SEVENTH FRAMEWORK PROGRAMME

"Information Society Technologies"

D1.1.3

Technical Achievements and Progress Reports including summary of research accomplishments and evaluation

Project acronym: +Spaces

Project full title: Policy Simulation in Virtual Spaces

Contract no.: 248726

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Executive Summary

In order to highlight the research and technical challenges posed in +Spaces as well as the highly innovative nature of the project, D1.1.3 collects and reports the research goals, achievements and lessons' learned in +Spaces. Each partner that is engaged into research – namely IBM, NTUA, Fraunhofer, UEssex and KULeuven – has shared their research agenda and the conclusions are aggregated in this document.

The listed research challenges are split into two main categories: ICT-oriented research and social-oriented research. Even though the distinction is a bit blurred it aims to depict that +Spaces required a multidisciplinary approach with tasks stemming from computer-based research and others originating from other scientific areas such as sociology.

Overall, this document discusses the most prominent research themes which +Spaces tackles or plans to tackle and provides concrete plans about them. It is part of a series of deliverables on the technical achievements (D1.1.x) from WP1. It is assumed that the reader has obtained a certain familiarity with the +Spaces concepts by that time.

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1 Introduction

This document discusses the open research and technical challenges that +Spaces tackled towards the implementation of its vision, i.e. to engage citizens in the policy making by provoking the appropriate stimuli in the environment to which they are active. The achievement of that goal included the finding of the spaces where the citizens already are (e.g. social media), the stimulation of their reflexes employing the in-world mechanics and the aggregation of their reaction and its interpretation into usable feedback.

Due to the interdisciplinary nature of this vision, the challenges required effort and expertise originating from various disciplines including service and software engineering, social sciences, data mining and legal research. As such, we structured the research and technical items in to two main categories: social-oriented and technical challenges. Every such challenge is linked to at least one workpackage and to one +Spaces partner. This document analyzes the work on the various aspects, focusing on the technical and research developments and the partners' plans to achieve innovation that helped the project meet its requirements. In detail the research and technical items are:

1. Technical aspects of interoperability of virtual spaces (WP3, WP4)
2. User experience of interoperability of virtual spaces (WP4, WP6)
3. Clarification of data protection legal issues in the frame of +Spaces (WP2)
4. Maintaining privacy when harvesting social network information (WP2, WP3, WP4)
5. Structuring unstructured debates and discussions (WP5)
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11. Service provision and management leveraging virtual space functionality and content (WP3)
12. Quality of Service notions in virtual spaces (WP3)

Having stated these, the document is structured as follows: Section 2 presents a high-level overview of the progress of the technical developments. Sections 3 provides the research plan that was followed by +Spaces, explaining how research matured and yield results. Sections 4 and 5 list and detail the social- and ICT-oriented research challenges respectively,

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as explained above. Finally, Section 6 summarizes the main conclusions that derive from this report.

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2 Technical Overview

According to the work-plan, the goal during the first six months of the project was the development of the infrastructure to support the +Spaces concept, and the testing of that infrastructure through a pilot application, i.e. polling application. Following that, during PM14-PM18 another task started, that involved the configuration of the infrastructure for supporting a new application (i.e. debating). The objective of this application is to test the overall suitability of the external services (i.e. Data Analysis, Recommendation and Reputation) as well as provide policy makers with a debates tool, on top of the polls that were implemented before. In parallel, during M12-18 work conducted to implement the project's third application and final goal: role-playing simulation.

The role-playing simulation attempts to stimulate people's thoughts by asking them to put themselves into the shoes of other people. The latter are selected, opinionated actors in a simulated policy scenario and the participants of the experiment are asked to play their role. For example, in a smoking banning scenario, one role can be the restaurant owner and another the non-smoker client. By asking people to think the same way as these roles would think, makes them see more clearly all the aspects of the problem that the policy is asked to tackle leading to more rational arguments. What is more interesting though, is that this guided process has some kind of liberating effect to the people's minds, enabling them to stop being reluctant and come up with a specific view. Figure 1 depicts the wealth of information that was produced in about 7' of a 2D role-playing simulation session.

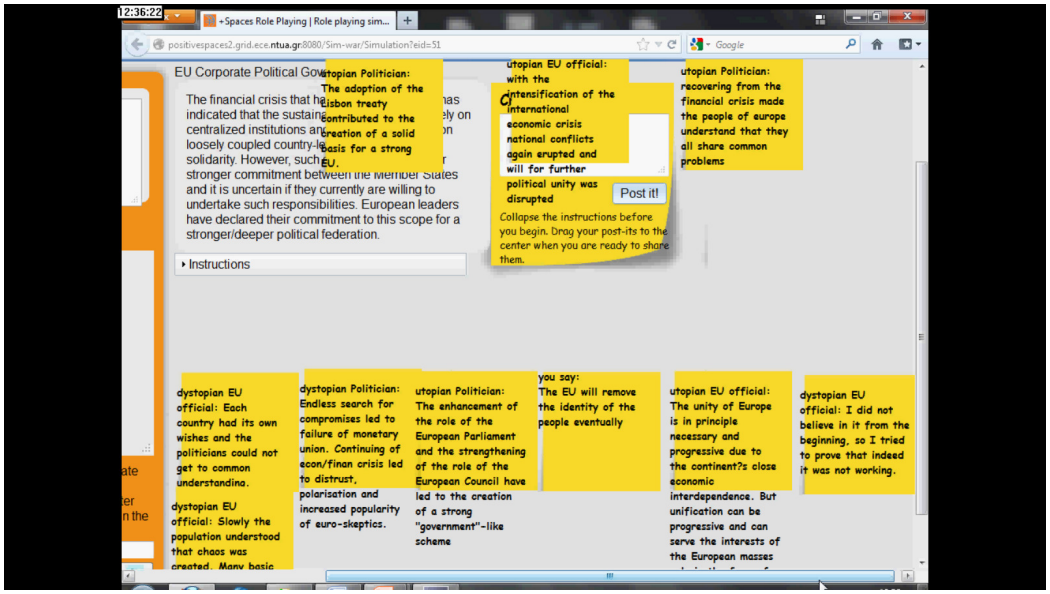

Figure 1: Screenshot of the "statement preparation" phase of a 2D role-playing simulation session

Already since PM07-PM18, +Spaces implemented a great portion of the underlying system, building on well-established technical solutions enhanced by the project innovation. The various components that were developed and that comprise the integrated system are depicted in **Figure 2** and described below:

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The **VS Management Layer** which acts as an abstraction layer on top of the Virtual Spaces. It provides a common interface to the underlying Virtual Spaces and can be used as a standalone tool. For each participating Virtual Space an adaptor has been developed acting as a bridge between the Virtual Space and the +Spaces platform. The layer's main goal is the transparent interoperability between all kinds of virtual worlds. The development of this component is linked to the technical aspect of the interoperability between virtual spaces since it enabled the seamless application deployment in various virtual spaces.

The **+Spaces Middleware** contains the main functionality of the platform. It handles the communication and data flow between the government end users, the VS Management Layer and the built-in and external analysis services. It offers data persistence, storing all information about experiments, actions and services and supports a recovery mechanism that allows analysis services to retrieve their data in case of failure. The implementation of the +Spaces Middleware provided solutions for tackling the interoperability challenges. Moreover, the +Spaces Middleware abstracts virtual space functionality to a service layer, while it is expected to host service quality negotiation operations based on novel definitions of QoS notion in virtual spaces.

The +Spaces platform is able to manage services that enhance the functionality of the platform by providing powerful processing functionalities. Three built-in analysis services have been developed in the framework of the +Spaces project: the **Data Analysis**, **Recommendation**, and **Reputation Services**. The development of each of these Services, contributed or is expected to contribute (once populated with user data during pilots) to specific research challenges of +Spaces. In detail, the Recommendation service is going to harvest social relationships between virtual space users in order to identify people with similar interests and recommend them to participate in relevant +Spaces experiments. At the same time, research is conducted on this component about the user experience when bringing traditional 2D concepts such as recommendation to 3D virtual worlds. Furthermore, the pilot results are going to be used so as to evaluate whether the Reputation service is able to effectively assess the reliability of virtual space users. Finally, the data from the experiments (and especially the debate experiments) are going to be used for training and evaluation of mechanisms for structuring unstructured debates and discussions in the Data Analysis service. The platform will however support the addition of more services, with similar or different functionalities, giving the government users a wider selection of tools.

Finally the **Front-End** is a graphical user interface that interacts with the platform via the +Spaces API and provides policy makers with an easy to use access point to the platform functionality.

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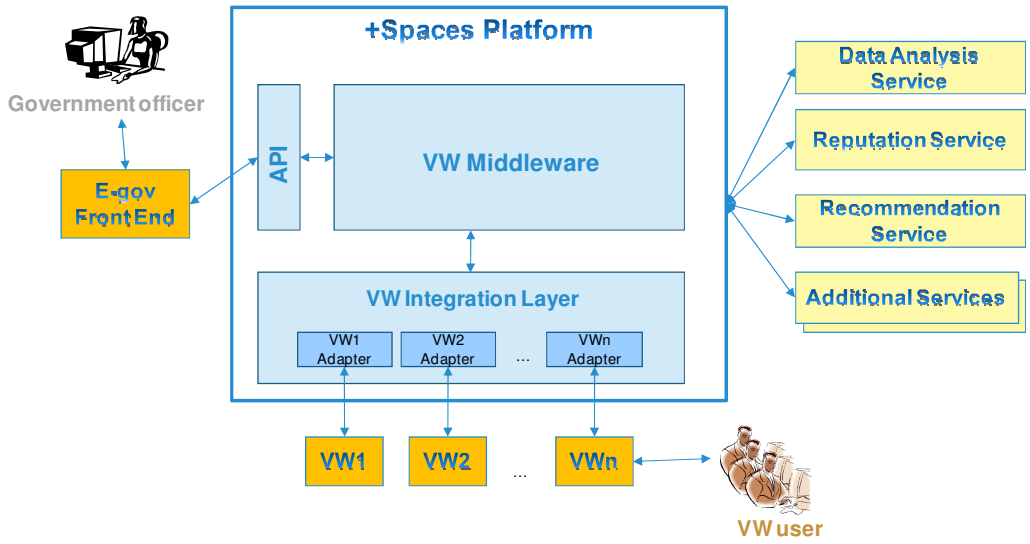

Figure 2: +Spaces high-level architecture

By implementing the above, +Spaces managed to reach and achieve all its objectives and reach the expected Milestones. More details are provided in the following session.

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3 Research Plan

The masterplan of conducting research and evaluation in +Spaces was structured based on the three iterations mentioned on Section 2, each one for a specific type of applications. In each iteration, technical capabilities and innovation was tested and the evaluation was used to either correct and/or improve the implementations or fine-tune the research so as to more effectively apply it to the scenarios.

Following that plan, even though +Spaces made significant impact on the aspect of research, not all the research items matured in the same way. Each of the identified research challenges was dependent on some preliminary conditions in the life of the project. These conditions affected either the preparatory work for the research or its evaluation. In fact, in some cases the research planning/modelling/development can start early but the actual experiments can only be conducted when evaluation is feasible. It is the meeting of these conditions that defined the time when the experiments produced results.

In general the research items lifecycle included 3 phases:

- design phase
- implementation phase
- testing phase

and results were presented in the scientific and other interested communities in all of them.

The design phase included actions of developing new plans or aligning existing to meet the explicitly stated user requirements. Some of these plans presented innovation and added value in the scientific community. Such were the plans for the sharing of experiences within and across Virtual Spaces, as well as the innovative middleware architecture for aggregating data and functionality from the underlying Virtual Spaces.

During the implementation phase the partners started developing their initial plans. This phase also involved the selection of methods, tools and algorithms for that purpose. In many cases the actual development details as well as the implementation itself was published in scientific papers and conferences, such as the middleware components, the VS adaptors, the legislation governance modules, the reputation modes, the data analytics in unstructured content and the role-playing simulation framework including the standalone application instances in the various supported worlds (e.g. OWL environment for role-playing simulation).

Finally, in the testing phase, +Spaces managed to evaluate and in cases even re-engineer the various models, methods and components it had built. The evaluation results provided a great input to the scientific community in many cases, and results were presented in various scientific conferences and journals.

An overview of the research activity and the research lifecycle is provided in the following figure.

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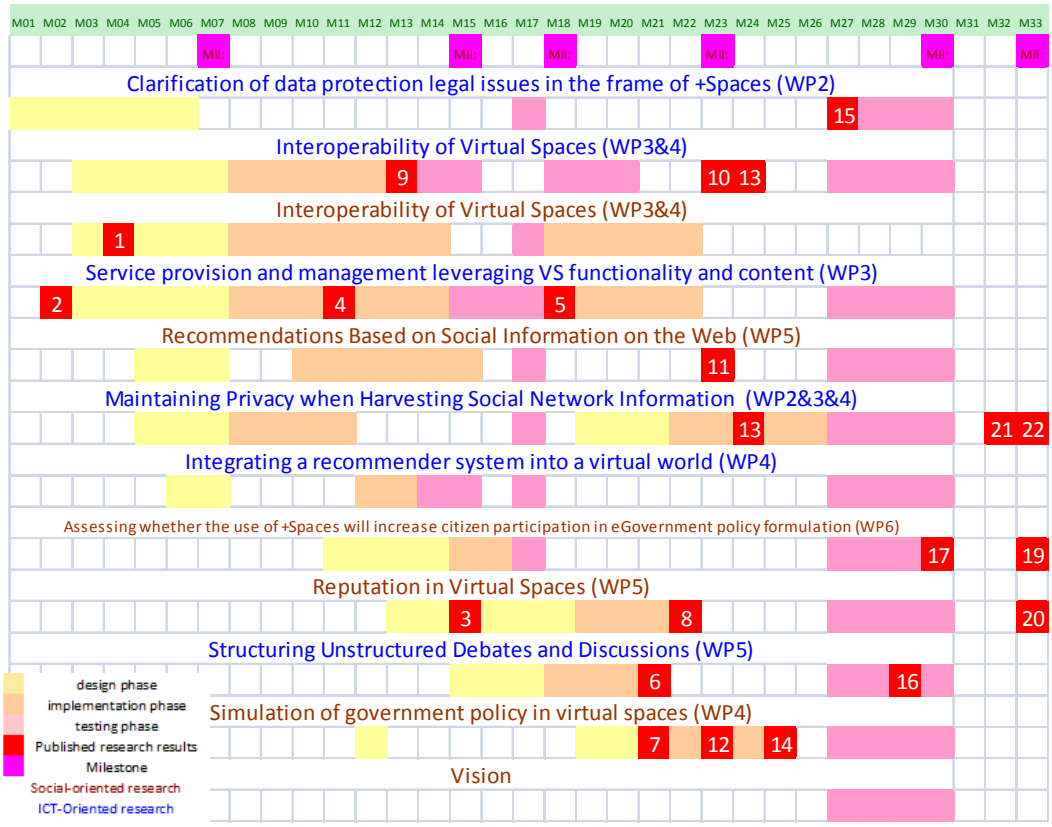

Figure 3: Research items lifecycle and progress

Figure 3 illustrates the progress of each of the research items in the course of the project. It depicts their lifecycle using a different colour for design, implementation and evaluation phase as mentioned above. The research challenges remain active during their whole lifetime but they deliver outputs on certain periods based on the type of research challenge and solution maturity. There are 22 outputs that are indicated on the table:

1. Gardner M., MIRTLE, SIMILLE and +Spaces, Immersive Education Initiative, Boston Summit, 23-25th April 2010
2. Tserpes K., Jacovi M., Gardner M., Triantafillou A,. and Cohen B., +Spaces: Intelligent Virtual Spaces for eGovernment, International Conference on Intelligent Environments, IE10, Kuala Lumpur, 19-21th July 2010
3. Guy I., Ur S., Ronen I., Perer A., Jacovi M.: Do you want to know?: recommending strangers in the enterprise. CSCW 2011: 285-294
4. Kardara M., Fuchs O., Aisopos F., Papaoikonomou A., Tserpes K., Varvarigou T., A Service Oriented Architecture Enabling Policy Simulation in Virtual Spaces, 3rd IEEE International Conference in Games and Virtual Worlds for Serious Applications- VS Games 2011, Athens, 4-5th May 2011
5. Kardara M., Fuchs O., Aisopos F., Papaoikonomou A., Tserpes K., Varvarigou T., A SOA based architecture for capturing public opinion in Virtual Spaces, International Journal of Interactive Worlds (IJIW), pp 236-243, IEEE Computer Society, 2011

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6. Klinger R., Riedel S., McCallum A.: Inter-Event Dependencies support Event Extraction from Biomedical Literature. In: Mining Complex Entities from Network and Biomedical Data (MIND), European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases (ECML PKDD), 2011.
7. Gardner M., Horan B., Serious Games for Role--Playing Government Policies, ReLIVE11 Creative Solutions for New Futures, September 21st - 22nd, 2011, The Open University, Milton Keynes, UK
8. Jacovi M., Guy I., Ronen I., Perer A., Uziel E., Michael Maslenko: Digital Traces of Interest: Deriving Interest Relationships from Social Media Interactions. ECSCW 2011: 21-40
9. Aisopos F., Kardara M., Klinger R., Senger P., Papaoikonomou A., Tserpes K., Gardner M., Varvarigou T.: e-Government and Policy Simulation in Intelligent Virtual Environments In: International Conference on Web Information Systems and Technologies, WEBIST 2012, 18-21 April, Porto, Portugal
10. Horan B., Producing Charts in Open Wonderland, Available at: http://blogs.openwonderland.org/2011/11/01/producing-charts-in-open-wonderland/
11. Guy I., Avraham U., Ur S., Carmel D., Jacovi M., Ronen I.: Mining Expertise and Interests from Social Media. Submitted to WWW'2012
12. Gardner M., Horan B., Using virtual worlds for online role-play, 1st European Immersive Education Summit (iED Summit), 28th and 29th November 2011, Madrid
13. Kardara M., Fuchs O. , Kosta E., Aisopos F., Spais I., Varvarigou T., Policy testing in virtual environments: addressing technical and legal challenges, International Journal of Electronic Government Research (IJEGR), , Volume 8, Issue 3, 2012
14. Gardner M & Horan B (2012). '+SPACES: Serious Games for Role-Playing Government Policies'. To be published as a chapter in the book 'Understanding Learning in Virtual Worlds', by Springer.
15. E. Kosta, Do Not Track initiatives: myths and reality around the lost user consent, BILETA 2012: 'Too many laws, too few examples' Regulation, technology, law & legal education, 29-30 March 2012, Newcastle
16. Klinger R., Senger P., Madan S. and Jacovi M., Online Communities support Policy-making: The Need for Data Analysis, In: Proceedings of the Third International Conference on eParticipation (ePart 2012), Kristiansand, Norway, Springer-Verlag 2012
17. Gardner M & Horan B (2012). 'Using virtual worlds for creative role-play: lessons learnt'. To be submitted to the Immersive Education Summit, 2012 Boston Summit, 14-16 June 2012.
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20. M. Jacovi, I. Guy, S. Kremer-Davidson, S. Porat, N. Aizendud-Reshef. The Perception of Others: Inferring Reputation from Social Media. Submitted to CHI'2013.

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21. Kosta E., Mifsud Bonnici J.P., Revisiting consent in the information society, 2012 Amsterdam Privacy Conference (APC 2012), Amsterdam-The Netherlands, 7-10 October 2012
22. Kosta E., “Legal Issues while researching users' behaviour in virtual spaces”, Workshop on “Legal challenges for FP7 projects: a +Spaces and WeGov Workshop” in the frame of the Samos Summit 2012, Samos,Greece

In what follows we provide details about the research and technical challenges and emphasize on the lessons learned.

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4 Social-oriented Research Challenges

4.1 Interoperability of Virtual Spaces – Social Aspects

4.1.1 Description

Social network environments are uniquely positioned for viral dissemination of information. The interoperability of +Spaces allows to use social networks for propagating the information about policy simulation experiments. Along with the recommendation system that also invites people in one virtual space to visit another, governments gain access to open and frank opinions of citizens more comfortable voicing their opinion online than in public.

The interoperability supported by the +Spaces platform, allows us to create new user experiences in virtual spaces. Users of one space can now become aware of events on another space. For instance, we implemented a Twitter interface inside Wonderland, that blows “balloons” with tweets on them – the balloons float slowly upward till they disappear off the top of the screen. Avatars who walk close by can become aware of Twitter activities, while inside Wonderland. We also implemented seamless experiences, such as allowing a policy maker (or another governmental figure) to conduct a debate with users from all these worlds, routing the messages through the +Spaces platform.

4.1.2 Achievements

Initially, interoperability in +Spaces was focused on the “write once deploy anywhere” paradigm, in which a single front-end serves for the policy maker to define an experiment (a poll, debate or role-play simulation), while the +Spaces platform deploys the same experiment in multiple virtual spaces (Facebook, Twitter, Open Wonderland as of now). However, in the course of the project, another type of interoperability was supported. This is the cross-space interoperability, in which the activities in the frame of an experiment in a single space are transmitted to the same experiment but in other spaces as well. As such, comments in a wonderland 3D debate were broadcasted in the same 2D debate in BlogSpot.

4.1.3 Lessons learned

Interoperability was one of the features that significantly impacted the success of the +Spaces experiments. Participants could select the environment of their choice in order to get involved. What is of interest we realized from the experiment statistics that the distribution of the space participation tended to look like the distribution of the actual popularity of the respective spaces, e.g. most participants preferred Facebook from BlogSpot, which shows that going to the environment in which people are more active rather than expecting them to join, is a critical decision. However, experiments also showed the importance of user experience: in environments where the manifestation of a +Spaces experiment resembled known (for the users) in-world tools, the participants were less reluctant to be engaged.

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Regarding the cross-space interoperability mentioned above, an interesting lesson was the combination of asynchronous and synchronous information gave a boost to the participation. This can be explained: Even though in the asynchronous experiments (e.g. 2D debates) people were more eager to participate and provide their opinion (mainly covering their reluctance in anonymity), in the 2D experiments they were always more active. When relevant preceding polls results and opinions from asynchronous experiments were made available, people were more relieved to share their personal opinion, probably because they witnessed an example which they could follow.

4.2 Recommendations Based on Social Information on the Web

4.2.1 Description

The Social Technologies group in IBM Research Haifa is researching social recommendations for several years now, constantly improving its Social Networks & Discovery architecture (SaND [1]), which is also used for recommendations in +Spaces.

SaND aggregates rich social network information from a large selection of **enterprise** sources including SNSs, blogs, wikis, file sharing applications, and more.

Different papers were already published by the group in conferences such as RecSys, CSCW, CHI, SIGIR, GROUP, and ECSCW ([1][2][3][4][5][6][7][8][9][10][11]).

+Spaces is the first SaND client that populates it with information from the web (rather than enterprise sources). It gave us the unique opportunity to research our recommendation findings on non-enterprise information, and to come up with new findings.

The +Spaces recommendation service maps +Spaces experiments to SaND documents and +Spaces users to SaND people. Some relationships between +Spaces people and experiments (e.g., participated in experiment, voted, added a comment) and among +Spaces people (e.g., participated in the same experiment) were new to SaND, and yielded different types of recommendations, whose quality and effectiveness had to be to examined.

4.2.2 Achievements

The operation of the Recommendation Service is orchestrated by the +Spaces middleware component. The service listens in on the NotificationManager and receives social network information from all the adaptors (i.e. the underlying Virtual Worlds). It parses the notifications and populates SaND with objects (people, experiments, tags) that, over time, construct a social graph of the +Spaces participants.

During the course of the project IBM continued its research about recommendations with SaND, studying various types of implicit relations between people – of similarity and of interest (see [10][11][28]).

4.2.3 Lessons learned

We investigated recommendation of mixed social media items, such as blogs, bookmarks, and communities – on in the case of +Spaces of policy making experiments. We compared the user's familiarity network as can be derived from social media interactions, such as

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"friending", proximity in a 3D world, and direct communication; with the user's similarity network as can be derived from social media activity, such common tags (e.g., Twitter hashtags) or policy making experiments. In previous studies we already found that the familiarity network yields more accurate recommendations, while similarity yields more diversity and serendipity [5]. We also examined tag-based recommendations and found they improve the accuracy further when hybridized with recommendations based on the user's network. Tags applied on the user by others are slightly more accurate than tags used by the user himself [9]. People recommendations, such as for matching a group of relevant people to a policy making experiment, are more challenging and substantially lower in accuracy [10]. Finally, we explored recommendation of news items (parallel in our study to policy making experiments) as part of the activity stream, where we used another type of network – the user's interest network as can be derived from blog commenting or tagging, and found it is as effective for recommendation as the user's familiarity network [11].

Due to legal issues, the IBM personnel was prohibited from accessing the data produced during the +Spaces pilots. However, we used similar settings and implementation in order to improve the algorithms that are also used in +Spaces.

4.3 Reputation in Virtual Spaces

4.3.1 Description

The Social Technologies group in IBM Research Haifa is initiating a research effort on reputation in virtual spaces. The goal is to use the rich social information aggregated by SaND, in order to compute people's reputation of different types.

Expertise is a type of reputation – is a person an expert in a specific area? Should she be approached for consultation? Is his participation in a discussion likely to yield a vivid discussion?

Influencers may be identified by analyzing the social graphs, as well as the dynamics of discussions. Both types of data needed for these analyses are fed by the +Spaces platform into SaND, as the virtual space adaptors notify of events such as friending, and participating in discussions.

Misuse identification is critical in +Spaces, as well as in many other egov applications. The social network information harvested from +Spaces into SaND may assist in identifying misusers.

During 2011, SaND was enhanced with various capabilities for identifying different types of reputation, as described above.

The research included:

- Recognizing the different types of reputation that may be calculated from the harvested social network information,
- Enhancing the harvested social network information with additional information that may be found in virtual spaces,

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- Developing algorithms for calculating reputation
- Designing the user experience for utilizing reputation (for both policy makers and citizens)
- Evaluating and improving the different algorithms through user trials

In this context, the paper [12] was submitted to CHI2013, focusing on expertise reputation.

4.3.2 Achievements

Similarly to the recommendation service, the reputation service is built on top of IBM's SaND. Unlike recommendation, which is a long-existing capability of SaND, reputation was being developed in SaND in parallel to the development of +Spaces.

Various sources were being examined as potentially contributing reputation information. The sources contribute **implicit** reputation information – meaning to say that the perception of other people towards a user is being inferred from day-to-day interactions with the user, rather than from explicit rating of the user by others. The decision to focus on implicit information is that it is "out there", and does not require the construction of a rating system that will then depend on the willingness of people to rate, and will also be susceptible to fraud.

Another direction which the IBM research on reputation pursued, was Graph Analysis. Algorithms such as PageRank, Hubs & Authorities, and Betweenness. These were examined in order to understand how their results can assist in evaluating users' reputation.

From a technical point of view, relevant information is retrieved by the +Spaces Reputation Service wrapper which is integrated into the +Spaces platform. It is also tied to the SaND reputation capabilities.

4.3.3 Lessons learned

As in the case of recommendations research, the IBM personnel was prohibited from accessing the data produced during the +Spaces pilots. However, we used similar settings and implementation in order to improve the algorithms that are also used in +Spaces. We defined different flavors of reputation, such as trust and influence. Trust is relevant to +Spaces as the data analysis service presents trust levels of a citizen who responded. It also may use a citizens trust score as a factor when calculating statistics. Influence is relevant to +Spaces as it may assist a policy maker in identifying citizens who may be used to reaching out to a larger group of citizens. We defined a unique user survey that allowed us to examine the different indicators that stem from social media, in order to assess their ability to predict these flavors [12]. We learned that trust is much more difficult to predict through social media indicators. Number of followers seems to be its strongest predictors, though the strength of this predictor is not high. Influence seems to be predicted best by the number of blog commenters. It turns out that the number of followers – which seems to be a basic indicator of the ability to reach out to more people – is not a good predictor of this reputation flavor.

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4.4 Integrating a recommender system into a virtual world

4.4.1 Description

In addition to exploring novel ways of using virtual worlds to support a range of e-Government applications (polling, debating and simulation), +Spaces also augmented the user's in-world experience, and allowed policy makers to extract additional information from virtual world sessions. This was achieved through the use of recommender and reputation systems that integrate with the +Spaces middleware layer.

Two key challenges here were in capturing the event data from 3D virtual worlds to feed into the recommender system, and then how best to convey recommendations back to the user in the virtual world.

Data captured from virtual worlds currently includes:

- user login and logout times
- textchat shared within the system (this would be time-stamped and from a particular user)
- when a user comes into proximity with another user
- log if a user speaks using the voice comms
- log whether a user creates a new shared app (time-stamped), or deletes a shared app
- log whether a user takes control of a shared app (start time, end time)
- log if a user goes through a portal (log time, start position, end position)
- log if a user jumps to a placemark (log time, start position, end position)
- we could possibly setup regions within a world and log time entered and time exited and region name

However, this list can be easily expanded through appropriate changes in the adaptor. A key question was when the user should be notified of recommendations and how this may be achieved in a 3D virtual space (for example, on login). Also, *how* should the user be notified of the recommendation. Currently this is implemented via a personalised notification that appears in the user's text chat window as well as through a dedicated Recommendation Heads Up Display panel.

4.4.2 Achievements

The Wonderland adaptor has been enhanced to provide an interface to the +Spaces recommendation sub-system. This is currently implemented as a 'Heads-Up-Display' or HUD on the Wonderland client, which appears once the user has logged into the +Spaces virtual world. The advantage of the HUD is that it provides a private display of recommendations to the user which is independent of the virtual world being explored by the user – this makes it easier to deploy recommendations across the 3 main +Spaces application types i.e. polls, debates and simulations. Currently recommendations can be presented in the following ways:

- A web recommendation in the form of a URL that resolves to a WWW resource

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- An Open Wonderland recommendation that resolves to a 3D location on a wonderland server

The Wonderland adaptor has also been enhanced to capture in-world events and feed them back to the +Spaces recommender sub-system. Currently, the following events are captured:

- User login and logout
- Text chat shared (i.e. global text chat)
- Text chat private (i.e. user-to-user)

4.4.3 Lessons learned

The lessons learnt is that this challenge is more concerned with the general interoperability between virtual spaces and other back-end services. The issue is now more one of sharing events between different virtual worlds, which we have implemented via the event capture/sharing mechanism (e.g. the OWL pigeon). In terms of integrating the recommender system into the Open Wonderland virtual world, we achieved this by developing a recommender 'panel' for each user which displayed recommendations provided by the +Spaces middleware. If more time/resource had been available, we would have liked to have provided more features in the virtual world to help display recommendations and reputation, such as modifying the users avatar to reflect this information.

4.5 Clarification of data protection legal issues in the frame of +Spaces

4.5.1 Description

Deliverable 2.3 “Ethical issues report”[13] identified the legal and ethical issues that are going to be researched within the +Spaces project. This deliverable managed to identify in a clear and systematic way the relevant issues and goal of the KU Leuven is to prioritise their research in order to meet the needs of the project. Deliverable 7.5 “Legal evaluation report” [14] carried out an evaluation of the legal and ethical issues that were researched within the +Spaces project, steered by the legal developments within Europe, as well as by the actual needs of the project and pilots.

As it was demonstrated during the +Spaces Workshop on the Privacy and Data Protection Framework that was organised on the 8th of December 2010, a number of data protection issues in virtual spaces were still open for research. Based on the outcome of the workshop, KU Leuven focused on research on the concept of personal data in virtual spaces. More specifically it examined the issue whether data relating to pseudonyms, qualify as personal data. During the development of the +Spaces project it became obvious that anonymous data could not be used in the +Spaces project, as the reputation and recommendation functionalities cannot function based on anonymous data. The outcome of this research has been documented in Deliverable 7.5. KU Leuven also continued its research on the limits and functioning of consent, which resulted in a paper entitled “Revisiting consent in the information society”, co-authored with Jeanne-Pia Mifsud-Bonnici that will be presented at

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the Amsterdam Privacy Conference (APC2012) in October 2012. The research conducted on the concept of consent was studied in view of the specific needs of the +Spaces virtual spaces and it was encompassed in the formulation of the consent forms that accompany the +Spaces pilots in the various virtual spaces. Finally, the role of the various actors and providers in the complex environments crated by virtual worlds, especially in realtion to the processing of user data was closely examined, and the outcome of the research in presented in Deliverbale 7.5.

Given the novel character of the issues, they have still not been addressed by the legal scholars in Europe. The Article 29 Working Party has made sporadic references to the need for further research on these issues, without however providing a definitive answer [15,16]. The opinion of the Greek Data Protection Authority (DPA) on the EU FP7 research project COCKPIT has been studied and the recommendations of the Greek DPA were taken into account for the shaping of legal and technical decisions of the +Spaces project, as explained in Deliverable D7.5. The research conducted in the frame of +Spaces contributes to the advancement of legal research on these issues and to the clarification of the European legal framework on data protection in view of the technological challenges posed by virtual spaces. KU Leuven also carried out a detailed analysis of the Terms of Use of the virtual spaces on which +Spaces carried out its pilots in order to ensure a legally compliant execution of the pilots.

Finally, KU Leuven led the organisation of a +Spaces workshop on “Legal challenges for FP7 projects” in collaboration with the WeGov project as part of the Samos Summit 2012. The workshop aimed at presenting issues, challenges and possible difficulties that EU research projects deal with, focusing mainly on the ones relating to legal and ethical ones. KU Leuven gave a presentation on “Legal Issues while researching users' behaviour in virtual spaces”

KULeuven submitted an abstract to the **BILETA 2012 Annual Conference** “'Too many laws, too few examples” that took place on 29-30 March 2012 in Newcastle (UK) [17]. The title of the abstract is “Do Not Track initiatives: myths and reality around the lost user consent” (Eleni Kosta). This abstract built on the experiences of +Spaces on consent, transferring it in the DoNotTrack initiatives that will be crucial for all online user transactions in the information society.

4.5.2 Achievements

KU Leuven has actively participated in the preparation of the pilots, focusing on the compliance of +Spaces prototype with the data protection framework. Building on the findings of Deliverable 2.3 “Ethical issues report”, KU Leuven carried out a detailed legal analysis based on European and the applicable national law, in this case of Greek law, to define the role of the different partners within the meaning of the 95/46/EC Directive and the obligations stemming from this legal framework. More particularly, KU Leuven drafted a multi-layered information notice to increase the transparency of the data processing activities generated by the system, it communicated with the Greek Data Protection Authority (DPA), it drafted necessary legal document that has to be signed between various +Spaces partners in relation to the processing of user data and, in collaboration with the

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+Spaces partner ATC, carried out a notification to the DPA, as required by the data protection legislation. The work is documented in D.7.5 “Legal evaluation report”.

KU Leuven submitted an aabstract to the **BILETA 2012 Annual Conference** “'Too many laws, too few examples” that took place on 29-30 March 2012 in Newcastle (UK). The title of the abstract was “Do Not Track initiatives: myths and reality around the lost user consent” (Eleni Kosta) [18]. . Moreover, KU Leuven submitted a paper entitled “Revisiting consent in the information society” (KOSTA E., MIFSUD BONNICI J.P.) which will be presented at the 2012 Amsterdam Privacy Conference (APC 2012), which will take place on 7-10 October 2012. The paper is built on the experiences gained from the +Spaces project on the function and the limitations of consent in online virtual spaces.

4.5.3 Lessons learned

+Spaces has been a very interesting project for the carrying out of legal research. Due to the fact that the +Spaces pilots were making use of user data, albeit pseudonymised, the research focused mainly on the protection of personal data. KU Leuven dedicated a large amount of its time and resources in order to ensure that the privacy of the users is protected and that the +Spaces platform as well as the respective pilots are legally compliant. However, this should not be the main task of a research partner and the European Commission should try to find alternative ways in order to allow legal partners to focus on fundamental research instead of focusing on compliance issues.

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5 ICT-oriented Research Challenges

5.1 Interoperability of Virtual Spaces – Technical Aspects

5.1.1 Description

Poor technical design and poor technical interoperability in particular, has been identified as one of the major barriers that can sabotage the efficiency of European e-Government services.

Each type of virtual space considered in +Spaces – social networks, micro blogs, blogs and 3D virtual worlds – has different characteristics. The different nature of the types of spaces was the first challenge, as we planned a single platform for e-government application creation and deployment across spaces.

A second challenge was to build a system that supports the execution of applications across virtual spaces with minimal space-specific code.

Lastly we envisaged methods to leverage the advantages of some spaces in other spaces within the scope of a single application running in multiple spaces.

These challenges were explored from two directions:

- Architecture
- Implementation

5.1.1.1 Architecture

The following objectives stand in the core of the +Spaces architecture to achieve interoperability between applications deployed across virtual spaces:

- Common e-Gov application definition
- Common data design
- Common APIs

The system design promotes the use of a single application definition standard that is defined once by the policy makers, and deployed and run within several different virtual spaces.

Several systems components are responsible for monitoring applications once for each virtual space. The collected data, coming from different types of virtual spaces and different types of applications, is normalized and processed in the same manner by the same layer. We achieve a substantial part of the required work using a component that is independent of the semantics of the application.

Each virtual space has a unique model of operation, different manipulation options and different supported APIs. In +Spaces we worked on a single API definition that is implemented by each virtual space adaptor, and a single API for the platform to support the notification from an adaptor. The common API and data model enforce each virtual space

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adaptor to provide the required functionality for +Spaces leaving the method of the implementation that is dependent on 3rd party APIs up to the adaptor designer.

By defining this standard the +Spaces middleware is made easily extensible and able to support additional spaces with no changes to the platform.

5.1.1.2 Implementation

Supporting e-Government applications in various virtual spaces raises design and implementation challenge, as the virtual spaces are not designed to support the needed functionality.

For each virtual space a different mechanism must be designed and created, to achieve the required functionality using the tools and APIs provided by the virtual space. These processes include components that are executing in the virtual space and external components; there is a need to synchronize processes and data between them to achieve the needed missing features.

5.1.2 Achievements

Our work started in two main processes, the first was the produce a detailed specification +spaces require for eGov applications in general, and then polls and debates specifically. The second process was to extract from each virtual space we intended to use the relevant APIs. As predicted, the virtual spaces had no direct support of the requirements raised by +spaces. Thus we have investigated each virtual space and came up with appropriate mechanisms to support the various requirements of our eGov applications.

Based on this work several artifacts were designed and implemented to support the write-once run anywhere paradigm:

- A common extensible eGov application description document.
- An API for deploying, activating managing and monitoring eGov applications.
- A Virtual Spaces Management and abstraction Layel (VSML).

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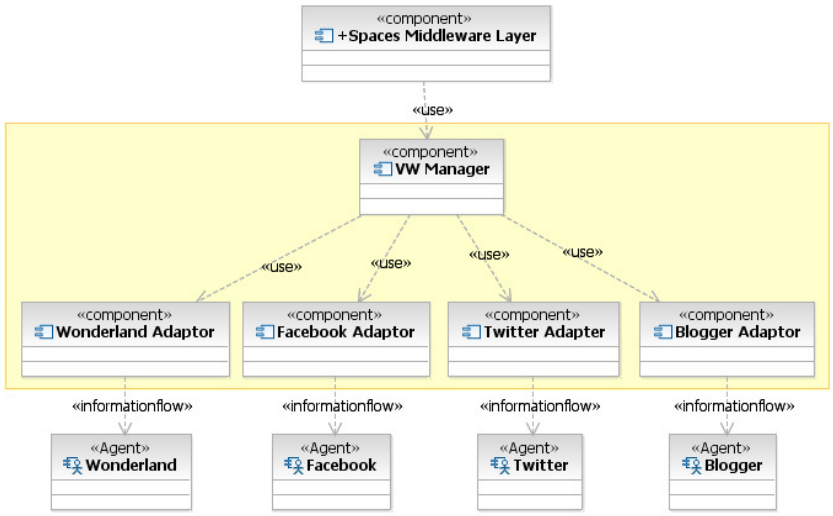

Figure 4. Architectural extension

In addition to the write once run anywhere attribute, a second goal was set – to share runtime data within the scope of an experiment between different virtual spaces.

To achieve that we came up with an architecture extension using the components already implemented, i.e. the adaptors and VSML. The architectural extension is shown in Figure 4.

At that point each virtual space agent and adaptor must implement the cross world messages display mechanism in a manner that suites the specific virtual space.

5.1.3 Lessons learned

One of the key lessons' learned in this case is that the reliance on third party platforms foments a risk: change in their technical implementation or in their terms of use of these platforms directly impacts the overlaying implementation. Changes in the Twitter API had to be reflected to the +Spaces API or in cases, changes in the terms and conditions of the underlying platforms led to +Spaces changing its own flow of logic.

5.2 Maintaining Privacy when Harvesting Social Network Information

5.2.1 Description

At the early phases of +Spaces, an analysis of the data protection and privacy related issues was conducted. The requirements that stemmed from the legal and ethical issues, imposed challenges on the architecture. The solutions to these challenges were interesting technical advances that are worth sharing with other architects dealing with social network analysis in Europe.

These are the highlights of the challenges stemming from privacy issues:

- Compliance with privacy guidelines:
    - Awareness – have a right to know that their data is being processed

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- Consent – have a right to be asked before their data is processed
- Access / correction / deletion – should have access to the data being stored and processed, be able to correct it, and ask to delete it.
- Security – have a right to know how their data is protected

- Data protection
- Pseudonymization for de-identification
  - Mechanism for creating pseudonyms to strengthen privacy and data protection with minimal reduction is features that are based on identity such as recommendation and reputation.
  - Design a layer based architecture that allows maintaining the +Spaces middleware oblivious of people's real user names

5.2.2 Achievements

Each of the implemented virtual spaces adaptors was designed and implemented with the range of privacy guidelines in mind, ensuring no collected data from or about a user is ever presented in a manner that expose the originating user identity. Since some of that adaptors are forced to work a-synchronously due to the API limitations of certain virtual spaces, some data have to be persisted in the adaptors. For that a carefully designed mechanism was developed, ensuring only minimal details are persisted and for a minimal duration, after which they are deleted.

Each adaptor or virtual space agent includes a consent mechanism in which a user can read the terms of use document and must give his or her consent before +spaces begins collecting information about them.

In the +Spaces middleware, a special module was developed to replace the user names coming from virtual spaces with pseudonyms. The Middleware layer therefore is never contaminated by any real' usernames of any virtual space. Likewise the components receiving their data from the middleware, i.e. reputation service, recommendation service, data analysis service and front end component are not exposed to a 'real' user name or id.

5.2.3 Lessons learned

The main outcome from tackling this technical challenge is that legal requirements need to be incorporate in the system design early, otherwise the cost for resolving the issue at later stages may result into losing valuable functionality.

5.3 Structuring Unstructured Debates and Discussions

5.3.1 Description

A lot of information is not available in structured form but only in unstructured text. This holds for biomedical texts (like Medline abstracts) as well as newspaper corpora. One way to find a structure in those is to perform a named entity recognition (NER) of classes of interest, like gene or protein names in the biomedical case or person and organization names in the newspaper example. Relations between the entities lead to informative networks of real world objects.

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In contrast, texts in the context of +Spaces are debates, dialogs and micro publications from various domains, as the platform can be applied to different policies. Therefore unsupervised methods to structure them are more suitable here – the context of the debate is not known in advance. While there is the lack of information of the domain, additional structured information is available, e.g. user profile or debate structure (who answered to whom) data. This multi modal data needs to be combined to allow visualizing textual debates for a beneficial comprehension of the main topics and relations.

The analysis of debates is multifold: Firstly, unsupervised methods can cluster similar comments and contributions to a debate to extract the most important topics. Methods to be tested include topic models (e.g. Latent Dirichlet Allocation) or hierarchical clustering. Secondly, a Named Entity Recognition of frequently occurring items of interest be applied. It needs to be evaluated if classes of interest are existing which occur frequently over different experiments. An example is the incorporation of existing available tools, e.g. for the detection of organization names, person names or places. Thirdly, a sentiment analysis may detect emotions related to specific comments or topics. This information should be combined with structured information (e.g. profile information) in a suitable visualization.

An example may be the detection of the main topics via LDA in the comments of a debate, representing the nodes in graph. The edges could represent transitions from one topic to another as they are occurring in the tree structure of the debate itself (where nodes are contributions and edges represent who answered to whom). Additionally, the nodes are associated with distributions of profile data to be visualized on request.

5.3.2 Achievements

This particular challenge was enabled only midway the project duration since it was then when the +Spaces framework to support debates was implemented. For the Data Analysis service, this implied that the respective requirements needed to be tackled and to support the relevant functionality which included the structuring of unstructured debates.

As a basis for the analysis of unstructured or semi-structured debates, a workflow for clustering similar contributions is implemented. This includes reading the debate from a defined XML-format and representing it in an internal data structure for testing purposes as well as collecting the data from the data manager via notifications. This data comes from Blogger as well as from Facebook. Upon that, a clustering method is applied for each source in combination, though the visualization is separated by source. To provide the policy maker with an easily perceivable representation, the clusters need to be labeled. The presentation as a graph where a node corresponds to a cluster and the edges correspond to the reply-structure of the members of the clusters is implemented.

This clustering is implemented as a k-means based approach followed by detecting the TF-IDF-based most important noun phrases and terms. Each cluster as well as the whole debate is associated with a sentiment analysis score. A visualization is implemented, showing the debate in a whole with colored highlights of the topics detected, the sentiment score, and

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the reputation score from the reputation service. An analysis on a manually annotated debate was performed.

The usability evaluation is performed based on the respective pilots. Research results are published in Klinger2012 [19].

5.3.3 Lessons learned

The main conclusion that was made from this work relates to the application of research to actual applications which are based on a business plan. It turns out that traditional content analytics mechanisms cannot be applied and perform well when the dataset is not of the appropriate size. In fact, when we are applying analytics such as sentiment analysis in the case of debates, we request documents of at least 50 words long. Otherwise the data analysis services are not efficient.

5.4 Service provision and management leveraging VS functionality and content

5.4.1 Description

+Spaces leverages on the functionality of existing Virtual Spaces and exposes it as service. The rationale is to allow for generic-purpose functionality to be exposed as service. This, in turn, will enable us to exploit the benefits of service oriented architectures so as to extend the underlying virtual spaces' content and functionality to more consumers, allowing for manipulation of basic in-world functions so as to build interesting constructs and for creating a marketplace of services that meet the policy makers' requirements when setting up societal experiments.

In order to implement this concept -which for itself it is an innovation- +Spaces built a middleware which hosts and manages the services. This middleware is based on service-oriented architecture principles and it uses web service technologies. +Spaces has made significant progress on delivering this complex component to the research community and the end-users having built the core components and integrated them so as to operate in an application- and VS- agnostic way.

+Spaces delivers an architecture that can support the provisioning and management of web services by "abstracting" the VS layer, similarly as a cloud infrastructure does for the resource layer. This provides the opportunity for +Spaces to comprise a baseline for a future infrastructure of public services. With public data collected and processed by external organizations (services) -while maintaining the privacy of the data- and the policy makers being able to orchestrate these so as to provide new e-gov services, +Spaces constitutes an ideal example of private-public partnerships.

Part of this work is reported in [20][21][22][23][24].

5.4.2 Achievements

+Spaces middleware is an integrated solution, supporting application prototypes for polling, debates and 2D and 3D role play simulation ("D3.2.2: +Spaces platform overall Architecture

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final version" [25]). Service provision and management was made dynamic, giving the ability to provide multiple alternative services for Data Analysis and Recommendation functionalities, so that the end-user (Policy Maker) can choose the one of his preference, according to each service terms.

For each action occurring in a virtual space, generic notifications are sent to the analysis services subscribed to the specific action type notifications, while all services assigned to an experiment are notified upon experiment creation/termination. Those notifications include all action details (actor pseudonimized id, timestamp etc.), as well as a subscription id which has been provided after service's subscription and can be used to pause / resume a subscription to an action type or unsubscribe.

Describing the platform intelligence, using the analysis services receiving and analyzing virtual space actions, we have published a scientific paper: "+ Spaces: Intelligent Virtual for eGovernment" in proceedings of the 6th international conference on Intelligent Environments, IE'10, 2010, and also submitted another entitled "e-Government and Policy Simulation in Intelligent Virtual Environments" in the special thematic issue on Virtual and Mixed Reality Intelligent Environments of the Journal of Ambient Intelligence and Smart Environments (JAISE).

5.4.3 Lessons learned

+Spaces service oriented infrastructure maintains the significant advantage of flexibility. Integrating services over a service bus it allows support for multiple Virtual Spaces instances and analytic services. The benefits of this plug 'n' play approach are threefold:

a) A variety of options are provided to the policy maker to decide to which worlds to deploy his experiment and which are the more appropriate services to select for analyzing the incoming data of the particular experiment.

b) Supporting multitude instances of virtual spaces enables a fault tolerance approach. If a wonderland server crashes, a new one can always replace it easily.

c) From a business point of view, the +Spaces middleware comprises a platform that may bring users to either virtual space providers or service analytics developers. As such, +Spaces comprises a marketplace for developers and service providers acting as a broker between them.

Having stated this, it is imperative to appreciate the circumstances under which these benefits are feasible. That is, it is important that an organization with a sizeable infrastructure to host these services and virtual space instances adopts +Spaces. More importantly however, this organization must have the ability to maintain and strengthen communities of participants willing to participate. In general, during the course of the project, it has been proven that the fixed workflows that +Spaces supports for each application, place some resources in the critical path and if no backup instances exist, this may create a crucial problem to the system operation.

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5.5 QoS notions in Virtual Spaces

5.5.1 Description

In the frame of developing a SOA architecture to support the open service market concept of +Spaces, NTUA developed a mechanism for allowing service consumer and providers to negotiate the quality of the offered services. This mechanism is built on existing architecture principles and standards (namely WS-Agreement), however +Spaces innovated on the adaptation to the specific context. The definition of the service quality terms is rather different than what it used to be in service oriented systems. WS-Agreement is meant to accommodate resource-level quality of service (QoS) terms. +Spaces, aimed at including quality of business (QoBiz) terms [26] which derive from the blending of the policy makers' language and the service-oriented, +Spaces language.

What is of special interest is the new notion that fundamental terms take in the +Spaces architecture. An example are the resources: in +Spaces, VS users can also be considered as resources.

Therefore, the +Spaces middleware will allow for negotiation of hosted services not on the basis of provided resources, but on the basis of high-level parameters, such as the number of VS users or the availability of resources, as well as, the qualitative characteristics of the analysis and the results (e.g. quantified depth of analysis).

This work is reported in D3.3.2 [27].

5.5.2 Achievements

The work started with the definition of some of the high level QoS notions (Number of Participants, Service Availability terms, etc) needed in the +Spaces case study, which guided us to extending the WS-Agreement specification [28], by developing and adding a local namespace with the extra features [29]. This extension provides some legal logic to the service agreements (disclaimer) along with the extra SLA terms upon negotiation.

The SLA Manager component along with the whole +Spaces service-oriented architecture, are described in the published paper entitled "A Service Oriented Architecture Enabling Policy Simulation in Virtual Spaces" in proceedings of the 3rd International Conference on Games and Virtual Worlds for Serious Applications, VS-Games 2011 [30] as well as in its sequel [31].

5.5.3 Lessons learned

Even though the SLA Manager component greatly adds to the exploitation potential of the +Spaces platform, it has never been really evaluated during the course of the project. The reason is that there is no clear incentive for the service provider to meet the requirements defined in the SLA during the pilot phases of the project. During the pilot the SLA notifications were mostly logged and ignored in order to allow the participants to participate without troubling them with other potential issues.

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5.6 Assessing whether the use of 3D virtual worlds will increase citizen participation in eGovernment policy formulation

5.6.1 Description

At the beginning of the +Spaces project, there was a great deal of interest in using immersive virtual environments for a range of different applications. Much of this has been stimulated by the success of commercial platforms such as the World of Warcraft for online gaming, and Second Life for online social networking and e-commerce. These environments have a high level of realism and associated levels of engagement as well as supporting and encouraging social interaction. Davies [32] reported on how virtual worlds can be used to simulate real spaces such as an intelligent campus, and the University of Essex has built smart spaces for teaching and learning (MiRTLE facilities [33]). However, little has been done in the way of using this technology for egovernment applications.

The main research challenge here was to explore how virtual world technologies can be used to allow government bodies to measure public opinion on a large scale and maximize the value from prospective policy measures by leveraging the power of these communities. This can range from simple polling and debating applications to more advanced policy simulation spaces.

Ultimately the success of this technology will be whether we can design, deploy and run pilot applications and field trials that lead to much greater citizen engagement in the policy making process. The evaluation of this will be critical and will need to assess the usability, acceptability and sustainability of the different pilot applications. There is also a subsidiary research challenge of designing applications that exploit the affordances of 3D immersive environments. Although we hope to build on existing research in this area (e.g. [34]), there will still be an opportunity for the project to add to this research by building novel 3D applications.

5.6.2 Achievements

+Spaces poll's pilot took place during April and May 2011, debates during May and June 2012 and role playing simulation on August and September 2012. It was helpful in terms of integration and fine tuning of the +Spaces platform. A focus group held by HeP on May 2011 referred to the increase of citizens' participation as something that still must be "proved" through the debates and role-playing simulation phases. These are the applications that provided something innovative to the policy makers much more than the already familiar polls. On the other hand, policy makers recognized the added value of a 3D poll that focus on youngsters.

In addition, the interoperability of several virtual spaces – the simultaneous deployment of a poll application and the filtering of results – is considered an added value at legislation formation even at this early stage of the +Spaces platform implementation.

With these things in mind, the consortium moved ahead with the role-play simulation experiments in which the feedback was enthusiastic. Policy makers who tested it as well as participants in general reported that this Socratic method is very appropriate for extracting

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public opinion and that the guided process was less burdensome and more entertaining, leading a major advantage on the citizen attraction front. As a main downside, it was considered the fact that role-play simulations were synchronous, i.e. requiring the user participation in real time (in contrast to the offline nature of 2D debates).

5.6.3 Lessons Learned

The increase of user participation has been proven one of the most difficult problems. +Spaces attempted to go where the citizens are, i.e. the social networking sites and to build appealing spaces in order to attract them. However, gathering citizen participation requires something more than simple presence on social media or entertaining environments; it requires constant dissemination and marketing effort in order to persuade citizens to form a new, active community. Significant effort is also required in order to maintain this community alive.

An interesting example is when the consortium attempted to address existing, active communities and bring them to the +Spaces space so they can engage in the +Spaces applications. People were reluctant to do it and would only be easier if there was an already established community where we asked them to go. This effort also met strong resistance from the administrators of the related existing communities, who (logically) found that it was not in their best interest to allow people migrate even temporarily from their supported environments (e.g. fora).

5.7 Simulation of government policy in virtual spaces

5.7.1 Description

One of the aims of the project was to use virtual worlds to simulate government policy. This is a real research challenge as there are many unknown issues that need to be solved. These include:

- Understanding what we mean by the simulation of government policy. Is this best understood as a macro level or a micro level concept, or more likely the combination of the two (as a meso level concept). See [35][36].
- Understand how to model these simulations in a way suitable for deployment in a virtual world
- Understanding how virtual worlds can be used to represent and deploy these simulations
- Develop tools to enable policy makers to create and deploy simulations, and then analyse the results afterwards
- How to make the simulations engaging and usable
- How to validate the simulation scenarios, and resulting usage data

5.7.2 Achievements

In the beginning the issue was approached by exploring a number of simulation scenarios around the following topics:

- Recycling of household waste

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- City transport policies
- Online marketplaces
- Online communities

A further analysis was made of the issues raised in this workshop, and a separate study was carried out into the use of role-play as a form of simulation. A common problem with computer-based simulations is the 'black-box' nature of the model that drives the actual simulation. Often the internal model is hidden from the end-user. This is a good thing in terms of improving the overall usability of the interface, but a major weakness for a policy-making application, where the internal rules of the model will make up the framework for the implementation of any new policy. From a policy-making perspective the transparency of the internal model is critical to understanding the factors that will affect the successful or unsuccessful outcome of any new policy. Also by the nature of their very implementation (i.e. highly complex models) computer-based simulations are often very specific to a particular problem domain and they do not generalise very well to more than one problem domain. This makes it very difficult for +Spaces to build a general framework for policy simulation without having to re-implement a different simulation for each policy being considered. This essentially makes computer simulations an infeasible option, as it does not easily support the dissemination and use of the outputs from the project by other parties.

An alternative simulation scenario therefore is to provide a virtual space in which the participants themselves can act out a particular government policy issue through an online role-play simulation activity. This could be a mediated task (i.e. facilitated by an online consultant) whereby the users are assigned roles (e.g. central government policy maker, civil servant, local government agent, citizen, etc) and then asked to act out a particular simulation scenario (e.g. implementation of a new waste removal service by private contractors). The role-play could take place in a virtual world that visually recreated the location of the intended policy e.g. town hall, local street, etc.

The use of role-play within the context of +Spaces is illustrated in the following diagram:

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Figure 5: Role-play in the context of +Spaces

A number of role-play templates have been explored which could be used by the project as a framework for holding online policy focussed role-play simulation activities.

An analysis was also carried out into whether Game Theory could be used to support this work. The implication of Game Theory to the use of role-playing as a simulation framework within the +Spaces project are that in order for game theory to be applied to a simulation scenario we would need to be able to break-down the game/role-play into defined moves and payoffs (with predetermined values and outcomes). This would work well with simple game-like scenarios but can be difficult to scale to real-world/fuzzy problems. Also, often it will be difficult for a policy maker to predict the outcomes (i.e. payoffs) from different scenario decisions – after all the purpose of the role-play/simulation is to expose these payoffs so that they can be considered in the refinement of the policy in the first place (a chicken and egg situation).

So in summary, Game Theory matches well with structured 'serious games', which require this level of pre-planning. However, it does not easily support unstructured dialogue based role-play scenarios.

These finding are documented in the D4.1.1 report [37].

A presentation of the issues around +Spaces simulations was made at the Immersive Education Initiative Summit in Boston in May 2011 [38].

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5.7.3 Lessons learned

The lessons learnt from this are that it is very difficult to simulate government policy in virtual worlds without having access to large-scale virtual worlds in which people spend a large amount of time in. Without the ability to fully customize the features in these worlds (e.g. the underlying economic model used), it is very hard to implement changes in associated government policy. Also, the danger is that in creating bespoke simulations it is not possible to generalize this approach to other government policy issues - so the simulation cannot be reused easily by other people. Our solution to these problems was to develop a generalisable role-play framework which can be used to simulate many types of government policy issues.

Other experts also back up this analysis such as Prof. Richard Duke, author of 'Policy Games for strategic management: pathways to the unknown' (2004 Purdue University Press) [39]. His work has moved away from using simulations precisely because of their black-box nature, to a more general approach based on role-playing simulation exercises that allow different players to engage each other. Professor Duke believes that this provides a far less deterministic approach, which is more generalisable, and introduces an unpredictable element of human choice into the process (which is a good thing).

An alternative simulation scenario therefore is to provide a virtual space in which the participants themselves can act out a particular government policy issue through an online role-play simulation activity. This could be a mediated task (ie. facilitated by an online consultant) whereby the users are assigned roles (eg. central government policy maker, civil servant, local government agent, citizen, etc) and then asked to act out a particular simulation scenario (eg. implementation of a new waste removal service by private contractors). The role-play could take place in a virtual world that visually recreated the location of the intended policy eg. town hall, local street, etc.

This type of virtual world simulation is often referred to as a 'serious game'. A serious game is defined as (from Wikipedia):

Serious games are designed for the purpose of solving a problem. Although serious games can be entertaining, their main purpose is to train, investigate, or advertise. Sometimes a game will deliberately sacrifice fun and entertainment in order to make a serious point. Whereas video game genres are classified by gameplay, serious games are not a game genre but a category of games with different purposes. This category includes educational games and advergames, political games, or evangelical games. The category of serious games for training is also known as "game-learning".

Serious games are often used where it would be too dangerous or too costly to attempt the game in a real-world setting. Examples include safety training on oil rigs and war-gaming exercises. In both these examples, the keys factors are:

- A realistic virtual world environment (reflecting the real world)

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- Multi-player scenarios and collaboration, often with users role-playing different characters (eg. paramedic, doctor, patient)
- A rich underlying model reflecting the real-world behaviours available (eg. fire fighting capabilities on an oil rig)

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6 Conclusions

+Spaces aimed at the increase of user engagement and participation in policy making by leveraging on the popularity of social media as well as the mechanisms they implement. As such, +Spaces enabled the policy maker to define once and deploy multiple instances of a simulation experiment that he/she would like to perform so as to collect social intelligence and thus citizen opinions on topics. In order to develop the technical platform to support this concept and also to validate the main assumption that "going to where the people are" will improve the user experience of participating users, +Spaces developed and tested three typical egov applications: polls, debates and role-play simulations. The two former were mainly used in order to guide the implementation of the platform and evaluate its operation both in technical and social terms.

In this context, during the first two project iterations these two applications were developed and evaluated by policy makers, citizens and application developers. The development resulted in an infrastructure that can support the "write once, run anywhere" capability with applications being deployed in 3D virtual spaces (OWL), Twitter, Facebook and Blogger (BlogSpot). The application adaptors managed the manifestations of the applications to the respective environments as well as the collection of user data. Because of the sensitive nature of the exploited private data +Spaces seek solutions for a legal ground. From the available options it turned out that the one that also enhanced platform sustainability was the request and provision of explicit user consent.

The final step for implementing the vision was the development and testing of an application that engaged the citizens using advanced metaphors about the policy in question. This application simulated the context to which the decision is made by providing the pros and cons in an interactive way making it part of the users' experience. The role-playing simulation, challenged the participants' way of thinking by asking them to place themselves into the shoes of people supporting a different (often opposite) opinion. This was a guided process resembling Socratic method, creating a form of inquiry and debate between individuals with opposing viewpoints based on asking and answering questions to stimulate critical thinking and to illuminate ideas.

Even though this method was proved to be successful into stimulating people's mind and liberating their thoughts in giving their opinions, it didn't completely resolved the issue of increased citizen engagement into policy making. It was expected that in this grand challenge features such as the interoperability in virtual spaces ("going where the people are") and the 3D immersive environments would assist. With these, the goal was achieved to a great extent but not entirely. The main obstacle was the amount of energy that is needed to be put into building active communities. For that, it takes more than the profile of a research project like +Spaces, but that of a well-known organization or individual. The latter, must have either access to existing communities (e.g. the Facebook friends of a minister) or the resources and prestige to create one in a short notice. Otherwise, significant resources need to be spent into maintaining the citizens' communities that participate in +Spaces.

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Summarizing, the main conclusion is that +Spaces achieved its main research and technical goals and provided a evidence and a stepping stone towards the implementation of the great vision of actively engaging the masses of citizens into policy making.

More detailed analysis of the lessons learned from the research and technical work in +Spaces can be found on Sections 4 and 5.

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