EXPERIMEDIA

D2.1.2

First Scenarios and Requirements

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This deliverable provides an early first iteration on the Scenarios informing the EXPERIMEDIA project, and the Requirements we derive from them. The document provides the EXPERIMEDIA developers will an initial set of functionalities expected to be supported by the facility during the connectivity phase, to be included in the V1.0 release. The document further develops the needs of the three driving scenarios of (live and augmented, live and 3D, and live and online) along with technologies and working practices necessary to support the experimental lifecycle. The document considers the implications of the initial results of methodology D2.1.1 and provides initial requirements for security and data protection from WP5.

SEVENTH FRAMEWORK PROGRAMME

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v1.0	First release
v1.01	Broken reference fixed
v1.02	Updated front page and meta-data table; added conclusion

Table of Contents

1. Executive Summary

This document is the EXPERIMEDIA Deliverable 2.1.2 “1st Requirements and Scenarios”. It provides a description and discussion of the software Requirements that will drive the project's 1st year development activities, of the Scenarios that motivate these Requirements and form the conceptual framework for the 1st year’s development activities, and discussion of related matters.

Section 2 provides a general introductory discussion of this Deliverable. Of particular importance are the constraints facing the current version of this document, and the consortium's scheduled improvements, which will result in future Deliverables 2.1.5 “2nd Requirements and Scenarios” and 2.1.8 “Final Requirements and Scenarios”.

Section 3 describes the project's global-scope Motivating Scenarios and Experiments, which are the high-level conceptualisation of potential use to which the EXPERIMEDIA Facility will be put. This conceptualisation drives and motivates the project in general, but is not specific enough to derive concrete Requirements, and later a specific architecture. Also, these Scenarios will inform the future Open Calls, so that the Open Call Experiments are influenced by the vision laid out in this section (as opposed to simply extending the ideas of Section 4).

Section 4 describes the project's Embedded Experiments, the specific, concrete experiments that will be conducted in the 1st year of the project. These are still "scenarios" here, but they are "actionable", i.e., they are ready for the project to base its next activities upon them. The Requirements in Section 6 are derived from these Embedded Experiments and the more general scenarios of the previous Section. The experiments in Activity 4 will also be based on these descriptions.

Section 5 describes the technologies provided to the EXPERIMEDIA Facility by the project's technical partners. The choices represented by this section have been shaped by the Venue partners' interests in using the EXPERIMEDIA Facility, and by the general vision of the project as represented in Section 3. However, these choices are also pragmatically based on the actual capabilities of the partners making each contribution. This section provides the general vision and conceptualisation of the project's technologies, which informs the specific choices of Requirements in Section 6.

Section 6 provides a list of tabulated Requirements. These are the specific software requirements which the first iteration of developing the EXPERIMEDIA facility aims to support. The Requirements have been derived from Sections 4 and 5, which provide user point of view and technical point of view contexts for them, respectively. The immediately following work of the project in Task 2.1.3, "Blueprint Architecture", will be based on these Requirements.

2. Introduction

This document is the EXPERIMEDIA Deliverable 2.1.2 "1st Requirements and Scenarios". In this introduction, we first provide an overview the role of the deliverable, throughout its lifetime, in the project. Then we focus on the contribution of the current, first iteration of the deliverable.

We also note the following technicality. This document necessarily refers back to the main document originally describing the EXPERIMEDIA project, the EXPERIMEDIA Description of Work (DoW), when discussing the organisational aspects of the project (e.g. in various sections, we say "this material will be used later in the project in" ... "Driving Experiment 1" or "Workpackage 4"). However, the DoW is not a publicly available document. Therefore, in the Appendix, we provide an outline of the project's organisational structure, for the general reader to be able to fully understand the current text.

2.1. EXPERIMEDIA Scenarios and Requirements - all versions

The EXPERIMEDIA project aims to provide a Facility to enable large-scale, realistic experimentation in the area of the Future Media Internet. EXPERIMEDIA lays the groundwork for future experiments by providing them with

- A technological platform
- Venues where experiments can be hosted; the Venues
    - can deploy the platform for the purposes of experiments
    - possess experience in conducting experiments using this platform
    - can bring users for participation in experiment
- Easy access to users who will take part in the experiment (within strict ethical and legal guidelines)
    - the Venues themselves (as noted above) can bring users to the experiment
    - integration with Living Labs efforts as a valuable source for additional users
    - the experimenters themselves
- Methodological support for planning and carrying out experiments (see D2.1.1 for details)

In this Deliverable (all versions), we present practical Scenarios according to which this facility can be designed, implemented, tested and used. From the Scenarios, we derive specific Requirements for the EXPERIMEDIA Facility. The purpose of the Deliverable is to provide a starting point from which further work of the project progresses. Most prominent amongst the further work which is immediately dependent on this Deliverable are:

- Task 2.1.3, Blueprint Architecture

  - In order to design an Architecture for the EXPERIMEDIA Facility, we need to have an intuition about how it will be employed (the Scenarios) and specific guidelines as to its objectives and constraints (the Requirements)

- Work Package 2.2, Facility Building
  - In designing and implementing the specific technologies of EXPERIMEDIA, we will need to refer back to the Scenarios and Requirements, which informed the design of the Architecture

- Activity 4, Experimentation
  - In setting up and conducting the Embedded experiments of the project, we will once more need to refer back to the Scenarios and Requirements, which informed the design of the Architecture and the development of the Facility

It is important that the project will continuously refer back to this Deliverable. In the work immediately following the delivery of the first version of this document, this Deliverable will be the fundamental building block, however this document will remain relevant throughout the project. This means that the initial version of the Document is likely to prove insufficient when the project has reached much more mature phases of its execution, and will therefore need to be revised. Taking this into account, three iterations of Scenarios and Requirements have been planned and will be documented in D2.1.2, D2.1.5 and D2.1.8. Specifically, the major future versions of this Deliverable are future Deliverables 2.1.5 "2nd Requirements and Scenarios" and 2.1.8 "Final Requirements and Scenarios". We view D2.1.2 as a living document and may also make intermediate, internal updated versions as necessary.

2.2. EXPERIMEDIA Scenarios and Requirements - first version

The most important factor that must be taken into account when considering the first version of Scenarios and Requirements (D2.1.2), and the reason why it was absolutely necessary in structuring this project to require multiple versions of this Deliverable, is that there is a cyclical dependency in the needs of EXPERIMEDIA partners to receive information from each other on the precise roadmap and decisions each partner develops and makes in order to conduct the project.

- Technical partners need input from Venue partners as to what Scenarios the Venues envision for the use and exploitation of the EXPERIMEDIA Facility. Only if the technical partners have detailed information as to how their technologies will be used in practice, can they implement the correct technological components for the purposes of the project.
- Venue partners and User-oriented partners need input from the Technical partners as to what Requirements the technologies are going to fulfil. In a normal Software Engineering scenario, it is expected that the "users" have the first say, and are the only party to define the purpose of a system to be developed. However, in EXPERIMEDIA, we are implementing a Facility, which is primarily intended to be exploited by organisations outside the initial EXPERIMEDIA consortium. There are Embedded Experiments that

will be conducted by the project, but these are primarily of an exploratory nature, aiming to further our understanding of the Facility. The offering of EXPERIMEDIA to future experimenters thus has a fundamental aspect of technology push: the value proposition says "here is a Facility enabling experimentation with the following important Technologies". Thus, the Venue partners need to know what these technologies are, before they can formulate a plan for how these technologies will be exploited.

In a simple "waterfall" workflow, the above cyclical dependency would indeed be catastrophic. This is why we have three versions of the current Deliverable, and why the current, first version is being delivered very early in the project. The objective is to make a best-effort determination of both Scenarios and Requirements, and then proceed straight ahead with the development of the first version of an Architecture for the EXPERIMEDIA Facility. These first versions are guaranteed to require revisions. However, once the first versions are ready, initial, exploratory experiments can be conducted, and, finally, enough information will be available to develop much more mature future versions. In other words, the project progresses iteratively, in an agile manner, and the current deliverable is the first iteration in this process.

3. Motivating Scenarios and Experiments

3.1. Function of Motivating Scenarios and Experiments in the project

EXPERIMEDIA is a "FIRE" project: Future Internet *Research and Experimentation*. But what is "experimentation" in this context and what does it mean for the project? Fundamentally it means that we do not know what the researchers using the EXPERIMEDIA facility will want to do. This is completely different from a research project where all partners are in the consortium from the start with well-defined problems that must be solved. In EXPERIMEDIA we have partners providing Venues for experimentation who are also conducting their own experiments. The first thoughts on these experiments can be found in Section 4 and whilst they help with the requirements capture exercise we must be careful not to just focus on these three embedded experiments but think more broadly about what Future Media Internet researchers will want to do in the next few years. This is where the three motivating scenarios come into play.

Looking over the research being done by companies and universities both within and beyond the consortium, and taking clues from the EC's Networks of Excellence (for instance the "Research on Future Media Internet", 2009 document[1]), three scenarios were written to inspire the project to think beyond the bounds of the embedded experiments. These scenarios are discussed in the rest of this section.

The Motivating Scenarios are the "glue" between the current (first year) and future activities of EXPERIMEDIA. EXPERIMEDIA follows a strict workflow, where progressive versions of the Facility are developed, with the final one intended for exploitation beyond the project. The project's technical activities constantly improve the Facility through these versions, but in addition, experiments are conducted using each version with the result of clearly demonstrating (amongst other things, e.g. validation) which improvements are most important. (The experiments also have intrinsic value as Future Media Internet experiments, of course.) Each experiment is self-contained, and makes sense independently of the global EXPERIMEDIA plan: in the first year of the project, the three embedded experiments, and in the following years, experiments from the Open Calls and unfunded experiments (e.g. 3rd parties or FIRE experimentation, STREP projects, etc). The vision of the project is held together by the Motivating Scenarios, within the context of which each experiment is defined. Thus, we describe the Motivating Scenarios in this section, and the Embedded Experiments described in the next section are a subset of these ideas, which will be the first to be addressed. Lessons from the Embedded Experiments will inform us not only with respect to the Facility technologies, but also with respect to our understanding of the Motivating Scenarios - and our improved understanding of the Motivating Scenarios will inform the Open Calls for further experiments, continuing the iterations.

The original specification of the EXPERIMEDIA project (as provided in the project's internal Description of Work document) describes the Scenarios at a generic level, appropriate to that document. As a conceptual description of the Scenarios, that material still stands, and we will not copy it here. In the following sub-sections, we describe the main concept and list the main

[1] Research on Future Media Internet, 2009, published by the European Commission, DOI: 10.2759/11972

content production stages in each scenario. We also tabulate the main facts about each scenario for easy reference: the specific technologies involved; which Task in WP22 will provide them; which Venue partner will also support them technically, e.g. with infrastructure provision or modelling input; which experiments will further develop them; when in the project lifetime they will be developed; and which Embedded Experiment will exploit and test them (we should note two points here: the Embedded Experiments also link to particular Venues, and the technologies will of course also be used for future experiments, which will be documented in future versions of this deliverable).

3.2. Live and augmented

The main objective of this scenario is to support experiments that investigate the production, management and delivery of content to mobile devices for the participative augmentation of reality, especially in the context of live public events. Content may originate from a variety of different sources and be available in different forms. This includes user generated and editorial content, in the form of geo-referenced data, user comments, audio/video, etc. For content being available for the augmentation of reality, geographical references need to be exploited. User generated content management needs to be capable of handling large-scale use cases. In principle, the following stages in the scenario can be differentiated:

- Production of editorial/professional content (text, images, audio, video; with geo-references)
- Production of user generated content (text, images, audio, video; with references)
- Management of content
- Delivery of content to mobile devices
- Stimulation of user engagement to close the loop to content production, i.e. users should not only consume data but also contribute new content implicitly or explicitly by providing feedback, comments or uploading media.

3.2.1. Technology distribution for Scenario 1

Scenario 1: Live and augmented Scenario technology	Technology provider			Sched-ule	Experi-ment Using It
	WP22 Task	Venue	Experi-menter		
Support large-scale, user generated content production, management and delivery	T223	SCH-FHW		Y1	DE1, DE3
Mechanisms for synchronizing distributed live events providing common experience	T221, T222			Y2-3	DE1, DE3
Mechanisms for socially driven content metadata annotation and dissemination – annotation process	T222, T226			Y1	ALL
Mechanisms for socially driven content metadata annotation and dissemination – annotation meta-model		ALL	ALL	Y1	ALL
Personal, dynamic adaptation of content according to individual and/or group	ALL			Y2-3	ALL

preferences					
Real-time orchestration allowing for adaptive narratives and content, customising the user experience	T226			Y1-3	DE1, DE3
Mobile platforms enhanced for augmented reality applications	T226			Y1	DE1, DE3
Integrated services for evaluation, in terms of technical features, content and user experience		SCH-FHW	ALL	Y1-3	ALL
Scalable tools supporting: generation of content by users in live public events	ALL	ALL (infrastructure)	ALL	Y1-3	ALL

3.3. Live and 3D

The main objective of this scenario is to support experiments that investigate the capture of the production high quality content for remote sports analysis and training at live events. Content will originate from audio/visual sources and be available in different forms. This includes athletic performance, in the form of quantified measurements, expert comments, audio cues etc. For content being available for the augmentation of reality, interdisciplinary terminology references need to be exploited. Generated content management needs to be capable of handling different formats of high-quality content. In principle, the following stages in the scenario can be differentiated:

- Use of accompanying media e.g. a soundtrack.
- Production of metadata content by trainer.
- Production of athlete generated content (images, audio, video; with references).
- Management of content.
- Delivery of content to multiple remote locations to handle simultaneous interdisciplinary input, i.e. the coach, choreographer and athletes all simultaneously provide feedback for training improvements.

3.3.1. Technology distribution for Scenario 2

Scenario 2: Live and 3D Scenario technology	Technology provider			Sched-ule	Experi-ment Using It
	WP22 Task	Venue	Experi-menter		
Acquisition and synchronisation between cameras feeds, audio and metadata, including matching exact frames from different cameras	T224	CAR (infrastructure)		Y1	DE2
Integrated automatic data collection and management systems	T224	CAR (infrastructure)		Y1-3	DE2
Metadata annotation and generation tools based on accepted domain standards	T224			Y1	DE2

Real-time communications and data exchange including integrated 3D collaborative trans-media	T224, T225	CAR (infrastr ucture)		Y1-2	DE2
On the fly 3D reconstruction of live events "in virtue" including geo-location in indoor enclosed spaces	T225			Y1-3	DE2
Tools to correlate the technical parameters of an experiment to the assessed QoS and QoE	T224, T225		CAR	Y1-3	DE2

3.4. Live and online

The main objective of this scenario is to support experiments that investigate the production, management and delivery of advanced interactive multimedia services. Content will originate from a variety of sources and be available in different forms. Users will send and receive messages. They will receive video and metadata annotations, this includes cultural and educational content, in the form of 3D content, expert comments etc. For content being available for user interactivity, metadata annotations need to be generated linking user preferences to virtual content. Generated content management needs to be capable of handling different formats of high-quality, user interactive content. In principle, the following stages in the scenario can be differentiated:

- Production of virtual content (3D renditions, audio content)
- Production of user generated content (text, images, audio, video; with references)
- Generation of content from the communication between users
- Management of content
- Delivery of content to multiple remote locations to handle simultaneous interdisciplinary input, i.e. the expert provides feedback regarding represented content users all have the ability to provide feedback.

3.4.1. Technology distribution for Scenario 3

Scenario 3: Live and online Scenario technology	Technology provider			Sched-ule	Experi-ment Using It
	WP22 Task	Venue	Experi-menter		
Adapt and provide efficient management of media content	T223, T224		SCH, FHW	Y1	DE1, DE3
Provide improved personalised social experiences	T222		SCH, FHW	Y1	DE1, DE3
Access to different social networking platforms	T222		SCH	Y2-3	DE1
Monitoring of the social activities (real and online) performed by individuals and communities for the purpose of evaluating the experiment	T222			Y1	ALL
Provide access to, and capability to reference,		ALL		Y1-3	DE1,

Venue content, within the social graph		(modelling)			DE3 (DE2)
Analysis of social graphs for extraction of social knowledge and proximity of users to content			ALL	Y1	DE1, DE3 (DE2)
Knowledge services for media QoS and QoE parameters derived from social behaviours	T221				ALL
Tools for sharing: immersive and interactive cultural and educational experiences	T222, T223, T224, T225			Y1	DE1, DE3
Real-time tools supporting: immersive and interactive cultural and educational experiences	ALL	ALL (infrastructure)	ALL	Y1-3	ALL
Allowing "live" visitors and remotely-located ("online") users to interact	T222, T223	ALL (infrastructure)		Y1	DE1, DE3

4. Embedded Experiments

4.1. Function of Embedded Experiments in the project

EXPERIMEDIA will conduct three Embedded Experiments, led by the Venue partners of the project. These experiments have multiple purposes:

- Offer real value to the Venues conducting them, i.e., answer real questions the Venues have concerning the improvement of their real business activities
- Conduct a test of the first EXPERIMEDIA implementation, so as to ensure a well-designed, well-implemented, useful Facility is provided to further experiments
- Resolve questions concerning the general design of the Facility itself (see Section 2.2)

In the first version of this Deliverable, we provide one experiment scenario for each Venue. We are not yet ready to discuss details of the experimental procedure these experiments will follow, since the exact methodology that will be followed is itself being studied concurrently to the writing of this document (see deliverable D2.1.1 for details on methodological considerations). We are also not yet ready to describe the exact use of specific technologies in these scenarios, since there is as yet no specific Architecture defining the precise technological profile of the EXPERIMEDIA Facility. Thus, as discussed above, this version sets out our best-effort results in determining initial experimentation ideas.

4.2. Schladming

4.2.1. Description

4.2.1.1. Introduction

Schladming is a tourist place that depends on visitors and their satisfaction. The main objective for Schladming therefore is to provide visitors and citizens with innovative future internet technology solutions that improve the visitor experience and improve the quality of life. Visitors as well as citizens should have all the information they need to have the best possible experience in Schladming available instantaneously. For visitors this should improve the quality of experience and ideally the EXPERIMEDIA technologies deployed in the experiments will help to attract new visitors to the region, improve the visitor retention rate and contribute to a positive economic development of the region.

The experiment should support a smooth and satisfactory "customer journey" that starts when the visitor researches information about an event or vacation in Schladming, continues throughout all further phases including the actual stay at Schladming until the visitor leaves the place and shares his experiences with friends. The experiment will target specific parts of the "customer journey" that are best suited.

As part of the experiment a mobile application (or “app”) should be created, which allows visitors to experience the region and its activities in a modern and innovative way. The app will help visitors of the ski world championships find side events and help them see where "the party is on". The service should also connect fans and help them in getting together. So for instance a

fan from Norway could find other Norwegians to support their athletes and spend a great time together. Another idea for the app is an augmented reality view, which shows the region in the opposite season. For example it shows how the ski slope is used during summer and that there is a mountain bike downhill trail. This would also help the region to show winter guest how great summer in Schladming is and vice versa.

In this scenario, Social Networking Sites are exploited as an interface between real-world and virtual information, and for location-sensitive real-time group messaging. Other technologies are "actuated" through the social interconnection of users. For example, users can initiate a video streaming service through their interconnection, and use it to communicate with each other.

We will set up 3D capture points on standard routes for non-competitive skiing, where EXPERIMEDIA end-users can have a 3D snapshot of their interesting achievements taken. We will explore various delivery options, ranging from holographic display to 3D TV. During their actual visit to Schladming, visitors will be able to use their mobile devices to interact with the static capture system - the latter having been strategically placed in locations where many interesting events happen, e.g. where amateur skiers often perform good jumps. Visitors' mobile devices will allow them to immediately find the captured content that concerns them, and will be given further instructions how to view the content (e.g. in the case of holograms, a special procedure may be necessary). For the purpose of the experiments, certainly the capture points will only be set up during the experiments themselves, and will not operate outside the (ethically and legally controlled) environment of the experiments.

4.2.1.2. Scenario Background

A group of friends are at Schladming. The group can split in various ways, e.g. kids/young adults go to watch a race while adults/parents stay at a restaurant, dads and boys go shopping while mums and daughters go skiing, one family goes to a local museum while another goes for a mountain hike.

In order for independence of individuals/sub-groups to be possible while also keeping the whole group together when desired, they need to combine several information flows, and communicate contextual information as well as their own ideas to each other.

4.2.1.3. Ideas

- Discover location-based and activity-based information, with social filtering
    - E.g. find restaurants
        - Nearby
        - With good recommendations
        - "The one my cousin liked last year"
    - E.g. get suggested beautiful walking routes
        - starting near current or planned location, ending at near a desired destination

    - Suggestions that the system makes are (or can be, if the user chooses) influenced by social content, e.g. whether friends Liked an item
    - As another example, in route planning, points of interest can be taken into account (adjusting the route to visit a point of interest)
        - e.g. a certain place is marked as "must see" by a Friend (in a real-time interaction this could take the form of a recommendation message, or this could be an offline interaction, e.g. some other user had posted a positive comment previously)

- Collaborative decision making and scheduling for group activities
    - Sharing online information about potential activities (e.g. restaurant reviews) within the group, as a "discussion of what to do"
    - Sharing current environmental, population distribution (e.g. quiet spot) and visual information (e.g. posting picture of a restaurant one user is currently looking at, so rest of group can take a look)
    - Voting on choices

- Defining rendezvous locations
    - Automated mapping tool assists each user in getting there
    - Exploit socially-available information on the way (e.g. while walking to meet the rest of the group in an agreed place, one user passes outside a restaurant that a friend of hers highly recommends – system can ask: "do you want to take a look?")

- Defining rendezvous times
    - Automated reminders if required, taking into account time-to-destination
    - Use location-sensitive and time-sensitive information to improve experience (e.g. "a friend is preparing to drive in the direction you will soon need to walk, do you want to ask for a lift?")

- Stay connected with other members of the group
    - monitor locations in real time on a map of the location
    - group chat

- Simple social messages to everybody in group
    - e.g. "hey everybody, come here"
    - e.g. "make sure you take a look at this", accompanied by a photo and a geo-tag

- 3D capture of skier's highlight moments
    - Mobile app syncs with capture system to allow user to easily find highlight recordings

- Per-case capabilities to view recording, e.g. we hope to focus on a hologram playback, but this must be examined technically in more detail

4.2.1.4. Scenario Story

Everybody is having breakfast together. Tom and Jenny want to go skiing but Alice and Bob want to go to a small local museum first. Alice and Bob are slightly better skiers, so they agree to meet at an "advanced" slope in one hour. On their way to warm up at an easier slope, Tom and Jenny pass a gallery that is a commercial shop and not listed in the tourist guide, but would probably interest Tom and Jenny. Jenny uses her EXPERIMEDIA app to mark the spot as interesting. Meanwhile, in the museum, Alice and Bob spot a brochure for another cultural landmark. They use their EXPERIMEDIA app to find out more information. It turns out it's far away and people have commented that it's not very interesting, so they decide to skip it. As Tom is skiing, he pauses and takes a nice picture of a funny-shaped hill with some huge trees. He uses his EXPERIMEDIA app to post the picture on his favourite social networking sites – so with one click, the picture is now on several sites, and it is also automatically accompanied with context information, like where the picture was taken, what time it was, and even (possibly) what Tom was doing ("picture taken while I was skiing"). When Alice and Bob set off for the slope, their EXPERIMEDIA app suggests a detour to see the gallery Jenny had marked for them. Since they accept the suggestion, the app automatically notifies Tom and Jenny that Alice and Bob will arrive at the pre-arranged meeting point twenty minutes later than previously planned.

4.2.1.5. Experiment

The users here are quite free. Therefore, an experimental methodology is needed where the experimenter can track a variety of user behaviours and perform general measurements, or classify activities and events according to generalised categories. There are many system parameters and possible functionalities to try out, and correlate with user experience. For example, it might be interesting to see whether users who are in the same location prefer to give each other ideas and suggestions "live", or whether they prefer to view comments and recommendations made by previous visitors. It could be further checked whether users prefer to restrict their attention to comments and recommendations made in previous visits of people they are socially connected to, or whether they prefer to rely on the "global" wisdom of the entire "crowd".

4.2.2. Summary Table

Scenario ID	1
Venue	Schladming
Scenario Name	Schladming Embedded Scenario
Relevance to Driving Experiments	-Live and Augmented -Live and 3D -Live and Online

EXPERIMEDIA Technologies used	-Testbed management services (T2.2.1) -Social networking (T2.2.2) -User generated content management and delivery (T2.2.3) -High quality content production and delivery (T2.2.4) -3D Internet tools and services (T2.2.5) -Augmented reality services (T2.2.6) -Cloud infrastructure (T2.2.7) -Security (T2.2.8)
Actors	Team of tourists
Physical Locations involved in the scenario	Schladming
Future Media Internet Context	Implementation and experimentation of a FIRE application used in the context of media and social immersive tourism.
End-User Value	The usage of the EXPERIMEDIA facilities will improve the way the tourists experience their visit in Schladming. The online integration of information concerning attractions, accommodation, etc, and its combinations with social-networking, offers the visitors all of the information required within the one mobile application.
Venue Value	The EXPERIMEDIA technologies that will be developed in the context of this scenario will offer an immersive tourism experience to the people visiting Schladming, and in this way it will help boost its attractiveness to such organised tourism, and in general contribute to the economic development of the region.

4.3. CAR

4.3.1. Description

4.3.1.1. Introduction

In this scenario, metadata, augmented reality and remote stream control is exploited.

4.3.1.2. Scenario Background

In this experiment we would like to enhance the process to create a new synchronized swimming choreography and improve the training sessions done by the team.

4.3.1.3. Ideas

- Music metadata
    - Put different tag at specific moments of the music
    - Be able to hear the music in slow motion to be able to set the tags in an accurate manner.
- Movements database
    - Select and crop pieces of video with the movement to store it in the database.
    - Add information associated to the piece of video

- Make searches using the date, choreography name or the associated information

- Enhanced playback
  - Synchronization of the choreography with the music and their associated metadata
  - Overlay of the music metadata over the video while the team is performing the choreography and for the playbacks *in situ* and remotely

- Remote control
  - It is possible to seek to the same video position: a trainer, at home, has the same content as the team performing the choreography in the swimming pool.
  - All the persons can use the screen as a whiteboard and draw over the images

- Piece selection
  - Select the piece of music that has to be reproduced by the team to do the training.

4.3.1.4. Scenario Story

The Synchronised Swimming group wants to create a new choreography.

They make their usual workflow:

1) To have a high level of ideas the group of 14 members is divided into two different groups. Each group does their own brainstorming and creates a choreography for the same music. Each group makes an exhibition to present their ideas. The trainer records the movements and selects the most interesting parts.
2) To talk about moments of the music, the team assigns numbers to different parts. The whole team knows that at a specific number they must have done a movement and reached a position with some part of their body, e.g. leg must be stretched. The trainer would like to have the numbers overlaid on the screen while they watch the choreography.
3) In a training session, the trainers and team might decide to discard any of the movements for that choreography. The trainer can decide to keep the video with the recorded movement in the database in order to reuse it in the future.

For the team that is training, it is important to be able to make corrections as fast as possible; the best for them is to have the comments from the trainer while they're still in the water. The trainer might want to seek to a specific position of the video using the music tags instead of searching through the content the desired position to show as fast as possible what should be corrected.

The trainer might also ask the swimmers to repeat a specific part of the choreography instead of doing everything again. The trainer has to be able to select the piece of music, the team has to repeat it and the system has to record it.

Perhaps one of the trainers couldn't be *in situ* that day, but his opinion is very important. That person might connect from home and see the same images the team is watching at the swimming pool. The person at home should be able to seek forward and backward how he wants, once he has found the position of the video he wants to comment he could control remotely what the swimmers are watching on the television next to the swimming pool.

All the people can use the screen as a whiteboard; put the marks on the screen. This information shouldn't be stored, but, if somebody is connected remotely, he should be able to see it.

4.3.1.5. Experiment

This scenario offers a great opportunity to experiment with synchronization of video, audio and metadata and check how it improves the training process. It also offers the opportunity to have a ubiquitous system for the trainers that will help to see how streaming in the EXPERIMEDIA system works. It will be also important to have the feedback from the trainers that can do remote-work.

With the possibility of cropping pieces of content and reuse them for future choreographies, CAR will see how it affects to the dynamics of creating a new choreography.

4.3.2. Summary Table

Scenario ID	2
Venue	CAR
Scenario Name	CAR Embedded Scenario
Relevance to Driving Experiments	-Live and Augmented -Live and Online
EXPERIMEDIA Technologies used	-Testbed management services (T2.2.1) -User generated content management and delivery (T2.2.3) -High quality content production and delivery (T2.2.4) -Augmented reality services (T2.2.6) -Cloud infrastructure (T2.2.7) -Security (T2.2.8)
Actors	-Training team -Remote trainer -Synchronised Swimming group
Physical Locations involved in the scenario	-CAR premises -Locations of the remote trainer
Future Media Internet Context	This scenario revolves around a FIRE application which is based on the concept of augmented reality, and used in the context of synchronized swimming choreography training. It also involves the experimentation on a media application over the internet that will enable remote trainers to participate in a collaborative training session.

End-User Value	The usage of augmented reality technologies with advanced metadata capabilities in an easy-to-use media application allows for better time management, while reducing the effort of both the training team and the athletes, and consequently will lead to an overall reduction of the cost for using the training facilities. Remote trainers are also given the opportunity to participate in a collaborative training session without being physically present.
Venue Value	This scenario involves the development of a Future Media internet application that CAR may offer to the trainers to enhance the way they communicate with the athletes and manage the material that is produced after each training session. It also enables the trainers to receive feedback from other remote trainers that couldn't be physically located at the CAR premises. The offering of such an application may attract more training teams in the future, since it increases the productivity of both the athletes and the trainers.

4.4. FHW

4.4.1. Description

The Foundation of the Hellenic Word (FHW) provides each year a series of exhibitions. But the permanent exhibition is the one of the "Tholos" (Dome) building. The Tholos has been designed as a Virtual Reality museum, which hosts FHW's digital collections making them accessible to the public. The peculiarity of the Tholos is its ability to project onto the projection surface, with an inclination of 23 degrees, fully interactive content. The content that is projected on the Tholos, "Kivotos" (Ark) and "Magic Screen", is not "taped" but thanks to its digital infrastructure it possesses flexibility and liveliness. Under the framework of EXPERIMEDIA we will exploit for test some properties of Tholos along with a series of other exhibitions that are available at the Venue.

During the usual operation of Tholos, an FHW museum educator guides the audience through a 3D educational movie. To this direction, the proposed scenario involves the deployment of a Future Internet Research and Experimentation (FIRE) application over the EXPERIMEDIA facility that will enable the collaborative presentation of the 3D movie that is projected in Tholos. In more detail, in the proposed scenario a museum educator who is physically located in Tholos, responsible for presenting and for navigating through the 3D movie, is joined by a panel of experts, i.e. given that the movie displayed in Tholos is about some ancient ruins, this panel of experts could be historians and/or archaeologists that were actually involved in the excavation of the ruins. This team of experts may be geographically dispersed and are brought together and in contact with the museum educator and the audience in Tholos by using the EXPERIMEDIA facilities.

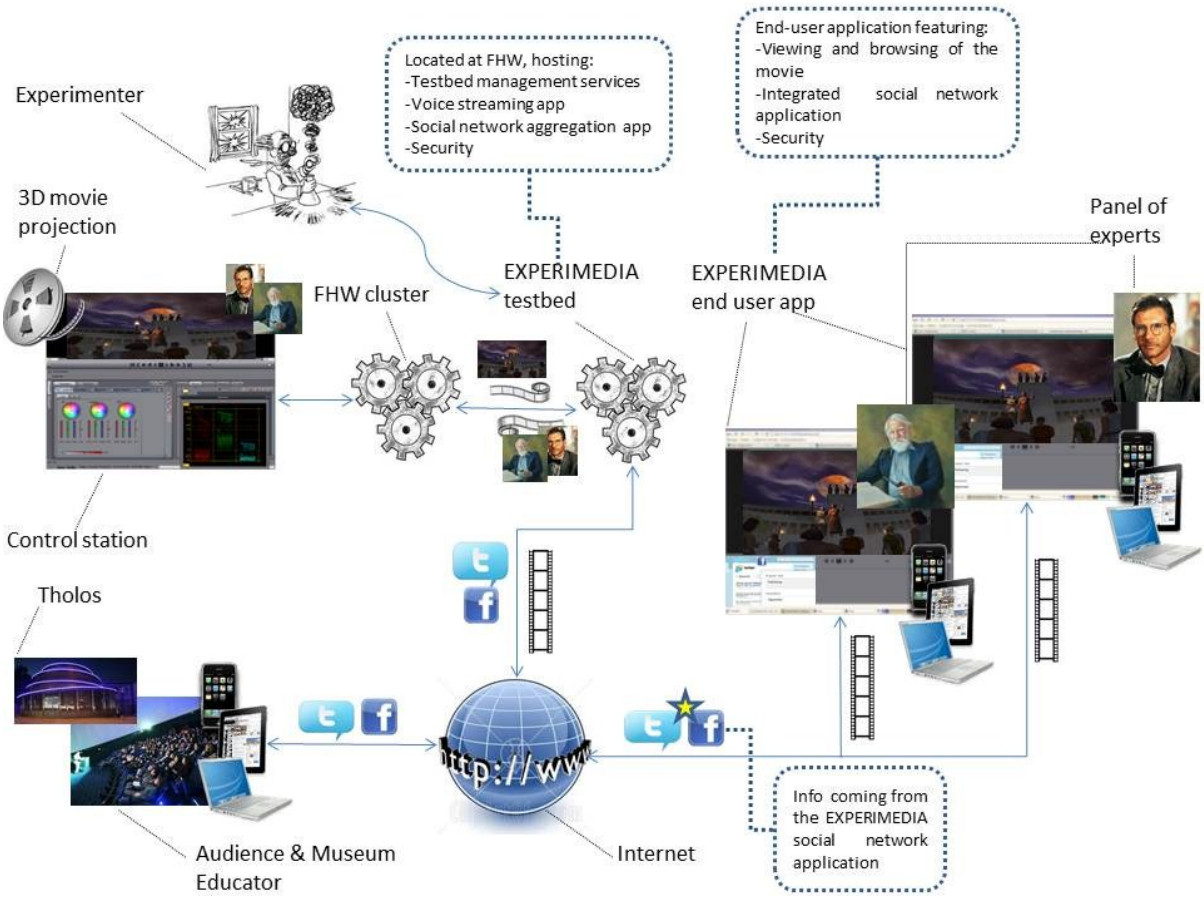

Figure 1. High-level view of the EXPERIMEDIA FIRE application in FHW's premises

As demonstrated in Figure 1, apart from the two existing actors, that is the museum educator and the audience, this scenario involves two more entities: the panel of experts, and the experimenter. The panel of experts, with the use of an EXPERIMEDIA end-user Application, will be able to remotely view in real time as the presentation is given the 2D version of the 3D movie that is being shown to the audience, over a secure communication channel. The audience, while viewing the 3D movie, will be able to interact with the panel of experts (i.e. ask questions, make comments, express preferences, etc.) through their preferred social networking interface using smart-phones, laptops, or tablet PCs.

During the presentation, the experts can send feedback to the audience and the museum educator either by answering questions in real time, or by texting answers. To facilitate this, the experts' end-user application will be enhanced with a social network plug-in that will automatically collect and present to the archaeologist any relevant comments/questions coming from the remote audience in Tholos. The feedback enhances the presentation by providing answers to directed questions regarding the visual content of Tholos in real time.

The FHW experimenter is the entity responsible for using the EXPERIMEDIA testbed management services to perform all required actions for setting up the experiment (negotiation, configuration, definition of QoS level, etc.). Using the same services, the Experimenter will be also capable of monitoring the QoE of the actors participating in the experiment. Furthermore, during the experiment and in the background, all social network-related data that has been transferred by all external communicators (i.e. both the panel of experts and the audience), will

be stored to the EXPERIMEDIA testbed for processing. These data will be packaged and accessed by the Experimenter in order to draw useful conclusions. To clarify, this paragraph is stating that the experimenter, when running the experiment, is responsible for using the testbed management services, provided through an appropriate Graphical User Interface, to set up the experiment, manage its quality and other parameters, monitor it, etc.

In the next step of the scenario, the audience has the ability to visit the real world site which is displayed in Tholos. To prepare for this, the presentation system in Tholos will generate metadata, synchronised with the Tholos visual content. The metadata is meant to relate the audience's view of the real world with that of the virtual world. During the Tholos presentation, the audience can tag virtual locations of interest to them. These tags are automatically translated into references to 3D assets corresponding to the virtual locations chosen by the audience, which in turn correspond to specific real-world locations.

We now describe an interesting extension to the current scenario. At the time of writing of this deliverable, it remains to be investigated whether this idea can indeed be included as part of the current Embedded Scenario, or perhaps should be provided as a guiding example for the Open Calls in the future. At the real site itself, the audience can use an Augmented Reality application, as shown in Figure 2. This application allows visitors to compare the current state of a site with the virtual reproduction provided by FHW. The Augmented Reality view is an enhanced view of the buildings, artefacts and/or surroundings, achieved through the use of mobile devices, which provides them with additional information; for instance, a 3D model of the building appears within the view displayed in the mobile device, making a current ruin appear as it did when it was new. Possibly, a panoramic image comes to life exemplifying the day to day interaction of people in that environment in ancient times. A more simple capability is that information is displayed regarding the use of a building or artefact or any other subject in sight relevant to the exhibition.

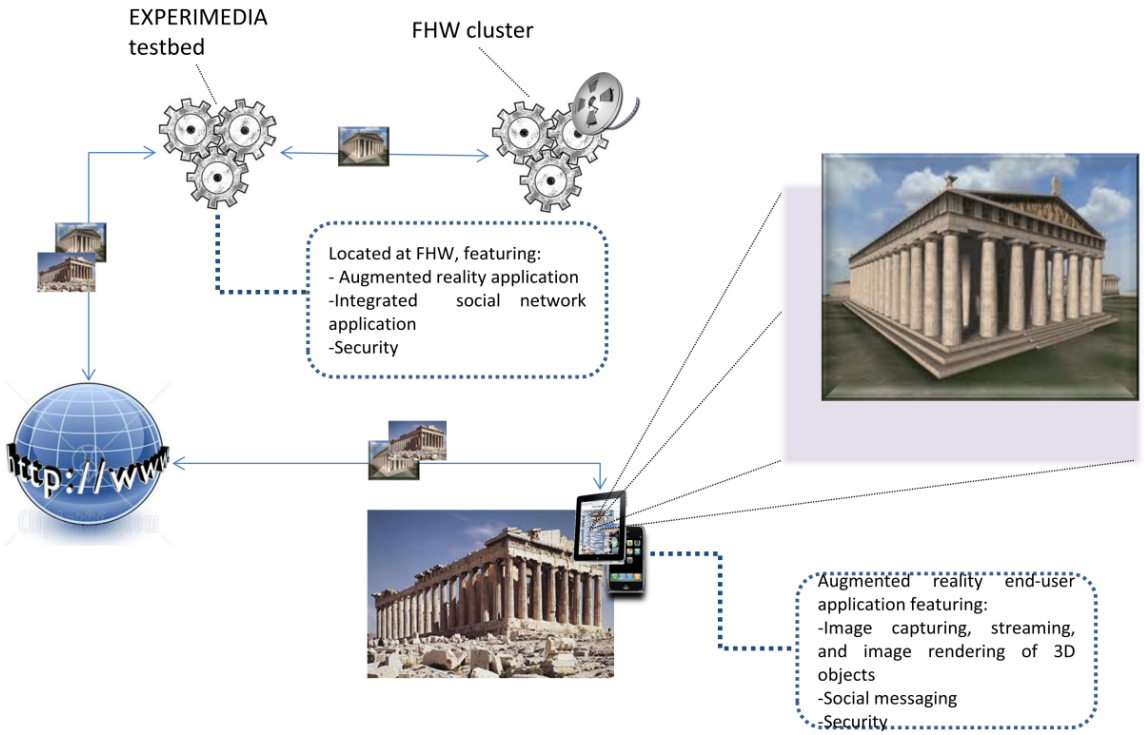

Figure 2. High-level view of the FHW Augmented Reality application

The interrelation/synchronization of the two environments gives the audience the opportunity to explore a fully immersive virtual reconstruction of an ancient site, and then visit the same site physically, remember points of interest from the virtual tour, find the same locations, view them in their current form, and even repeat the visualisation on a smaller scale but on-site for maximum information and clarity.

Another possibility worth exploring is collecting information from audiences before they visit Tholos. In one scenario, they first visit an archaeological site; in another scenario, they visit an exhibition about an archaeological site (e.g. this could show photographs of different phases of an excavation in a large site which took decades to fully excavate). The second case is technically easier: at the Hellenic Cosmos premises markers will be placed that the mobile clients could track and perform 3D image registration of the 3D assets that the visitor has tagged. In both cases, visitors use a Social Networking application to tag content of interest. By sharing their tags, and commenting on them and the location, they create a collaborative environment in which interests and questions about the site are revealed. This material is aggregated and provided to the presenter in the Tholos and/or to the panel of experts (the latter being especially useful due to the large size of a typical audience), who can adapt the presentation to the audience's specific interests and needs. Thus, the presenter and/or experts take their audience on a customized tour. The socially driven content provided will not just be used by the current panel but will also provide FHW with the feedback it needs to change or further enhance their productions.

4.4.1.1. Summary Table

Scenario ID	3

Venue	FHW
Scenario Name	FHW Embedded Scenario
Relevance to Driving Experiments	-Live and 3D -Live and Augmented -Live and Online
EXPERIMEDIA Technologies used	-Testbed management services (T2.2.1) -Social networking (T2.2.2) -High quality content production and delivery (T2.2.4) -Augmented reality services (T2.2.6) -Cloud infrastructure (T2.2.7) -Security (T2.2.8)
Actors	-Museum educator -Audience in Tholos -Panel of experts -Experimenter
Physical Locations involved in the scenario	-FHW premises -Real-world site displayed in Tholos -Locations of the different experts
Future Media Internet Context	Implementation and experimentation of a multimedia platform over the internet for doing collaborative presentations. Furthermore, another future media internet application is based on the concept of social media, which is used in the context of multimedia immersive museum exhibits.
End-User Value	-Museum Educator: will be able to do a collaborative presentation in Tholos with a group of experts that are geographically dispersed. -Audience: the usage of augmented reality, and its combination with social networking capabilities, enhances the audience's experience in FHW, and also allows for linking the acquired knowledge with the real world. -Panel of experts: are given the opportunity to do a collaborative presentation of a movie in Tholos without being physically present, and at the same time use social networking to interact with the audience. -Experimenter: can draw useful conclusions from the aggregated social networking and QoE information that is gathered and stored during the experiment. This information can be used, for example, to make changes, enhancements, corrections in the 3D movie that is projected, and/or in the way it is being presented.

Venue Value	-Creation of a FIRE application that will enable the collaborative presentation of the 3D movie that is projected in Tholos by bringing together the museum educator and a team of experts that may be geographically dispersed. This facility could be used by the FHW in the following ways: • For organizing special events such as celebration events, or in general events that may target a special audience • For collecting and automatically processing live feedback from an audience of experts during pilot projections of new 3D FHW productions in order to make corrections/enhancements before offering them to the public • Could be offered to other companies for collecting feedback from an audience about pilot commercials, movies, series, a specific product, etc. -In general, the offering of technologies such as augmented reality, social networking, enhances the audience experience in FHW, and may attract more visitors in the future.

5. Technology Issues and "Toolbox" of the EXPERIMEDIA Facility

5.1. Introduction to the EXPERIMEDIA technical platform

In this section the technical platform that will support the scenario-based experiments described in Sections 3 and 4 is presented. Fundamental to the successful delivery of the EXPERIMEDIA technical platform is the need to:

- Support an experimental process that depends on diverse and dynamic technologies
- Effectively capture and marshal large experimental data sets of varying types
- Provide a framework to assist the analysis of technology performance (Quality of Service), user experience (Quality of Experience) and community behaviours (Quality of Community)

To meet these objectives, the EXPERIMEDIA technical platform will consist of components that will a) provision the synthesis of future internet technologies under investigation and b) support the execution of the experimental process itself. Of particular importance are the potential insights to be gained from the examination of the impact of a particular technology configuration on individual users and communities. The 'tool-box' presented in this section offers the resources (deployed throughout the experimental lifecycle) that are specifically geared toward generating and integrating data for this purpose.

The EXPERIMEDIA Facility will be designed as a consistent IT system that can support a wide range of Future Media Internet experiments. Many fundamental functions will be used in every experiment, for example configuration and monitoring capabilities. However, the Facility also provides a broad range of media-oriented technologies for Future Media Internet, which will not all be relevant to every experiment. For example, some experiments may use Augmented Reality but not adaptive Video Streaming, while for others the reverse may be true. This is why we view the complete set of technologies contributed by the EXPERIMEDIA partners to the EXPERIMEDIA Facility as a toolbox, for experiments to choose the required tools from it.

Data collection of quantitative and qualitative types is considered at a number of different levels: from devices that collect samples from an individual user; in systems that are physically shared by groups of users; and in virtual platforms upon which potentially thousands of users interact. Concrete measures such as CPU usage; network traffic metrics; or service response time are examples quality of service (QoS) measurements that provide a quantitative view on the experimental set-up. Orthogonal to this are the experiential responses, or 'quality of experience' measures (QoE) provided by users during the run-time of the experiment and the 'quality of community' (referred to here as QoC) metrics that can be extracted by analysing user group interactions and community generated content.

The combined measurement concerns of QoS, QoE and QoC are addressed through the provision of the toolbox technologies and experimentally controlled using the process support functionality offered by the test-bed and data management services (see Figure 3).

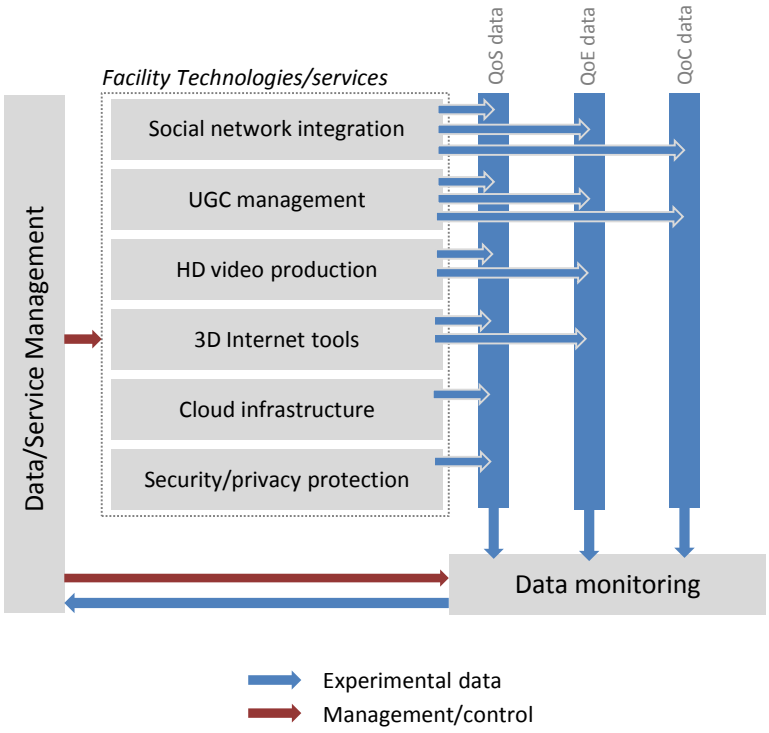

Figure 3. Overview of EXPERIMEDIA technologies

In the following sections, these components are described in more detail, including the EXPERIMEDIA experimental lifecycle; QoE data capture techniques; experimental data monitoring and management; and an initial list of facility technologies to be made available to experimenters and their users.

5.2. Experiment Lifecycle

All pieces of research and experimentation follow a similar pattern of having an idea (a hypothesis), trying it out and analysing the results to determine what to do next. In common with other FIRE projects, such as BonFIRE[2] and TEFIS[3], we term this pattern the "experiment lifecycle" and propose the following simple formulation:

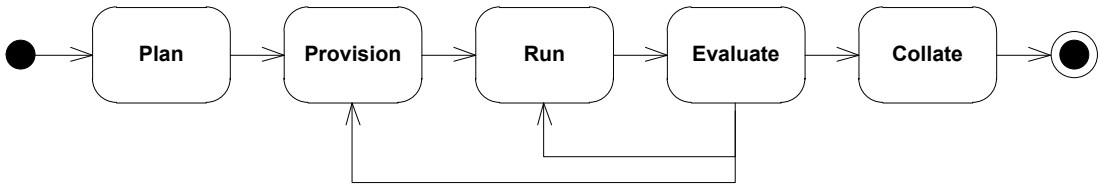

Figure 4. Simple experiment lifecycle.

This lifecycle should in no way be considered to be a comprehensive description of the options available to an experimenter. Rather it is just intended as a framework to help us understand the main flow that an experimenter would move along and the points of interaction with EXPERIMEDIA.

[2] BonFIRE: EC framework 7 project (ICT-2009.1.6), number 257386.
[3] TEFIS: EC framework 7 project (ICT-2009.1.6), number 258142

1) Plan: encompassing having an idea, the background research and working out and describing the experimental method and the required resources.
2) Provision: all the processes required to obtain the resources (both IT and human resources) necessary to run the experiment. This can include requesting and creating contracts and service level agreements with service providers and/or participants, the service provider reserving resources and deploying software.
3) Run: conducting, monitoring (and potentially controlling) the actual experiment and collecting all the associated data.
4) Evaluate: analysing the data produced in the "Run" stage and also collecting additional data from participants. Determining if the experiment is complete or whether additional "Run" steps, "Provision" steps (or even "Plan" steps) are required.
5) Collate: the generation of reports and publications related to the experiment.

EXPERIMEDIA touches on the majority of these lifecycle steps:

- ethical review of experiment plans and advice on data protection and experiment execution;
- service management software and cloud infrastructure tools to help with provisioning;
- tools for social networks, user-generated content, video streaming and control, 3D and augmented reality systems, to be used by experimenters during their experiment and linking to service management systems;
- assistance with evaluation, for instance through social network analysis tools and monitoring tools.

5.3. Quality of Experience

Understanding user experience within the life-time of an experiment provides important indicators as to the fitness for purpose of the technological framework under experimentation. It is therefore essential that the EXPERIMEDIA toolbox includes the provision of user experience data capture. Within the EXPERIMEDIA setting, QoE data will be defined in terms of measures used in contemporary human-computer interaction methodologies - including psychometric scales and other self-reporting responses. It is important that such qualitative measures are contextualized within a well-defined scope during the experimentation process. To contextualize the QoE measures, additional externally observable measures relating user activity (such as interaction logging and task metrics) will also be taken during experimentation. Finally, it must then be possible to collate these data sets by a means that will allow experimenters to easily explore, analyse and relate user experience data with other metrics (such as quality of service) gathered by the toolbox.

5.3.1. QoE sampling modalities

Due to the nature of the activities, events and environments that characterise the EXPERIMEDIA scenarios it is reasonable to assume that it may be inappropriate or impossible for every user to respond to QoE sample requests using the same interaction modality. For example, in situations where a user is engaged in a sporting activity, it may be difficult for them to use a conventional (keyboard and mouse) computer terminal to respond to affective statements where an audio presentation and voice recognition system could be less disruptive.

The following modalities should be considered (where appropriate) as a means by which users can provide qualitative data during an experimental process.

5.3.1.1. Touch

In situations where a binary, category or scaled response to either a question or statement is required, where this is presented visually, it should be possible for the user to indicate their response by physically or virtually touching the displayed response item.

5.3.1.2. Audio/visual

Some sampling moments may require an alternative or dual-mode approach to user response. Here, it may be useful to present a request for a qualitative response visually on a 'read only' medium (such as a large, wall-mounted display) whilst requiring users to respond vocally (using a wireless microphone attached to a voice recognition system).

5.3.1.3. Gesture

Gesture based responses may also be possible, depending on context. In cases where the participants can be tracked using video inputs, it could be possible for them to respond to certain types of questions (such as binary or category) using the physical gestures of their bodies. Here, users themselves would not require any special technology to take part in the experiment.

5.3.1.4. Dialogue

At particular phases of the experiment, there may be enough time and resource for users to provide a more detailed and personalized account of their experiences (particularly before and after the primary experimental activity). Contextualization of this data could be carried out by conducting a semi-structured interview between the experimenter and the participant in which directed questioning would elicit a conversational response from the user.

5.3.2. QoE sampling technologies

Four modalities are set out above indicating the course through which QoE data could be retrieved. These modalities can be potentially provisioned through a number of technologies within the EXPERIMEDIA toolbox:

5.3.2.1. Personal interaction devices

Hand-held or wireless sensors/effectors have the capability to meet some or all of the modalities discussed above. Many modern 'smart phones' and tablets now provide touchable displays; provide audio input/output and can be connected wirelessly to internet based services. Other, less capable technology such as Bluetooth headsets can be locally coupled to a computing service that can present and respond to human speech.

5.3.2.2. Shared interaction devices

Some experiments will place groups of people in social scenarios where collaborating individuals are geographically co-located. In such circumstances it may be appropriate for individuals acting as a group to provide responses via the medium of a shared interface - such as wall-mounted touch screen or a gesture-based interaction space.

5.3.2.3. Conventional computing devices

Remote collaborators may not have access to the technology immediately present in an EXPERIMEDIA scenario are more likely to use conventional computing technology to participate within an experiment. For these users, gathering qualitative responses may be more conventionally met by a web-based, form filling user interface or alternatively by monitoring social network data.

5.3.3. Data capture requirements

The frequency and means of sampling affective responses from users will depend in part on the technology provisioned to support the measurement and also by the nature of the activities carried out by the users themselves.

5.3.3.1. Explicit and implicit data capture

The contextualization of QoE data within an experiment implies two orthogonal data dimensions: a) explicit, qualitative self-report data and b) implicit, externally observable user behaviour. In the former case, users will overtly be asked to respond to psychometric scales whilst the latter a third party or technology will make observations on user behaviour. These observations may take the form of interaction logging (where a user's use of a particular technology is recorded) or real-world observation (recording physical properties of the user). For both cases, an EXPERIMEDIA compatible implementation of the sampling service must be factored in to the experimental set up. The former case will require a client that is capable of presenting qualitative questioning using some form of configurable automation. In the latter case, the externally observable measurement will require either a) the deployment of an independent technology to capture user actions or b) the direct adaption of the experimental technology itself to record interactions.

5.3.3.2. On-line capture

Where devices are connected to a live network and can carry the data effectively, it may be possible for qualitative data to be gathered in 'real time' from the user and returned directly for processing by the experimenter. An example of this could be the implementation of a web service that can be executed on personal or shared interaction devices. The advantage of this is that the experimenter will be able to examine data immediately and manipulate the experimental environment responsively - if this is appropriate for the experimental methodology.

5.3.3.3. Batched capture

Some scenarios may not always offer on-line data capture for all participants. For example, some physical spaces may not provide connectivity to a computer network; in some points during an experiment data bandwidth may drop below a point at which all responses from users can reliably return data. Here, the sampling technology must have the ability to temporarily (and securely) cache the respond data and then transmit it after the experiment has been completed.

5.3.4. Data processing requirements

5.3.4.1. Data integrity

The EXPERIMEDIA scenarios look ahead to experiments that potentially engage thousands of users over hours or even days. In such a situation, it must be possible to draw up a service level agreement between the experimental technology provider and the device capturing the QoE data. Whilst it is unlikely that the volume of data from any one user will be high, the collective response from a large number of users may be demanding on the data capture service as a whole. Given this possibility, it is important that QoE data collection will:

- Have some form of transaction process (to reduce data loss)
- Have redundancy in its human form of presentation/response where possible
- Have redundancy in its storage options (offering batch mode transfer where possible)

5.3.4.2. Post-experiment data processing

Once the raw QoE data has been captured, it may be necessary to pre-process some of the data types such that the data can be normalized against other responses to the same psychometric measures taken in another form of modality. For example, in cases where users have posted qualitative responses to a social network, this data may require extracting from the social network platform and transforming into a common QoE EXPERIMEDIA format.

5.3.4.3. Data management and description

After the experiment has been conducted and the QoE samples (and other data) have been collected, an initial first step is to partition the data into meaningful units for analysis. To do this, the experimenter may wish to compare the affective responses to particular qualitative factors with the behavioural data associated with particular groups of users. For example, it may be useful to examine to compare the attitudinal responses to the use of video feedback technologies to enhance sporting performance with the frequency of use of the media navigation functionality provided for the purpose.

An early baseline for this type of data analysis should be the provision of basic descriptive statistics. It is typical for QoE measures to use psychometric scales and to report by examining means, standard deviations and principal component analysis. From the perspective of the experimenter, it would be useful for the toolbox to offer these analysis functions to allow comparison and correlation between QoE data sets and other metrics captured within the experimental data set.

5.4. Facility Technology: Testbed management services

Testbed management services provide two major functions:

1) Managing services, both general ones deployed at a testbed and those deployed for a specific experiment.
2) Managing data produced during the use of the facility.

These aspects overlap in the area of monitoring data. Both the service management systems and the researcher need to be able to measure the running system and this data must be stored for later analysis. We therefore also briefly discuss monitoring issues.

5.4.1. Monitoring

If you're not measuring something then you don't know what's going on. Monitoring data can come from a variety of sources and be used for a variety of purposes. Sources include:

- Infrastructure, e.g. measuring CPU load, network traffic or storage occupancy.
- Virtual infrastructure: many virtual machines, virtual networks or virtual storage systems can co-exist on physical infrastructure and have their own measures.
- Application metrics: metrics indicating application-specific information such as "frames per second" for a video streamer. Applications can be components supplied by the EXPERIMEDIA project or may come from an experimenter.
- QoE data: some sorts of QoE data may be gathered and reported systematically during the execution of an experiment.

It is often a requirement that monitoring data from different sources needs to be analysed to discover the state at certain times. For this reason, monitoring data must be time-stamped and sources must all have synchronised clocks.

There are two distinct classes of use cases for monitoring data: those that require live data during the execution of an experiment and those that require a record of monitoring data. Looking at the uses of live data we have:

- A systems administrator may monitor a live system to check its health and adjust its configuration accordingly.
- An automated service management system may monitor and adjust a live system according to defined policies.
- The experimenter may require monitoring data from a live system to help steer an experiment or determine if the experiment should be stopped.
- An experiment component may require live monitoring data to make decisions.
- An experiment may include the provision of certain live monitoring data to the participants.

Cases where access to a record of monitoring data include:

- A systems administrator reviewing the performance of the services provided to an experiment.
- An automated service management system using records of QoS data to provide decision support to a systems administrator.
- An experimenter reviewing what happened during an experiment and perhaps combining that data with data gathered outside of the system.
- Experiment participants reviewing what happened during an experiment (which may play a part in gathering additional QoE data).

With such diverse data sources and access patterns, the access control for all these classes of data must be carefully considered.

5.4.2. Data Management

An experiment cannot be performed without data: data is generated at all points through the experiment lifecycle. The EXPERIMEDIA facility will need to make provision to store experimental data and so we must understand what data there is, when it is generated, how much data there is, how long it must be kept for and who should have access to it.

The following tables attempt to describe the types of data that are expected during an experimental process. For a piece of work using the EXPERIMEDIA facility we must assume that most, but not all, data will be generated by the system or the application under test and that this data will need to be stored for a period of time. Before going into the details of the data types, some requirements are immediately apparent:

- Volumes of data could be very large (video streams for instance).
- Access to most of the data should by default be restricted to the researcher.
- The owner of some data should be able to delegate access to other people and other systems (workflow and analysis tools).
- Data should be kept for a defined time, beyond the time of the experiment and the researcher should have time to download the data they require before it is removed.

Table 1. Data from the "Plan" stage.

Data type	***Source***	***Scope***	***Volume***	***Access***
Notes and ideas	Researcher	Long-term, beyond the EXPERIMEDIA engagement.	Moderate	Generally private to the researcher, not stored by EXPERIMEDIA.
Test descriptor: describes what the test will be in enough detail to be reproducible. This includes the method and desired resources. Parts may be machine-readable.	Researcher	Relates to a specific, individual piece of work.	Small	Machine readable part stored and acted on by EXPERIMEDIA.

Table 2. Data from the "Provision" stage.

Data type	**Source**	**Scope**	**Volume**	**Access**
Contract	Researcher - provider negotiation	Long-term. For the duration of the relationship.	Small: a page or two.	Known to both parties. Could be stored with the experiment data.

Service level agreement (SLA): identifies the expectations and agreed levels of performance.	Researcher-provider negotiation	Relates to a specific, individual piece of work. Will often reference a general *contract*.	Small: a page or two.	Known to both parties. Stored by EXPERIMEDIA and actively monitored.
Information provided to participants	Researcher	Relates to an individual piece of work.	Small	Shared between the researcher and participant.
Formal conditions for participation	Researcher	Relates to an individual piece of work.	Small	Shared between the researcher and participant.
Participant consent data (e.g. signed agreement)	Participant	Relates to an individual piece of work.	Small	To be accessed by the researcher only.
User characteristics (e.g. ages, previous experience)	Participant	Relates to an individual piece of work.	Small	To be accessed by the researcher only.

Table 3. Data from the "Run" stage.

Data type	Source	Scope	Volume	Access
Quality of service (QoS) data: metrics describing the service provided by the system and application under test.	System	Specific to a single run. Collected automatically during the execution of the test.	Can be large	Collected by the system and accessed by the researcher and service management system.
Quality of experience (QoE) data: metrics describing the users' experience.	System and users	Specific to a single run. Some QoE data can be collected systematically and requires user interaction during execution.	Can be large: increasing with number of participants	Collected by the system and accessed by the researcher.
Application outputs	Application under test	Specific to a single run.	Could be very large if it was e.g. multiple HD video streams.	Collected by the system and accessed by the researcher.
Social network streams, e.g. all traffic for a period with a certain keyword.	System	Specific to a single run.	Can be large	Collected by the system and accessed by the researcher.

Table 4. Data from the "Evaluate" stage.

Data type	Source	Scope	Volume	Access
QoE data	Users	Specific to a particular run. Questionnaires following a test can provide further data.	Medium	Collected by the researcher, potentially using online tools. Could be stored in EXPERIMEDIA.
Analysis of data collected during run	Researcher using system tools or own tools	Analysis may be over one or many runs.	Medium	Stored by EXPERIMEDIA if created using system tools.

Table 5. Data from the "Collate" stage.

Data type	Source	Scope	Volume	Access
Reports and publications	Researcher	May be reporting on many experiments just in part using EXPERIMEDIA.	Medium	Not stored in EXPERIMEDIA.

5.4.3. Service Management

We expect that experiments will make use of services, either deployed permanently or on request. Services and other resources along with the required QoS will be described in part of an experiment's test descriptor.

EXPERIMEDIA will provide two service management technologies:

- Infonova R6: a commercial suite of services.
- Ting: software from IT Innovation developed in the EC projects SERSCIS[4] and PrestoPRIME[5].

The service management systems will provide the following functions:

- Test descriptors will used to drive the deployment of infrastructure tools and processes used for the measurement and observation of experiments.
- An orchestration engine will be provided based on the Infonova R6 product for the automation of experiment management processes.

[4] SERSCIS: EC framework 7 project (ICT-SEC-2007.1.7), number 225336.
[5] PrestoPRIME: EC framework 7 project (ICT-2007.4.3), number 231161.

- The SLA services will allow QoS agreements between experimenters and testbed providers to be established based on test descriptors which are incorporated as SLA terms to ensure QoS guarantees, accountability and efficiency in testbed operations.
- Monitoring data will be gathered by the service management system.
- Monitoring data will be displayed to the experimenter (and other actors) in whatever way is most appropriate.

By defining policies in the service management system, the components and services of a running experiment can be automatically reconfigured to meet some QoS terms.

5.5. Facility Technology: Social network integration

The EXPERIMEDIA Socio-Mobile-Visual Toolbox (SMVT) will provide Social Networking support for building software services addressing:

- communication-intensive,
- media-intensive,
- live,
- mobile,
- real-time,
- multi-participant applications.

Social networking today primarily addresses asynchronous communication of people irrespective to their location. Indeed, this point of view infuses even what we currently call "mobile social networking" with a relatively static outlook. "Mobile social networking" primarily refers to:

- Smartphone apps allowing access to standard Social Networks (which are still asynchronous and location independent)
- Location-based apps, such as informing a user of "interesting" nearby places, or informing her when her "friends" are close by (including "easy" Augmented Reality where the "augmentation" involves text tags or icons rather than 3D graphics embedded naturally in the real-world view); commercial examples of such SNS include foursquare and gowalla, which allow users to "check in" at a specific location, and then provide the user with information such as comments other users have made about the same location
- Any attempts to include Social Networking elements in very "high-tech" applications, such as (real) Augmented Reality (c.f. above)

The EXPERIMEDIA Socio-Mobile-Visual Toolbox will provide applications with improved capabilities. Note that the purpose is to experiment with these capabilities – therefore, they are intentionally designed to be highly ambitious initially, so that end-user experiences can be assessed, and the best functionalities of the Toolbox accepted for normal use. The capabilities include:

- Integration with standard Social Network Sites (e.g. Facebook, Google+, hopefully also Diaspora – actual choice to be determined); this means we will facilitate accessing the information available in each user's account on these SNS

- Forming live "groups" based on links between SNS accounts; live groups consist of people linked on the SNS who find themselves in the same location at the same time and create a session in an application that uses the EXPERIMEDIA Socio-Mobile-Visual Toolbox, which (session) will allow live, real-time, location-based social interactions
- Real-time, location based social interactions between members of the group; categories with simple examples here, more discussion in the next section:
    - messaging (simple examples: "come here", "look at this")
    - actions (simple examples: add new friend, follow friend's path)
    - interfacing with the physical world (simple examples: ID object, annotate object)
- Capable supporting functionality to increase the impact of the social interactions above. This includes:
    - Path-finding using the locations of users and constraints on their movements, e.g. when receiving a "come here" message, a user can follow a route suggested by the application, optionally satisfying constraints arising from other messages, such as "see this object"
    - Media-processing software services, such as object identification and face recognition, to support functions such as annotating physical objects with digital metadata

The following list provides the main technical tools that will make up the SMVT:

- Basic tools - Mobile, media-centric Social Network integration:
    - Built-in access to multiple Social Network Sites
    - Access user's SNS accounts, drawing identification info, content and social links from them
    - Explicitly open, modular architecture for content-centric communication of users (examples depend on integrating further components)
        - Draw content from Social Networking Sites
            - e.g. Video Streaming a posted video to a mobile EXPERIMEDIA user
            - e.g. AR mark-up of exhibits with community comments
        - Draw content from Venues
            - e.g. Video Streaming exhibition content to a user
            - e.g. Augmented Reality (AR) enrichment of exhibits
        - Draw content from Devices
            - e.g. Video Streaming similar to a video call
            - e.g. Advanced AR idea: "writing into each other's experience (live)"

        - Contribute content to Social Networking Sites
            - e.g. User generated content, created at Venues, uploaded to SNS
        - Contribute content to Venues
            - e.g. Mark-up exhibits with links to online content
        - Contribute online content about Venues to Social Networking Sites
            - e.g. Add social media annotations to exhibits
        - Share content between End Users, live
            - e.g. Real-time, social interactions of Venue visitors based on SNS groups
    - Social messaging, allowing "live" experiences to be "socially coordinated"
        - Easy formation of user groups to allow shared messaging
        - Real-time status updating for non-intrusive monitoring of the group
        - User messaging with location-based and time-specific content
            - e.g. Setting meeting points, co-ordinating a live agenda, negotiating
    - Sharing content "back" to experiments, to allow the analysis of experiment results
        - Allow monitoring of user "experience" (content viewed, interactions, activities) with experimenters
        - Integrated questionnaires
- Advanced tools - Content processing over the above "mobile, media-centric Social Network integration":
    - Social Content Analytics
        - Cope with large-scale user annotations, likely to be subjective, contradictory
    - Path-finding and/or location recognition for guided user positioning and/or touring
        - Constraints beyond shortest-path, especially visual guidelines
            - e.g. visiting interesting locations, which may be defined as regions
            - e.g. viewing interesting "sights", which may be possible from multiple specific locations

- Visual processing toolbox
  - Depending on the scenarios, the " Socio-Mobile-Visual Toolbox" (SMVT) will integrate State of the Art visual processing components
    - e.g. object recognition
    - e.g. spatial tracking from video feed
- Initiation and/or configuration of EXPERIMEDIA technologies, and/or content authoring using EXPERIMEDIA technologies, through mobile social interfaces
  - User generated content management and delivery
    - Access location-specific content or create content using a mobile device, upload content to SNS, create or change access privileges on the SNS or generate appropriate invitations to the content on the SNS for targeted sharing
  - High quality content production management and delivery
    - Initiate streaming from remote device or location-specific cameras to recipients chosen through social links on SNS
  - 3D Internet tools and services
    - Not yet clear how 3D internet services for end-users can be integrated here
    - However, other SMVT applications can make use of technical capabilities of the "3D Internet tools and services" tools, e.g. 3D model reconstruction from video on the fly
  - Augmented reality tools and services
    - Display socially authored annotations of physical object through AR interface, allow mobile users to create new location-based annotations or content that is only displayed to other users socially connected to the content author, mirror AR world in virtual world on SNS

5.6. Facility Technology: User generated content management and delivery

The EXPERIMEDIA Facility will provide an interesting variety of User Generated Content (UGC) technologies, focusing on the management and delivery of UGC.

- Facilitate the designing of a pervasive game experience
  - Technically advanced feature
  - To be completed in project Year 1 for use in Embedded Experiments

  - Background: will integrate Creator, a software framework for designing and hosting pervasive games, or more generally location-based activities

- Host and game master a pervasive game
  - Technically advanced feature
  - To be completed in project Year 1 for use in Embedded Experiments

- Track the location of people and things in real-time
  - Fundamental feature for EXPERIMEDIA
  - To be completed in project Year 1 for use in Embedded Experiments

- Evaluate user experience among mobile participants
  - Fundamental feature for EXPERIMEDIA
  - To be completed in project Year 1 for use in Embedded Experiments

- Custom-developed sensor-based user interfaces
  - Technically advanced feature
  - To be completed by project Year 2 for use in Open Call Experiments

- Online collection of cross-references design patterns for Game Play Design
  - Fundamental feature for EXPERIMEDIA
  - To be completed in project Year 1 for use in Embedded Experiments

- Embed technology in aesthetically meaningful objects
  - Technically advanced feature
  - To be completed in stages with progress in each of Years 1, 2 and 3 of the project; simple examples possible in Embedded Experiments, full capabilities to be used in Open Call Experiments
  - Example: Ability to embed sensors and technology in everyday objects, clothes, on the body etc.

- Ability to index and cluster large text-based datasets according to semantic similarity
  - Technically advanced feature
  - To be completed in project Year 2 for use in Open Call Experiments
  - More details: Indexing based on vector-space models, employing techniques from computational linguistics to organize, cluster, find and present 'similar' texts based on a metric that resembles semantic similarity as experienced by humans, i.e. texts that are about the same topic, even if they might use different words.

- Development of mash-ups of various kinds of online services

  - To be completed in stages with progress in each of Years 1, 2 and 3 of the project; simple examples possible in Embedded Experiments, full capabilities to be used in Open Call Experiments

- Sound-based navigation in a real-world environment
  - Technically advanced feature
  - To be completed in project Year 1 for use in Embedded Experiments
  - Specifically: integration of the Ping! platform

- Supporting end users to stream live video and audio from their mobile phone, and present it to other people on a web page.
  - Technically advanced feature
  - To be completed in project Year 1 for use in Embedded Experiments
  - Specifically: integration of the MoreVideo platform

5.7. Facility Technology: High quality content production management and delivery

The EXPERIMEDIA Facility will focus on specific important video communication services, providing high quality performance for experiments, where high quality is critical.

- HD Audio/Video Live Transcoding Service
  - In order to distribute audio visual content over the Internet, the content should be encoded properly to ensure the content consumer experience. This includes high codification in H.264 and multiple qualities so the user receives the best possible stream that his network temporal conditions allow.

- HD Live Streaming Service
  - Allow to distribute high quality video to large audience from a good connection supporting different terminals.

- Digital Video Recording (DVR) Service
  - Provide server side (online) support of DVR.

- Time Synchronized Metadata Service
  - Allow to synchronised data with the video which can be used to change the behaviour of the Player, show synchronised information together with the video.

- Collaborative Annotation Service
  - Supporting the server side and web UI to allow annotation of live events in real-time by different users.

- Video Chat Service

- Like Skype but integrated into EXPERIMEDIA Facility.

- Digital library of high quality rich media contents about sustainability facts and education
  - Use in any application of enhanced reality experience rich media contents (video, images, etc...) provided by the SOS-21 partnership with the United Nations Environment Program as well as the UNESCO or the European Environment Agency in Copenhagen.

5.8. Facility Technology: 3D Internet tools and services

The EXPERIMEDIA Toolbox for the 3D internet will be dynamically populated through the Living Lab partner in EXPERIMEDIA, FDF. Example technologies are:

- 3D Virtual Reality Immersive Solutions
  - A user will be represented with an avatar in a 3D representation of Schladming. He/she will be able to interact with sites and vendors within the model.

- Technologies for user centric interactions cross-media channels
  - I participate through my PC or Phone in a game or a TV Broadcast or movie, real-time during the broadcasting.

- Holograms
  - The feature is a holographic 3D broadcast medium that is a unique display system for 180° animation.

- 3D scan with mobile
  - Like Google Goggles but for 3D models.

- Marker-less dynamic motion analysis
  - Using multiple 2D video cameras to track the subject. The data output from each camera is fed into a vision processor which maps every pixel of information and triangulates the location of the subject by seeing where the various camera images intersect.

5.9. Facility Technology: Augmented reality tools and services

- Application for presenting layers in AR apps
  - E.g. when visiting a Venue in winter the application can provide a view through the mobile device showing what it looks like in summer, etc.

- "Classical" augmented reality app for Android providing additional information on mobile devices (e.g. smart-phones, tablets) to items in reality
  - Wikitude does that generally, can be customised in a similar application.

- Marker solutions for AR apps, based on QR-code and similar approaches to improve
    - Pointing mobile device at marker or QR code to provide further information, make positioning more accurate
- Improved positioning for AR apps based on multiple sensors (e.g. accelerometer, GSM, WI-FI signals, etc.)
- Real world augmentation through RFID and NFC technology
    - More information can be displayed; some action can be triggered on the mobile device (e.g. tweeting about the position/Venue, liking an object on Facebook, etc.)
- Presenting 3D models in an AR app
    - A 3D model can be placed in the real world via an AR app, e.g. when constructing new buildings the smart-phone app can show what the final building will look like

5.10. Facility Technology: Cloud infrastructure integration

This technology will be developed under T2.2.7 "Cloud Infrastructure integration" of WP2.2. The main goal of this task is to implement the Cloud computing infrastructure underneath the EXPERIMEDIA facility, following the Infrastructure-as-a-Service (IaaS) cloud computing model. To this direction this task will produce software solutions for the provisioning of virtualized physical resources in terms of computing, networking, and storage. The combination of the software produced within the context of T2.2.7 with the one coming from T2.2.1 "Testbed Management Services" targeting the Platform-as-a-Service (PaaS) cloud model, will constitute a complete Cloud software solution that will be used by the Venues to deploy their own on-premise Cloud platform customized to fit their needs, and possibly offer it to other parties that will be interested in conducting experiments using the Venue's facilities.

To this direction, the focus of T2.2.7 is on using and combining existing and robust open source IaaS software solutions to create cloud computing software that will be able to facilitate more efficiently the deployment and operation of the EXPERIMEDIA FIRE applications. Therefore, the main technologies that will be offered by the Cloud infrastructure are:

- A virtual machine image registry that will be:
    - Equipped with tools for registering and uploading new virtual images that may use a variety of different formats (i.e. VHD, VDI, qcow2, etc).
    - Provides a standard interface for querying information about the available virtual machine images that are already registered.
- Automatic negotiation of the usage of physical resources for using virtualized applications on the EXPERIMEDIA Cloud. This implies the following:

  - Communication with the Testbed Management services for negotiating with the Experimenters the usage of the offered applications using Service Level Agreements (SLAs).
  - Automatic discovery of virtual machine and storage images
  - Efficient allocation of the virtualized services on the physical resources for cost reductions
  - Accounting and billing

- Provisioning and management of the virtual networks of services that are hosted in the physical resources of the cloud focusing on the following points:

  - Deployment of the services in the Cloud resources
  - Elastic cloud computing platform, that is able to scale up and down to meet variations in the workload
  - Hypervisor agnostic platform, i.e. it will provide support for a variety of hypervisors
  - Hardware agnostic platform, i.e. it will provide support for variety of standard hardware configurations.

- Communication of monitoring information about the usage of the running virtual machine instances to the Testbed Management Services. This monitoring facility may be extended to incorporate specific QoE related information that is of relevance to the Testbed Management services and the Experimenter.

5.11. Facility Technology: Security and privacy counter measures

This work package will implement the necessary security and privacy counter measures for data protection compliance as recommended by WP5.1 and in accordance with operation policies of testbed sites.

Security requirements are likely to include:

- Allowing a service to identify the user (known as "authentication" or "AuthN").
- Allowing the user to identify the service to ensure they are communicating with a system they trust.
- Securing the communication channel to prevent eavesdropping by third parties.
- Access control policies to determine, once a user is authenticated, whether they are authorized ("AuthZ") to access or operate on a particular resource.
- Delegation of rights (e.g. if Alice can access a resource, she can permit Bob to access the resource).

Authentication of users can be done in a variety of ways ranging from using simple usernames and passwords, to single sign-on techniques such as Kerberos and Windows Active directory (which uses Kerberos) to digital signatures used in X.509 certificates. For access to highly sensitive data two-factor authentication may be required where two of three classes of information must be provided by the user:

1) something the user knows (e.g. a password, PIN, mother's maiden name)
2) something the user has (e.g. an ATM card or smart card)
3) something the user is (e.g. a fingerprint or iris scan)

The most common form of two-factor authentication is invoked when withdrawing money from an ATM: to do this you need to know the PIN and have the cash card.

In decentralised scenarios involving more than one organisation, systems are needed to permit the system the user is logging into (the "relying party") to trust assertions made by a separate identity provider (such as the user's home system authentication service) so that the relying party can effectively say "well, I can't authenticate this user myself but I can rely on certain other party to authenticate them properly". For web-services, the WS-Federation specification serves this purpose and an adaptation of it (WS-Federation Passive Requestor Profile) is used to federate Microsoft systems such as SharePoint. In the academic world, identity federation of this sort is done using Shibboleth which has been developed as part of the "Internet2" initiative. Modern web applications increasingly use another alternative called OpenID.

To allow the user to identify the service it is common to use transport layer security (TLS) which is also commonly used for securing the communications channel against eavesdropping by way of encryption. TLS typically uses public key infrastructure (PKI) and X.509 certificates to enable the client to verify the server's identity. During the initialisation of the client/server connection (the "handshake") message authentication codes (HMAC) are exchanged. The HMACs are generated using the service's private key and the client can verify the authenticity of the codes because it has either previously had the (independently verified) server's certificate installed into its local trusted list, or knows to trust the certificate authority that issued the server's certificate.

Access control policy systems range from simple access control lists (ACLs) defining which user is permitted to access which resource, through more complex ACLs which also define what operation on what resource a user may execute, to complex specification languages such as the eXtensible Access Control Markup Language (XACML) or SecPAL (from Microsoft).

Delegation of authority has in recent years moved from the corporate and research field into every-day life. Increasingly websites are using delegation to share data between services. For instance, a website may request access to your Gmail address book so that it can link you up with your friends. In some cases this is done badly by directly requesting your Gmail username and password: this is not delegation and the password should not be provided as it permits the website complete control of your email account. In other cases it is done through the OAuth2 protocol where essentially you provide a short-lived token to the website that permits it to just read your address book for a limited time-period. OAuth2 is a limited example of a broader field called object-based security (or "ocaps") where possession of token permits the bearer to execute a limited set of operations on a certain resource or set of resources. Another common example of this technique is in photo-sharing websites where to share (read access to) an otherwise private photo you may send your friends an obscure and unguessable address.

Privacy requirements centre around the handling of user-data and the tracking and tracing of users. We say a user can be "tracked" if it is possible to correlate different pieces of data and say

that they come from the same user (though we do not have to know who that user is). To "trace" a user means to discover which specific user data is associated with.

This task will deliver advanced technical measures necessary to minimise risks to privacy including:

- use of secure data storage, encrypted transfer, controlled and auditable access for different classes of data distributed over the same channel;
- obscuring/removing user identities at source (e.g. in the user's own smartphone or home network, depending on application) to prevent direct user tracing;
- obscuring even the user ID as much as possible (depending on application needs) to prevent user tracking e.g. using peer-to-peer data aggregation networks where individual responses are not needed or using ID obscuration unless user tracking is needed (e.g. for billing or to allow consistent user interactions)
- obscuring location through indirect/delayed routing to prevent individual localisation as much as possible and limit user tracking through correlation of depersonalised data based on its location.

6. Requirements for Embedded Experiments

6.1. Introduction

As explained in Section 2, this Deliverable provides a first, exploratory version of the project's Requirements and Scenarios. At this stage, we have produced what is essentially a first estimation of what requirements we can gainfully impose on the EXPERIMEDIA Facility, simultaneously providing the Venue partners with a first documentation of the technologies they can expect to have available to them for their experiments, and the technology-provider partners with a first documentation of the needs these technologies are intended to satisfy. The priority is not to have a complete set of requirements for a finished software product, but a list of the (sometimes subjectively) most important requirements, which will guide the remainder of the EXPERIMEDIA connectivity phase. We expect to further clarify requirements not just for version 2 of this Deliverable, but much sooner: specifically, as soon as the project's Venue partners can provide feedback to a user-level description of the Architecture (and the choices behind that architecture). This will start at Month 4 of the project (Jan-2012), due to the fact that the first concrete technical choices that will be made in order to define the architecture will offer additional, concrete understanding of the Facility to the Venue partners. The requirements tabulated below are not sufficient for the envisioned final version of the EXPERIMEDIA Facility, which will be useful and exploitable beyond the project itself, but they are sufficient for the consortium to proceed to the first Architecture development phase, pending future iterations to both requirements and architecture. Thus, the current material is successful at meeting its current role in the project lifecycle.

6.2. Requirements

Requirement ID	0
Requirement	Streaming of video rendered in real-time on the "Tholos" system.
Description	This is a more specific case of Requirement 2. The video produced in real time by the "Tholos" system will be connected with the EXPERIMEDIA video streaming capability.
Priority	Mandatory
Responsibility	Task 2.2.4, WP4.3

Requirement ID	1
Requirement	Accessibility to multiple Social Networks.
Description	The EXPERIMEDIA Social Media Tool will provide an API based on SocIoS for built-in access to multiple Social Network Sites, e.g. Facebook, Google+, Twitter etc. It will provide accessibility and handling capabilities of users' SNS accounts.
Priority	Mandatory
Responsibility	Task 2.2.2

Requirement ID	2
Requirement	A video stream produced at a Venue can be streamed to mobile devices at any geographic location
Description	The EXPERIMEDIA facility running at a Venue will provide a video input feature, capturing video from cameras, or receiving a video stream from other IT infrastructure at the Venue. The facility will then be able to provide real-time video streaming (essentially relaying the input video stream) to any compatible receiver, e.g. appropriately connected mobile devices.
Priority	Mandatory
Comments	The EXPERIMEDIA facility will provide a specific input interface for capturing video streams. Each Venue, or experiment at the Venue, must provide any desired video stream to the facility through this interface. Mobile devices will need to have a sufficient internet connection, run a custom EXPERIMEDIA client (or software including this client as a module), and log on to receive this service through an appropriate authentication mechanism.
Responsibility	Task 2.2.4

Requirement ID	3
Requirement	The EXPERIMEDIA "HD Live Streaming Service" allows the distribution of high quality video to a large audience, supporting different terminals.
Description	The EXPERIMEDIA facility includes a high-capability video streaming component, capable of supporting multiple receiving devices at the same time; the receivers may be different types of physical devices.
Priority	Mandatory
Responsibility	Task 2.2.4

Requirement ID	4
Requirement	The "Tholos" audience will be able to send Social messages to the remote Panel of Experts monitoring the presentation.
Description	The EXPERIMEDIA Social Networking components will set up a Social Networking environment in which the "Tholos" audience members can post messages that will be specifically identified in real time as originating from the current presentation. The messages will be provided to the panel members through the standard Social Network interface, and also in an aggregated format.
Priority	Mandatory
Responsibility	Task 2.2.2, WP4.3

Requirement ID	5
Requirement	Experiment-mediated Groups will function through Social Networking Sites to support experiment-specific message exchange during the experiment
Description	The EXPERIMEDIA facility will allow access to a variety of Social Networking Sites through a unified interface. It can set up experiment-specific Groups under the SNSs. It provides the option of making the default environment of the Social Networks essentially transparent, i.e. use the social connectivity information (e.g. Friends links) to interface users with each other, but replacing the presentation layers of the SNSs with an EXPERIMEDIA-specific messaging service. This allows the easy setup of communication channels between users during an experiment. Messages created during the experiment can also be posted to the user's normal SNS profiles if desired.
Priority	Mandatory
Responsibility	Task 2.2.2

Requirement ID	6
Requirement	A specific messaging vocabulary will be provided through the EXPERIMEDIA live + mobile Social Networking capability, to support Group movements, activities and scheduling during an experiment.
Description	The EXPERIMEDIA facility will allow users to send and receive specific messages related to the Group dynamics that are relevant to an experiment where connected users navigate potentially large spaces. The messages consist of imperatives including "come here", "meet at X location at Y time", "see Z object in the Venue".
Priority	Mandatory
Responsibility	Task 2.2.2

Requirement ID	7
Requirement	A recording of the athletes' movements synchronized with audio segments can be saved to a database.
Description	Through the use of the EXPERIMEDIA facility trainers at the CAR facility will be able to record (synchronized) video and audio of training sessions.
Priority	Mandatory
Responsibility	Task 2.2.4, WP4.2

Requirement ID	11
Requirement	An application can be used by trainers to set metadata tags on video and audio.
Description	EXPERIMEDIA metadata manipulation software will give trainers the ability to tag particular video scenes and audio segments of a training session.
Priority	Mandatory
Responsibility	Task 2.2.4, WP4.2

Requirement ID	12
Requirement	A "metadata video overlay application" will provide trainers with an interface to view and manipulate metadata tags on video and audio content.
Description	EXPERIMEDIA metadata manipulation software will give trainers the ability to seek to a specific position of the video using the music tags instead of searching through the content the desired position to show, as fast as possible, what should be corrected.
Priority	Mandatory
Responsibility	Task 2.2.4, WP4.2

Requirement ID	13
Requirement	Experts within Experiment-mediated Groups will manipulate metadata with the use of augmented reality software.
Description	The EXPERIMEDIA facility will allow access to augmented reality software. Using this software, experts can view and manipulate metadata tags. This allows for more efficient ways of synchronizing multiple visual or audio outputs.
Priority	Mandatory
Responsibility	Task 2.2.6

Requirement ID	14
Requirement	Augmented Reality capabilities in EXPERIMEDIA will be delivered on standard mobile devices (e.g. smartphones)
Description	Tools and services will be provided through EXPERIMEDIA augmented reality capabilities thus eliminating current performance bottlenecks of mobile devices through the use of intelligent algorithms. Traditional web information sources will be enhanced to allow their integration in mobile location-based and/or augmented reality applications. The EXPERIMEDIA facility will allow users to manage mobile and/or augmented reality application providing state of the art functionality. Users will be able to overlay multiple video images upon each other, manipulate and output changes.
Priority	Mandatory
Responsibility	Task 2.2.6 (supported by Task 2.2.7 where necessary)

Requirement ID	15
Requirement	A "remote process management application" will provide trainers and athletes with the ability to interact and provide input from remote locations.
Description	Perhaps one of the trainers couldn't be at the site that day, but his opinion is very important. That person might connect with through the EXPERIMEDIA testbed from home and see the same images the team is watching at the swimming pool. The person at home should be able to seek forward and backward how he wants, once he has found the position of the video he wants to comment he could control remotely what the girls are watching on the television next to the swimming pool.
Priority	Mandatory
Responsibility	Task 2.2.4, WP4.3

Requirement ID	16
Requirement	QoE-optimised path-finding capabilities
Description	The EXPERIMEDIA Path-finding application will provide the optimal path and location recognition for guided user positioning and/or touring (e.g. viewing interesting "sights", i.e. also taking into account from where it is best to view something).
Priority	Mandatory
Responsibility	Task 2.2.2 (supported by WP4.1 and WP4.3)

Requirement ID	17
Requirement	Experiment-mediated Groups will function between remote locations though mobile applications.
Description	EXPERIMEDIA facilitates remote user capabilities. Experiment Groups will be able to overlay technical information in real-time, present suggestions and make changes.
Priority	Mandatory
Responsibility	Task 2.2.2

Requirement ID	21
Requirement	A Smartphone application will provide visitors with location-based and activity based information.
Description	Visitors accessing the EXPERIMEDIA mobile application will be provided with list of recommendations regarding nearby walking trails, sites to visit, on-going exhibitions or free parking spots. A map will display all of the related information, including current location and suggested path. The suggestions that are made will be influenced by social media content e.g. things friends liked.
Priority	Mandatory
Responsibility	Task 2.2.2, WP4.1

Requirement ID	22
Requirement	The EXPERIMEDIA facility running on mobile devices will provide location-based (e.g. displayed on Google Maps) and activity-based information appearing in the form of a list.
Description	The EXPERIMEDIA facility will provide information on a map along with suggested sites. The Venue will provide information regarding the listed suggestions through the mobile interface. An Experiment Group will sign into an account and be able to manipulate information regarding suggested meeting locations etc.
Priority	Mandatory
Responsibility	Task 2.2.2, WP4.1

Requirement ID	23
Requirement	The EXPERIMEDIA facility will draw upon social insight and knowledge from online communities and will list customized information tailored to each logged on user. Large scale user generated content, management, delivery and evaluation will be handled by the EXPERIMEDIA testbed.
Description	For example a group will be provided with a link to a restaurant that may take into account the preferences of majority of the members and that takes into account the size. A map providing the closest parking lot with adequate availability in proximity to the desired location.
Priority	Mandatory
Responsibility	Task 2.2.3, WP4.1

Requirement ID	24
Requirement	The Social Network Smartphone application will give users the ability to make collaborative decisions with other remotely located groups.
Description	E.g., a larger group that had been split up would like to make a change regarding the previously proposed meeting place. The EXPERIMEDIA mobile application will give the user the ability to relay information in more than one way, by means of a simple text message, or as a location meeting update notification, or even a voice message. The new proposed meeting location will appear on the application map along with the proposed path.
Priority	Mandatory
Responsibility	Task 2.2.2, WP4.1

Requirement ID	25
Requirement	The EXPERIMEDIA facility will provide the graphical user interface on a mobile application. It will provide the ability to a user/group of users to connect to a Venue Social Network. The software will provide information adequate in dealing with the specific needs of groups visiting the Venue, thus restricting the possible choices but gaining on ease of use. Additionally it will offer users to relate messages (voice/text).
Description	A group may want to change the meeting location previously agreed upon. The graphical interface will automatically update the proposed location on the Social site and notify all related parties. If further explanation is needed the group will be able to send a voice message to all other related groups expecting an update.
Priority	Mandatory
Responsibility	Task 2.2.2, WP4.1

Requirement ID	26
Requirement	The EXPERIMEDIA facility will provide functionality for cooperative production, prioritization and synchronization of UGC across large numbers of (mobile) users in real time. User interfaces will enable visualization and shared control for large scale events, where users could be participating at the same live event, geographically separated live events, or across time in a series of events.
Description	The EXPERIMEDIA facility will handle the complexity of synchronizing input of multiple groups. Multiple inputs provided by a plethora of groups will notify all interested participants of the Social Network group, the application will automatically take the input provided and generate the additional information needed, thus decreasing complexity of use. For example the map locations and suggested paths will automatically be generated based on new proposed meeting location.
Priority	Mandatory
Responsibility	Task 2.2.3 (supported by Task 2.2.2), WP4.1

Requirement ID	27
Requirement	An application relaying video and other relevant information to skiers.
Description	A user accessing the EXPERIMEDIA mobile application will be able to view relevant video information regarding ski lift times, suggested runs of the day and live video feed of junction points on the ski runs.
Priority	Mandatory
Responsibility	Task 2.2.4, WP4.1

Requirement ID	31
Requirement	Scalability of the EXPERIMEDIA Cloud
Description	The EXPERIMEDIA services that will be hosted in the Cloud infrastructure, such as social networking applications, image-rendering services, etc, should be able to support a dynamically varying number of users. Therefore, the EXPERIMEDIA cloud should be able to scale up/out and down to support the variations in the workload, due to the dynamically varying number of users and patterns of requests. To this direction, possible federation solutions with other clouds should also be investigated.
Priority	Mandatory
Responsibility	Task 2.2.7

Requirement ID	32
Requirement	Private and public cloud solution
Description	The EXPERIMEDIA facility should build a complete Cloud software solution that will enable organizations to build their own private cloud platform around it to fit their own needs. The proposed solution should target both the IaaS service model, which refers to the provision of resources (computational, storage, networking and other devices), but also the PaaS service model, which refers to the provision of the platform and the corresponding services (e.g. monitoring, accounting and billing, etc) to enable offering of cloud-based services that will be developed within the context of EXPERIMEDIA. However, depending on the specific EXPERIMEDIA FIRE application that will be deployed in each embedded experiment, it may be desirable to provide the usage of the EXPERIMEDIA facility in the Venues themselves to third parties as a complete product. To this direction, the EXPERIMEDIA Cloud computing software will support the creation of on-premise clouds as well as of public clouds, to support the customers interested in conducting experiments in the existing Venues.
Priority	Mandatory
Responsibility	Task 2.2.1,Task 2.2.7

Requirement ID	33
Requirement	QoS provisioning and support for various types of multimedia services
Description	As the media services that will be deployed in the EXPERIMEDIA facility will support different types of multimedia, for example VoIP, multimedia streaming, image search, image-based rendering, video transcoding, etc, in order to meet their different QoS requirements, the EXPERIMEDIA testbed management services and cloud infrastructure shall provide QoS provisioning and support for various types of multimedia services.
Priority	Mandatory
Responsibility	Task 2.2.1,Task 2.2.7

Requirement ID	34
Requirement	Provisioning for various types of end-user devices
Description	As the described scenarios involve different types of devices, such as personal computers (PCs), smart-phones, and tablet PCs , the EXPERIMEDIA Cloud facility shall be able to adapt the multimedia content to fit the processing capabilities of the different types of devices.
Priority	Mandatory
Responsibility	Task 2.2.4 (supported by Task 2.2.1 and Task 2.2.7)

Requirement ID	35
Requirement	In order to distribute audio visual content over the Internet, the content should be encoded properly to ensure the content consumer experience.
Description	The EXPERIMEDIA HD Audio/Video Live Transcoding Service will support high codification (e.g. in H.264) and multiple qualities so the user receives the best possible stream his network temporal conditions allow.
Priority	Mandatory
Responsibility	Task 2.2.4

Requirement ID	36
Requirement	Certain QoS and QoE requirements will have to be met when accommodating large audiences.
Description	The EXPERIMEDIA HD Live Streaming Service will allow for the distribution of high quality video to large audience from a good connection supporting different terminals.
Priority	Mandatory
Responsibility	Task 2.2.4

Requirement ID	37
Requirement	Synchronization of multiple video feeds and the data it relates to.
Description	The EXPERIMEDIA Time Synchronized Metadata Service will provide the capability to synchronize video with other correlated data, which can be used to change the behaviour of the Player. Users will obtain synchronised information together with the video.
Priority	Mandatory
Responsibility	Task 2.2.4

Requirement ID	41
Requirement	High QoE of voice and video chat capabilities.
Description	The EXPERIMEDIA integrated video chat service will provide communication through voice and video chat. Voice and video chat allows telephone and video calls between pairs of users and conference calling, and uses a proprietary audio/video codec.
Priority	Mandatory
Responsibility	Task 2.2.4

Requirement ID	42
Requirement	High QoE of VR solutions
Description	The EXPERIMEDIA 3D Virtual Reality Immersive Solution will give users the option to interact with other users, vendors and/or sites through a VR world representing the Venue.
Priority	Mandatory
Responsibility	Task 2.2.5

Requirement ID	43
Requirement	High QoE of cross-media integration
Description	The EXPERIMEDIA Technologies for user centric interactions cross-media channels will give users the ability to participate with the use of major platforms mobile and/or PC in a VR game or a TV broadcast in real-time.
Priority	Mandatory
Responsibility	Task 2.2.5

Requirement ID	44
Requirement	High QoS of dynamic motion analysis
Description	The EXPERIMEDIA Marker-less Dynamic Motion Analysis tool will provide capability for generating relevant data regarding tracking subject motion through input provided by a grid of 2D video cameras.
Priority	Mandatory
Responsibility	Task 2.2.5

Requirement ID	45
Requirement	Being able to track the location of users.
Description	The EXPERIMEDIA Tracking tool will handle location tracking input from many devices, and provide location information to any other Facility service or component requiring it.
Priority	Mandatory
Responsibility	Task 2.2.6

Requirement ID	46
Requirement	Provide evaluation features to track quality of services
Description	The EXPERIMEDIA Tracking tool will handle evaluation input from mobile participants.
Priority	Mandatory
Responsibility	Task 2.2.6

Requirement ID	47
Requirement	Ability to index and cluster large text-based datasets according to semantic similarity.
Description	The EXPERIMEDIA Advanced Index Tool will provide Indexing based on vector-space models, employing techniques from computational linguistics to organize, cluster, find and present 'similar' texts based on a metric that resembles semantic similarity as experienced by humans, i.e. texts that are about the same topic, even if they might use different words.
Priority	Mandatory
Responsibility	Task 2.2.6

7. Conclusion

We have further developed the scenarios in the description of work which motivate the project and from these scenarios, the wider future internet perspective and the driving experiments have listed an initial set of requirements for the baseline components of the project.

A second version of this document will be created one year later, at project month 15.

Appendix A. Outline of Project Structure

As the description of work for the project is not a public document, we reproduce the project's hierarchy of activities, workpackages and tasks to aid the readers' understanding.

Activity 1: Project management

- Workpackage 1.1: General coordination
    - Task 1.1.1: Project management
    - Task 1.1.2: Financial administration
    - Task 1.1.3: Quality assurance
    - Task 1.1.4: Programme Management
- Workpackage 1.2: Management of experiments
    - Task 1.2.1: Selection of experiments
    - Task 1.2.2: Integration of experiments
    - Task 1.2.3: Project management of experiments and ethical oversight
    - Task 1.2.4: Management of the 'unfunded experiments'

Activity 2: Construction

- Workpackage 2.1: Architecture blueprint
    - Task 2.1.1: Methodology definition
    - Task 2.1.2: Requirements and scenarios
    - Task 2.1.3: Blueprint architecture
- Workpackage 2.2: Facility building
    - Task 2.2.1: Testbed management services
    - Task 2.2.2: Social network integration
    - Task 2.2.3: User generated content management and delivery
    - Task 2.2.4: High quality content production management and delivery
    - Task 2.2.5: 3D Internet tools and services
    - Task 2.2.6: Augmented reality tools and services
    - Task 2.2.7: Cloud infrastructure integration
    - Task 2.2.8 Security and privacy counter measures
- Workpackage 2.3: Integration and Packaging
    - Task 2.3.1: Verification and validation planning
    - Task 2.3.2: Integration and systems testing
    - Task 2.3.3: Packaging and release

Activity 3: Operations

- Workpackage 3.1: Facility operations
    - Task 3.1.1: Overall facility operations
    - Task 3.1.2: Schladming operations
    - Task 3.1.3: CAR operations
    - Task 3.1.4: Foundation for the Hellenic world operations
    - Task 3.1.5: 3D innovation living lab operations
    - Task 3.1.6: Other facilities
- Workpackage 3.2: Experiment support
    - Task 3.2.1: Definition of support procedures
    - Task 3.2.2: Support desk
    - Task 3.2.3: Training

Activity 4: Experimentation

- Workpackage 4.1: EX1: augmented reality services and UGC at large-scale live events
    - Task 4.1.1: Experiment Design
    - Task 4.1.2: Implementation
    - Task 4.1.3: Execution
    - Task 4.1.4: Analysis and publication
- Workpackage 4.2: EX2: content production and delivery for high quality and 3D Internet-based remote sports analysis
    - Task 4.2.1: Experiment Design
    - Task 4.2.2: Implementation
    - Task 4.2.3: Execution
    - Task 4.2.4: Analysis and publication
- Workpackage 4.3: EX3: shared, real-time, immersive and interactive cultural and educational experiences
    - Task 4.3.1: Design
    - Task 4.3.2: Implementation
    - Task 4.3.3: Execution
    - Task 4.3.4: Analysis and publication

Activity 5: Legal, sustainability and promotion activities

- Workpackage 5.1: Legal, ethical and regulatory framework
    - Task 5.1.1: Ethical, legal and regulatory framework for social and networked media
    - Task 5.1.2: Ethical oversight for Experiments
    - Task 5.1.3: Policy Recommendations

- Workpackage 5.2: Dissemination, promotion and sustainability
    - Task 5.2.1: Strategy, planning and reporting
    - Task 5.2.2: Demand generating activities
    - Task 5.2.3: Provider activities
    - Task 5.2.4: Sustainability planning
    - Task 5.2.5: Establishment of Competence Centre
- Workpackage 5.3: Collaboration
    - Task 5.3.1: FIRE dissemination
    - Task 5.3.2: FIRE forum
    - Task 5.3.3: FIRE portal
    - Task 5.3.4: FIRE architecture board and cross-project implementations
    - Task 5.3.5: FIRE external relations

