This report contains a presentation and discussion of the results of the experiments carried out in Athens and Vigo during the summer of 2013, with participants using the REENACT system to recreate the Battle of Thermopylae. We include evaluation in terms of QoS, QoE and QoC parameters that should be taken into account to target bigger communities, other historical scenarios and other venues than the Foundation of the Hellenic World. A summary of key conclusions about FMI technology and EXPERIMEDIA is also included.
<table>
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<th>Project acronym</th>
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<tr>
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<td>Experiments in live social and networked media experiences</td>
</tr>
<tr>
<td>Grant agreement number</td>
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</tr>
<tr>
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<td>Workpackage 4.9</td>
<td>REENACT experiment</td>
</tr>
<tr>
<td>Deliverable lead organisation</td>
<td>UVIGO</td>
</tr>
<tr>
<td>Authors</td>
<td>Martín López-Nores (UVIGO), Yolanda Blanco-Fernández (UVIGO), José Juan Pazos-Arias (UVIGO), Alberto Gil-Solla (UVIGO), Jorge García-Duque (UVIGO), Manuel Ramos Cabrera (UVIGO)</td>
</tr>
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<td>Nicholas Vretos (CERTH) and Dimitri Nicolopoulos (ICCS)</td>
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<tr>
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</tr>
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1. Executive Summary

This document reports the findings of the REENACT experiment, following the experimentation sessions carried out in Athens and Vigo during the summer of 2013. The work plan of REENACT was followed as presented in D4.9.1, “REENACT Experiment: Problem Statement and Requirements”, with tasks allocated over four phases:

- **PLAN (PM13 to PM15, completed).** The goal of the PLAN phase was to fully work out the problem statement and the experiment design, bearing in mind the advance of Activity 3 (construction of the EXPERIMEDIA facility). An initial review of the ethics and privacy considerations was conducted. Moreover, implementation and experimentation plans were sketched to drive the rest of the work. The results from this stage were gathered into D4.9.1.

- **PROVISION (PM15 to PM20).** The PROVISION phase deals with the realisation of all the processes required to obtain the IT and human resources needed to run the experiment at the FHW. From PM15 to PM18, the efforts were devoted towards implementation of the elements of the REENACT system, which started to be integrated during PM19 and were completed in PM20.

- **RUN (PM21 to PM23).** During the RUN phase, between PM21 and PM23, the goal was to collect as much data as possible for the evaluation of QoS, QoE and QoC as explained in D4.9.1 and D4.9.2. Concurrently to the experiments being run, UVIGO personnel would examine the feedback gathered in order to prepare new releases of the REENACT software, solving bugs and implementation defects. The software and documentation were updated in D4.9.3.

- **EVALUATE (PM22 to PM24, current).** Finally, the EVALUATE phase was devoted to analysing the data gathered during the RUN phase. Conclusions are presented in this document.

The conclusions in this document include a final update on the integration of the REENACT system with the EXPERIMEDIA facility.
2. Overview of the experiments

The core of the experimentation for REENACT was conducted during the summer of 2013 in the Hellenic Cosmos (the venue provided by the FHW in Athens). Taking advantage from the fact that the General Assembly of EXPERIMEDIA would be held from June 10th to 12th, the FHW took the lead to arrange experimentation sessions for REENACT as well as for the BLUE experiment between June 13th and 16th. The FHW itself and the University of Peloponnese recruited participants among their communities of visitors, students, researchers and other staff. They were all asked to sign the informed consent of Figure 1.
The FHW experimentation plan was supplemented by LWGO with an "auto experimentation system" between May 27th and June 7th (to get early feedback and fix defects in the software or in sessions between May 27th and June 7th) to analyse what you did during stage 1. After living the event from inside, with a very partial vision, it is turn to learn more by watching things from outside, seeing how your recreation compares to the real historic events. The explanations will be given by one expert connecting from a remote location.

Finally, in stage 3, the expert will drive a (short) collective brainstorming about the consequences of the event in the short, medium and long term. Using the mobile device, you will be able to provide comments and rate the ones provided by the other participants.

PURPOSE OF DATA COLLECTION AND PROCESSING

The data collected or logged during the experiment will be used in order to draw conclusions about parameters and design aspects that influence quality of service and levels of satisfaction. The treatment will be statistical and not per individual.

Data gathered will include the information you are generating through a mobile device during the course of the experiment, plus your replies to a questionnaire that will be delivered at the end of testing. No personal data will ever be handled, monitored or recorded. Your personal details (name and surname) only exist in the present document, which will be kept in the project file and not be available to anyone but the coordinator of the REENACT experiment, Mr. Martín López from the University of Vigo.

RECIPIENT OF THE DATA

The data collected or logged during the experiment will only be available to the experimenters and not be used for any other purpose. There is no commercial intention behind the collection of the data, so no third parties will ever be allowed to access them and no transfers will be permitted.

FREE CONSENT

I declare that I have read the above, that I agree with the terms and conditions and that I want to participate in the REENACT experiment of the EXPERIMEDIA project.

Name
Signature Date
the experiment design) and *ex post* sessions between July 22\(^{nd}\) and August 9\(^{th}\) (to gather further evidence for the evaluation). Again, participants were recruited among the communities of students, researchers and other staff of the University of Vigo.

The following table summarises the dates, the number of participants and the sessions completed after those three rounds of experimentation:

<table>
<thead>
<tr>
<th>Dates</th>
<th>Location</th>
<th>Number of participants</th>
<th>REENACT sessions completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 27(^{th}) to June 7(^{th})</td>
<td>School of Telecommunication Engineering, University of Vigo, Vigo, Spain</td>
<td>24</td>
<td>4</td>
</tr>
<tr>
<td>June 13(^{th}) to June 16(^{th})</td>
<td>Hellenic Cosmos, Athens, Greece</td>
<td>19</td>
<td>4</td>
</tr>
<tr>
<td>July 22(^{nd}) to August 9(^{th})</td>
<td>School of Telecommunication Engineering, University of Vigo, Vigo, Spain</td>
<td>18</td>
<td>3</td>
</tr>
</tbody>
</table>

As explained in D4.9.2, the experiment intended to measure and assess the value of the REENACT proposal in terms of key performance indicators derived from *Quality of Service* (QoS), *Quality of Experience* (QoE) and *Quality of Community* (QoC) metrics. The *Experiment Control Component* (ECC) of the EXPERIMEDIA facility was set up to monitor a number of parameters (see sections 3 to 5), and the rest of the data came from the questionnaire shown in Figure 2.
Finally, it is worth noting that the devices to be used in the experiments were provided by UVIGO, knowing that the software required certain capabilities that might not be available in

![EXPERIMEDIA](image)

Please rate the following features of your REENACT experience from 1 (least positive, strong disagree, a little bit...) to 5 (most positive, strong agree, quite a lot...).

**QUESTIONNAIRE**

How do you rate the educational potential of the REENACT approach...?
- ☐ 1  ☐ 2  ☐ 3  ☐ 4  ☐ 5
- ☐ for children?
- ☐ for teenagers?
- ☐ for adults?

How do you rate the level of entertainment...
- ☐ 1  ☐ 2  ☐ 3  ☐ 4  ☐ 5
- ☐ for children?
- ☐ for teenagers?
- ☐ for adults?

How do you rate the quality and completeness of the contents available for the event of the Battle of Thermopylae?
- ☐ 1  ☐ 2  ☐ 3  ☐ 4  ☐ 5

Do you think the REENACT approach can be a valuable asset for History-related museums?
- ☐ 1  ☐ 2  ☐ 3  ☐ 4  ☐ 5

Do you think the REENACT approach can be a valuable asset for educational institutions?
- ☐ 1  ☐ 2  ☐ 3  ☐ 4  ☐ 5

Please rate the value and interest of the reenactment game.
- ☐ 1  ☐ 2  ☐ 3  ☐ 4  ☐ 5

Please rate the value and interest of the interactive maps.
- ☐ 1  ☐ 2  ☐ 3  ☐ 4  ☐ 5

Please rate the value and interest of 360° views.
- ☐ 1  ☐ 2  ☐ 3  ☐ 4  ☐ 5

Please rate the value and interest of the augmented-reality features.
- ☐ 1  ☐ 2  ☐ 3  ☐ 4  ☐ 5

Please rate the value and interest of video footage.
- ☐ 1  ☐ 2  ☐ 3  ☐ 4  ☐ 5

Please rate the value and interest of background music.
- ☐ 1  ☐ 2  ☐ 3  ☐ 4  ☐ 5

Please rate the value and interest of the expert's audio and video feeds.
- ☐ 1  ☐ 2  ☐ 3  ☐ 4  ☐ 5

Please rate the value and interest of multiple-choice questions.
- ☐ 1  ☐ 2  ☐ 3  ☐ 4  ☐ 5

Please rate the value and interest of social networking among participants in REENACT experiences.
- ☐ 1  ☐ 2  ☐ 3  ☐ 4  ☐ 5

Any textual comments will be greatly appreciated.
mobile devices brought by the participants. Specifically, UVIGO leased six Samsung Galaxy Tab 7.7 tablets under the conditions stated in the agreement of Figure 3.

Figure 3. The device loan agreement.
3. QoS findings

As explained in D4.9.2, the QoS measurements are using the following parameters:

- CPU, battery and memory consumption of the reenactors’ app
- Quality and latency of the pre-recorded videos delivered to the reenactors’ app
- Quality and latency of the expert’s video feed from a remote location to the projection screen

At this point, it is worth to include the specifications of the Samsung Galaxy Tab 7.7 devices:

<table>
<thead>
<tr>
<th>DESIGN</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Device type</td>
<td>Tablet</td>
</tr>
<tr>
<td>Operating system</td>
<td><strong>Android (3.2 or 4.0.4)</strong></td>
</tr>
<tr>
<td>Dimensions</td>
<td>196.7 x 133 x 7.89 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>335 g</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DISPLAY</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical size</td>
<td>7.7 inches</td>
</tr>
<tr>
<td>Resolution</td>
<td><strong>1280 x 800 pixels</strong></td>
</tr>
<tr>
<td>Pixel density</td>
<td>196 ppi</td>
</tr>
<tr>
<td>Technology</td>
<td>Super AMOLED Plus</td>
</tr>
<tr>
<td>Colors</td>
<td>16,777,216</td>
</tr>
<tr>
<td>Touchscreen</td>
<td>Multi-touch</td>
</tr>
<tr>
<td>Features</td>
<td>Light sensor</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BATTERY</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td><strong>5100 mAh</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HARDWARE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Processor</td>
<td>Dual core, 1400 MHz</td>
</tr>
<tr>
<td>Graphics processor</td>
<td><strong>Mali-400MP GPU</strong></td>
</tr>
<tr>
<td>System memory</td>
<td><strong>1024 MB RAM</strong></td>
</tr>
<tr>
<td>Built-in storage</td>
<td>64 GB</td>
</tr>
<tr>
<td>Storage expansion</td>
<td><strong>microSD, microSDHC up to 32 GB</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CAMERA</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Camera</td>
<td>3 megapixels, LED flash, auto focus</td>
</tr>
<tr>
<td>Camcorder</td>
<td>720p HD, video calling</td>
</tr>
<tr>
<td>Front-facing camera</td>
<td>2 megapixels</td>
</tr>
</tbody>
</table>
In terms of CPU and memory usage, it was found that none of the features of the reenactors’ app exceeded the capabilities of the device, even though the Augmented Reality navigation (due to the identification and processing of the 2D markers plus the rendering of the 3D models) reached peaks of 80% CPU and 55% memory usage. This fact suggests that devices with lower specifications could have problems while running the app—at least, the users would have to face longer loading times. Yet, the biggest concern in this regard relates to the splash screens displayed while loading the Metaio software, which caused severe delays (up to 20 seconds) not related to any computations, but rather to the fact that REENACT was using a free version of Metaio.

In regard to battery consumption, it was found that the whole REENACT experiences—with up to 20 minutes for replay and debate—would take up an average of 43% of the full capacity (5100 mAh). The greatest contributions were due to the AR processing and the Wi-Fi communications through the REENACT server. Screen activity also has an effect, to the point that a simple implementation feature like preventing it from turning off (following periods of inactivity) could add up to 15% consumption from the end of the reenactment stage to the end of the debate.

The videos delivered to the reenactors’ app from the REENACT server could be displayed in native resolution (1280 x 800 pixels) with an average latency of 3.2 seconds, which nobody complained about.

Finally, the transmission of the expert’s video feed was relayed in two different configurations: one provided by UVIGO through WebRTC technology, and the other using an AVCC component provided by ATOS. The WebRTC implementation had a lower memory footprint on both sides of the communication, but had some problems traversing different network configurations (e.g. it required some tweaking depending on whether the expert was using the UVIGO campus network or not). The AVCC component worked flawlessly in all the scenarios.
In principle, the UVIGO team was also concerned about the delays in switching the contents displayed on Tholos screen, which was hard-wired to special media servers that could need some time to load. In the end, it turned out that REENACT would use four different regions of the screen, which the FHW staff connected to separate computers. Given the appropriate permissions, it was possible to connect those computers to four different views provided by the expert’s front-end (see D4.9.3) through a web browser. There were no problems regarding connectivity or latencies at any time, and the expert’s participation in the replay and debate could be handled practically in real time.
4. QoE findings

The main input to assess Quality of Experience was the questionnaire of Figure 2. The 61 responses yield the following averages between 1 (least positive, strong disagree, a little bit …) to 5 (most positive, strong agree, quite a lot…).

<table>
<thead>
<tr>
<th></th>
<th>Quality and completeness of the contents available for the Battle of Thermopylae</th>
<th>3.5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Educational potential of the REENACT approach…</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>… for children</td>
<td>4.1</td>
</tr>
<tr>
<td></td>
<td>… for teenagers</td>
<td>3.9</td>
</tr>
<tr>
<td></td>
<td>… for adults</td>
<td>4.3</td>
</tr>
<tr>
<td>3</td>
<td>Level of entertainment…</td>
<td></td>
</tr>
<tr>
<td></td>
<td>… for children</td>
<td>3.4</td>
</tr>
<tr>
<td></td>
<td>… for teenagers</td>
<td>3.1</td>
</tr>
<tr>
<td></td>
<td>… for adults</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>Opinion about REENACT being a valuable asset for History-related museums</td>
<td>4.4</td>
</tr>
<tr>
<td>5</td>
<td>Opinion about REENACT being a valuable asset for educational institutions</td>
<td>4.1</td>
</tr>
<tr>
<td>6</td>
<td>Value and interest of the reenactment game</td>
<td>4.4</td>
</tr>
<tr>
<td>7</td>
<td>Value and interest of the interactive maps</td>
<td>4.1</td>
</tr>
<tr>
<td>8</td>
<td>Value and interest of 360° views</td>
<td>4.6</td>
</tr>
<tr>
<td>9</td>
<td>Value and interest of the augmented-reality features</td>
<td>3.4</td>
</tr>
<tr>
<td>10</td>
<td>Value and interest of video footage</td>
<td>3.8</td>
</tr>
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<td>11</td>
<td>Value and interest of background music</td>
<td>3.2</td>
</tr>
<tr>
<td>12</td>
<td>Value and interest of the expert’s audio and video feeds</td>
<td>3.7</td>
</tr>
<tr>
<td>13</td>
<td>Value and interest of multiple-choice questions</td>
<td>3.8</td>
</tr>
<tr>
<td>14</td>
<td>Value and interest of social networking among participants in REENACT experiences</td>
<td>3.1</td>
</tr>
</tbody>
</table>

Overall, the ratings were quite positive, even though the participants were actually faced with just a prototype of what the REENACT experiences could be like, given sufficient time and effort to develop a full-fledged scenario — whereas much of the work within the EXPERIMEDIA project was in technical development. In this line, the average rating for point (1) above suggests that it is not really necessary to create a wealth of content about an event, since it appears to be more important to ensure that all the participants have something to do at every time during the reenactment stage — dead times allowed by the current script of the Battle of Thermopylae had a negative impact on point (3). The same goes for the dead times while waiting for Metaio to load, which several participants criticised as severe drawbacks (especially for children and teenagers, who tend to be more impatient than adults).
Points (2), (4) and (5) show that participants, in general, appreciate the novelty and potential value of the REENACT proposal when concerning History-related museums and educational institutions. These are positive findings that can make us think about further development and actual commercial exploitation of the REENACT system.

Points (6) to (14) are ratings for different technical features of the REENACT system. The lowest values highlight points that should be improved in the future. Criticism regarding the AR features was, most likely, not due to a lack of appeal on the participant side, but rather to the long loading times that caused a sensation of tiredness every time the script required one person to move from one place of the reenactment space to another. The background music was expressed as being “difficult to notice” most of the times. Finally, the social networking features were criticised for being “little more than one chat” in the current state of implementation, and many participants expected to find something closer to what they can do on Facebook.

The aforementioned comments relating to the mood of the participants during the REENACT experiences were in line with the numbers reported by the mood control available on the main screen of the reenactors’ app (see Figure 4). Statistical analysis of the data gathered by the ECC, coupled with the events recorded during the reenactment stage, showed that participants had positive mood most of the time. Bad mood was only apparent sometimes after returning from the AR navigator and during idle times allowed by the current script of the Battle of Thermopylae.

Figure 4. In the middle of the screen, the slider control indicates the user’s mood at any time during the reenactment stage.
The following are some of the comments gathered in the free text boxes included at the end of the questionnaire.

<table>
<thead>
<tr>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>“It would be nice if you could return to the augmented reality features once you have found where you needed to go.”</td>
</tr>
<tr>
<td>“The 360º views should be enriched to enable more interactions than just looking around.”</td>
</tr>
<tr>
<td>“More decision paths (potential ends) should be added to the gameplay.”</td>
</tr>
<tr>
<td>“The usability of the application would further improve with a consistent set of symbols to be used.”</td>
</tr>
<tr>
<td>“I would like to have more videos and mini-games.”</td>
</tr>
<tr>
<td>“The game of reenactment should be faster and not have so much waiting. The AR should also be available during the waiting.”</td>
</tr>
<tr>
<td>“The expert should make more questions and work to engage the users more into the chat.”</td>
</tr>
<tr>
<td>“Smart idea. You have to try more about speed!”</td>
</tr>
<tr>
<td>“I see great values for museum here, to teach about events in the regional scope.”</td>
</tr>
<tr>
<td>“You get significantly different experiences depending on the role you are given. As Ephialtes, I was idle for very long times.”</td>
</tr>
</tbody>
</table>

The experts’ opinions were also assessed in conversations with the experimenters. In general, they appreciated the information provided by the experts’ front-end, but they agreed it would have been useful to have other sources of feedback from the reenactors apart from the chat. Yet, they did not think that a live video feed from the conference room would help, especially under the dark environment inside the Tholos.
5. QoC findings

QoC measurements were aimed at checking whether the social activities sought during the reenactment stage and the replay and debate occurred uniformly or in “islands”, i.e. only among people who knew each other beforehand. To this aim, the reenactors’ app displayed a list of the nicknames of all the participants, so that each user would tick those of his/her acquaintances. With this data, as explained in D4.9.2, the ECC recorded the following parameters:

- Number of ratings and comments entered in the social room
- Number of ratings and comments between acquaintances
- Ratio of positive/negative ratings between acquaintances
- Number of ratings and comments between participants who did not know each other before the experiment
- Ratio of positive/negative ratings between participants who did not know each other before the experiment

Whereas subjective evaluations from the experimenters suggest that strangers did keep distances during the reenactment, analysis of the data gathered by the ECC for the aforementioned parameters revealed that there were nearly 24% more interactions between acquaintances than between strangers, but the ratio of positive/negative ratings was 13% better in the latter case, as if strangers would only blur distances for good.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of ratings and comments entered in the social room</td>
<td>273</td>
</tr>
<tr>
<td>Number of ratings and comments between acquaintances</td>
<td>151</td>
</tr>
<tr>
<td>Ratio of positive/negative ratings between acquaintances</td>
<td>61%</td>
</tr>
<tr>
<td>Number of ratings and comments between strangers</td>
<td>122</td>
</tr>
<tr>
<td>Ratio of positive/negative ratings between strangers</td>
<td>74%</td>
</tr>
</tbody>
</table>

These figures suggest that the participants in the REENACT experiences could actually be seen as a sporadic social network of people doing something together for some time, rather than just a group of people doing something in the same room. Actually, several users wrote comments asking for more sophisticated social networking features (e.g. linking to real Facebook accounts), but these went beyond the privacy limits imposed by the EXPERIMEDIA experimentation guidelines.
6. Some pictures of the experiments

Figure 5. One participant acting as if she were dead during the session of June 13th.

Figure 6. Participants looking for their next locations during the session of June 16th.
Figure 7. Participants looking at 3D views during the session of June 13th.

Figure 8. The expert appearing on one side of the Tholos dome during the session of June 16th.
Figure 9. Participants watching the expert during the session of June 13th.

Figure 10. Participants replying to a question raised by the expert during the session of June 16th.
7. Update on dissemination efforts

During the preparation of the experiment, UVIGO (sometimes in collaboration and co-authorship with Prof. Manolis Wallace from the FHW) has made submissions to present the ideas and goals behind the REENACT experiment to the scientific community in the area of technology-enhanced learning. Since no results were available yet, those submissions were extended abstracts or proposals for demonstration, intended to get early feedback that could be useful to assess the value impact of the proposal.

The first paper, titled “REENACT: Learning about historical battles and wars through augmented reality and role-playing — An EXPERIMEDIA experiment”, was submitted to the 5th International Conference on Computer Supported Education (CSEDU). It was accepted for oral presentation, which was delivered by Prof. Yolanda Blanco-Fernández in Aachen, Germany in May 2013. The paper appeared in the CSEDU proceedings with a length of 6 pages.

The second paper, titled “REENACT: Augmented reality and collective role playing to enhance the pedagogy of historical events — An EXPERIMEDIA Experiment”, was initially submitted to the 13th IEEE International Conference on Advanced Learning Technologies (ICALT), to be held in Beijing, China in July 2013. The paper was 5 pages long, but due to the absence of results it was accepted as a 2-page paper for poster presentation. UVIGO personnel found it hard to justify the cost of a trip to China for such a humble merit, and therefore the submission was withdrawn. The paper was updated with new material and submitted to the 10th International Conference on Signal Processing and Multimedia Applications (SIGMAP). The paper was accepted and presented by Prof. Martín López-Nores in Reykjavík, Iceland in July 2013. It appeared in the SIGMAP proceedings with a length of 8 pages.

One extended abstract titled “REENACT: Future Media Internet technologies for immersive learning about historical battles and wars” has been accepted to be presented at the eChallenges 2013 event, to be held in Dublin, Ireland in October. Prof. Alberto Gil-Solla will take that opportunity to present some of the results included in this document.

Finally, a 6-page paper titled “Leveraging Short-Lived Social Networks in Museums to Engage People in History Teaching” has been accepted for presentation at the 8th International Workshop on Semantic and Social Media Adaptation and Personalization (SMAP), to be held in Bayonne, France in December 2013. This article puts forward some of the ideas UVIGO will seek to develop after the end of the REENACT experiment within EXPERIMEDIA.

In addition to submissions to conferences, the REENACT experiment has made it into local and regional media, as it can be seen in the following links:

http://duvi.uvigo.es/index.php?option=com_content&task=view&id=6763&Itemid=23
http://www.farodevigo.es/gran-vigo/2012/12/19/universidad-recluta-300-termopilas/729080.html
Finally, Prof. Martín López-Nores was invited to give talks about REENACT at two cultural events in the cities of Ourense and Santiago de Compostela:

- “A historia no medio” (“History in the media”, http://historiaourense.blogspot.com.es/p/a-historia-no-medio.html) on April 5th, 2013. This event was a space to discuss the connection of History with other disciplines, making visible the role of the historian in the world and the social setting of the speech as a collective construction, structured in the form of short presentations and panel discussions.
- “Relaciones entre creatividad e cultura” (“Relationships between creativity and culture”, http://www.cidadedacultura.org/es/evento/creatividad-y-tecnologia) on September 27th, 2013. This was a theoretical-practical workshop about the role of technological tools in the construction of new workflows, new services and new cultural formats.

UVIGO sees these events as opportunities to get additional feedback about the design of the REENACT experiment and, above all, to explore exploitation opportunities in contact with stakeholders of the cultural sector.
8. Conclusions

In this section, we provide a summary of conclusions about the REENACT system, wondering about its potential impact in commercial exploitation, and about the FMI facility being developed within the EXPERIMEDIA project.

8.1. About the REENACT impact

The experimentation was ultimately intended to evaluate the impact of the REENACT proposal for cultural venues like the Foundation of the Hellenic World, as well as for the different people involved in the experiences. The analysis of the data gathered during the summer of 2013 served to assess the potential truth of some claims included in D4.9.1:

- “Museum educators will be able to participate in a new type of collective experience, supplementing the expertise and knowledge provided by the experts in replays and debates.”
  - The feedback gathered from the FHW staff and other representatives of cultural institutions attending the dissemination events listed in Section 7 confirmed the potential interest of the REENACT proposal in the cultural domain, with several people emphasizing the interest of using the system to recreate events in the local and regional scopes. REENACT brings in possibilities to make the most of (possibly unused) spaces, technological facilities, content and personnel in venues like the FHW, offering of a new kind of collective experience to reinforce the understanding of events that have shaped the history of a certain area of the world.

- “Museum visitors will enjoy new edutainment experiences aimed at improving the understanding of historic events, relying on social networking functionalities and augmented reality capabilities. They will also have the opportunity of interacting with one another, and also with geographically distributed experts via user-friendly interfaces. The most likely target group is that of schoolchildren accompanied by their teachers.”
  - The opinions gathered from the participants in the experiments reinforced the idea that REENACT is appealing to a wide audience. However, it seems necessary to redesign or reimplement some aspects to avoid idle times and waiting times that may have a negative effect on children and teenagers.

- “Experts will be able to offer their services to collaborate with museum educators in new pedagogical experiences, interacting more closely than ever before with people interested in knowing more about major historical events. They will be able to efficiently browse repositories of multimedia contents to relate historical facts to specific situations lived by museum visitors during the reenactment of the events, providing annotations, images, diagrams, animations, video clips, etc. Besides, they will be able to conduct live debates about the consequences of the fights in the short, medium and long terms.”
  - The feedback gathered from historians confirmed their interest in participating in REENACT sessions as an additional outlet for their professional activities. They were curious about the proposal and emphasized the importance of having professional assessment in the debates, to prevent an a-historical reasoning process.
that may have exactly the opposite effects of those desired. Nonsensical questions could only speculate more and more hypotheses and not help to understand the complexity, interdependence and causality of the historical process.

- “Content creators/providers will find an additional outlet for the multimedia contents they produce, which will be usable to provide historically-meaningful explanations to the situations arisen during the reenactments and to the arguments raised during the debates.”
  
  o Even though it was found that participants in the reenactment of the Battle of Thermopylae could be reasonably pleased with only a few pieces of content, they usually made comments asking for more stuff, especially videos and 3D views of the different locations of the game. Additional contents could be important to fill in idle times, too. This suggests that content creation may be a crucial aspect to be considered in the budget of any new scenario for the deployment of the REENACT solution.

- “Last but not least, the experimenters will draw useful conclusions from metrics proposed to assess QoS, QoE and QoC from the data gathered during the experiments, about the ease of use of the game-like interfaces provided for the reenactment, the didactic value of the different stages, the interest of engaging in social discussions, etc. This valuable insight will serve to enhance their ongoing research activities in the area of information services, which deal with various flavours of technology-enhanced distance learning.”
  
  o Undoubtedly, the UVIGO team has learnt a lot from the development and testing of the REENACT system, and they will keep an eye on possibilities for commercial exploitation in parallel with their continuing research activities on generalising the idea of the kind of sporadic social networks that built up during the experiments.

By means of the dissemination efforts discussed in Section 7, it was also found that the REENACT proposal might be just as suitable for primary or secondary education institutions as well as for History-related museums. Educators encountered at divulgation events and research conferences (as well as some who participated in the experiments themselves) highlighted the potential interest of the idea and asked the UVIGO team to keep developing the system together with new scenarios. This way, commercial exploitation of the solution could also happen through the selling of the technology, its implantation in schools, training courses for professors, implementation of reenactment scripts and production of multimedia content.

8.2. About the FMI facility

Deliverable 4.9.1 summarised the findings and expectations of the UVIGO team regarding some of the pieces of software included in the baseline components of the EXPERIMEDIA facility. This section provides a discussion about up to what point those pieces were finally used and those expectations were fulfilled, while bearing in mind that REENACT (just like the other experiments from the 1st Open Call) was intended to push forward the development of the facility.
8.2.1. Usage of the Pervasive Content Component

The relevant features of the Pervasive Content Component (PCC) of the EXPERIMEDIA facility for REENACT were the following:

- Orchestration of live games
- Location tracking
- QoE measurement
- Augmented reality

The live game of the reenactment stage required means to orchestrate events entering and leaving the reenactors' front-ends according to a given script. Those means were to be provided by the Creator environment, contributed by the Interactive Institute. Unfortunately, due to insufficient early documentation, UVIGO personnel were unable to implement the interactions envisaged for the Battle of Thermopylae. Interactive Institute committed to providing an implementation themselves, but this did not arrive until the experimentation sessions of May, June and July had been completed. Those sessions could be carried out thanks to an implementation of the interactions on the REENACT server, with constructs defined ad hoc for that specific event.

Interactive’s implementation of the script for the Battle of Thermopylae came during the first days of August 2013. It can be browsed in the Appendix. Following some reviews by UVIGO, the implementation is to be tested during the second half of September, using Android clients to trigger and listen to events. If those tests are successful, it will be quite an easy task to move from the current orchestration provided by the REENACT server to orchestration provided by the Creator, with changes to a few classes of the software provided as part of D4.9.3. Overall, with the hands-on work of the last weeks, UVIGO has quite positive feelings about the possibilities and value of the Creator:

- First of all, the members of the UVIGO staff are convinced that the Creator is a very powerful tool for its purposes, grounded on sensible abstractions and wise design decisions. It can readily support much more complex interactions than the ones that had been implemented in the REENACT server, allowing for a variable number of participants, a more flexible procedure for the distribution of roles, etc.
- Furthermore, UVIGO has found that the Creator can be a convenient place to store additional content linked to different roles and states: text (either plain or HTML-formatted), images, 3D models, AR markers, etc. This would leave only audio and video to the AVCC, as one would expect. Following this design idea while developing the first working version of the REENACT system would have made the reenactors’ front-end much lighter and also reduce the burden on the REENACT server.
- Finally, UVIGO has learnt lessons about how to specify interactions in this kind of games, partially thanks to the documentation Interactive delivered during the GA in Athens. Those patterns would help to rewrite the script of the game for the Battle of Thermopylae in a radically different way, which would be easier to understand, maintain and scale.
UVIGO people believe the Creator's sample implementation for REENACT, together with the sample Android client created for testing purposes, can be a good starting point for others, including, of course, 2nd Open Call experimenters. The documentation is becoming better and better, so it should be easier for them than it was for UVIGO.

Apart from the orchestration of events in the live game, REENACT was first thought to rely on means to track the movements of the participants, at least to recreate the main locations relevant to the event in question. The Tracker service proposed for the “Location tracking” element of the PCC seemed to be a tool with which one could keep track of a group of people in real-time, fed by GPS data. This was not suitable for REENACT for two reasons: (i) the precision attained by GPS is generally too coarse for the scale of the movements expected from the reenactors, and (ii) GPS does not work well in indoor environments, which is the first choice of the experimenters. In the absence of precise mechanisms for indoor location tracking, the experimenters decided to sacrifice the recreation of precise army moves, while maintaining the delimitation of different zones in the reenactment space, which would be identified and recognised by means of bidimensional codes. It did not seem feasible at any time during the project to implement finer location mechanisms with Augmented Reality solutions with people moving around —it would require too much tweaking or manual intervention. This feature was not considered crucial for the experiment, anyway, and doing without it made some things easier for the experimenters to implement and for the reenactors to understand, even though the feeling of immersion was reduced.

In regard to “QoE measurement”, the PCC included the Babylon software provided by the Interactive Institute, which is a tool intended to evaluate the opinions of the users while they utilise a given game or service. The reenactors’ front-end initially relied on the same methods as the iOS sample Babylon client to record emotions during the reenactment, replay and debate stages, but later on it was changed to report directly to the ECC, as it will be explained later in this document.

Finally, the “Augmented Reality platform” element of the PCC was used in REENACT with the limitations explained in Section 3. The experiments revealed it was troublesome to rely on a free version of the Metaio SDK inasmuch as it caused severe delays (up to 20 seconds) not related to any computations. Yet, it must be said that Metaio provided all the features needed in the experiment. The UVIGO team believes that EXPERIMEDIA should work to provide an AR platform of its own or to somehow seek to negotiate advantageous conditions for experimenters to use Metaio.

8.2.2. Usage of the Social Content Component

The interactions among reenactors, experts and experimenters during the replay and debate stages were provided by the Social Content Component (SCC) by means of an extension of the Social Integrator tool developed by ICCS/NTUA following the demands of the REENACT team —yet, UVIGO had to work out some adaptations to integrate that software with the other parts of the reenactors’ front-end. This component worked as expected during the experiments, so the main observations in this regard relate to the difficulties encountered during the implementation of the social features:
• On the one hand, it is of utmost importance to highlight difficulties arising from having chosen Facebook as the social network behind the scenes. Facebook has been often criticised for changing the APIs without prior notice, which happened during the development of REENACT. Furthermore, the Facebook platform hampered the creation of user accounts ad hoc for REENACT, so the experiments had to use the personal accounts of the members of the UVIGO team. Overall, the conclusion after these months is that it would have been much easier and more convenient to rely on more predictable social networks with a clearer operation, such as Twitter.

• On the other hand, it was noticed that some things did not work exactly the same way on different versions of the Android operating system. Having to deal directly with threading issues, asynchronous tasks and updates of the user interface forces the developers to work out several patches. The conclusion about the Android development environment is that it does not really make it possible to work from a high level of abstraction and focus on putting modules together – as FMI experiments would expect. The iOS environment for iPhone and iPad devices seems more convenient from this point of view.

8.2.3. Usage of the Audio Visual Content Component

The Audio Visual Content Component (AVCC) of the EXPERIMEDIA facility was used in REENACT to deliver pre-recorded videos to the reenactors’ tablets and to transmit the live video feed from the expert to one of the computers connected to the screen of the Tholos dome. As for the pre-recorded videos, it seems reasonable to prepare as many versions as different codes and resolutions may be expected from the reenactors’ devices (only H.264+ACC at 1280x800 pixels for the Samsung Galaxy Tab 7.7 devices used in the REENACT experiments reported in this document). As for the live video stream, the AVCC stood out in comparison with a WebRTC-based solution developed by UVIGO due to its ability to traverse any network configurations, as explained in Section 3. This advantage came only at the expense of a slightly greater memory footprint, but this is compensated by the flexibility and adaptability of the AVCC.

In relation to the use of the AVCC to deliver audio and video contents, as noticed in Section 8.2.1, UVIGO found the Creator environment bundled within the PCC to be a convenient place to store additional contents like pieces of text, images, 3D models or AR markers. It could be a good idea to provide means to access both sources of content (the AVCC and the Creator) uniformly from end user devices.

Finally, following comments provided by the experts who participated in the REENACT experiments, UVIGO believes that it could be a strong point for EXPERIMEDIA to work out solutions by which one person addressing an audience could have rich feedback from them, beyond the textual comments posted on a chat and a live video feed that, in many cases, would just show a number of faces in the distance and in a dark environment. The answer should probably come from the mobile devices in the hands of the audience.
8.2.4. Usage of the Experiment Content Component

The *Experiment Control Component* (ECC) serves as a central point for experimenters to define and configure the experiment architecture, as well as to gather all the relevant information about the experiment results. It was used during the REENACT experiments to store all the data coming from the three front-ends of the REENACT system (the reenactors’ front-end, the expert’s front-end and the experimenter’s front-end) through the REENACT server, and afterwards to retrieve and analyse the data. The live monitoring features were also used during the running of the experimentation sessions, especially during the reenactment game to track the activities and states of the participants.

There were no problems during the installation, configuration and running of the ECC, except for a few occasional crashes that were apparently solved in the latest release of the software (V1.2, announced on July 25th). REENACT did not need any of the major new features (C# client support, C++ client support, dynamic entity support and entity ‘enable/disable’ support), but it has benefitted by great flexibility to traverse the different stages (definition, deployment, monitoring etc.) whereas the ECC available at the beginning of the experiment enforced one rigid workflow.
Appendix A. Implementation of the script of the Battle of Thermopylae on the Creator

The following is a collection of slides detailing the implementation of the script of the Battle of Thermopylae in the Creator environment. It adheres to the specification included in D4.9.3, “REENACT Software and documentation”, considering six participants with five roles: Xerxes, Leonidas, Ephialtes, one Spartan soldier and two Persian soldiers. The following sections describe what can be seen on the CONFIGURE, RULEBOOK and CREATE tabs of the Creator (see the picture below).

A.1. The CONFIGURE tab

Initially, the CONFIGURE tab displays the Services (in the Creator terminology) used in the implementation of the script, as well as the states of the Rule Engineer Server and the Console Server.

On the one hand, the Game Objects menu shows the following items:

- **Game State**, with three String properties named e, m and r, which relate to state variables described in D4.9.3.
- **Edge** and **State**, with no properties. These are artifacts needed to implement a specification given in the form of state machines.
• **Trigger**, with one Integer property named id. This object corresponds to events that trigger state transitions.

On the other hand, the Players menu displays items corresponding to the 5 roles (with Persian soldier and Greek soldier as subclasses of Soldier), plus the Experimenter and the System itself. The participants’ roles (e.g. Xerxes) are characterized by their state in the game (an Integer value), whereas the system contains the global variables indicated in D4.9.3.

A.2. **The CREATE tab**

The CREATE tab is the place to display the number of objects existing in the game, including 8 players (6 participants + experimenter + system), 34 triggers and 1 game state.
A.3. **The RULEBOOK tab**

The RULEBOOK tab is the place where the actual interactions among the different objects in the game are coded. Currently, it displays eight pieces of code as shown in the following picture, even though “Check Treasure” and “KVRule” are there only for tutorial purposes.
A.3.1. Act1 Triggers code

The following is the code corresponding to the transitions specified for Act 1 of the script of the Battle of Thermopylae in D4.9.3.

```ruby
xerxes = Xerxes.find_by_name("xerxes")
persian1 = PersianSoldier.find_by_name("persian1")
persian2 = PersianSoldier.find_by_name("persian2")
ephialtes = Ephialtes.find_by_name("ephialtes")
leonidas = Leonidas.find_by_name("leonidas")
spartan = SpartanSoldier.find_by_name("spartan")

#1 Start first Act
if(target.id == 1)
  if(xerxes.state == 100)
    xerxes.state = 1
  end
  if(persian1.state == 100)
    persian1.state = 1
  end
  if(persian2.state == 100)
    persian2.state = 1
  end
  if(ephialtes.state == 100)
    ephialtes.state = 14
  end
  if(leonidas.state == 100)
    leonidas.state = 7
  end
  if(spartan.state == 100)
    spartan.state = 7
  end
```
Hadouken2Service.distribute("1.Start first Act", actor)
end

#2 Checkin all Persians in Asia Minor
if(target.id == 2)
    if(xerxes.state == 1)
        xerxes.state = 2
    end
    if(persian1.state == 1)
        persian1.state = 2
    end
    if(persian2.state == 1)
        persian2.state = 2
    end
Hadouken2Service.distribute("2.Checkin all Persians in Asia Minor", actor)
end

#3 Persians ready in Asia Minor
if(target.id == 3)
    if(xerxes.state == 2)
        xerxes.state = 3
    end
    if(persian1.state == 2)
        persian1.state = 3
    end
    if(persian2.state == 2)
        persian2.state = 3
    end
Hadouken2Service.distribute("3.Persians ready in Asia Minor", actor)
end

#4 Checkin all Persians in Hellespont
if(target.id == 4)
    if(xerxes.state == 3)
        xerxes.state = 4
    end
    if(persian1.state == 3 && actor.e == 1)
        persian1.state = 13
    end
    if(persian1.state == 3)
        persian1.state = 4
    end
    if(persian2.state == 3 && actor.e == 2)
        persian2.state = 13
    end
    if(persian2.state == 3)
        persian2.state = 4
    end
Hadouken2Service.distribute("4.Checkin all Persians in Hellespont", actor)
end

#5 Bridge built
if(target.id == 5)
    if(xerxes.state == 4)
        xerxes.state = 5
    end
    if(persian1.state == 4 && actor.e == 1)
        persian1.state = 5
    end
    if(persian2.state == 4 && actor.e == 2)
        persian2.state = 5
    end
Hadouken2Service.distribute("5.Bridge built", actor)
#6 Checkin Persians in camp Thermopylae
if(target.id == 6)
    if(xerxes.state == 5)
        xerxes.state = 6
    end
    if(persian1.state == 5)
        persian1.state = 6
    end
    if(persian2.state == 5)
        persian2.state = 6
    end
end

Hadouken2Service.distribute("6. Checkin Persians in camp Thermopy", actor)

#7 End of first Act
if(target.id == 7)
    if(xerxes.state == 6)
        xerxes.state = 101
    end
    if(persian1.state == 6)
        persian1.state = 101
    end
    if(persian2.state == 6)
        persian2.state = 101
    end
    if(ephialtes.state == 15)
        ephialtes.state = 101
    end
    if(leonidas.state == 12)
        leonidas.state = 101
    end
    if(spartan.state == 12)
        spartan.state = 101
    end
end

Hadouken2Service.distribute("7. End of first Act", actor)

#9 Leonidas chooses to kill emissary or not
if(target.id == 9)
    if(leonidas.state == 9)
        leonidas.state = 10
    end
    if(persian1.state == 13)
        persian1.state = 5
    end
    if(persian2.state == 13)
        persian2.state = 5
    end
end

Hadouken2Service.distribute("9. Leonidas chooses to kill emissary", actor)

#10 Checkin Ephialtes in Thessaly
if(target.id == 10)
    if(ephialtes.state == 14)
        ephialtes.state = 15
    end
end
end
Hadouken2Service.distribute("10.Checkin Ephialtes in Thessaly", actor)
end
#11Checkin all Spartans in Sparta
if(target.id == 11)
    if(leonidas.state == 7)
        leonidas.state = 8
    end
    if(spartan.state == 7)
        spartan.state = 10
    end
Hadouken2Service.distribute("11.Checkin all Spartans in Sparta", actor)
end
#12Checkin emissary in Sparta
if(target.id == 12)
    if(leonidas.state == 8)
        leonidas.state = 9
    end
Hadouken2Service.distribute("12.Checkin emissary in Sparta", actor)
end
#13Spartans ready to advance on Thermopylae
if(target.id == 13)
    if(leonidas.state == 10)
        leonidas.state = 11
    end
    if(spartan.state == 10)
        spartan.state = 11
    end
Hadouken2Service.distribute("13.Spartans ready to advance on Thermopylae", actor)
end
#14Checkin Spartans in camp at Thermopylae
if(target.id == 14)
    if(leonidas.state == 11)
        leonidas.state = 12
    end
    if(spartan.state == 11)
        spartan.state = 12
    end
Hadouken2Service.distribute("14.Checkin Spartans in camp at Thermopylae", actor)
end
defend
xerxes.save
persian1.save
persian2.save
ephialtes.save
leonidas.save
spartan.save

A.3.2. Act2 Triggers code

The following is the code corresponding to the transitions specified for Act 2.

xerxes = Xerxes.find_by_name("xerxes")
persian1 = PersianSoldier.find_by_name("persian1")
persian2 = PersianSoldier.find_by_name("persian2")
ephialtes = Ephialtes.find_by_name("ephialtes")
leonidas = Leonidas.find_by_name("leonidas")
spartan = SpartanSoldier.find_by_name("spartan")

#20 Start second Act
if(target.id == 20)
    if(xerxes.state == 101)
        xerxes.state = 25
    end
    if(persian1.state == 101)
        persian1.state = 26
    end
    if(persian2.state == 101)
        persian2.state = 26
    end
    if(ephialtes.state == 101)
        ephialtes.state = 20
    end
    if(leonidas.state == 101)
        leonidas.state = 29
    end
    if(spartan.state == 101)
        spartan.state = 29
    end
    Hadouken2Service.distribute("20. Start second Act", actor)
end

#21 Check in Ephialtes in Persian camp
if(target.id == 21)
    if(ephialtes.state == 20)
        ephialtes.state = 25
    end
    Hadouken2Service.distribute("21. Check in Ephialtes in Persian camp", actor)
end

#22 Check in Spartans in camp at Thermopylae (Act 2)
if(target.id == 22)
    if(leonidas.state == 30)
        leonidas.state = 31
    end
    if(spartan.state == 30 && spartan.s == "yes")
        spartan.state = 32
    end
    if(spartan.state == 30 && spartan.s == "no")
        spartan.state = 102
    end
    Hadouken2Service.distribute("22. Check in Spartans in camp at Thermopylae (Act 2)", actor)
end

#24 End of second Act
if(target.id == 24)
    if(xerxes.state == 22)
        xerxes.state = 102
    end
    if(persian1.state == 28)
        persian1.state = 102
    end
    if(persian2.state == 28)
        persian2.state = 102
end
if(ephialtes.state == 22)
    ephialtes.state = 102
end
if(leonidas.state == 31)
    leonidas.state = 102
end
if(spartan.state == 33 && spartan.s == "no")
    spartan.state = 102
end
Hadouken2Service.distribute("24.End of second Act", actor)
end
# 25 Ephialtes decision about reliving
if(target.id == 25)
    if(ephialtes.state == 23 && actor.r == "yes")
        ephialtes.state = 22
    end
    if(ephialtes.state == 23 && actor.r == "no")
        ephialtes.state = 24
    end
Hadouken2Service.distribute("25. Ephialtes decision about reliving", actor)
end
# 27 Checkin all participants in first battle
if(target.id == 27)
    if(persian1.state == 26)
        persian1.state = 27
    end
    if(persian2.state == 26)
        persian2.state = 27
    end
    if(leonidas.state == 29)
        leonidas.state = 27
    end
    if(spartan.state == 29)
        spartan.state = 27
    end
Hadouken2Service.distribute("27. Checkin all participants in first battle", actor)
end
# 28 End first battle
if(target.id == 28)
    if(persian1.state == 27)
        persian1.state = 28
    end
    if(persian2.state == 27)
        persian2.state = 28
    end
    if(leonidas.state == 27)
        leonidas.state = 30
    end
    if(spartan.state == 27)
        spartan.state = 30
    end
Hadouken2Service.distribute("28. End first battle", actor)
end
# 30 Leonidas chooses to vigilate path
if(target.id == 30)
if(spartan.state == 30 && spartan.s == "yes")
    spartan.state = 32
end
Hadouken2Service.distribute("30.Leonidas chooses to vigilate pat", actor)
end

#31Checkin Spartan soldier in Anopae
if(target.id == 31)
    if(spartan.state == 32)
        spartan.state = 33
    end
    Hadouken2Service.distribute("31.Checkin Spartan soldier in Anopae", actor)
end

#32Xerxes decision on Ephialtes life
if(target.id == 32)
    if(xerxes.state == 25)
        xerxes.state = 22
    end
    if(ephialtes.state == 25 && &actor.m == "yes")
        ephialtes.state = 23
    end
    if(ephialtes.state == 25 && &actor.m == "no")
        ephialtes.state = 22
    end
    Hadouken2Service.distribute("32.Xerxes decision on Ephialtes' li", actor)
end

xerxes.save
persian1.save
persian2.save
ephialtes.save
leonidas.save
spartan.save

A.3.3. Act3 Triggers code
The following is the code corresponding to the transitions specified for Act 3.

```ruby
xerxes = Xerxes.find_by_name("yerxes")
persian1 = PersianSoldier.find_by_name("persian1")
persian2 = PersianSoldier.find_by_name("persian2")
ephialtes = Ephialtes.find_by_name("ephialtes")
leonidas= Leonidas.find_by_name("leonidas")
spartan = SpartanSoldier.find_by_name("spartan")

#40Start third Act
if(target.id == 40)
    if(xerxes.state == 102)
        xerxes.state = 41
    end
    if(persian1.state == 102 && persian1.s == "yes")
        persian1.state = 42
    end
    if(persian1.state == 102 && persian1.s == "no")
        persian1.state = 44
    end
```
if(persian2.state == 102 && persian2.s = "yes")
    persian2.state = 42
end
if(persian2.state == 102 && persian2.s = "no")
    persian2.state = 44
end
if(ephialtes.state == 102 && actor.pa = "yes")
    ephialtes.state = 42
end
if(ephialtes.state == 102 && actor.pa = "no")
    ephialtes.state = 41
end
if(leonidas.state == 102)
    leonidas.state = 48
end
if(spartan.state == 102 && spartan.s = "yes")
    spartan.state = 50
end
if(spartan.state == 102 && spartan.s = "no")
    spartan.state = 48
end
Hadouken2Service.distribute("40. Start third Act", actor)
end
#41 End of third Act
if(target.id == 41)
    if(xerxes.state == 41)
        xerxes.state = 103
    end
    if(persian1.state == 46 || persian1.state == 47)
        persian1.state = 103
    end
    if(persian2.state == 46 || persian2.state == 47)
        persian2.state = 103
    end
    if(leonidas.state == 49)
        leonidas.state = 103
    end
    if(spartan.state == 49)
        spartan.state = 103
    end
    if(spartan.state == 50 && actor.pa == "no" || spartan.state == 43)
        spartan.state = 24
    end
    Hadouken2Service.distribute("41. End of third Act", actor)
end
#42 Checkin all participants in second battle
if(target.id == 42)
    if(persian1.state == 44)
        persian1.state = 45
    end
    if(persian2.state == 44)
        persian2.state = 45
    end
    if(leonidas.state == 48)
        leonidas.state = 45
    end
if(spartan.state == 48)
    spartan.state = 45
end
Hadouken2Service.distribute("42.Checkin all participants in seco", actor)
end

#44 Checkin Persian soldier in Anopean path
if(target.id == 44)
    if(persian1.state == 42 && actor.ea == "yes")
        persian1.state = 43
    end
    if(persian1.state == 42 && actor.ea == "no")
        persian1.state = 47
    end
    if(persian2.state == 42 && actor.ea == "yes")
        persian2.state = 43
    end
    if(persian2.state == 42 && actor.ea == "no")
        persian2.state = 47
    end
    if(spartan.state == 50 && actor.pa == "yes")
        spartan.state = 43
    end
 Hadouken2Service.distribute("44.Checkin Persian soldier in Anope", actor)
end

#45 End of battle in Anopean path
if(target.id == 45)
    if(persian1.state == 43)
        persian1.state = 47
    end
    if(persian2.state == 43)
        persian2.state = 47
    end
    if(spartan.state == 43)
        spartan.state = 24
    end
 Hadouken2Service.distribute("45.End of battle in Anopean path", actor)
end

#47 End of second battle
if(target.id == 47)
    if(persian1.state == 45)
        persian1.state = 46
    end
    if(persian2.state == 45)
        persian2.state = 46
    end
    if(leonidas.state == 45)
        leonidas.state = 49
    end
    if(spartan.state == 45)
        spartan.state = 49
    end
 Hadouken2Service.distribute("47.End of second battle", actor)
end

xerxes.save
persian1.save
A.3.4. Act 4 Triggers code

The following is the code corresponding to the transitions specified for Act 4.

```ruby
xerxes = Xerxes.find_by_name("xerxes")
persian1 = PersianSoldier.find_by_name("persian1")
persian2 = PersianSoldier.find_by_name("persian2")
ephialtes = Ephialtes.find_by_name("ephialtes")
leonidas = Leonidas.find_by_name("leonidas")
spartan = SpartanSoldier.find_by_name("spartan")

#60 Start fourth Act
if(target.id == 60)
  if(xerxes.state == 103 && actor.pa == "yes" || (actor.pa == "no" && actor.ea == "no"))
    xerxes.state = 64
  end
  if(xerxes.state == 103 && actor.pa == "no" && actor.ea == "yes")
    xerxes.state = 66
  end
  if(persian1.state == 103 && persian1.s == "yes")
    persian1.state = 63
  end
  if(persian1.state == 103 && persian1.s == "no")
    persian1.state = 64
  end
  if(persian2.state == 103 && persian2.s == "yes")
    persian2.state = 63
  end
  if(persian2.state == 103 && persian2.s == "no")
    persian2.state = 64
  end
  if(ephialtes.state == 103)
    ephialtes.state = 63
  end
  if(leonidas.state == 103)
    leonidas.state = 60
  end
  if(spartan.state == 103)
    spartan.state = 60
  end
  Hadouken2Service.distribute("60.Start fourth Act", actor)
end

#61 Checkin of ambushers in third battle
if(target.id == 61)
  if(xerxes.state == 61)
    xerxes.state = 62
  end
  if(persian1.state == 63 || persian1.state == 61)
    persian1.state = 62
  end
```
if(persian2.state == 63 || persian2.state == 61)
    persian2.state = 62
end
if(ephialtes.state == 63)
    ephialtes.state = 62
end
if(leonidas.state == 61)
    leonidas.state = 62
end
if(spartan.state == 61)
    spartan.state = 62
end
Hadouken2Service.distribute("61.Checkin of ambushers in third ba", actor)
end
#62End of fourth Act
if(target.id == 62)
    if(xerxes.state == 61 && actor.pa == "no" || xerxes.state == 66 || xerxes.state == 62)
        xerxes.state = 24
    end
    if(persian1.state == 61 && actor.pa == "no" || persian1.state == 62)
        persian1.state = 24
    end
    if(persian2.state == 61 && actor.pa == "no" || persian2.state == 62)
        persian2.state = 24
    end
    if(ephialtes.state == 62)
        ephialtes.state = 24
    end
    if(leonidas.state == 61 && actor.pa == "no" || leonidas.state == 62)
        leonidas.state = 24
    end
    if(spartan.state == 61 && actor.pa == "no" || spartan.state == 62)
        spartan.state = 24
    end
    Hadouken2Service.distribute("62.End of fourth Act", actor)
end
#65Checkin all participants in third battle
if(target.id == 65)
    if(xerxes.state == 64)
        xerxes.state = 61
    end
    if(persian1.state == 64)
        persian1.state = 61
    end
    if(persian2.state == 64)
        persian2.state = 61
    end
    if(leonidas.state == 60)
        leonidas.state = 61
    end
    if(spartan.state == 60)
        spartan.state = 61
    end
    Hadouken2Service.distribute("65.Checkin all participants in thir", actor)
end
A.3.5. Experimenter code

The following is the code corresponding to the transitions triggered by the experimenters.

```plaintext
#Experimenter Triggers
xerxes = Xerxes.find_by_name("xerxes")
persian1 = PersianSoldier.find_by_name("persian1")
persian2 = PersianSoldier.find_by_name("persian2")
ephialtes = Ephialtes.find_by_name("ephialtes")
leonidas= Leonidas.find_by_name("leonidas")
spartan = SpartanSoldier.find_by_name("spartan")

#Act 1
#1. Start first Act
if true
    xerxes.state = 1;
    Hadouken2Service.distribute("1", xerxes)

    persian1.state = 1;
    Hadouken2Service.distribute("1", persian1)

    persian2.state = 1;
    Hadouken2Service.distribute("2", persian2)

    ephialtes.state = 10;
    Hadouken2Service.distribute("2", ephialtes)

    leonidas.state = 13;
    Hadouken2Service.distribute("13", leonidas)

    spartan.state = 13;
    Hadouken2Service.distribute("13", spartan)

#5. Bridge built
#elsif actor.state = 101
#    xerxes.state = 5;
#    Hadouken2Service.distribute("5", xerxes)

#gs = GameState.find_by_name("gamestate")
#persian = PersianSoldier.find_by_name(gs.e)
#persian.state = 5
#Hadouken2Service.distribute("5", persian)
#persian.save

#7. End of first Act
#elsif actor.state = 102
#    xerxes.state = 101;
#    Hadouken2Service.distribute("101", xerxes)

#persian1.state = 101;
#Hadouken2Service.distribute("101", persian1)
```
A.3.6. Reset code

The following is the code needed to initialize the system prior to beginning an experimentation session.

```c
#persian2 .state = 101;
#Hadouken2Service.distribute("101", persian2)

#ephialtes.state = 101;
#Hadouken2Service.distribute("101", ephialtes)

#leonidas.state = 101;
#Hadouken2Service.distribute("101", leonidas)

#spartan.state = 101;
#Hadouken2Service.distribute("101", spartan)

#Act 2
#20.Start second Act
#elsif actor.state == 103
#xerxes.state = 25;
#Hadouken2Service.distribute("25", xerxes)

#persian1 .state = 1;
#Hadouken2Service.distribute("26", persian1)

#persian2 .state = 1;
#Hadouken2Service.distribute("26", persian2)

#ephialtes.state = 25;
#Hadouken2Service.distribute("25", ephialtes)

#leonidas.state = 13;
#Hadouken2Service.distribute("29", leonidas)

#spartan.state = 13;
#Hadouken2Service.distribute("29", spartan)

end
#24.End of second Act
#28.End first battle

#Act 3
#40.Start third Act
#41.End of third Act
#45.End of battle in Anopaean path
#47.End of second battle

#Act 4
#60.Start fourth Act
#62.End of fourth Act
xerxes.save
#persian1.save
#persian2.save
#ephialtes.save
#leonidas.save
#spartan.save
```
A.4. Testing

In order to test the implementation, Interactive provided UVIGO with a sample Android client that could be used to simulate the triggering of events on behalf of the players, the experimenter or the system itself, and to check that the state of the game progressed as expected.

The implementation of the Android client starts out with the CreatorClientListener interface:

```java
package com.tii.creator;
public interface CreatorClientListener {
    public void onCreatorResponse(String payload);
}
```

This interface is implemented by the MainActivity class, which in the following code simply sends an event to the Creator through a CreatorClient object:
package com.tii.creatorsimpleandroidclient;

import java.util.ArrayList;
import org.apache.http.NameValuePair;
import org.apache.http.message.BasicNameValuePair;
import android.app.Activity;
import android.os.Bundle;
import android.view.Menu;
import android.widget.Toast;
import com.tii.creator.CreatorClient;
import com.tii.creator.CreatorClientListener;

public class MainActivity extends Activity implements CreatorClientListener {
    private CreatorClient _client;

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);
        _client = new CreatorClient(this);
        _client.setURL("http://creator.sykewarrior.com");
        setState("65");
    }

    private void setState(String state) {
        ArrayList<NameValuePair> pairs = new ArrayList<NameValuePair>(2);
        pairs.add(new BasicNameValuePair("interaction", "spell_cast:Hadouken2Service"));
        pairs.add(new BasicNameValuePair("keyword", state));
        pairs.add(new BasicNameValuePair("service_api_key", "0c5f947fffc2937f61c3b5c7bd8acc9e425d90e5"));
        pairs.add(new BasicNameValuePair("identifier", "system:pass");
        _client.postParameters(pairs);
    }

    @Override
    public boolean onCreateOptionsMenu(Menu menu) {
        getMenuInflater().inflate(R.menu.main, menu);
        return true;
    }

    @Override
    public void onCreatorResponse(String payload) {
        Toast.makeText(this, payload, Toast.LENGTH_LONG).show();
    }
}

The CreatorClient object deals with the serialisation of the data to be sent to the Creator, sending through an HTTP request, waiting for the corresponding HTTP response and deserialising the data it may contain:

package com.tii.creator;
import java.io.BufferedReader;
import java.io.InputStreamReader;
import java.util.ArrayList;
import org.apache.http.NameValuePair;
import org.apache.http.HttpClient;
import org.apache.http.client.entity.UrlEncodedFormEntity;
import org.json.JSONTokener;
import android.os.Looper;

public class CreatorClient {
    private String _url;
    private CreatorClientListener _listener;

    public CreatorClient(CreatorClientListener listener) {
        _listener = listener;
    }

    public void postParameters(final ArrayList<NameValuePair> params) {
        Thread t = new Thread() {
            public void run() {
                Looper.prepare();

                HttpClient client = new DefaultHttpClient();
                HttpConnectionParams.setConnectionTimeout(client.getParams(), 10000);
                HttpResponse response;

                try {
                    HttpPost post = new HttpPost(_url + "/service/receive_keyword");
                    post.addHeader("Accept", "application/json");
                    post.setEntity(new UrlEncodedFormEntity(params));

                    response = client.execute(post);

                    if (response != null) {
                        BufferedReader reader = new BufferedReader(new InputStreamReader(response.getEntity()));
                    }
                }
            }
        }
    }
}
StringBuilder builder = new StringBuilder();
for (String line = null; (line = reader.readLine()) != null) {
    builder.append(line).append("\n");
}
JSONTokener token = new JSONTokener(
    builder.toString());
_listener.onCreatorResponse(token.nextString('}'));
}
else {
    _listener.onCreatorResponse("Please, try again.");
}

} catch (Exception e) {
    e.printStackTrace();
}
Looper.loop();
};
t.start();

public void setURL(String url) {
    _url = url;
}