--|---|---|
| FMA1 7 | Fast filtering/ search | It shall be possible to perform faster than real-time filtering / search of audiovisual content using the descriptions provided by the media annotation tools | N |
| FMA1 8 | Unambiguous content description syntax | The media analysis tools shall present the content description they generate to the rest of the system in an unambiguous format, namely AVDP. | I |
| | Search Tools | | |
| FST1 | Visual search in image library | The visual search engine shall support visual search in a pre-indexed image library based on a query image. | N |
| FST3 | Visual search in video library utilising video key frames | The visual search engine shall support visual search in a pre-indexed video library based on a query image. Search and access points are restricted to video key-frames. | F |
| FST5 | Off-line indexing of image library | The visual indexing engine shall support off-line creation of a database/index for a library of image resources. | I |
| FST6 | Off-line indexing of video library based on video key-frames | The visual indexing engine shall support off-line creation of a database/index for a library of video resources where search and access points are restricted to video key-frames. | I |
| FST7 | Ranking of the search results based on matching confidence | The visual search engine shall support ranking of the search results based on match confidence. | F |
| FST9 | Multiple content types | The visual search and indexing engines shall be able to process audiovisual content comprising images <i>and/or</i> video. | I |
| FST1 0 | Coding independence | The visual search and indexing engines shall be able to process audiovisual content independently of the content coding format. | I |
| FST1 1 | Content modification robustness | The visual search and indexing engines shall support visual search to be robust to audiovisual content modifications such as temporal resampling, spatial resampling, spatial aspect ratio changes, A/D conversion, and I/P conversion. | I |
| FST1 2 | Robustness to visual deformations | The visual search and indexing engine shall support visual search that is robust to viewing aspect, illumination changes, partial occlusion and similar artefacts. | I |
| FST1 3 | Content description self-containment | The visual search and indexing engines shall derive and use content descriptions which are self-contained, in that their use does not require the access to the content | I |

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| | | from which they were generated. | |
| FST1 4 | Content non-alteration | The visual search and indexing engines shall leave the audiovisual content from which they were derived unaltered. | I |
| FST1 5 | Integration with content-based search | The visual search and indexing engines shall execute queries based on content input by the user. | N |
| | 3D Tools | | |
| F3T1 | Feature point extraction | The feature point extraction tool shall extract a set of robust feature points in several images corresponding to the same 3D scene. | I |
| F3T2 | Generation of matching pairs | The generation of matching pairs tool shall identify pairs of 2D points in different images known to correspond to the same 3D point in the related 3D scene. | I |
| F3T3 | Camera calibration | The camera calibration tool shall provide both, the intrinsic and extrinsic parameters of the user's camera used to capture particular pictures. | I |
| F3T4 | Reconstruction of isolated 3D point locations | The reconstruction of isolated 3D point locations tool shall provide sets of reconstructed isolated 3D points. | I |
| F3T5 | Dense mesh reconstruction | The dense mesh reconstruction tool shall create a dense 3D reconstruction starting from a sparse representation. | I |
| F3T6 | 3D model update | The 3D model update tool shall be able to update a pre-computed 3D model by adding additional images/videos. | I |
| F3T7 | 3D model rendering | The 3D engine shall be able to render a 3D model through a sparse representation (e.g. point clouds) or dense representation (e.g. meshes). | F |
| F3T8 | 3D viewpoint synthesis | The 3D engine shall be able, starting from a 3D model of a scene, to create a synthetic 2D view of that scene from any possible viewpoint. | N |
| F3T9 | 3D model coding | The 3D model coding tool shall be able to <i>efficiently</i> compress/decompress sparse/dense 3D model representations. | N |
| F3T1 0 | Audio scene modelling | The audio scene modelling tool shall be able to generate a description of the position of the acoustic sources <i>and acoustic properties</i> of a 3D scene. | N |
| | Application-related Presentation | | |

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| FAP1 | Bridget presentation | The presentation system shall present time-aligned and global bridgets associated with a programme using the information provided by the synchronisation system. | F |
| FAP2 | Multiple bridgets presentation | The presentation system shall be able to present more than one bridget at the same time. | F |
| FAP7 | Content presentation | The presentation system shall be able to decode and render destination content linked by a bridget. | F |
| FAP9 | Search results presentation | The presentation system shall provide at least one way to present the content or the bridgets provided by the Search tools. | F |
| FAP10 | Multi-view scene on-line reconstruction | The presentation system shall provide scene rendering and reconstruction methods. | F |
| FAP11 | 3D model rendering – sparse | The presentation system shall be able to render 3D models through a sparse representation (e.g. point clouds) using the 3D engine. | F |
| FAP12 | 3D model rendering – dense | The presentation system shall be able to render 3D models through dense representation (e.g. meshes) using the 3D engine. | F |
| FAP13 | Binaural audio rendering | The presentation system shall be able to render audio tracks binaurally. | N |

IX. Player

Table 12 - Player functional requirements

| | Player functionalities | Description | Level |
|------|-----------------------------------|--|-------|
| | Bridget Representation | | |
| FBR3 | Bridget source programme | The bridget format shall allow specification of the associated source programme. | I |
| FBR5 | Bridget types | The bridget format shall allow specification of whether the bridget is associated to a specific time interval of the programme (time-aligned) or to the entire programme (global). | I |
| FBR6 | Bridget destination content | The bridget format shall allow specification of one destination content item. | I |
| FBR7 | Bridget destination content types | The bridget format shall allow specification of audiovisual, audio, 3D video, 3D audio, or 3D video/audio scenes as destination content. | I |
| FBR8 | Bridget extended | The bridget format may allow specification of any kind of media or combination thereof as destination content | I |

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| | destination content types | (e.g. images, text, web pages, etc...). | |
| FBR9 | Bridget destination content description | The bridget format shall support inclusion of descriptions related to the destination content (e.g. content type, media duration, MIME type, file size, etc...). | I |
| FBR10 | Bridget multiple sources for destination content | The bridget format shall support inclusion of a list of alternative sources for the destination content. | I |
| FBR11 | Bridget default icon | The bridget format shall allow the definition of a default icon or image that can be used to visually present the bridget to the user. | I |
| | Synchronisation | | |
| FSY1 | Synchronisation presentation delay | The synchronisation tool shall allow bridget presentation, synchronised to a point in the media timeline of a programme, with a maximum delay of 5s. | P |
| FSY2 | Detection accuracy | The synchronisation tool shall be able to identify the programme watched and the relative point in the media timeline with a temporal detection accuracy comparable to the average length of the visual shots. | P |
| FSY3 | Bridget identification | The synchronisation tool shall be able to identify the bridgets to retrieve and present at specific points in the media timeline of a programme. | F |
| FSY4 | Programme media time identification | The synchronisation tool shall be able to retrieve the media time from the main programme at specific points in time. | F |
| FSY5 | Independence from main screen interactions | The synchronisation tool shall be able to synchronise the presentation of a bridget to a programme without any interaction with the main screen (e.g. using audio and/or video fingerprinting mechanisms). | F |
| FSY6 | Automatic synchronisation | The synchronisation tool shall be able to identify and retrieve synchronisation information automatically from the programme stream (i.e. without the intervention of the user). | F |
| FSY7 | Synchronisation information production | The synchronisation tool shall be able to create synchronisation information from a segment of a programme. | F |
| | Content Access | | |
| FCA1 | Content delivery | The content access system shall support access to content delivered through HTTP and HTTP adaptive streaming. | F |

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| FCA3 | CDN | The content access system shall be able to access content delivered through a Content Delivery Network (CDN). | N |
| FCA4 | Bridget delivery | The content access system shall support access to bridgets delivered through HTTP. | F |
| | 3D Tools | | |
| F3T7 | 3D model rendering | The 3D engine shall be able to render a 3D model through a sparse representation (e.g. point clouds) or dense representation (e.g. meshes). | N |
| F3T8 | 3D viewpoint synthesis | The 3D engine shall be able, starting from a 3D model of a scene, to create a synthetic 2D view of that scene from any possible viewpoint. | N |
| F3T9 | 3D model coding | The 3D model coding tool shall be able to <i>efficiently</i> compress/decompress sparse/dense 3D model representations. | N |
| F3T10 | Audio scene modelling | The audio scene modelling tool shall be able to generate a description of the position of the acoustic sources <i>and acoustic properties</i> of a 3D scene. | N |
| | Application-related Presentation | | |
| FAP1 | Bridget presentation | The presentation system shall present time-aligned and global bridgets associated with a programme using the information provided by the synchronisation system. | P |
| FAP2 | Multiple bridgets presentation | The presentation system shall be able to present more than one bridget at the same time. | P |
| FAP7 | Content presentation | The presentation system shall be able to decode and render destination content linked by a bridget. | P |
| FAP11 | 3D model rendering – sparse | The presentation system shall be able to render 3D models through a sparse representation (e.g. point clouds) using the 3D engine. | I |
| FAP12 | 3D model rendering – dense | The presentation system shall be able to render 3D models through dense representation (e.g. meshes) using the 3D engine. | F |
| FAP13 | Binaural audio rendering | The presentation system shall be able to render audio tracks binaurally. | N |

Appendix B.Partners List

| Nr. | Organisation name | Short name | Country |
|------------|---|-------------------|----------------|
| 1 | University of Surrey | UNIS | UK |
| 2 | CEDEO SAS di Chiariglione Leonardo e C. | CED | IT |
| 3 | Fraunhofer Gesellschaft zur Foerderung der Angewandten Forschung E.V. | FHG | DE |
| 4 | Huawei Technologies Düsseldorf GmbH | HUA | DE |
| 5 | Institut Mines-Télécom | IMT | FR |
| 6 | RAI – Radiotelevisione Italiana | RAI | IT |
| 7 | Telecom Italia S.p.A. | TI | IT |
| 8 | Universidad Politécnica de Madrid | UPM | ES |
| 9 | Visual Atoms | VA | UK |