SEVENTH FRAMEWORK PROGRAMME

"Information Society Technologies"

D4.1.1
Testbeds Environment Analysis

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Editor:	Konstantinos Tserpes	NTUA
Author(s):	Michael Gardner	UESSEX
	Michal Jacovi	IBM
	Bernard Horan	UESSEX
	Omri Fuchs	IBM
	Zak Mandel	IBM
	Sigalit Ur	IBM
Authorized by	Michal Jacovi	IBM
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Reviewer	Fotis Aisopos	NTUA
Reviewer	Katja Sonnhalter	ATOS
	Konstantinos Tserpes	NTUA
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Executive Summary

This document examines both 3D immersive collaborative spaces and 2D web social networking services. These are the main application categories within which the +Spaces applications will be implemented. For each category we look at the recent trends and make a clear definition for each area, in terms of how they will be used by the +Spaces project. We then examine some of the more detailed characteristics for these virtual world platforms and where appropriate present some example applications that have been developed. We then identify the main platforms being considered by the +Spaces project to implement the policy-making applications. A comparison of features is then made between each platform to identify the advantages and disadvantages of each. A detailed specification is then provided for the virtual space manager and adaptors that will interface with and each virtual world platform. Finally some of the issues for creating +Spaces simulations are identified in more detail.

The main implications for the +Spaces testbed applications are summarised below:

The following **user groups** can be targeted for +Spaces trials:

I. Facebook – the project needs to identify which specific user groups will take part in the trials
II. Blogger – the project needs to identify which specific user groups will take part in the trials
III. Twitter – the project needs to identify which specific user groups will take part in the trials
IV. SecondLife – the project needs to identify which specific user groups will take part in the trials. The age range will be 18+
V. OpenWonderland – specific targeted user groups

The **3D virtual world** +Spaces applications of polling, debating and simulation can be implemented using the OpenWonderland platform. These applications could even be accessed by an alternative originating virtual world (eg. SecondLife, Facebook), which could launch an OpenWonderland +Spaces app by embedding an appropriate URL within a 2D or 3D in-world object. In this context, the originating virtual world will therefore be used to provide access to specific user groups for the trials.

The **2D +Spaces** applications will be implemented using Facebook, Twitter and Blogger RESTful APIs. In addition, Facebook application framework and blogger widgets will also be implemented.

The following **issues** will need to be resolved when implementing the +Spaces testbed:

I. OpenWonderland supports up to 25 concurrent users. The +Spaces applications and user trials will need to be designed around this as a maximum number at any one time.

II. Ideally each OpenWonderland world should run on a dedicated server. It is possible to configure the server to have a number of different worlds, but only one world can be loaded at any one time (supporting up to 25 concurrent users). The server architecture will need to be designed to account for the anticipated maximum number of concurrent Wonderland worlds that will be needed at any one time.
III. If SecondLife is to be used, the project will need to have access to an existing island on SecondLife, or will have to purchase its own island and populate it with appropriate 3D content, etc.
IV. Users will have to give permission to the project in order to take part in any of the trials. This may require users to electronically sign an authorisation form prior to and during the course of the trials.
V. The project will need to decide which user authentication mechanisms will be used to identify and authorise user participation in the project trials. For example, will the project have to create its own user registry database (eg. LDAP) or will it use existing user account information (eg. Facebook accounts).
VI. The project will need to consider issues around providing different language versions of the +Spaces applications and environments (eg. Greek, English, etc)
VII. The +Spaces simulation application still needs to be analysed in more detail in order to better understand the implications for the testbed environment.

The use of virtual worlds for simulations for policy making is a complex and challenging task with many issues beyond the scope of the +Spaces project. This document has presented an analysis of these core issues and some possible scenarios for further consideration in the design phase of the project.

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1 Introduction

This document presents the results from task 4.1.1 'Virtual Worlds Environment Analysis'. The purpose of this task is to study a range of commonly used virtual world environments that are candidates to be used in the project.

The outcome from this study forms the special requirements and characteristics that +Spaces applications must address in order to integrate with each virtual world. This document provides the basis for the definition of the testbed environments, in which the core +Spaces policy simulation applications will be deployed.

1.1 Expectations

In the context of +Spaces, the scope of "Virtual Worlds" is broad. 3D immersive virtualized environments typically allow users to collaborate with one another (such as Second Life and Open Wonderland) in an online virtual space. However, the project is also considering simpler environments that allow users to meet and share information within a social network to also constitute a type of virtual world. Users of social network environments, bloggers and microbloggers all communicate with each other within their respective systems, creating rich patterns of interaction. Examining these systems will enable us to tap into an extensive and diverse user base, overcome some of the entry barriers to the more complicated 3D environments, and study a wider variety of technologies to receive more representative insights into the problem domain.

The study is therefore focussed on the two broad categories of virtual world environments:

- 3D immersive collaborative virtual worlds
- 2D web-based social networking services

1.2 Analysis approach used

For each category of virtual world environment being studied, a sub-definition is given, which is used to characterise the main features pertinent to that type of environment. These features are described in more detail and candidate virtual world platforms and services are then identified and more explicitly described using these characteristics. An analysis is then made of the results from the study and recommendations are made for the virtual world platforms or services that will be used by the +Spaces project, the virtual space management layer and adaptors are defined in more detail, and the issues and scenarios for +Spaces simulations are considered.

It is particularly important that the virtual world platform selected by the +Spaces project work with a common +Spaces API framework and with the supporting infrastructure services. The virtual worlds will need to be constructed and integrated within this defined, environment, allowing for user, application, infrastructure, data extraction, and data analysis testing. This report makes recommendations for which virtual world platforms will be used to form the +Spaces testbed environment and scopes out the implications for the future user experiments (for example, size of user community, type of interactions possible). The

output from this report will feed directly into Task 4.3 for the actual implementation of the testbed and +Spaces applications.

1.3 Document Structure

This document starts by examining both 3D immersive collaborative spaces and 2D web social networking services. These are the main application categories within which the +Spaces applications will be implemented. For each category we look at the recent trends and make a clear definition for each area, in terms of how they will be used by the +Spaces project. We then examine some of the more detailed characteristics for these virtual world platforms and where appropriate present some example applications that have been developed. We then identify the main platforms being considered by the +Spaces project to implement the policy-making applications. A comparison of features is then made between each platform to identify the advantages and disadvantages of each.

The implications for the +Spaces testbed applications are then considered. This is achieved by re-examining the key requirements for the project arising from the D2.1 deliverable, and assessing their impact on the choice of platforms to be used by the project. The document then identifies the issues that now need to be resolved by the project in the next stage, which will be implementing the +Spaces applications and designing the user trials to be carried out.

The next sections then define the Virtual Space management later and adaptors that will be used to interface with each virtual world (OpenWonderland, Facebook, Twitter and Blogger).

Finally the document examines some of the issues related to the creation of simulations to support policy-making scenarios – ultimately the most challenging part of the +Spaces project. A number of different simulation scenarios are identified and the issues and challenges for the project are clearly highlighted.

2 3D immersive collaborative virtual spaces

This section considers the application of 3D virtual worlds, and reflects on some of the recent changes in this sector. It also makes a definition for 3D virtual worlds and examines some of the characteristics of this new technology and application area. We explore what is actually meant by 3D Virtual Worlds, and some of the differentiators between the platforms that are now becoming available. Some example business applications are then given.

A number of candidate 3D virtual world platforms are then selected for more in depth analysis by the +Spaces project. Each virtual world is analyzed against the different characteristics identified for 3D virtual world platforms, which includes their online social dimensions, whether they have an economic model, and the types of users, and a technical analysis of their implementation (eg. development models supported).

2.1 Recent trends

Over the recent years we have seen growing interest in the use of 3D Virtual Worlds across all areas of business. This followed the initial success of popular online games like World of Warcraft (which had 11.5 million users registered in December 2008[1]). However the early euphoria over the possibilities presented by these virtual worlds has since become more realistic as the community starts to explore the business opportunities enabled by this technology. It has been recognised that the industry until very recently was in the 'disillusionment trough' phase of the classic Gartner hype cycle[2] and is now working its way up the 'enlightenment slope' towards greater levels of productivity. This status is also reflected by the Rogers Innovation Adoption Curve[3], as the industry moves from engaging with 'early adopters' through to acceptance by the wider 'early majority' and the promise of more widespread adoption. We are now starting to see exciting new uses for 3D virtual worlds across all sectors. There are early signs of a move away from purely consumer applications, through to new ways of businesses working online in the three dimensional space.

One of the great success stories of the recent years has been SecondLife, created by the company Linden Labs, which in January 2010 had 18 million accounts[4]. Second Life has been a profitable service for some time now, though it never became the next big Internet sensation the way marketers were predicting three or four years ago.

We have seen a lot of activity in the supplier side of the business, with changing priorities and the evolution of the market. For example, IBM has decided to draw back from its initial investment in 3D virtual worlds, as evidenced by its withdrawal from the experimental business unit it set up with Linden Labs. There has also been significant churn in the 3D virtual world market. For example, in the past 12 months we have seen the following market shifts (as examples):

- Sun Microsystems withdrawing its commitment to Project Wonderland (prior to the Oracle takeover). However this platform has since been adopted by the community as part of the Open Wonderland initiative
- The sale of Forterra's OLIVE platform to Science Applications International Corporation (SAIC)
- The closure of There.com
- Nortel selling their virtual world business to Avaya
- Linden Labs decision to reduce headcount by 30% and reduce their commitment to enterprise virtual worlds

These events underline the observation that the 3D virtual world market recently underwent a period of instability. However, it could be argued that there is now a more realistic view about the opportunities afforded by virtual worlds, backed up by some real examples of the benefits that some organisations achieved through the early adoption of this technology.

[1] Cavalli, Earnest (December 23, 2008). "World of Warcraft Hits 11.5 Million Users". Wired. Retrieved 2009-11-03.
[2] Gartner Hype Cycle for Social Virtual Worlds, Temporal Perspective by Gary Hayes, muvedesign.com, January 2009
[3] Everett Rogers, New product adoption and diffusion, Journal of Consumer Research, 1976
[4] "Current user metrics for Second Life". Secondlife.com. Retrieved 2010-02-19

Virtual Worlds have moved from being a topic of the research lab and are now being considered for real business applications.

The key impact of these trends on the +Spaces project has been the shift in focus to include not only 3D virtual worlds but also 2D social-network services as candidate platforms for the +Spaces applications. With the continued rise in the number of users registered with these 2D social networking services (such as Facebook), it is felt that this will provide the project with a much larger user base of citizens with which to test out new government policies.

2.2 Definition

The term Virtual World covers a lot of territory. Wikipedia describes it as '*a genre of online community that often takes the form of a computer-based simulated environment, through which users can interact with one another and use and create objects*'. More specifically in this section we are considering three-dimensional (3D) virtual worlds, as a specific sub-group within this wider virtual world definition. These *are interactive 3D virtual environments, where the users take the form of avatars visible to others graphically. These avatars are usually depicted as textual, two-dimensional, or three-dimensional graphical representations, although other forms are possible (auditory and touch sensations for example)*. Other key characteristics of a virtual world are that it is a *multi-user* environment that supports *synchronous* communications between its users, and the state of the worlds persists beyond when the individual user is logged in.

It is important to define what we mean by a 'virtual world', and a 'virtual world platform'. Some services offer an environment that already exists, and provide a virtual world in which new users can just make use of and/or extend this world (perhaps having to pay a premium to do this). For example SecondLife already provides a virtual world, which new users can straight away start using. However, if they want to, a user can purchase and build a virtual world of their own (as an 'island'), which essentially extends the existing SecondLife world. Social networking sites like Facebook and Twitter also operate in a similar way, in that users can make use of the existing networks on these sites, but can also create their own sites and groups which extend what is already there. Virtual world platforms like OpenWonderland and OpenSim are different, as they are essentially toolkits for deploying your own virtual world on your own server. In the process of deploying these worlds, you have to essentially construct (or at least choose) which virtual world will be deployed on the platform. There is no existing virtual world (with users and content) that you are joining – you are essentially constructing your own virtual world from scratch.

The implications for the +Spaces project are that it needs to make use of both types of virtual world platform. i.e. the project needs to make use of virtual spaces that provide it with access to large numbers of users/citizens with which to test out new government policies (e.g. Facebook, SecondLife); and the project also needs to make use of virtual world toolkits (such as OpenWonderland) that enable it to build new innovative ways of implementing the planned +Spaces applications (polling, debating and simulation).

2.3 Characteristics

(3D) Virtual Worlds have been used for a very wide range of applications, and this can often make it difficult to generalise about their characteristics and the benefits accruing from the use of the technology. Figure 1 illustrates one possible framework for describing the usage of virtual worlds, derived from the use of virtual worlds for teaching and learning (ie. e-learning). Here one dimension is the formality of use, i.e. whether the world is a controlled environment for formalised use (such as online lectures) or whether it is an informal space for users to enter when needed (such as a museum environment). The other dimension is whether the world is primarily built to allow its users to interact with the three-dimensional content (such as a science experiment), or whether the world provides a set of tools to allow its users to collaborate more effectively with one another (such as a collaborative working environment). The intended use of the virtual world will also determine how one would evaluate its effectiveness. For example, a world designed to support e-learning would need to consider the pedagogical issues whereas a world designed for business collaboration would have more pragmatic success criteria (such as ease of use for setting up meetings). However, whatever the requirement, the decision to use a virtual world will usually be based on two fundamental objectives, that of *cost* (ie. it is cheaper to achieve in a virtual world than in real life) and *safety* (ie. it would be too dangerous or impossible in real life).

There are also some key technical and service characteristics, which can help to differentiate between different types of virtual world platform. These are:

- Business model: proprietary/commercial or open source
- Hosting: public subscription model, private hosted or deploy on own server
- 3D content creation: proprietary or open art path, in-world or external tools
- Robustness: suitability for mission-critical deployment
- Client: downloadable install, Java applet, browser-based
- Extensibility: scripting, APIs, extensible module architecture, development environment
- Graphics engine: OpenGL, DirectX, Flash, JME
- Notable features: voice communication, shared applications, streamed media, etc
- Scalability and performance: number of concurrent users, extensible architecture, behaviour on server or client
- Graphics quality/fidelity
- Client hardware requirements
- Collaboration tools e.g. shared applications, voice communications, chat, etc
- Online social dimensions, e.g. whether the world has an economic model,
- Types of users supported
- Privacy/security, authentication

These characteristics will be used in the next section where some selected 3D virtual world platforms are analysed in greater detail.

Given the current state of development of 3D virtual world technologies, the key technical differentiator of robustness seems to be dependant on the business model adopted by the technology provider. Commercial suppliers such as Linden Labs (SecondLife) and Unity

Technologies have invested many millions in the development of their respective platforms for specific niche markets, and are generally regarded as being fairly resilient well-supported platforms. Whereas there are a number of free open-source offerings such as OpenSim, OpenWonderland and OpenCobalt, all at a relatively early stage of development, and with variable levels of training and support. Consequently these tools have so far been more widely used in the research lab rather than for mission-critical applications.

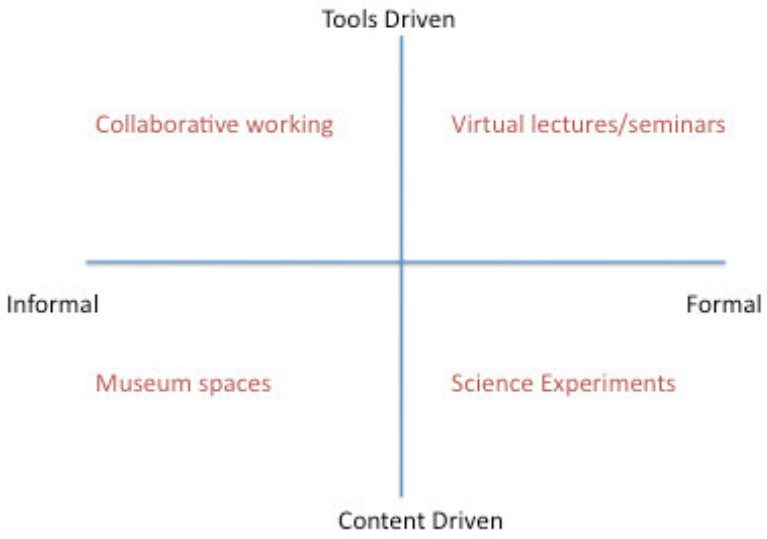


Figure 1. Virtual worlds usage framework

There are already thousands of deployed virtual worlds, and a multitude of different development tools and platforms for creating and hosting them. Virtual worlds are moving away from being stand-alone services to becoming part of the jigsaw of applications in the world of web services and mash-ups. There are a multitude of tools for creating the raw 3D content through to customising the avatars and giving them more life-like behaviours. It is possible to buy virtual land from a commercial provider, or rent your own private server, or deploy a virtual world as part of your own computing infrastructure. Real business applications are starting to emerge for virtual worlds, which go beyond the consumer games environment that they originated from, and more importantly are based on real expectations rather than the previous hyperbole.

2.4 Example business applications

2.4.1 Online lectures: using virtual worlds to extend your business

From the start, universities and businesses were early adopters of the SecondLife platform (amongst others), often creating virtual versions of their campuses and offices online. However, many of them struggled when it came to taking it to the next stage, in terms of moving from a peripheral activity to more active use, as part of their day-to-day business operation. This is now starting to change, as a number of organisations are using virtual worlds to deliver their live lectures to a wider audience. For example, the MiRTLE[5] project (Mixed Reality Teaching & Learning Environment), which was developed by the University of Essex in the UK, originally used the Open Wonderland platform to provide a mixed reality environment for live lectures. This supported a combination of local and remote students in a traditional instructive higher education setting. Specialised teaching rooms were created which allowed a physical classroom to be linked to an online class, and which facilitated greater communication between the online and live participants. See figure 2 for a view of a MiRTLE classroom in operation.

A number of teaching organisations are now starting to roll out their own MiRTLE facilities. For example, St Paul College in the USA has the world's largest MiRTLE facility and is using it actively to teach a range of Computing and ICT courses. The Minnesota Public Schools Systems (MPSS) is also starting to role this infrastructure out to high-school teaching institutions across the state. The reason for the success of MiRTLE is that it provides real business benefits (ie. increasing the number of students who can take courses) whilst requiring minimal change in how lectures are delivered by the staff members. It also provides the springboard for organisations to be able to then explore other more innovative uses for the technology. The key technical requirement for this type of application is good quality audio communications and a highly collaborative environment (eg. shared applications, whiteboards, presentations). The 3D graphics quality is typically of secondary importance. MiRTLE has so far been deployed on both the Open Wonderland and SecondLife platforms.

[5] Gardner M, Scott J & Horan B (2008). 'Reflections on the use of Project Wonderland as a mixed-reality environment for teaching and learning'. ReLIVE 08 conference, Open University, UK.

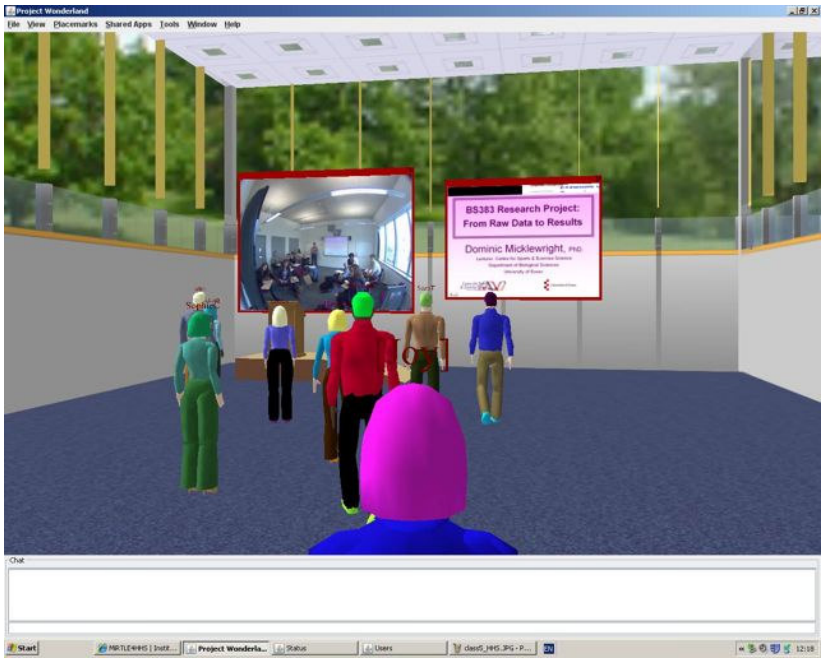


Figure 2. MiRTLE classroom in operation

2.4.2 Visualisation and co-creation: generating new business

One of the advantages of the 3D virtual world environment is that it can be used throughout the lifecycle of customer engagement, from initial discussions, sharing of ideas, through to being able to virtually walk around the finished product. Businesses are now starting to make use of these 'super' collaborative environments to not only improve internal communication between distributed workers, but also to engage and work more actively with their customers. These spaces allow for truly informal conversations between stakeholders, with support for multiple simultaneous activities, and more spontaneous and 'social' collaboration. The virtual space provides the context, and the arrangement of the space and type and position of objects impart the social cues. These spaces can be said to have a high emotional and social bandwidth, providing a visual representation of the corporate culture.

Depending on how this strategy is applied, virtual worlds (when combined with other Web 2.0 technologies) provide an ideal collaborative environment with the ability to share applications and documents and link to back-end systems. So far we have seen a range of virtual world platforms used to share designs for new business propositions in this way. Examples include the development of 3D architecturally accurate representations for new office spaces, mock-ups for new railway operations centre, and also designs for a new hospital. The ability for some 3D virtual worlds to allow stakeholders to share ideas by dragging and dropping images, documents and 3D models into the virtual world is particularly important in this process. The granularity of the end results is also entirely dependant on the needs of the individual customer. For example for the creation and

visualisation of quick sketches, a 3D graphics environment may be suitable with simple mesh structures and low fidelity textures (eg. Google Sketchup models imported into an Open Wonderland environment). However, for larger projects where realism is more important we might see the use of higher end virtual world environments that allow for complex shading and environmental features (eg. Maya objects within a Unity3D gaming environment). Another important requirement might be to add behaviour to in-world objects (eg. a train routing algorithm within a railway control centre). This might be achieved by using in-world scripting such as Linden Script in SecondLife, or might require the virtual world to be integrated with other software though an API (eg. such as the Open Wonderland Java interface).

2.4.3 Cross-platform virtual worlds: new 3D virtual business on the web

One of the few companies making money out of virtual worlds for business use is Unity Technologies, the developer of the Unity3D platform. They claim to be revolutionizing the game development industry with their development platform for creating highly interactive 3D content - including video games, training simulations and medical and architectural visualizations. The main advantage is that these applications can then be delivered on the personal computer, the web, mobile device and games console. The Open Wonderland platform initially blazed this cross-platform trail with their Java based platform. The key difference with Unity is that it came out of the games arena, and the Unity graphics environment provides a much richer games-like experience to the end user.

Other companies are now starting to take the Unity web plugin and use it to integrate with other back-end systems. For example Rezzable in the UK are developing an interface to a back-end Opensim world, and are using the Unity web-based plugin as the main user interface. This gets around the problem of having to use separate client applications and focuses everything on the web.

Other companies are also starting to adopt this strategy. For example gojiyo.com, which is a large mass-market development that integrates Facebook with its own virtual world, based on OpenSim, but using the Unity3D browser-based plugin. The world surpassed Second Life's registered user base in India (18,000) within 12 hours of launch. The makers claim that the virtual world includes more than 30 different social games, a huge range of avatar personalisation and customisation options, in-world shopping, live music events and social hangouts. We can expect to see many more uses for this technology in the future, particularly in areas such as serious games and online commerce.

2.4.4 Citizalia: virtual worlds for EU policy making

Citizalia[6] is an animated social networking platform that captures the essence of the European Parliament. A beta release is planned to go live in late 2010.

[6] http://blog.citzalia.eu/about-citzalia/

Citzalia is described as a world you inhabit and help create. Using a Web browser, users can create an avatar, which they use to walk around, interact, network and debate the issues of today in the corridors of the European Parliament and contribute to a vibrant virtual community. By contributing to the discussions and adding content, participants accumulate experience points, which appear on their profiles.

Citzalia aims to provide a greater understanding of how the EU's democratically elected Parliament works. Through participating in debates and writing articles on issues relating to the European Parliament and EU policy, users will gain an insight into and expertise on how democracy works in the EU.

The interactive platform provides an opportunity to hear how fellow citizens feel about current issues and about the role of the European Parliament. Official information will be available side by side with discussion forums. The platform will be available in all 23 official languages of the EU.

Citzalia aims to help citizens understand the European Parliament and get closer to the decision-making process. It has a number of tools needed to join in the European debate. It aims to be a fun and simple-to-use online platform where users can meet other Europeans, EU experts and where they might even bump into a Member of the European Parliament. It is also a place to share their opinions and discuss the issues that they care about.

Citzalia recreates parts of the various buildings of the European Parliament in Brussels and Strasbourg. Citzalia has several areas where their avatar may explore:

- The Citizens' Agora is a general discussion forum about the workings of the European Parliament and of the European Union in general.
- The Press Room features news and views on current events and issues. Users can also vote on content and gain experience points.
- EU Lex Lab is an activity offering a simulation of the legislative process. Users can propose legislation themselves and experience how laws are passed at EU level.
- The Exhibition Hall is a space where virtual exhibitions are held.
- The Education Corner provides space for young people with dedicated content for teachers as well.
- The Library is a database of all archived content published by the community.

Citizalia has been designed and implemented more as 2.5D web based application (similar to Metaplace[7] in appearance), rather than a fully immersive 3D environment. The designers particularly wanted to create a simple to use environment that could be run in a standard web browser without the need to download and install any additional software.

[7] http://en.wikipedia.org/wiki/Metaplace

2.5 Virtual world platforms

2.5.1 SecondLife

Second Life (SL) is a virtual world developed by Linden Labs that launched on June 23, 2003, and is accessible on the Internet. A free client program called the Viewer enables its users, called Residents, to interact with each other through avatars. Residents can explore, meet other residents, socialize, participate in individual and group activities, and create and trade virtual property and services with one another, or travel throughout the world (which residents refer to as "the grid"). Second Life is for primarily for people aged 18 and over. There is also a Teen Second Life for people aged 13 to 17, however it is understood that this may be terminated soon as a Linden Labs service.

Built into the software is a three-dimensional modelling tool based around simple geometric shapes that allows a resident to build virtual objects (assuming that they have the correct privileges within a particular piece of land). This can be used in combination with the Linden Scripting Language, which can be used to add functionality to objects. More complex three-dimensional sculpted prims (colloquially known as "sculpties"), textures for clothing or other objects, and animations and gestures can be created using external software. The Second Life Terms of Service provide that users retain copyright for any content they create, and the server and client provide simple digital rights management functions.

There is no charge to create a Second Life account or for making use of the world for any period of time. Linden Lab reserves the right to charge for the creation of large numbers of multiple accounts for a single person but at present does not do so. A Premium membership extends access to an increased level of technical support, and also pays an automatic stipend of L$300/week into the member's avatar account. However, the vast majority of casual users of SL do not upgrade beyond the free "basic" account. Premium membership allows users to own ‘islands’ of virtual land on which they can build their own content and control access.

Avatars can communicate via local chat or global instant messaging (known as IM). Chatting is used for localized public conversations between two or more avatars, and is visible to any avatar within a given distance. IMs are used for private conversations, either between two avatars, or among the members of a group, or even between objects and avatars. Unlike chatting, IM communication does not depend on the participants being within a certain distance of each other. As of version 1.18.1.2, voice chat, both local and IM, is also available on both the main grid and teen grid. Instant messages may optionally be sent to a Resident's email when the Resident is logged off, although message length is limited to 4096 bytes. If a message is sent to an offline Resident it will also be saved to be viewed when they log on.

Second Life has an internal currency, the Linden dollar (L$). L$ can be used to buy, sell, rent or trade land or goods and services with other users. Virtual goods include buildings, vehicles, and devices of all kinds, animations, clothing, skin, hair, jewellery, flora and fauna, and works of art. Services include "camping", wage labour, business management, entertainment and custom content creation (which can be broken up into the following six

categories: building, texturing, scripting, animating, art direction, and the position of producer/project funder). L$ can be purchased using US Dollars and other currencies on the LindeX exchange provided by Linden Lab, independent brokers or other resident users. Money obtained from currency sales is most commonly used to pay Second Life's own subscription and tier fees; only a relatively small number of users earn large amounts of money from the world.

2.5.2 Open Wonderland

Open Wonderland is a 100% Java open source toolkit for creating collaborative 3D virtual worlds. Within those worlds, users can communicate with high fidelity, immersive audio, share live desktop applications, and collaborate in an education, business, or government context. Wonderland is completely extensible; developers and graphic artists can extend its functionality to create entirely new worlds and add new features to existing worlds.

The vision for Open Wonderland is to provide an environment that is robust enough in terms of security, scalability, reliability, and functionality that organizations can rely on it as a place to conduct real business or education. Organizations should be able to use Wonderland to create a virtual presence to better communicate with students, customers, partners, or friends. Individuals should be able to do their real work within a virtual world, eliminating the need for a separate collaboration tool when they wish to work together with others. Individuals should also be able to tailor portions of the world to adapt to their needs and to express their personal style. The types of collaborations that can happen within the space include audio communication; live desktop applications of all kinds, and collaborative creation of world content (both graphical and procedural).

One important goal of the project is for the environment to be completely extensible. Developers and graphic artists can extend the functionality to create entire new worlds, new features in existing worlds, or new behaviours for objects and avatars. The art path for Wonderland is also open. The eventual goal is to support content creation within the world, but in the shorter term, it already supports the import of art from open source 3D content creation tools as well as professional 3D modelling and animation applications.

Open Wonderland is governed by the non-profit making Open Wonderland Foundation. The foundation is keen to emphasise that Open Wonderland is software under active development and that it is NOT a product. The Wonderland development team is small; there is no Q/A or documentation team. Their focus is on developing the key features to enable others to build interesting virtual worlds on top of the platform in an open-source development framework.

2.5.3 OpenSim

OpenSim, is an open source server platform for hosting virtual worlds. While it is most recognized for compatibility with the Second Life client, it is also capable of hosting alternative worlds with differing feature sets with multiple protocols. OpenSim is designed to be easily expanded through the use of plugin modules and several modified distributions exist, such as realXtend, and additional plugins can be found on the OpenSim Forge. Multiple

servers can be integrated into a 'grid', which allows larger more complex areas to be simulated.

OpenSim can operate in one of two modes: standalone or grid mode. In standalone mode, a single process handles the entire simulation. In grid mode, various aspects of the simulation are separated among multiple processes, which can exist on different machines. Standalone mode is simpler to configure, but is limited to a smaller number of users. Grid mode has the potential to scale as the number of users grows.

OpenSim utilizes loadable modules for most of its functionality. These loadable modules can be independently developed to add functionality to the server.

At one level, OpenSim can be viewed as being very similar to SecondLife but with the added advantage of being able to host and run your own virtual world (without the need for a third-party commercial provider, such as Linden Labs). Given that it is possible to use the Linden Labs viewer (amongst others) with an OpenSim world, the user experience can sometimes be indistinguishable with that of SecondLife. However OpenSim does not currently support all of the same features that are currently provided by SecondLife, although given the open nature of its architecture, it is always possible to develop and extend the feature set that is available (given suitable programming expertise). Notable differences between OpenSim and SecondLife are the absence of the SL economy, and the lack of inbuilt voice communications (although this can be added by someone with suitable programming expertise).

2.5.4. Comparison table

	SecondLife	**OpenSim**	**OpenWonderland**
Business model	Commercial service	OpenSource community	OpenSource community
Hosting	Public subscription	Deploy on own server	Deploy on own server
3D content creation	In-world tools	Primarily in-world tools. RealXtend supports the importing of mesh models	Import Collada content eg. Google Warehouse
Robustness	Commercial service – fairly resilient. Although SecondLife Viewer 2 is still at Beta status.	Pre-release Beta quality	Pre-release Beta quality

Client and hardware requirements	Client software downloaded from SecondLife site (Windows, OSX, Linux)	Client software downloaded. Can use standard SecondLife client or other opensource releases (eg. Hippo, RealXtend)	No client required. Requires Java 1.6 Uses Java Webstart to download and launch client
Extensibility	Not possible to build new extensions to the SecondLife service. LindenScript can be used to create customisable dynamic options/behaviours and link to other systems (eg. Moodle)	Server built on .Net framework. A number of opensource server add-on modules are available. Currently supports LSL, OSL and C# scripts. But with limitations.	Client and server built on Java. Relatively easy to customise the server functionality. Supports a module warehouse model as a framework for adding new functionality to Wonderland. There is a beta scripting module – although this has limited functionality.
Graphics engine	Proprietary OpenGL based engine	Re-engineered SL OpenGL client (RealXtend uses the open source OGRE 3D engine)	JME (JMonkey Engine) Java based
Notable features	Ability to customise avatars Large user base Powerful scripting	OpenSim clients have been developed on other platforms eg. as a web-page plugin (on Facebook) using the Unity viewer	Easy to integrate with other back-end systems eg. authentication Module warehouse allows the platform to be easily extended
Scalability and performance	Linden Labs recommend around 40 concurrent users on any one island There can be over	Around 20-30 concurrent users per server. Servers can be linked using the OpenSim	Around 25 concurrent users per server. Possible to link

	50,000 concurrent users on SecondLife	Grid mechanism.	servers via portals.
Graphics quality/fidelity	Medium quality	Medium. RealXtend is higher quality as it supports customisable avatars and better shading/textures.	Low quality
Collaboration tools	Limited collaboration tools in the current viewer. However Viewer 2 supports a MediaBrowser which allows any web page and rich web content (eg. Flash, video, audio) to be shared. High-quality voice communications	Limited collaboration tools No inbuilt voice capability	Shared Wonderland applications eg. PDF viewer, whiteboard, etc Any X11 application can be shared eg. Firefox, OpenOffice A VNC module enables the sharing of any VNC desktop/application High-quality voice bridge
Social dimensions	Rich economic model and marketplace systems to support the trading of SecondLife goods. Large user population.	Small user populations – designed for intranet usage.	Small user populations – designed for intranet usage.
Types of users	Over 18 years of age Large public user base	Any Essentially for private installations	Any Essentially for private installations
Privacy/Security and Authentication	Users must register an account with LindenLabs. Currently users cannot use their real names (however,	The responsibility of the server provider. Can build your own mechanisms for this.	The responsibility of the server provider. Can build your own mechanisms for this. For example, the Wonderland server

	this is likely to change).		can implement a simple authentication mechanism, or the server can be linked with a separate LDAP server.

Table 1. Comparison between candidate 3D virtual world platforms

3 2D web social networking services

Social networking services now have a huge market share. Nielsen Reports finds that "social networks and blogs are now the 4th most popular online activity ahead of personal email. Member communities are visited by 67% of the global online population, time spent is growing at 3 times the overall Internet rate, accounting for almost 10% of all Internet time".[8] Tapping into this immense user base seems worth exploring in the context of the +Spaces project.

This section defines 2D web social networking services virtual worlds, and examines some of the characteristics of this application area. We explore what is actually meant by social networking services, and supply a few examples of the applications available in different areas. Three types of candidate social networking services are then selected for more in depth analysis by the +Spaces project. Each type is described in terms of user interactions available. Finally, a specific site representing each type is selected.

3.1 Definition

Wikipedia defines **a social network service** as "an online service, platform, or site that focuses on building and reflecting of social networks[9] or social relations[10] among people, e.g., who share interests and/or activities". Thus, the key components of social network services are the data encompassing the connections between people who are members of the service. However, all the services contain additional components, which, combined with the social network structure, enable users to communicate with their networks.

3.2 Characteristics

Social networking sites tend to share some conventional features. Most often, individual users are encouraged to create profiles containing various information about themselves. Users can often upload pictures of themselves to their profiles, post blog entries for others to read, search for other users with similar interests, and compile and share lists of contacts. In addition, user profiles often have a section dedicated to comments from friends and other users. To protect user privacy, social networks usually have controls that allow users to choose who can view their profile, contact them, add them to their list of contacts, and so

[8] Social Networks & Blogs Now 4th Most Popular Online Activity, Ahead of Personal Email, Nielsen Reports. March 9, 2009. Retrieved September 19, 2010
[9] http://en.wikipedia.org/wiki/Social_network
[10] http://en.wikipedia.org/wiki/Social_relation

on. In recent years, it has also become common for a wide variety of organizations to create profiles to advertise products and services.

Social network environments are uniquely positioned for viral dissemination of information. When a user posts a status message, comment or link, their friends are immediately informed. If they find the information interesting, he/she can easily propagate the information to the circle of their friends, and so on. Information received via a friend is given preferential treatment by its receivers, thus enhancing its effect even further.

By design or historical accident, different social networks have caught on in different audiences. Some (like LinkedIn) are geared towards professional networks, while others (Facebook) are more informal. Different networks are popular according to geographical location[11] and correspondingly several languages are utilized. Several services are consciously designed with a young audience in mind, while others attempt to target a wider audience. Overall, social networks are proliferating widely: Facebook boasts more than 500 million active users[12]; [13]; Hi5 (social gaming) – 60 million[14]; Twitter – 75 million[15]. More than 133,000,000 blogs have been indexed by Technorati since 2002 and around 77% of Internet users read blogs according to Universal McCann.[16] YouTube, the most popular video exchange site, has 56 million registered users, in addition to the millions of entries to its site by unregistered 'net surfers.[17] All this activity affords a unique opportunity to access unprecedented numbers of people.

Many social network services provide a framework for 3rd party applications, which are proliferating into many areas. A partial list, culled from Wikipedia, includes:

- Business - Companies have found that social networking sites such as Facebook and Twitter are great ways to build their brand image. According to Jody Nimetz, author of Marketing Jive,[18] there are five major uses for management tool, for recruiting, to learn about new technologies and competitors, and as a lead gen tool to intercept potential prospects. These companies are able to drive traffic to their own online sites while encouraging their consumers and clients to have discussions on how to improve or change products or services.
- Science - Julia Porter Liebeskind et al. have published a study on how New Biotechnology Firms are using social networking sites to share exchanges in scientific knowledge.[19] They state in their study that by sharing information and knowledge with one another, they are able to "increase both their learning and their flexibility in ways that would not be possible within a self-contained hierarchical organization." Social networking is allowing scientific groups to expand their

[11] Social Nets Engage in Global Struggle, AdWeek. Oct 5, 2007, Retrieved September 19 2010.
[12] Facebook statistics. Retrieved September 19, 2010.
[13] Facebook statistics. Retrieved September 19, 2010.
[14] Its A "High Five" For Hi5 As It Raises $14 Million, Watblog, July 20, 2010. Retrieved September 26, 2010.
[15] Twitter now has 75M users; most asleep at the mouse. ComputerWorld. Retrieved September 19, 2010.
[16] Adam Singer, More than 133,000,000 blogs have been indexed by Technorati. The Future Buzz. December 10, 2009. Retrieved September 19, 2010.
17 http://www.numberof.net/number-of-youtube-users/ suggests a method for counting the number of Youtube users using google search. Employing this method on 26 September 2010 resulted in the cited number.
[18] Jody Nimetz on Emerging Trends in B2B Social Networking Sunday, November 18, 2007, Marketing Jive, Retrieved September 19, 2010.
[19] Liebeskind, Julia Porter, et al. "Social Networks, Learning, and Flexibility: Sourcing Scientific Knowledge in New Biotechnology Firms". *Organization Science*, Vol. 7, No. 4 (July-August 1996), pp. 428–443.

knowledge base and share ideas, and without these new means of communicating their theories might become "isolated and irrelevant".

- Education - Because many students are already using a wide-range of social networking sites, teachers have begun to familiarize themselves with this trend and are now using it to their advantage. Teachers and professors are doing everything from creating chat-room forums and groups to extend classroom discussion to posting assignments, tests and quizzes, to assisting with homework outside of the classroom setting. Social networks are also being used to foster teacher-parent communication. These sites make it possible and more convenient for parents to ask questions and voice concerns without having to meet face-to-face.
- Social action - Social networks are being used by activists as a means of low-cost grassroots organizing. Extensive use of an array of social networking sites enabled organizers of the 2009 National Equality March to mobilize an estimated 200,000 participants to march on Washington with a cost savings of up to 85% per participant over previous methods.[20] Protesters in Iran overcame government restrictions on communications and posted their reports on Twitter.[21]
- Government - Social networking is more recently being used by various government agencies. Social networking tools serve as a quick and easy way for the government to get the opinion of the public and to keep the public updated on their activity. For example, NASA has taken advantage of a few social networking tools, including Twitter and Flickr. They are using these tools to aid the Review of U.S. Human Space Flight Plans Committee, whose goal it is to *"ensure that the nation is on a vigorous and sustainable path to achieving its boldest aspirations in space"*[22].

Some social networks lend themselves easily to a rich set of interaction modes. In addition to the ubiquitous web interfaces, many social networks can be accessed by various mobile devices, enabling continuous contact and updates.

3.3 Types of social network services

Many different social network services are available, however they are often categorized into three broad types: social networks environments, blogging environments, and microblogging environments. These groups share many features, and overlap to a certain extent, but are sufficiently different that we would like to explore the use of a representative member of each type. In this section we give a general description of each type.

3.3.1 Social networks environments

Social networks environments such as Facebook, LinkedIn, Orkut and many others, focus on friending networks. Users explicitly create connections with other users within the service, and thereafter interact closely with their friends. Users can update their friends on their

[20] Carlson, Ben (April 28, 2010). "March 2.0: Success of the National Equality March relied on social media tools". Media Bullseye. Retrieved September 19 2010.
[21] Twitter Links Iran Protesters to Outside World, **June** 16, 2009. Fox News**.** Retrieved September 19 2010.

[22] Review of U.S. Human Space Flight Plans Committee, Retrieved September 19 2010.

activities, interests and recommendations, and this information in turn can become the basis of comments and feedback.

While the basic structure is that of a network, many social networks environments also provide the concept of groups, created by users to assemble people who share common interests. Members of a group can view content specific to the group, and communicate with each other within a common space.

Social network services usually provide a 3rd party application framework, which enables application developers to implement extensions to the service. These extensions have (controlled) access to the social network data on site, and can use it to offer related services.

Social network environments already offer abilities relevant to the +Spaces agenda. User-posted content often sparks hot debate among the user's friends, which can get propagated to friends of friends. Polling mechanisms are implemented in various ways in many environments, either through 3rd party applications or as an integral part of the system. Different design decisions on the part of system implementers have resulted in the creation of several privacy models, which should be explored. Users can control the access of others to information they create, and groups restrict certain actions to members of the groups. Some information is open to the general public. This offers interesting issues to explore: to what extent do people radicalize or tone down their rhetoric as a function of how widely they expect it to be disseminated? Can polls be propagated notwithstanding privacy controls? Do peer pressure effects apply in virtual social groups? To what extent do language barriers inhibit the propagation of information within social networks? These questions and others are key to the study of social network environments in our context.

To represent this type of service, we have chosen Facebook as the most widespread system:

- More than 500 million active users
- 50% of active users log on to Facebook in any given day
- Average user has 130 friends
- People spend over 700 billion minutes per month on Facebook
- Over 900 million objects that people interact with (pages, groups, events and community pages)
- Average user creates 90 pieces of content each month
- More than 30 billion pieces of content (web links, news stories, blog posts, notes, photo albums, etc.) shared each month.[23]

[23] Facebook statistics. Retrieved September 19, 2010.

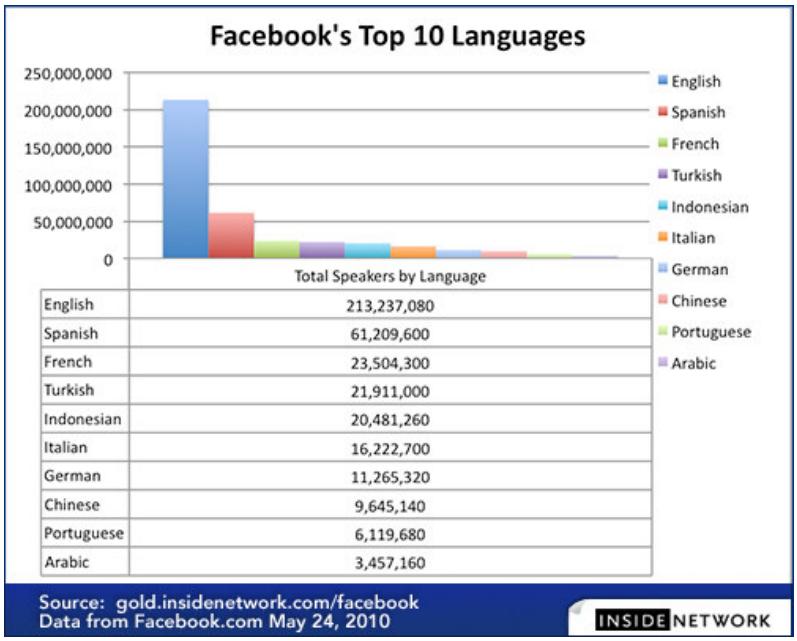


Figure 3 – Facebook's Top 10 Languages [24]

Facebook is used primarily in English, but also has a wide user base in other languages (see figure 3), enabling research into the issue of language barriers. Facebook users are quite evenly distributed age-wise (see figure 4), enabling access to different age groups with potentially different interaction patterns and opinions.

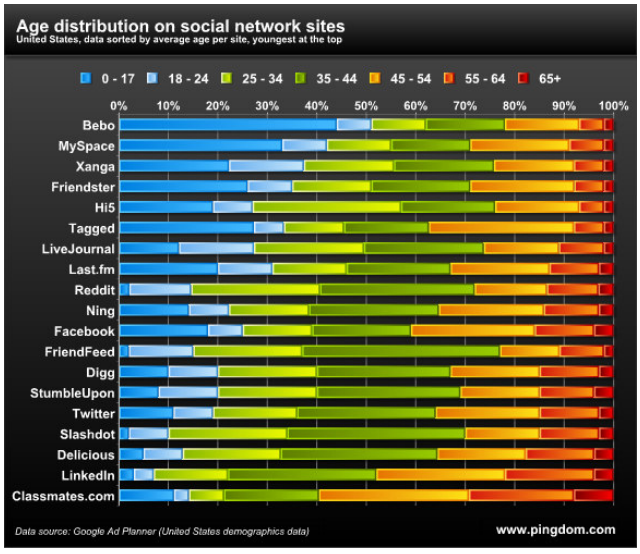


Figure 4 – Age distribution on social network sites [25]

[24] Facebook's Top Ten Languages, and Who is Using Them, Inside Facebook, May 24th, 2010. Retrieved September 26, 2010.
[25] Study: Ages of Social Network Users. Pingdom, February 16, 2010. Retrieved September 26, 2010.

3.3.2 Blogs

Blogs (or web logs) are "*usually maintained by an individual with regular entries of commentary, descriptions of events, or other material such as graphics or video*" (Wikipedia). Blog posts are "heavy" in content, with descriptions of new information learnt, compendia of references to useful materials, opinions and analysis. Users can encounter blog posts while searching the internet for relevant keywords, or can subscribe regularly to read content in a specific blog. Some blogs have restricted access, but most are open to the public.

A key feature is the ability of other people to comment on blog entries, potentially creating conversations centred on topics of interest to the community. Blogs and blog posts are often *tagged*, thus creating a rudimentary searchable classification of topics, useful to users who are looking for blogs relevant to their interests.

Blogs are uniquely suited to act as focal points for debates. While social networking environments focus on short, informational content, blog posts often contain extensive, well-researched and –referenced opinion pieces, which spark off debate among commenters. Furthermore, an influential blog post will often prompt other bloggers to respond in their own blogs, thereafter propagating the discussion into other spheres.

To represent this type of service we have chosen Blogger.com, a widely-used blogging site owned by Google.

3.3.3 Microblogging

Microblogging environments are similar to blogging environments in that they enable users to post individual content. However, as their name implies, the content is severely restricted in size, thereby creating a very different set of interactions. Whereas blog posts are often long, well thought out opinion pieces, *tweets* (as posts in the most popular micro-blogging environment site – Twitter – are called) are short , often fragmentary messages. As such, they lend themselves easily to other modes of interaction, including mobile phones.

Users of microblogging environments subscribe to follow posts by others in whom they are interested, and environments usually offer some level of access control to restrict followers. Microblogging environments are often used for "re-tweeting" – the broadcasting of pointers to content on different sites, for the benefit of the users who are following the tweeter's stream. Some sites also provide tagging possibilities, to help users categorize and search for interesting people to follow.

Microblogging environments are ideally suited for use as polling platforms. Poll questions can be floated into the environment as posts, and answers are posted thus spreading information about poll participation and prompting readers to weigh in and have their say.

Microblogging is a key component in the viral dissemination of information.[26] While microblog posts are too limited in size to convey much information in themselves, they often

[26] Haewoon, Kwak, Changhyun, Lee, Park, Hosung, and Moon, Sue. (2010). What is Twitter, a Social Network or a News Media?. *19th International World Wide Web (WWW) Conference*.Raleigh, North Carolina April 26-30.

refer to other sites which contain more extensive content, and are used to propagate this content to wide audiences. Thus microblogging sites are ideally positioned as a testbed for interoperability research.

To represent this type of service, we have chosen Twitter, the most widely used site:

- 75 million visitors in January
- 50 million tweets are sent a day
- Twitter.com is the number twelve website in the world. [27]

3.3.4 Interoperability

In addition to examining the aforementioned services, we plan to look into the use of the interconnections between them. Already, users can increase the resonance of their actions by connecting their accounts on different environments: Twitter accounts can be connected to Facebook so that every tweet updates the Facebook status line; blogs can be connected to Facebook and Twitter so that whenever a new post is published, it is announced on both. The +Spaces platform will systematize these sporadic connections, and enable cross-platform information collection and dissemination. This will create a powerful system, in which the strengths of each environment are utilized, and the different environments complement each other.

It will thus be possible to study the impact of blurring the boundaries between environments.

4 +Spaces Testbed

4.1 Testbed requirements

The D2.1 deliverable 'User Requirements' documents the key needs and requirements for the +Spaces project. The following medium and high priority requirements can be extracted from this document as being relevant to the +Spaces testbed and virtual world platforms. In this table, the relevance of each individual issue to the +Spaces testbed and the choice of virtual worlds platform is identified.

No.	Description	Type	Priority*	Remarks	Relevance to the testbed
1.3	Collect citizen's opinion and monitor the effects resulting from legislation	Need	High	Polls and debates will try to understand citizen's opinions and aggregate an average result and simulation will monitor the actual effect of a new	The virtual world needs to support polls and debates and simulation activities

[27] Alex Wilhelm, Twitter statistics: The full picture. The Next Web. February 22nd, Retrieved September 19 2010.
* priority defined by users.

				policy by measuring people's behaviour without even knowing it	
2.2	Social Network Sites Facebook Twitter and LinkedIn are the most popular (many accounts, visited often, contribute content)	Need	High	Good choice of using Facebook as one of +Spaces VW platform	Need to consider 2D social network sites as well as 3D virtual world platforms
2.3a	Second Life and Wonderland considered the most popular 3D VW platforms	Need	High	Both should be included in +Spaces VW platform	SecondLife and Wonderland need to be considered for the +Spaces testbed
2.3b	Slight bias towards Wonderland	Fact		Don't have to install anything (no pre-installed client), more secure, more open (guest access), better controllable environments and popular to teachers and students (education environment)	Wonderland has some key advantages in terms of supporting the +Spaces requirements eg. customisability
2.6	Find an easy way for users to register and provide profile info	Need	Medium	The solution we hope for is to use the profile info from the VW platforms themselves. We also hope that users will participate in more than just one experiment, while registration is just a one-time effort	Need access to the VW profile system (eg. user registration). This is supported by Wonderland. Not easily supported by SecondLife.
4.4	Policy makers should be able to control the audience. Define participants target group	Need	High	Well defined target groups will provide effective results in a short period of time. This is true in debates and polls, but not in simulation	Need to be able to target specific groups and VW locations. In SL this could be a dedicated 'island'. In WL this could be a dedicated server/world.
4.7	Advertize poll and debates is an important issue	Need	High		In-world advertising (in VWs) and also the users existing social networks
5.1	Policy makers should be able to control the number of questions. Options to be supported: a simple question with multiple options (referendum-style poll) and a questionnaire-style poll	Need	High		Need to be able to customise the in-world questionnaires
5.2	Policy makers should	Need	High		As above

	be able to configure types of questions (text questions included)				
5.3	Should be able to control visibility, privacy and anonymity	Need	High	Most favourable from users to deploy short polls, ensure anonymity (privacy) and the participation to be optional	Need to control the behaviour of the polls in the multi-user environment
5.4	Hide the act of undertaking a poll by a user	Need	High	It must be analyzed further as if the system reports to someone that his/her friends participated, probably will lead him to participation too	As above
5.5	Everyone should answer the same questions	Need	Medium	Based on scientific research methods, sometimes you may need to randomize the order of multiple questions for different users, so that the order will not effect the result	Dynamically modify the order of the poll questions
5.6	One opportunity to participate in a poll and in a defined period of time	Need	Medium		Need to control access to a poll (based on the user authentication)
5.10	Policy makers should be able to control the audience. Define participants target group	Need	High	Well defined target groups will provide effective results in a short period of time	Need to control access to in-world tasks.
6.1	Visible user's reputation during the debate	Need	High		Need to be able to augment the avatars appearance
6.3	Policy makers should act as moderators. Should be able to remove malicious or irrelevant entries, approve and publish user's opinions, monitor the experiment in general	Need	High	It seems like participants can't post their opinion automatically. Instead moderators have to approve each message. This is an option in many forums and should probably be considered in +Spaces (as something the policy makers can decide to activate or not)	Some 'super users' will need to have control over which users/avatars are taking part and what they can do.
6.5	Debate moderators should be able to guide and filter the discussion and even participate if necessary	Need	High		Should be able to dynamically 'reconfigure' a debate eg. add remove new participants
6.7	Manage debates when	Need	Medium		As above

	there are large number of participants (e.g. active and passive users)				
6.8	Three different set of users: defined speakers, users that their questions selected to be asked, users participate dynamically	Need	Medium		Need to be able configure user privileges, and manage user types
6.9	Visualization functionality concerning the discussion (presenting the results)	Need	High		Need to be able to display dynamic in-world visualisations related to a particular discussion
12.8	Implement and deploy based on open standards	Need	High		An open standards based platform is essential eg. Wonderland
12.9	Policy makers should be able to create their own VW platform	Need	Medium	Define target groups, control audience, help older to participate etc	Need an easy mechanism for creating and configuring virtual worlds

Table 2. Testbed requirements

4.2 Testbed platforms

Based on the above requirements, there appears to be the following key high-level needs for the testbed platforms:

I. The need to select virtual worlds that provide access to large numbers of users eg. Facebook, SecondLife
II. The virtual worlds must be highly configurable. Eg. have a scripting/programming environment
III. Need to be able to access user account information from the virtual world. This is problematic in SecondLife, but relatively easy in Wonderland and other platforms.
IV. Need to be able to control access to worlds and +Spaces events
V. Need to be able to easily create worlds and in-world +Spaces events

4.2.1 3D Virtual World platforms

The main candidate platforms for +Spaces have some advantages and disadvantages when mapped to the above key requirements. These are identified below:

Platform	Advantages	Disadvantages

SecondLife	Access to large user population Rich scripting environment Number of ready made widgets available	Need to purchase islands Cannot access user information easily Limited ability to truly customise the environment (it is a commercial service) Lack of expertise on the project team May need to purchase in-world art/models
OpenWonderland	Highly-configurable and extensible Easy to extract user information Can create new worlds by configuring new servers Easy to interface to other systems Opensource/open standards Open art-path High-quality audio interface	No pre-existing user populations Not a mainstream product/platform yet
OpenSim	Extensible/configurable Can create new worlds by configuring new servers Easy to interface to other systems	No pre-existing user populations Not a mainstream product/platform yet Art-path is limited No project expertise No audio interface (by default)

Table 3. 3D virtual environments advantages and disadvantages

The main advantage of SecondLife is that it offers access to a large user population. However, given that it is a commercial service this makes it problematic in terms of being able to truly configure the environment and being able to access user data.

OpenWonderland offers advantages in all the key areas except in not offering access to an existing large user population, and still being at pre-production quality.

Given the unavailability of suitable technical skills within the project, OpenSim is not really a feasible platform for the project. However OpenWonderland offers many of the same, and additional benefits to OpenSim.

One possible scenario is to capitalise on its configurability and use OpenWonderland as the main platform for implementing +Spaces 3D virtual world applications (polling, debating and simulation). OpenWonderland can then be linked to other environments as needed. For example a Facebook user could click on a hyperlink and launch a virtual world session in OpenWonderland. It would also be possible to embed links with SecondLife, so that SecondLife users could launch a +Spaces 3D application (poll, debate, simulation) in OpenWonderland. This would allow the project to access the SecondLife user population, whilst standardising on a single development environment for 3D +Spaces applications. Users can also be authenticated in OpenWonderland using the credentials from another platform if needed. For example, a Facebook user could use their Facebook account details to login to Wonderland. This would simplify and reduce the need for multiple user accounts.

4.2.2 2D Web Social Networking Platforms

Currently, there are dozens of 2D web social network implementations available in the world. After careful analysis, we came to decision that we should try to cover all possible social networks types, but to focus on a limited networks subset, having presentation of each type and choosing the most popular ones.

After sector analysis we came up with following list:

- Facebook (http://www.facebook.com)
- Twitter (http://twitter.com)
- Blogger (www.blogger.com)

These main candidate platforms for +Spaces have some advantages and disadvantages when mapped to the key requirements. These are identified below:

Platform	Advantages	Disadvantages
Facebook	- Access to large user population - Supports 3rd-party applications with dynamic content - 3rd-party applications have access to user profile on user confirmation - Provides RESTful API for creation of pages and groups and for users activity monitoring - Suitable for single/multiple question polls - Viral effect of posts - Possibility to push recommendations to users	
Twitter	- Access to large user population - Provides anonymous search API - Viral effect of posts - Possibility to push recommendations to users	- Limited in tweet size - Suitable for single-question polls only - There is no way to get user info on external web-page - User information is limited (no age, gender, etc.)
Blogger	- Access to large user population - Provides API for programmatic information posting	Inherently less suitable for polls. Incomplete user profile information.

	Supports gadgets on user pages - Viral effect of posts - Possibility to push recommendations to users Encourages longer posts and longer comments, suitable for discussions and debates.	

Table 4. web social networking platforms advantages and disadvantages

Facebook

In +Spaces we consider using Facebook in two main manners: Facebook application and Facebook pages/groups.

The first way is providing a Facebook application – i.e. a web application reachable from within Facebook. This application will also use Facebook RESTful API to acquire details from Facebook about the users using the application.

Facebook allows developers to write various types of applications such as web applications reachable from within Facebook, applications connecting other websites to Facebook, desktop applications and mobile application that interact with it.

Web applications reachable from within the platform can be published inside Facebook, if a users wish to use the application they add it to their account. Adding an application includes a phase of granting the application certain permissions. These permissions include allowing the application to access various types of information about the user profile and account, and in some cases to perform actions on behalf of the user. The basic set of permission allows accessing the users public profile information, this can include amongst other things name, gender, date of birth, preferences and list of friends.

The second way is to leverage the Facebook RESTful API to a use the basic building blocks inside the platform such as creating pages and groups and monitoring the activity in these objects. These activities include joining a group, clicking 'Like' on a page or object, writing a post on a message board – known as 'Wall' and commenting on posts.

Facebook's graph API and the Facebook Query Language API support retrieving information from the platform, such as retrieving users comments on an object, group information, viewing members of a group, statistics about different objects, following messages thread, following a note thread, a page, fans and users who like a page.

Twitter

Twitter offers two RESTful APIs: streaming API and search API.

The search API returns tweets that match a query specified in the request. It does not require authentication. Two commonly used formats are available, JSON and XML. The API call can search by keyword, hashtags, user (tweeting, re-tweeting, mentioning), time of tweet, geographical conditions etc.

Streaming API gives continuous access to public twitter updates and requires authentication it is less relevant to this project.

Statuses updates allow an application to update the status of an authenticating user.

We consider the following solution for votes: a Twitter user will be redirected to external +Spaces page, provide his input there and than will be redirected back to Twitter with prepared structured response. Then he will be able to click “Tweet” in order to publish his action, including +Spaces unique hashtag. +Spaces will be able to collect these actions using search API and looking for its unique hashtag.

Twitter profiles do not include information such as gender, age that is desired by the positive spaces analysis services. Optionally this information will be requested from the participating users in the external web page.

Blogger

Google data RESTful API allows various blog activities to be performed programmatically. This includes publishing a blog post, publishing comments, retrieving comments, editing a post, retrieving blogs of a certain user, authenticating a user, searching.

Blogger allows blog owners to add 'Gadgets' to a blog. Gadgets are web widgets that appear in a blog page. There is a large variety of gadgets offered by Google or by other developers a user can add to his or her blog. A gadget developer can write html and JavaScript code; this includes using techniques such as “iframes” to present data from another web page.

A gadget can leverage several JavaScript libraries that support different features. One specific library implements the OpenSocial API. Some popular gadgets present a list of the readers following a blog, support searching for the blog, rich text editing, ad sense, presenting an image, embedding video, and showing a blog roll, tags, and profile.

Polls can be deployed by embedding an external web page as a widget, implementing a JavaScript gadget or in an unstructured way by posting questions as one or more blog posts and analyzing users responses. We plan to implement debates by posting blog posts, and following users responses.

4.3 Testbed users and trials implications

The following user groups can be targeted for +Spaces trials:

I. Facebook – the project needs to identify which specific user groups will take part in the trials
II. Blogger – the project needs to identify which specific user groups will take part in the trials
III. Twitter – the project needs to identify which specific user groups will take part in the trials
IV. SecondLife – the project needs to identify which specific user groups will take part in the trials. The age range will be 18+
V. OpenWonderland – specific targeted user groups

The 3D virtual world +Spaces applications of polling, debating and simulation can be implemented using the OpenWonderland platform. These applications could even be

accessed by an alternative originating virtual world (eg. SecondLife, Facebook), which could launch an OpenWonderland +Spaces app by embedding an appropriate URL within a 2D or 3D in-world object. In this context, the originating virtual world will therefore be used to provide access to specific user groups for the trials.

The 2D +Spaces applications will be implemented using Facebook, Twitter and Blogger RESTful APIs. In addition, Facebook application framework and blogger widgets will also be implemented.

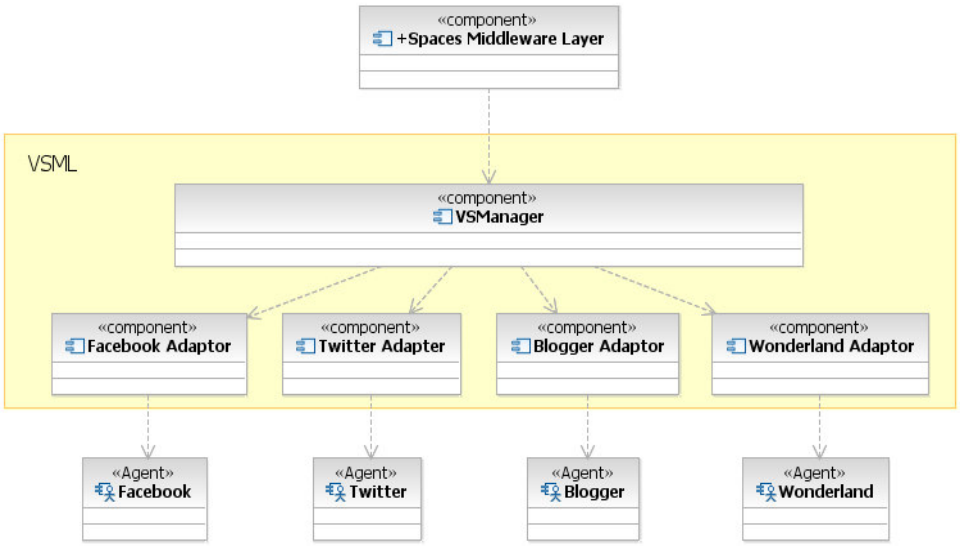
The following issues will need to be resolved when implementing the +Spaces testbed:

VIII. OpenWonderland supports up to 25 concurrent users. The +Spaces applications and user trials will need to be designed around this as a maximum number at any one time.
IX. Ideally each OpenWonderland world should run on a dedicated server. It is possible to configure the server to have a number of different worlds, but only one world can be loaded at any one time (supporting up to 25 concurrent users). The server architecture will need to be designed to account for the anticipated maximum number of concurrent Wonderland worlds that will be needed at any one time.
X. If SecondLife is to be used, the project will need to have access to an existing island on SecondLife, or will have to purchase its own island and populate it with appropriate 3D content, etc.
XI. Users will have to give permission to the project in order to take part in any of the trials. This may require users to electronically sign an authorisation form prior to and during the course of the trials.
XII. The project will need to decide which user authentication mechanisms will be used to identify and authorise user participation in the project trials. For example, will the project have to create its own user registry database (eg. LDAP) or will it use existing user account information (eg. Facebook accounts).
XIII. The project will need to consider issues around providing different language versions of the +Spaces applications and environments (eg. Greek, English, etc)
XIV. The +Spaces simulation application still needs to be analysed in more detail in order to better understand the implications for the testbed environment.

5 Virtual Spaces Management Layer

VS Management Layer is responsible for providing an interface between the +Spaces Middleware Layer and external systems, such as 3D virtual worlds (Wonderland and others) and 2D social networking sites (Facebook, Twitter, Blogger). The layer's main goal is the transparent interoperability between all kinds of virtual worlds.

The layer includes a central component named VSManager, which centralizes and manages all the work with plurality of components named VS Adaptors, which will provide a technical communication to the virtual spaces.



On a top boundary, the layer exposes programming interfaces for the +Spaces Middleware or for any other application, exposing services for adaptors management, for experiments management and for reporting events and actions from the virtual spaces.

On a bottom boundary, the layer has several direct interfaces to virtual spaces, in most cases connecting directly to 3rd party systems, while in some cases connecting to remote agent. These interfaces are being defined and managed by adaptors.

The layer was separated from the +Spaces middleware for multiple reasons. The main reason is to protect virtual space users' privacy and confidentiality, by hiding any information that can identify user. In addition, the intent was to make this layer generic, independent and customizable, to allow its reuse in future EU projects that require access to various virtual spaces. Moreover, the strict decoupling allows deployment of the layer either locally or remotely.

Adaptors deployment: The intention is to deploy adaptors as separate enterprise applications (EAR), in order to be able install/uninstall specific adaptor without interfering of proper VSML and other adaptors work.

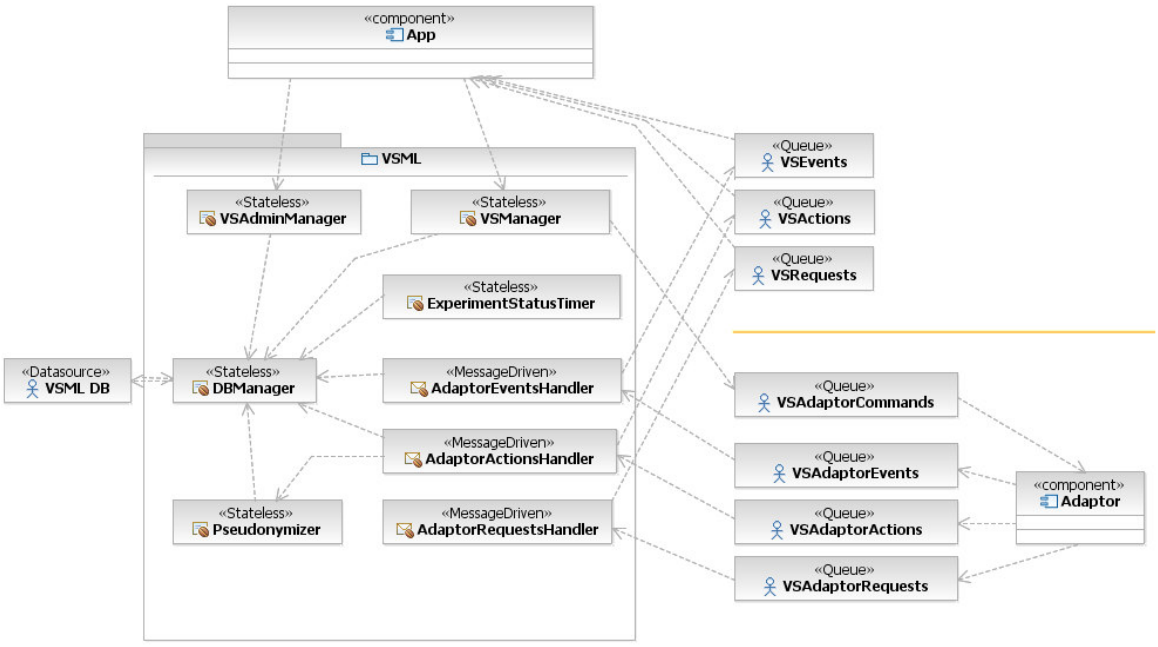
5.1 Virtual Spaces Manager

Virtual Spaces Manager is a core component of the layer, and is responsible for centralization of the adaptors work and for implementation of a convenient interface to the Middleware Layer.

Main functionality (see detailed description later):

- Adaptors management: adaptors registration, configuration, and the retrieval of status, enable/disable adaptors.
- Virtual spaces and resources management: declaration of new space/resource, storage of details, on-demand provision of these details to adaptors and to application layer
- Experiments handling: deployment of experiments, reporting of experiment statuses, control of resources utilization, forwarding of reported events and actions.
- Pseudonymization: replacement of users' real IDs by generated pseudonyms and vice-versa.
- Recommendations support: forwarding of recommendation requests from the adaptors to the application layer and forwarding recommendation commands from the application layer to the adaptors.
- Failover: handling of adaptors failure and later recovery.

The manager itself includes several internal modules, each responsible for handling part of the work, such as pseudonymization component, messages handlers, etc.



The layer exposes two interfaces to application layer:

- EJB remote interface: for layer controlling, passing commands and getting information on-demand

- JMS interface: for getting asynchronous events, actions and requests by the application

The layer exposes one interface to adaptors:

- JMS interface: both for sending commands and configuration to adaptors and for getting information back from adaptors (events, actions, requests)

Application EJB remote interface

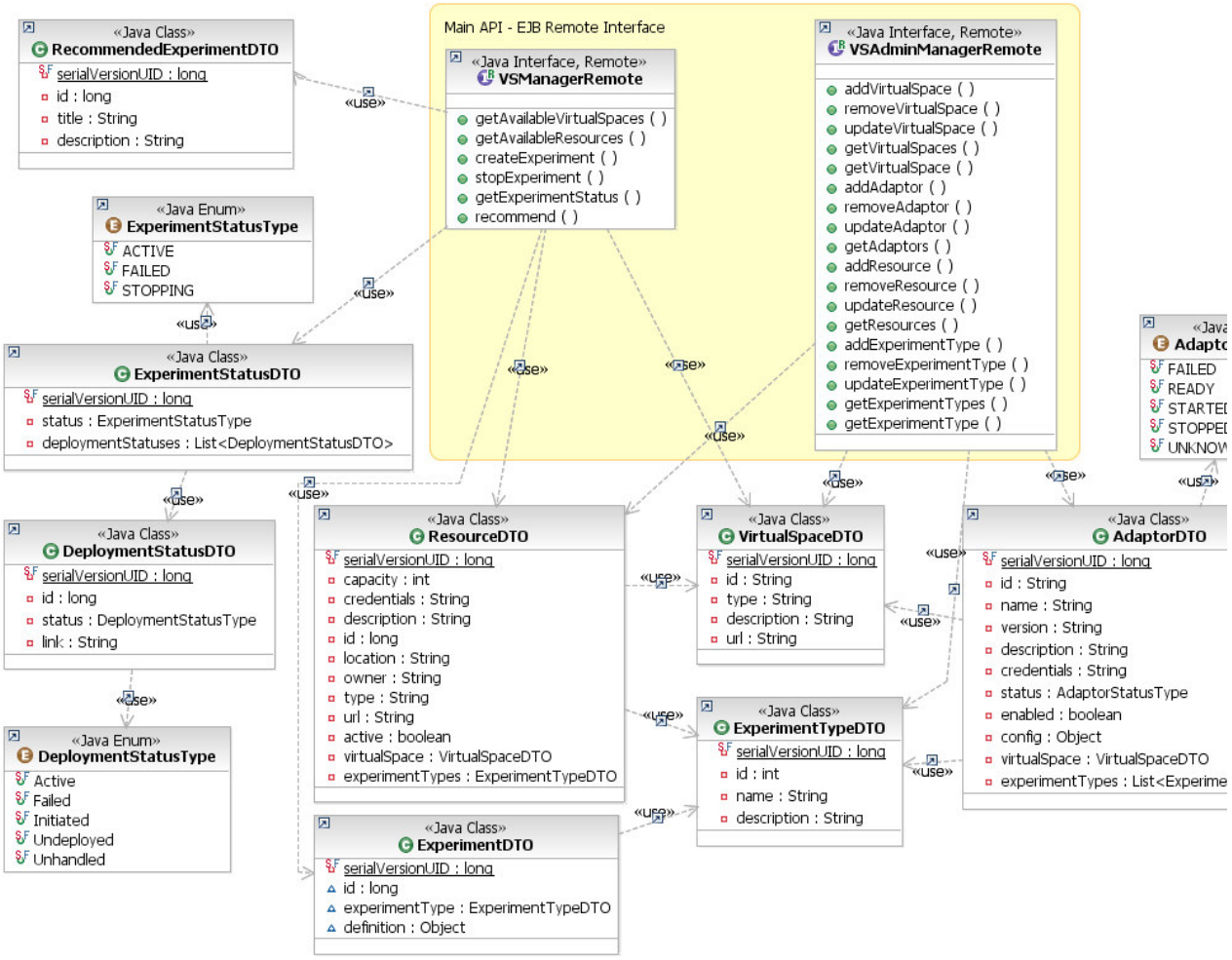
- The interface used to pass requests and to retrieve data from Virtual Space Management Layer.

The interface has:

- Main functionality interface (VSManagerRemote), which allows normal flow operations and experiments management.
- Administration interface (VSAdminManagerRemote), which allows basic administration, such as definition of virtual spaces, resources and adaptors.

It EJB remote interfaces, called directly from the application beans. The EJB interface to application can be easily transformed to web services, allowing deployment on separate independent server.

All the DTO (data transfer objects) implemented as simple Java classes.

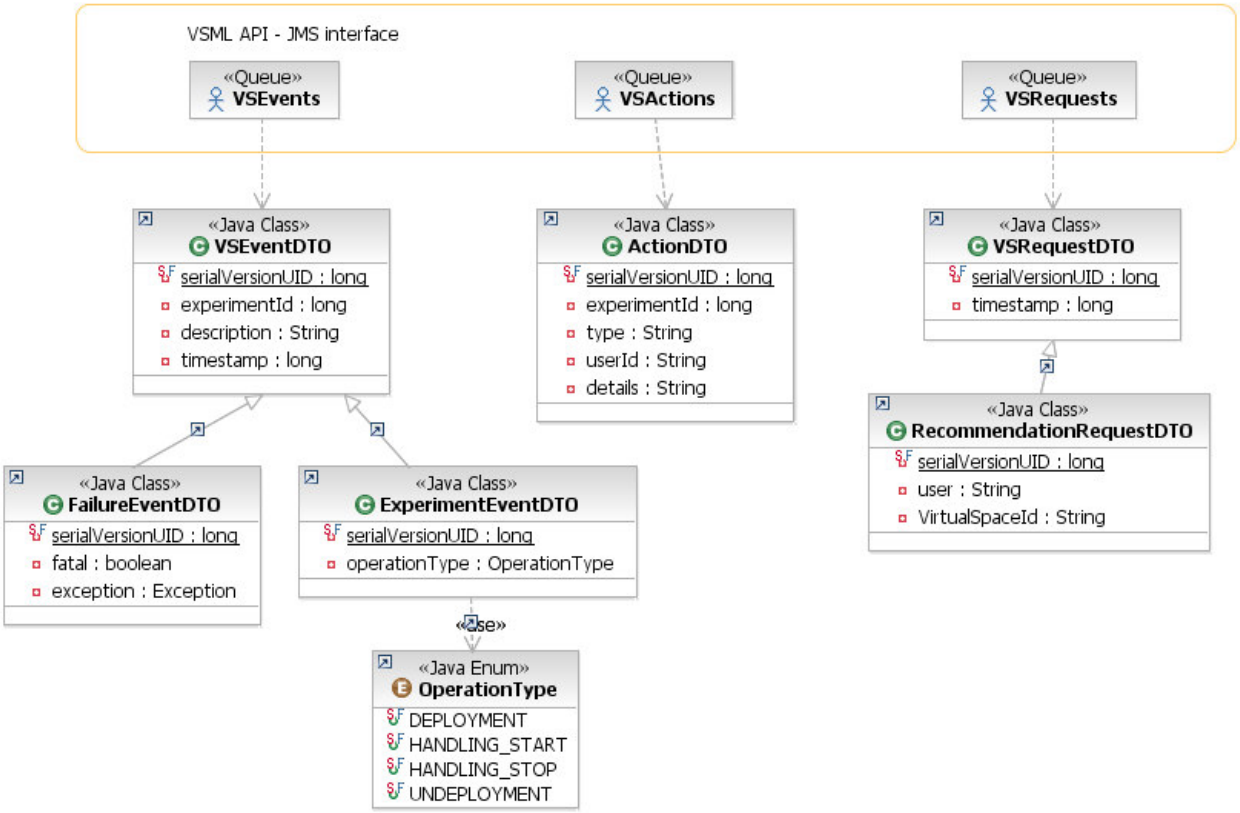

Main API - EJB Remote Interface
«Java Class»
RecommendedExperimentDTO
serialVersionUID : long
id : long
title : String
description : String
«use»
«Java Interface, Remote»
VSManagerRemote
getAvailableVirtualSpaces ( )
getAvailableResources ( )
createExperiment ( )
stopExperiment ( )
getExperimentStatus ( )
recommend ( )
«Java Interface, Remote»
VSAdminManagerRemote
addVirtualSpace ( )
removeVirtualSpace ( )
updateVirtualSpace ( )
getVirtualSpaces ( )
getVirtualSpace ( )
addAdaptor ( )
removeAdaptor ( )
updateAdaptor ( )
getAdaptors ( )
addResource ( )
removeResource ( )
updateResource ( )
getResources ( )
addExperimentType ( )
removeExperimentType ( )
updateExperimentType ( )
getExperimentTypes ( )
getExperimentType ( )
«Java Enum»
ExperimentStatusType
ACTIVE
FAILED
STOPPING
«Java Class»
ExperimentStatusDTO
serialVersionUID : long
status : ExperimentStatusType
deploymentStatuses : List<DeploymentStatusDTO>
«Java Class»
DeploymentStatusDTO
serialVersionUID : long
id : long
status : DeploymentStatusType
link : String
«Java Enum»
DeploymentStatusType
Active
Failed
Initiated
Undeployed
Unhandled
«Java Class»
ResourceDTO
serialVersionUID : long
capacity : int
credentials : String
description : String
id : long
location : String
owner : String
type : String
url : String
active : boolean
virtualSpace : VirtualSpaceDTO
experimentTypes : ExperimentTypeDTO
«Java Class»
ExperimentDTO
serialVersionUID : long
id : long
experimentType : ExperimentTypeDTO
definition : Object
«Java Class»
VirtualSpaceDTO
serialVersionUID : long
id : String
type : String
description : String
url : String
«Java Class»
ExperimentTypeDTO
serialVersionUID : long
id : int
name : String
description : String
«Java Class»
AdaptorDTO
serialVersionUID : long
id : String
name : String
version : String
description : String
credentials : String
status : AdaptorStatusType
enabled : boolean
config : Object
virtualSpace : VirtualSpaceDTO
experimentTypes : List<Experime

Application JMS interface

The interface is used to get asynchronous data back from VSML to the application:

- Events – experiment related events (deployment, handling, failure)
- Actions – virtual space actions reported by the adaptors, both experiment related and global ones
- Requests – requests sent by adaptors to the application

It is asynchronous JMS interface. Main reasons for selecting JMS technology was to keep the VSML layer generic, effective throughput of messaging flow and native integration into J2EE technology, supporting transactions management.



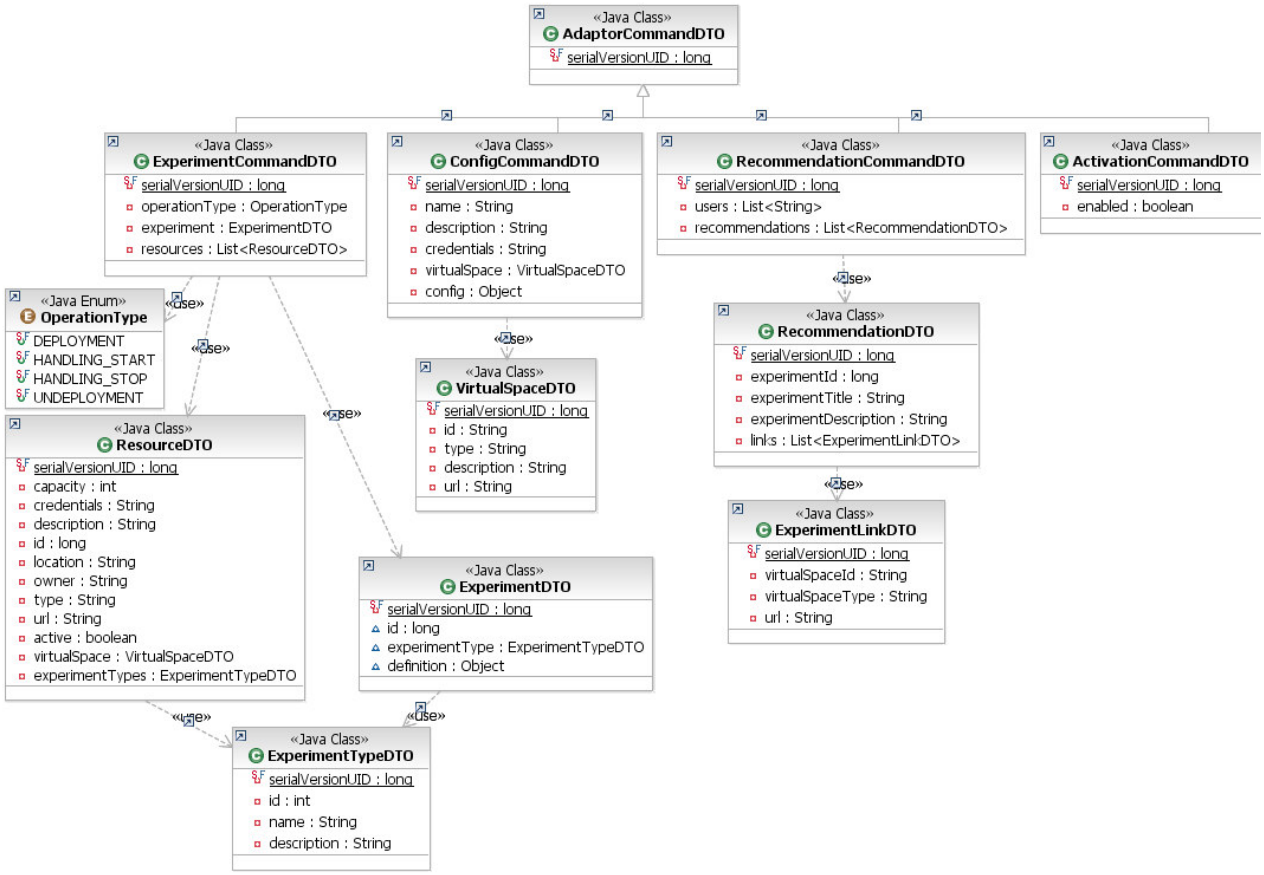
Adaptors Interface (VSManager -> adaptors)

The interface is used for sending commands to adaptors:

- ExperimentCommand – command to start/end deployment/handling of an experiment. The adaptor gets full information required for the deployment, including experiment details and list of relevant resources.
- ConfigCommand – command that passes configuration details to adaptor.
- RecommendationCommand – command to recommend experiment(s) to users(s)
- ActivationCommand – command to enable/disable adaptor. Used to handle failure situations.

It is asynchronous JMS interface. The main reason for selection of JMS interface to adaptors was to decouple between the layer and adaptors, in order to keep the layer generic.

All commands are sent to the same JMS queue (VSAdaptorCommands), while each command holds a message selector, to distinguish between target adaptors. Adaptors are identified by virtual space ID.

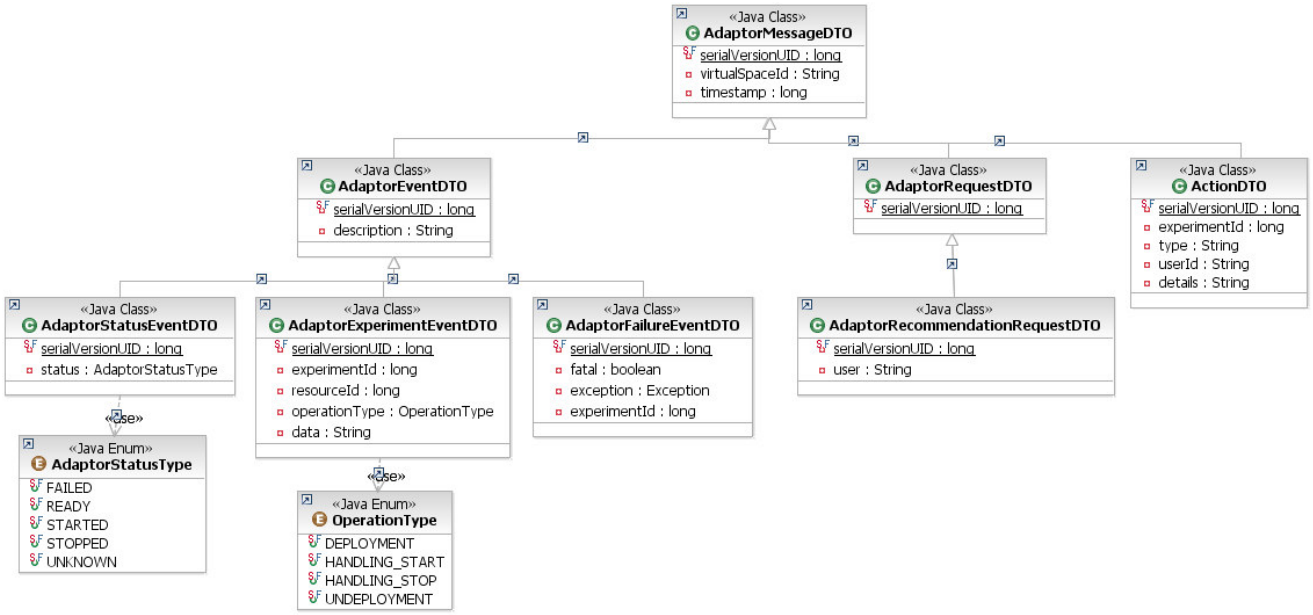


Adaptors Interface (adaptors -> VSManager)

The interface is used for sending information from adaptors to the VSML:

- Events – status/experiment/failure events. Experiment events are sent for each resource involved in the process.
- Requests – currently, recommendation requests only. Response comes back using commands interface.
- Actions – virtual space events, either experiment related or global ones.

It is asynchronous JMS interface. The reasons for selection of JMS technology were effective throughput of messaging flow and native integration into J2EE technology, supporting transactions management.

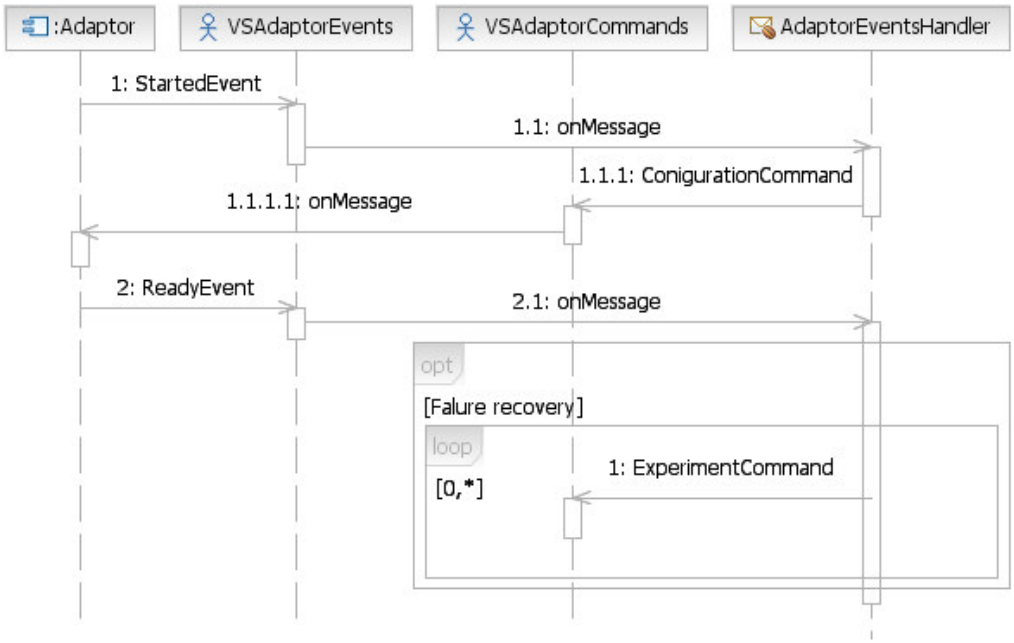


Adaptors Management functionality:

The VS manager is responsible for managing the VS adaptor components, their registration, configuration, and the retrieval of their status.

- **Adaptor registration:** a new adaptor will be installed by the system administrator as a separate application. After adaptor installation, the administrator will declare the adaptor to the VS Manager, using the administration interface. Upon a new adaptor declaration, the manager component will store the details in its database. The adaptor component itself is responsible for reporting its status to the manager component.

- **Configure adaptors:** the main configuration will be performed upon adaptor start event. The manager component will load the adaptor configuration details from the database and will configure the adaptor.
  On each configuration change, the manager will store relevant configuration in the database and forward updates to relevant adapter. The configuration details passed to adaptor include generic details, as well as custom details, passed as Object. Probably, some adaptor will use own mechanism for custom properties, such as properties file.



- **Get adaptors details and status:** the layer allows retrieval of adaptor details and statuses.

- **Forward adaptor events:** the layer forwards adaptor events to the application.

Resources management functionality:

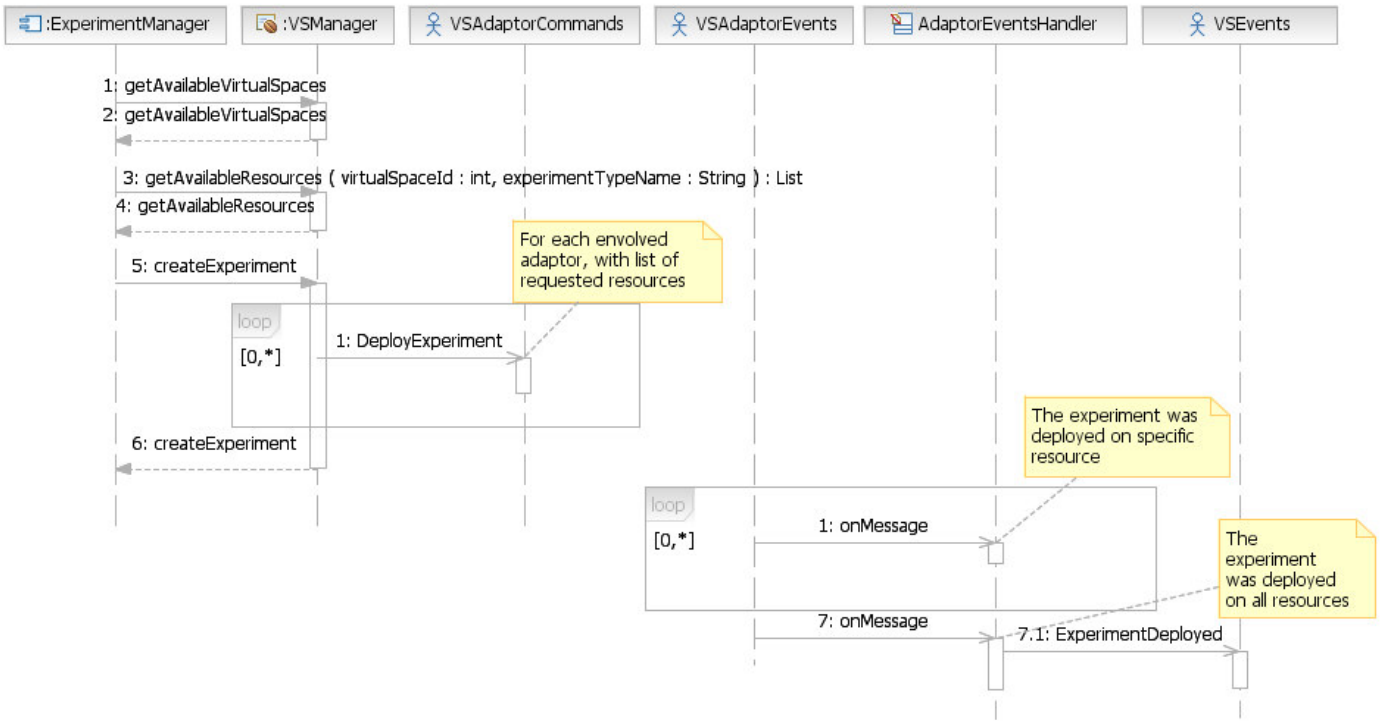
The manager component is responsible for handling all allocated resources in virtual spaces, to handle their status and utilization information. It is responsible for storing of resources details in the database and is able to restore it on failover.

- **Adding new resource:** the resource is allocated externally by a government employee and declared to a system using the administration interface. The basic resource details will be stored in tables of the VS Manager and provided to adaptors on experiment deployment.
- **Resources retrieval:** the manager allows retrieval of specific resource details. In addition it allows querying for currently available resources.
- **Resources allocation:** on any experiment deployment, the manager validates that adaptor capacity is not exceeded, and associates relevant resources with the experiment deployment.

Experiment management functionality:

The manager provides an application interface for deploying experiment details on selected resources and retrieval of deployment status, as well as forwarding reported experiment data back to the application.

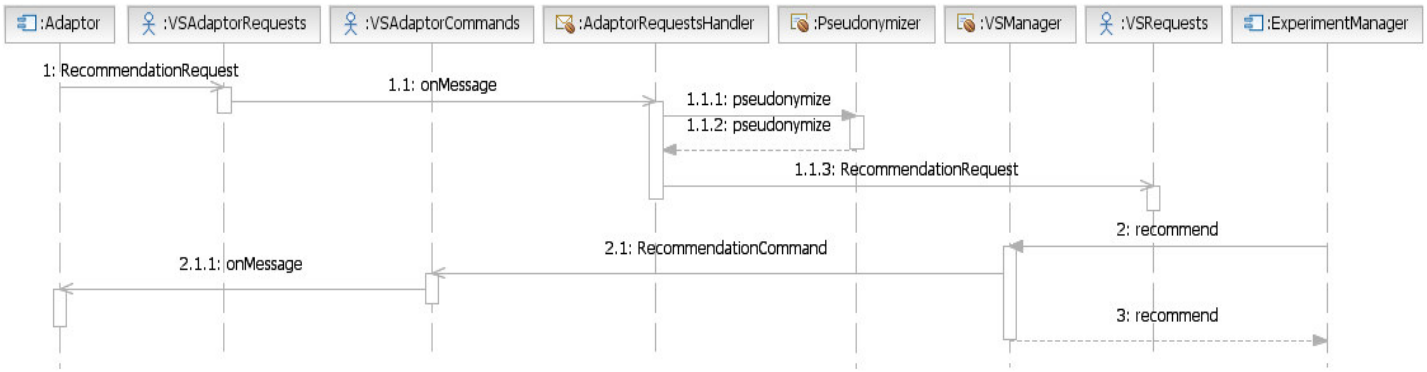
- **Deploy experiment on selected resources:** the manager will check selected adaptors status, will check the resources capacity limit and will pass deployment information to selected adaptors. Experiment details will be stored in the database, as BLOB, in order to support adaptors recovery. The manager will notify the application on successful deployment end or on any failure. The manager will monitor deployment execution and will alert the application if the process times-out.



- **Stop experiment deployment on selected resource:** the manager will pass the request to the selected adaptors and notify the application on successful completion or failure. On the process end, the experiment data will be cleaned from the database.

- **Actions handling:** the manager will accept all reported actions from the adaptors, replace user names by their pseudonyms (see below), load relevant experiment ID and pass the actions to an upper layer. The manager will also support global actions, not related to any experiment.

- **Recommendations support:** the manager will allow passing of recommendations to adaptors (recommendation of experiments for specific user or recommendation of users for specific experiment). In addition the manager will allow adaptor requests for recommendation. It will pass the application reply through commands interface. For example, when a user enters Facebook application, the application will ask for experiments recommended to the user. Additional example is when user finishes some experiment voting and the adaptor is interested to propose him participation in additional experiment.



Pseudonymization functionality: the manager will be responsible to hide real user names from the upper layer. For this purpose it will create a pseudonym for each involved user and will create bi-directional mapping in its database.

On each reported action from a virtual space, the manager will try to find the user pseudonym in its database and to replace the real name with it. On missing pseudonym, it will create a new one.

On each request from application to adaptors, the manager will find a real user ID by its pseudonym and replace it. On missing ID mapping, the manager will not pass the request and return error to the upper layer.

The manager is not familiar with the custom actions data that sent by adaptors to the application, therefore the solution was to agree on custom data format (XML string was chosen) and to agree on predefined XML element name that must be used for ID elements (USERID_ELEMENT_NAME constant). The manager will go over the custom action details and look for these predefined elements.

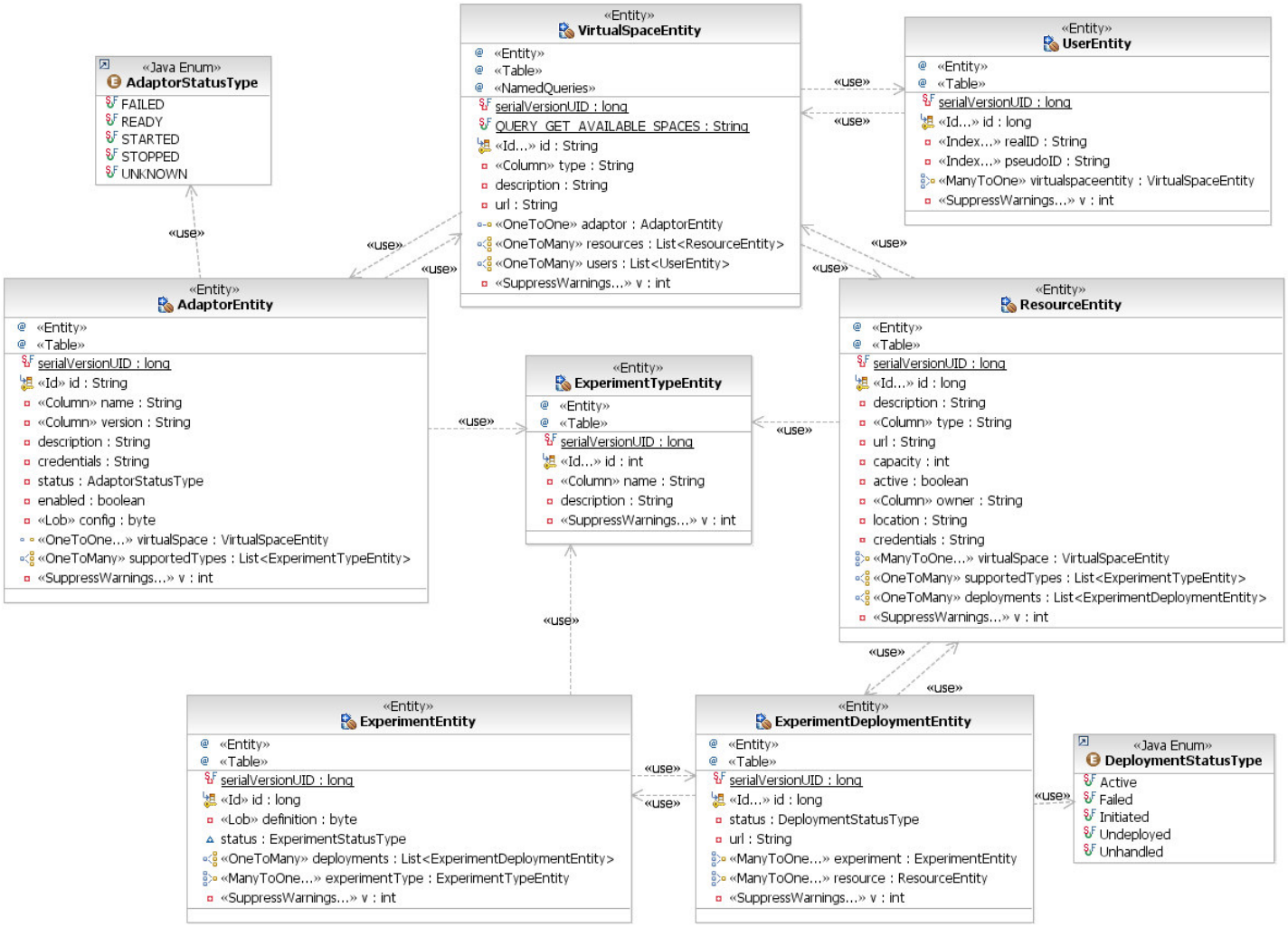
Failover recovery functionality: the manager will be able to handle both recovery of the whole system and recovery of specific adaptor. The manager will wait for adaptors to reregister and then will configure adaptors. For each ready adaptor, it will check if there are live experiments related to the adaptor and pass handling command for each experiment. The adaptors will be responsible to try to recover missed actions and to report them to the system.

Actions sharing functionality (optional): the manager will be able to share activities between virtual worlds, by reinjection of users' votes, opinions and other activities from one adaptor to other adaptors. The adaptors will be responsible to display these events on selected resources.

In this way users will be exposed to opinions of users from other worlds, and will have the possibility to distribute experiment links to additional accounts in many virtual worlds.

Data Layer

VSML database is separated from +Spaces database for the privacy issues explained earlier. The data modelling was implemented using JPA technology. Bellow is the database diagram:



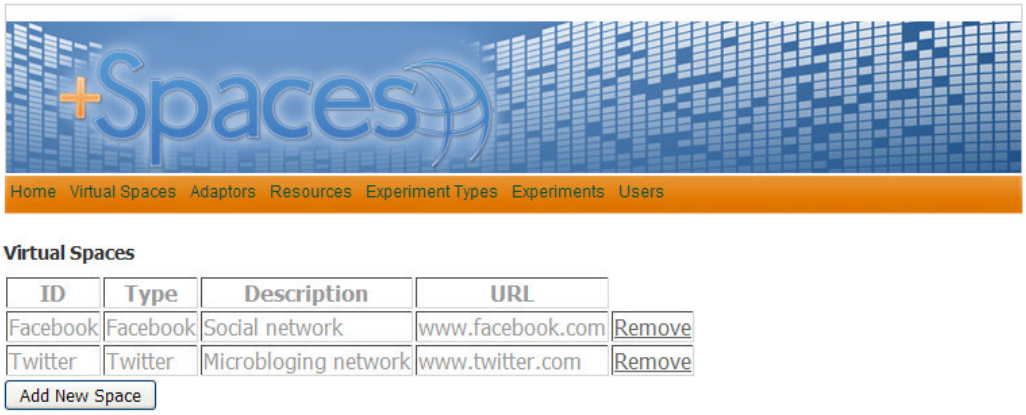
Comments:

- Virtual Space and Adaptor relation is 1:1, however it is likely that virtual spaces will be predefined statically, while adaptors data add/removed/updated dynamically.
- User mapping was done using simple SQL table, with indexing on ID fields.

Adiministration console

VSML layer provides administration console, which allows +Spaces administrator convenient adding/removal/updating of virtual spaces, experiment types, resources, adaptors. In

addition it allows monitoring current VSML state, such as adaptors status or handled experiments status.



6 Virtual Space Adaptors

6.1 Adaptors

The virtual spaces adaptors are the components, responsible for deploying experiments in virtual spaces, management and monitoring them. This general definition is translated to a common API, which all of the adaptors implement, and a single common API that all of the adaptors use, exposed by the VSmanager.

The communication between the VSmanager and each of the adaptors is performed asynchronously using Java Messages Services (JMS). In addition to a-synchronicity this method reduces the dependencies between adaptors and the VSManager, and increases maintainability.

Start up procedure

On start up, each adaptor reports it has started up. Then it receives configuration command from VSManager. If required, the adaptor connects to the virtual space, and then reports it is ready.

At this point the adaptor can receive experiment commands or any other command.

Experiment deployment and un-deployment

Adaptors can receive experiments commands, such as deploy and un-deploy. A deploy command includes an experiment definition object and a list of relevant virtual space resources, which is processed by the adaptor to create the experiment process. After the experiment is ready, the adaptor deploys the process in the virtual world. It begins to monitor the experiment and reports a successful deployment on the specified resources.

Monitoring experiment

Each adaptor is responsible to collect data of on going participation in the experiment. After obtaining the data, it is formatted and sent to the VSManager, in a predefined format.

Recommendations

Adaptors are also responsible on requesting recommendations for users, and presenting them in the virtual space. For example, when some user finishes experiment participation, adaptor may present him recommendation to participate in additional experiments, based on the user profile.

Generic adaptor

As described above some of the functionalities of an adaptor are common to all adaptors. They all use and expose the same interfaces to the VSManager and use the VSManager API. The communication is performed using JMS messages:

The generic adaptor component listens to messages on the following JMS queue

VSAdaptorCommands

The following commands types are supported:

ExperimentCommands

Experiment command can deploy experiment or un-deploy experiment.

In deploy experiment command the command includes all the needed information: the experiment ID, experiment definition, and a list of resources.

An Undeploy command includes experiment ID and resource IDs only.

In addition experiment command can start/stop experiment handling, for example in case of adaptor recovery.

ConfigurationCommands

These commands set configurable data in the adaptor.

ActivationCommands

This command is enables/disables adaptor functionality.

RecommendationCommands

A recommendation command comes as a response to a recommendation request issued by the adaptor, and includes user IDs for whom the recommendation is for, experiments IDs, links to the experiments in various spaces and description.

Each adaptor presents the recommendation in a different way.

In addition it sends messages on the following JMS queues:

VSAdaptorEvents

Used to notify the VSmanager on events, such as adaptor status, experiment event or failure event.

VSAdaptorActions

This queue is used to report the VSManager on actions users perform in the virtual space. These actions can be related to a single experiment or not.

VSAdaptorRequests

This queue is used to send requests for information to the VSManager such as request for recommendations for a specific user.

The Class diagram of generic adaptor is illustrated in figure 5.

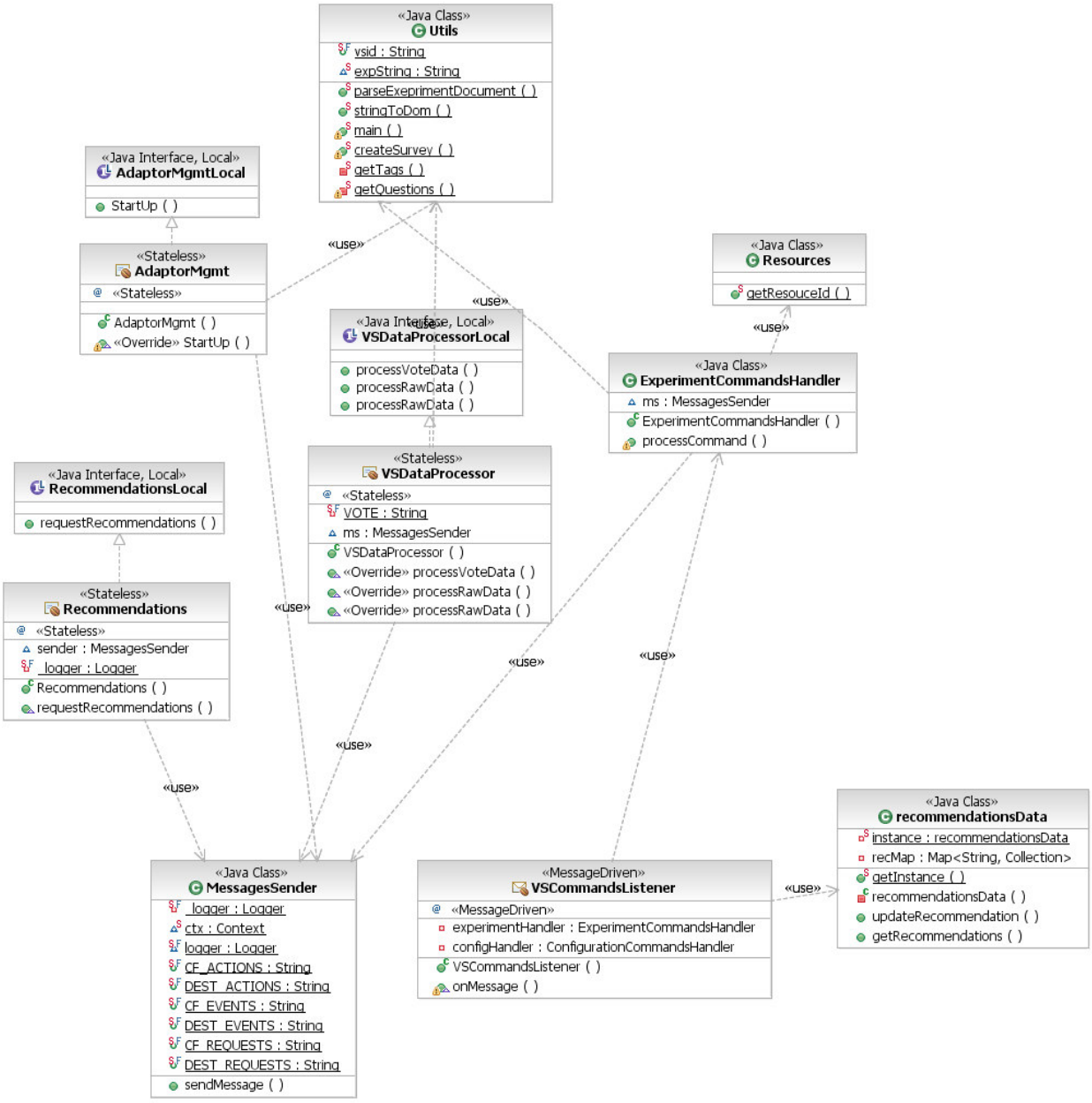


Figure 5. Class Diagram

6.1.1 Open Wonderland (OWL) Adaptor

The Open Wonderland Adaptor will be implemented as a J2EE application. The OWL Adaptor shall be responsible for configuration of a connection to an OWL server; the deployment of experiments on resources allocated on that server; the monitoring of user interaction with those experiments; and the management of those experiments. It shall not be responsible for the allocation of resources on an OWL server.

A user in the role of Public Servant shall be responsible for the allocation of a resource. The user shall insert an appropriate "Cell" in an OWL server (such as a cell representing a Polling Booth, debating area or simulation space) and then declare this Cell as a +Spaces resource to the system[28].

The Cells that represent a polling booth, debating area or simulation space shall be implemented as OWL modules. It is the responsibility of the OWL server administrator to ensure that the necessary modules are installed.

Configuration

At the configuration stage, the adaptor shall be provided with a URL to identify the location of the OWL server in addition to access credentials (username and password of an OWL server administrator). The adaptor shall attempt to open a connection with the OWL server using the credentials supplied. If successful, the adaptor shall report that it is ready. If unsuccessful, the adaptor shall report a failure with details of the reason.

Experiment Deployment

When the OWL adaptor receives a command to deploy an experiment, the command shall include an experiment definition object and the resource on which to deploy the experiment. The adaptor shall determine if the resource is available and suitable for deployment (for example a poll must not be deployed on a resource that is only appropriate for debating). The adaptor shall then deploy the experiment on the resource. On successful deployment, the adaptor shall start the experiment.

User Interaction and Monitoring

The OWL Adaptor shall receive events from the Cells on the OWL server. The events shall describe user interaction. The events shall be of two types: general events, or those relevant to an experiment, such as a user's selection in a poll, a user's contribution to a debate. The adaptor shall transform these events into instances of VSAdaptorAction and publish them to the appropriate JMS queue.

In the case of a Poll, the following event shall be published from the OWL Adaptor:

- Timestamp when user begins poll
- Timestamp when users completes poll

[28] Described on page 19 of 3.1.

- User's answers to poll questions

In the case of events that are not related to an experiment, the following have been considered. We have yet to make a decision on which ones of these are important for the recommendation engine. We believe it is possible to capture the following events, however no design has yet been put forward to implement the necessary software to capture these events. Development of this software would be a significant additional effort beyond that currently estimated.

- user login and logout times
- textchat shared within the system (time-stamped and from a particular user). This could be general textchat (ie. everyone logged into OWL can see it) or it could be textchat to a specific user (in which case the recipient's username would also be included in the event)
- when a user comes into proximity with another user (the distance between users could be specified, such as less than 2m, 2-5m, >5m, etc)
- when a user speaks using the voice comms (although capturing what the user has have would be very difficult)
- when a user creates a new shared app or deletes a shared app
- when a user takes control of a shared app (start time, end time)
- when a user goes through a portal (timestamp, start location, end location)
- when user jumps to a placemark (timestamp start location, end location)

Recommendations*:*

Recommendations to a user shall appear in a Heads-up-Display (HUD) on a user's OWL client. The HUD shall be implemented as an OWL Client Plugin module. The recommendations shall appear as "placemarks" indicating to a user the location of a Cell. A cell that has been recommended may itself be another experiment, or may be a (URL) link to an experiment in a different virtual space. It is the responsibility of the OWL server administrator to ensure that this module is installed.

The adaptor shall determine when to provide a citizen user with recommendations. The recommendations shall be communicated to the Client Plugin on the OWL server from the OWL Adaptor.

Technology

The communication between the OWL adaptor and an OWL server shall be over port 1139 (by default). It is necessary that the firewalls on which the J2EE application are installed are appropriately configured to allow traffic on this port.

6.1.2 Facebook adaptor

The Facebook polling module is implemented as a Facebook application. Facebook application is accessible from within the site, to the social network users.

E-gov application on Facebook Adaptor

Like any Facebook application a user can surf to the appropriate URL within Facebook and arrive to the application. The user must be logged into Facebook. This is checked and if the user is not logged in he is redirected to the Facebook login page.

Once a logged in user arrives, Facebook mechanism checks if the user has added the application to his applications list, if not she is asked to confirm she would like to add the application, and grant the basic set of permissions to her data. This process is done once per user and is similar in all Facebook application.

In the application a privacy statement is presented, a list of the current polls and a recommendations sections.

If the user clicks on a poll link, or arrived to the application by clicking on a poll link she is automatically redirected to a poll page. In the poll page a set of questions are presented for the users to answer. After the user has answered they can submit their vote.

If the user submits, they are asked if they would like to publish this activity on their Facebook wall. This publication includes a link to the application and is intended to attract more users.

Additional data collected

In addition to the experiment specific data such as user's votes, we collect some additional information that is included in the basic set of permissions the user grants us. This data is obtained when the user logs in to the application and can be used for statistical analysis of experiments results as well as the recommendations and reputation services. This data may include a list of friends, age, gender, …

Recommendations

In the Facebook application on the right hand side we present a list of recommendations. This list consists of the experiment title, the virtual space the experiment is deployed in, and a link to the experiment in a specific space. An experiment can run in multiple spaces, therefore the recommendations list may contain several links to the same experiment but in different spaces.

The cross platform attribute of our implementation of recommendations can assist in pulling users from very popular virtual spaces to less popular virtual spaces, for example getting Facebook users to try an experiment in Wonderland.

Technology – the Facebook adaptor has been implemented as a J2EE application. The interactions with users and with the Facebook site are all done using the http protocol. As implemented by Facebook APIs the adaptor use OAuth standards to ensure authentication of users. The user interface is implemented using standard web technologies such as JSP, html and javascript.

Facebook adaptor web layer

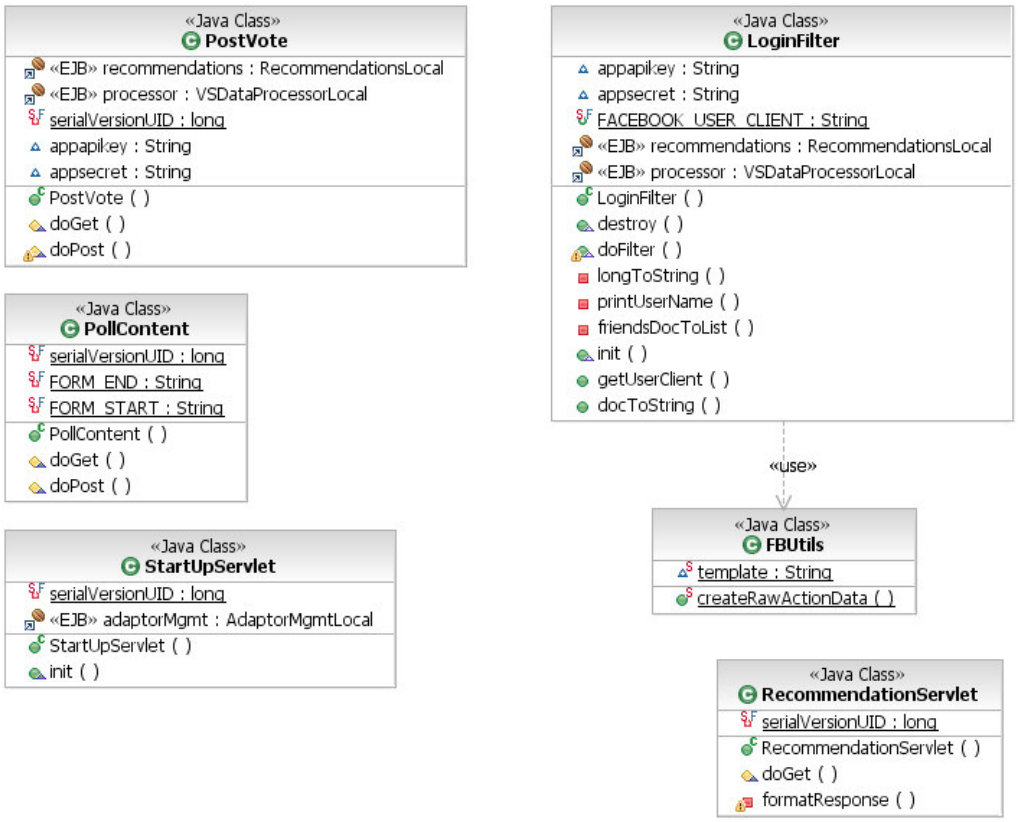


Figure 6. Facebook Adaptor web layer

6.1.3 Twitter adaptor

The twitter adaptor is composed of several components: twitter publishing component, twitter search component and a web application.

Configuration

In the configuration stage the component is granted the authentication tokens required to publish in twitter on behalf of a user.

Experiment deployment

When a new poll is deployed, a web page is generated with the poll questions and some additional scripting functionality, in the web application component.

Once the page is ready, a tinyurl is generated for the new page. Then the publisher component tweets a status update that contains the title of the poll, the tinyUrl and several hashtags. This tweet appears in the twitter feed of users who follow this user and in searches containing the hashtags we use.

User interaction and monitoring

Clicking on the tinyurl link will redirect a user to the generated web page. At this point the user is not identified in that webpage. If the user answers the questions and submits the poll the answers are saved along with a unique key. The user is then re-directed back to twitter, and some text appears in his status textbox. This text contains a message such as 'I participated in _experiment title_' tinyurl link, hashtags, and the unique code. The user can choose to click 'update' and publish this generated tweet. If he does, his followers will be exposed to the experiment.

The twitter search component periodically searches twitter for tweets generated by the twitter publisher component. Once such a tweet is found the user id is taken with the unique code, the code is used to find the vote that was previously saved and the combined information of vote and user id is sent to the vsManager.

Background activity:

The twitter adaptor periodically searches twitter for messages made by users that participates in positive spaces experiments (see TwitterTimer). The text information and the used hash tags are taken with the user id, and sent to the VSManager. This activity is done in order to provide the recommendation and reputation services with information about the users to help evaluate the reputation and provide good recommendations.

Persistency*:*

The twitter adaptor must save oauth tokens in order to publish new experiments. The token are saved on the file systems with file per twitter user (resource).

In addition the adaptor uses two database tables:

Table: Twitter_votes. In this table any vote action is saved, the vote data is saved with the unique code as a key.

The adaptor retrieves all codes from this table and searches twitter for tweets with the code. Once a code is found, the vote data is read and processed, and the record is deleted.

Structure

Name	Data type	Length	Nullable
CODE	CHARACTER	8	No
VOTE	BLOB	10240	No

Table: Twitter_users. In this table user names of twitter experiments participants are stored. This happens after a code is found in the twitter searches. The adaptor periodically reads the user names from this table and searches twitter for publications they made.

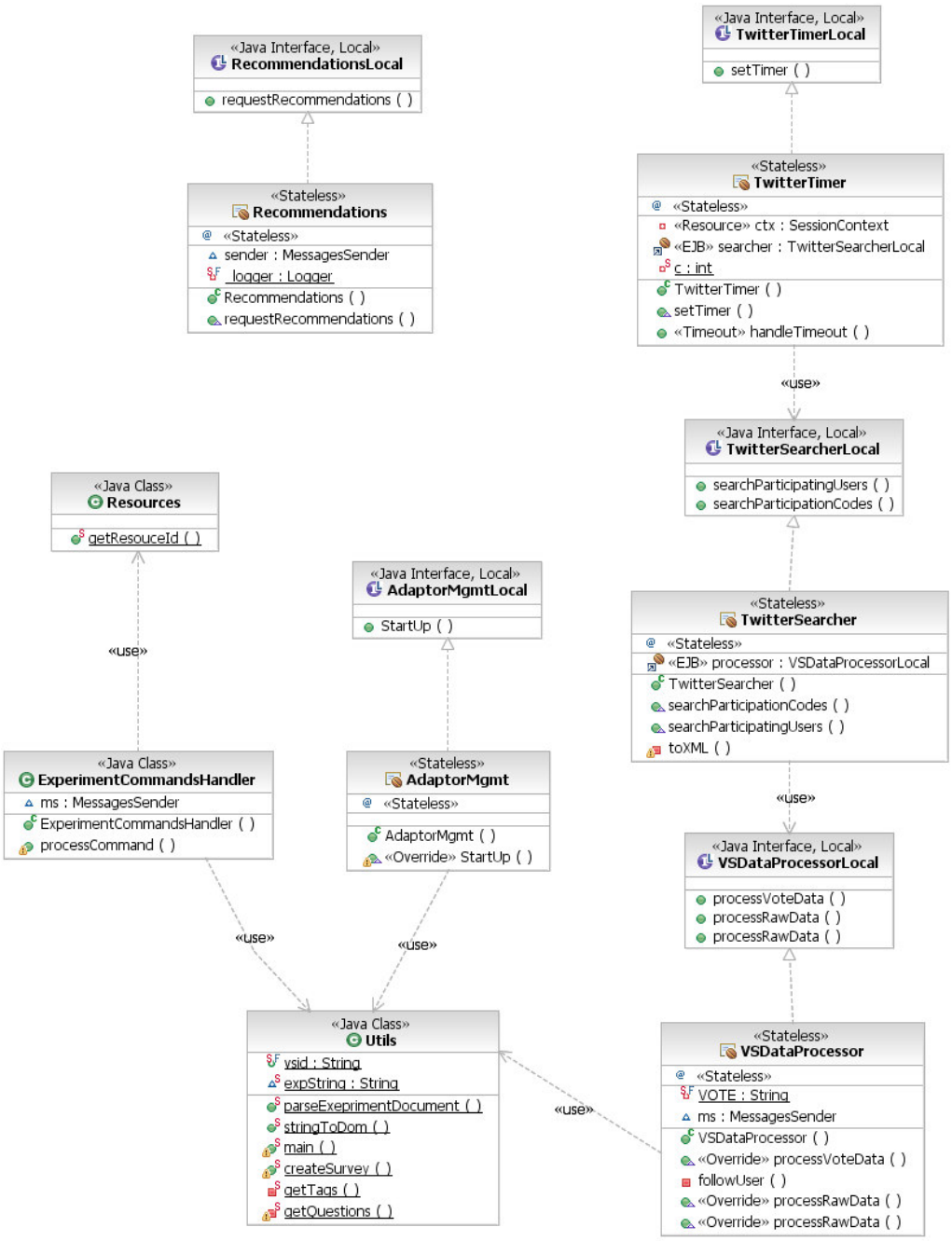
Structure

Key	Name	Data type	Length	Nullable
	ID	VARCHAR	30	No

Recommendations:

In the poll web page, a user has the option to mark whether or not she would like to receive personal recommendations from positive spaces. When a tweet containing the positive space code is found, the system also checks if the user has indicated he would like to receive recommendations. If so, at this point the adaptor issues a request to the recommendation service for recommendations for this user. Once a recommendation set is received, a message is formatted and sent to the user via twitter's direct message mechanism. The message contains titles, descriptions and links to experiments in various virtual spaces.

Twitter Adaptor EJB layer




«Java Class»
Search
twitterURL : String
searchParam : String
formatParam : String
qParam : String
hashTag : String
AT : String
FROM : String
main ( )
searchByHashTag ( )
searchByMention ( )
searchByUser ( )
«Java Class»
Parser
main ( )
parseSearchResultes ( )
«use»
«use»
«use»
«use»
«Java Class»
TwitterPost
from_user : String
geo : String
profile_image_url : String
iso_language_code : String
from_user_id : String
created_at : String
id : String
to_user_id : String
text : String
metadata : String
TwitterPost ( )
TwitterPost ( )
getFrom_user ( )
setFrom_user ( )
getGeo ( )
setGeo ( )
getProfile_image_url ( )
setProfile_image_url ( )
getIso_language_code ( )
setIso_language_code ( )
getFrom_user_id ( )
setFrom_user_id ( )
getCreated_at ( )
setCreated_at ( )
getId ( )
setId ( )
getTo_user_id ( )
setTo_user_id ( )
getText ( )
setText ( )
getMetadata ( )
setMetadata ( )
getHashTags ( )
toString ( )
«Override» hashCode ( )
«Override» equals ( )
«Java Class»
Publisher
TWITTER_PUBLISHER_ADDRESS : String
instance : Publisher
LINK : String
tiny : TinyUrlHandler
Publisher ( )
getInstance ( )
publish ( )
main ( )

Figure 7. Twitter Adaptor EJB layer

6.1.4 Blogger adaptor

The Blogger adaptor will be implemented in phase 2, and used for debate type e-gov applications.

7 Simulation in Virtual Spaces

The +Spaces proposal presented the concept of a Virtual World as a micro-society, where it has many of the same dynamics resembling those in the real world. Moreover, virtual spaces incorporate the dynamics of social networks that are already widely established, making them an actual testbed for experimentation in a society simulation.

As a micro-society based on the virtual interactions between real people, it was proposed that the reactions governments would see are real responses to simulated situations, rather than simulated responses in hypothetical situations. It was conceived that these measured reactions could be extrapolated to derive conclusions for the society at large.

+Spaces did not propose to create a simulation of society, something that is extremely difficult (if not impossible). Instead it propounded the use of environments that are already gaming-based simulations of reality, miniatures of society, which are richer in characteristics of reality. The intention was for +Spaces to build the tools to translate the behaviour in those spaces to predicted behaviour in real spaces. Virtual Worlds were seen as ideal environments for this scenario because the e- governance applications could be applied seamlessly over the Virtual World space, allowing the user to continue navigating through the virtual world without changing anything in that space.

This vision of using virtual worlds for simulating government policy presents several challenges to the project. This section of the document provides some more concrete examples of the use of virtual spaces for simulation and some suggested implementation scenarios. It also highlights some of the issues involved.

7.1 Virtual Space Simulation Issues

Section 2 of this document provided a distinction between ‘virtual worlds’ and ‘virtual world platforms’, where a virtual world is a community of users who meet in a virtual online space, whereas a virtual world platform is a toolkit for implementing a virtual space, but does not immediately provide an online community of users who can inhabit that space. SecondLife was given as an example of a Virtual World with a large number of public users (although private and controlled areas are commonly also found within it). The Open Wonderland toolkit was presented as an example of a virtual world platform, which can be used to build an online virtual space, which would then need to attract a community of users.

For the simulation of government policies within a virtual world the distinction between the virtual world and the platform will be crucial, as the simulation will be dependant on it being

implemented on a platform used by a community of users (in a virtual world). If a simulation is built using a virtual world platform, the platform will then need to be linked to either an existing group of users (eg. via Facebook) or attract a new set of users to make use of it.

Simulations also have several challenges when it comes to modelling the real world. For example how easy can we change a person's regular habits? How can we interpret a habit based on the policy?

We also need to be clear about what simulations can do that polls and debates cannot do. In polls the policy maker should know the exact question to be asked. In debates the question is usually more open but rooted in a core issue. Whereas, in a simulation, the policy maker may not know the exact question to be asked. In polls the users should give a direct answer, in debates they give more open answers, and in simulation they may be unaware that they are being asked anything at all.

There is a strong element of cognitive dissonance – if we force users to behave in a certain way, they will typically start to adapt their behaviour – that means that people that participate in simulations are likely to change their opinions about the topic be studied.

A key issue for +Spaces is the lack of a reusable simulation model. Most simulations, such as the BBC Climate Change Simulation[29] combine an underlying simulation model (ie. the rules and conditions which affect climate change) with an environment or user interface, which allows people to explore the simulation online.

Many simulations are also highly complex game playing environments, which have rich graphics, story narratives and game-playing metaphors.

There is also the issue of how to engage with citizens and policy makers using simulations. People generally want to engage with a simulation because (a) they are interested in the domain (eg. climate change), or (b) they are enticed by the game-playing or entertainment provided by the simulation (eg. Farmville). This then becomes more complex when we need to combine the simulation with a government policy-making objective.

Any simulation model is generally based on four factors:[30]

- Generality of scope (ie. broad scope)
- Precision (ie. not vague)
- Realism (ie. reflects knowledge and processes
- Lack of error (ie. accuracy of results)

A simulation model should aim to combine all of these factors – this is illustrated in figure 8. However in reality it is very difficult to combine all 4 factors in a single simulation (according to Bruce Edmonds at the Centre for Policy Modelling, Manchester Metropolitan University,

[29] http://www.bbc.co.uk/sn/hottopics/climatechange/climate_challenge/
[30] Bruce Edmonds (Centre for Policy Modelling, Manchester Metropolitan University, UK

UK), and policy simulation rarely goes beyond 2 factors. Generally 'lack of error' and 'generality of scope' are seen as the key dimensions for policy simulation.

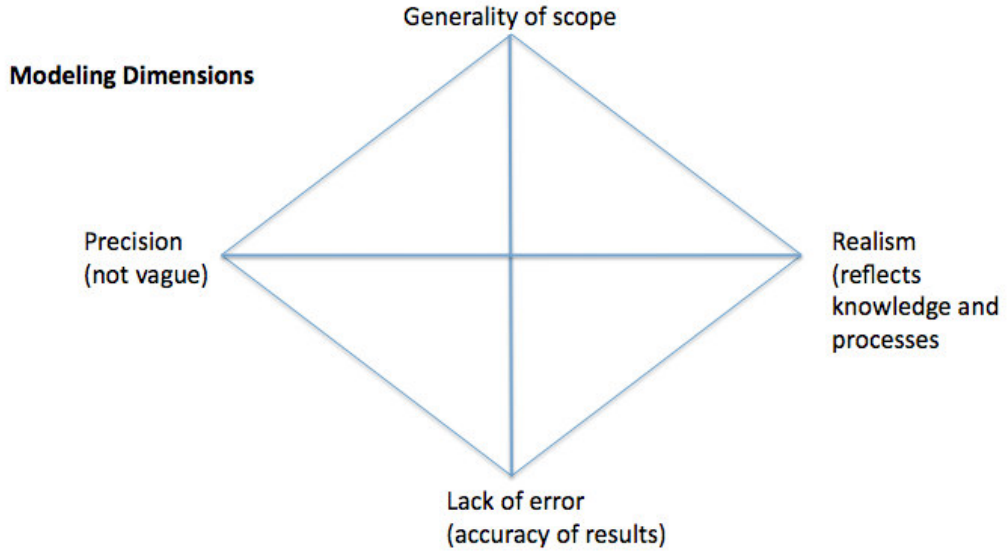


Figure 8. Simulation models

Edward Castronova [25] has done a great deal of research into economic modelling using virtual worlds. His past research has indicated that virtual worlds that exhibit some form of economic behaviour often reflect real world economic propositions. For example:

1) That as the price of a good rises, demand for it falls, and

2) If you insert more money into an economy, the price level rises.

For +Spaces he has made the following suggestions for the use of virtual worlds to assess policy issues:

A) Assess the virtual world population reaction to sales, income, wealth, and poll taxes.

B) Create a common pool of resources and test how the virtual world populations manage them

C) Create a market with no money and see what sorts of objects emerge as the currency

D) Create a job oriented game:

a. Create a job-oriented game with income and production inequality.

b. Invite experts in different political traditions to invent social policy for this game

c. Get these experts to agree on common metrics of success

d. Launch parallel versions of the game, implementing different policy in each

e. Wait a few months

f. Assess the performance of the societies against the metrics.

These are all valuable ideas for the use of virtual world simulations for policy making. However, they are all essentially projects in their own right and will require a level of effort and resourcing beyond what is currently available in the +Spaces project.

7.2 Virtual Space Simulation Scenarios

The following scenarios for +Spaces virtual space simulations have been identified (at a project workshop) as possible areas for future exploration:

7.2.1 Recycling

Recycling Game – engaging users in a game that would examine their willingness to recycle. This could involve the users in exploring the following issues:

What is garbage? Where does it come from? Where does it go?

A simulation could involve people having their own virtual homes and activities that produce garbage of different types (organic, plastic, paper, glass, metal, etc).

Typically recycling is not a priority issue for most people. This is also often reflected in virtual worlds where there are often similarly routine actions (e.g., killing varmints in FrontierVille).

Recycling activities can be represented in a virtual world in a number of aesthetic ways – like withered plants in Farmville, accumulated garbage, etc.

Users may gain (points) from taking recycling actions and be rewarded for their effort in recycling garbage that lies on the street. There could also be separate missions that require users to collaborate with one another (e.g., gather a large amount of cans). This could be potentially easy to implement in a game, as users consume things and then need to get rid of their packaging. They could either throw items away, or spend some time to sort and recycle items individually. However it may be difficult to simulate the environmental motivation and impacts within a virtual environment.

The results from this type of simulation may be more realistic than in other scenarios as we could expect users to express both negative and positive reactions to the recycling options presented. However, it may not suitable for simulating actual recycling laws, but the conclusions could help us to find additional motivations for recycling.

7.2.2 Transportation simulations

Modelling the transportation infrastructure for a particular area such as a town or city. This would have to be combined with some form of traffic modelling which could dynamically vary the characteristics of the simulation (eg. congestion, speed of traffic, etc), and allow

users to explore some of the implications of transport policy implementation (eg. closing some streets in central Athens for pedestrians only).

The simulation could have some of the following characteristics:

- Different transportation scenarios (eg. simulating central Athens and blocking certain streets)
- Users could have different types of vehicle, that they can gain as they play
- Would need to explore what would motivate people to use different transportation options
- Users could have different goals inside the game eg. travelling to work
- Users could get missions for getting from one place to another (typically from their home to their workplace)
- Transportation is a fundamental need in modern society, so it should be appropriate to be represented in a game format, as it is a common need
- Could be a good use for realistic 3D views of a city centre (eg. Athens)
- Private cars could be modelled to be more comfortable than public transportation eg. they are less crowded
- Emotional factor should be considered (e.g., such as not wanting to be in a crowded bus)
- The simulation would need to model real-life-like management of resources, such as
    - Room on bus
    - Parking places
    - Speed limits
    - Can't run over each other
    - Avoid car accidents for the sake of simulation
    - Users may be allowed to define "neighbours" or "friends" and car pools, if their missions collide

However for +Spaces, ultimately the transportation models may be too complex for the project to implement within the time frame and with the resources available.

7.2.3 Marketplace simulations

Some virtual worlds (such as SecondLife and Farmville) implement their own internal monetary systems and currencies that can be used to buy virtual goods and services. Often users can purchase internal credits with their real currency, and it has been proved by past research [25] that there is a close correlation between real and virtual buying behaviour. Virtual worlds could therefore provide an ideal simulation for economical policies based on a defined marketplace for virtual goods and services.

However, this type of simulation will have the following issues:

- Limited control over the simulation eg. Zynga games (who implement Farmville) do not support selling from one person to another, so creating a real market with supply and demand may be difficult
- Difficult to simulate a whole economic system
- Need to define the key characteristics eg. What are goods? What is money? Why should one be interested in having / saving money?
- Sometimes difficult to make this type of simulation attractive for young people
- It may be possible to borrow the economic model from existing virtual worlds eg. SecondLife, but it may be complex to implement
- This type of simulation is usually based on the concept of the user having a personal inventory of items, which they can buy or sell.
- Need to consider supporting mechanisms such as how users can advertise their goods/services, how they can exchange for the internal currency (eg. Linden dollars), how transactions are implemented eg. selling objects to others, etc
- This type of simulation is probably the most difficult to implement as it requires a well established community, marketplace and online economy, but if implemented, it could allow the project to simulate a variety of different policies
- Would need to establish what are the variables that policy makers are interested in? eg. VAT, opening hours of shops, where the goods come from (a friend, regional distributer, etc). This may make it difficult to model the real effect of a change (of policy). However, this type of simulation is often a good analogy to real life, as people actually care about their virtual properties.

7.2.4 Online communities and tasks

The previous simulation scenarios all involve some form of implementation of a game like environment eg. recycling, transport, and marketplace, that represents a real-world setting. This can be difficult to implement, as it will require an accurate representation of a real-world setting within an artificial virtual environment. This can be both difficult to model

graphically and also difficult to model in terms of the behaviours exhibited in the virtual world eg. transportation congestion, marketplace currencies, etc. It can also be difficult to attract users to participate in these new environments.

An alternative scenario is to focus on an existing virtual space in which users are already collaborating with one another and look at ways of experimenting with these virtual space implementations. For example we have built online e-learning virtual worlds in which students can participate in live online lectures and tutorials which incorporate video and audio feeds from live events, plus some form of application sharing and collaboration/interaction between the participants. This type of virtual world is already providing a simulation of real-world activity (ie. learning) with real users, and it could be used to explore other issues based around the particular implementation. For example, it could be possible to vary the fidelity (quality of interaction) of this type of event to explore the affect on the end users and the quality of the interaction. This could then be extrapolated out to assess whether the participants would be willing to pay for these service features. For example, it could be found that the quality of the video for the live event was crucial to the overall perception of the service and people would be more willing to pay for a higher quality video connection. This could then have implications for government policy on digital television, and new forms of web-mediated entertainment services.

In terms of +Spaces, users could be exposed to a simulation activity of this type, which could then be followed up by an online poll and debate (using the other +Spaces applications) which can help to capture further quantitative and qualitative information about the users perception of the main issues arising from the simulation.

7.3 Role-playing in virtual worlds

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 (ie. 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.

Other experts also back up this analysis. Prof. Richard Duke, author of 'Policy Games for strategic management: pathways to the unknown' (2004 Purdue University Press) is a pioneer of computer based urban simulation games and is President of the International Simulation and Gaming Association. 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)
- 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)

The creation of a serious game simulation will often have the same issues as identified for other complex simulations (as discussed above). However, there are some open source tools, which could be used by +Spaces to create a serious game policy making simulation. For example Pivote[31] is an open-source authoring system for learning in virtual worlds. Created by Daden originally for the JISC funded PREVIEW project, PIVOTE is now an open-source project and available for free download and use by anyone.

[31] http://www.daden.co.uk/pivote.html

PIVOTE lets you:

- Create learning exercises on the web using a simple forms based interface
- Create objects in a virtual world such as Second Life, which users can use to interact with the exercise
- Play the exercise in Second Life, OpenSim, or on the web or even an iPhone.
- Port exercises between virtual worlds
- Share PIVOTE compatible objects between exercises and institutions
- Rapidly edit exercises to create variations, or custom versions for different skill levels
- Export student performance data for us in an online learning environment

Using PIVOTE it would be possible to create a forms-based interface to allow policy makers to input the content for a simulation scenario. This could then be translated to a web-service, which can be interfaced to a range of front-ends, including SecondLife, Open Wonderland, and the web (eg. a Facebook page). PIVOTE also supports in-world chatbots which can used to structure the simulation dialogue with the user participants.

The role-play simulation could then be followed up by an online poll and debate using the other +Spaces applications, to elicit further information about the implications of the new policy initiative. This is illustrated in figure 9.

Figure 9 – Role-playing simulation scenario

The project may also be able to use existing role-play approaches and templates to assist the policy-maker in devising an appropriate role-play simulation to support a given policy issue being debated. The following are examples of existing role-play templates:

- Galactic wormhole
    - Participants pretend to be 5 years in the future and reflect on positive and negative outcomes from a particular strategy
- Depolarizer
    - Structured game based on the philosophy that many issues that we treat as problems to be solved are actually polarities to be managed
- Environmental decision-making
    - Participants learn about a particular environmental issue from multiple perspectives by interacting both online and face-to-face with their peers about a topic in assigned “stakeholder” roles

In terms of the +Spaces project and the level of innovation and the state of the art within role-playing, role-play can be said to be a tried and tested approach which has been used for many different purposes such as predicting outcomes, war-gaming, team-building, training, etc. Aspects of role-play have already been used elsewhere eg. online theatre, gaming, focused discussion forums, etc. The innovation for +Spaces is in the application of role-playing as a simulation tool for policy makers. The challenges for the project would include:

- How to support online participants across different virtual space platforms
- How to define a role-play and then select users and schedule (and setup) the event
- Managing the structured role-play in a virtual space
- Capturing the results from the role-play simulation
- Analysing the results to support policy making

From a project perspective the benefits of using a role-play simulation approach are that it emphasises the need for inter-operability across platforms (Facebook, Twitter, Blogger, Wonderland), across +Spaces applications (polls, debates, simulation), and with other core +Spaces services (recommender/reputation system selecting participants, data analysis service).

It will also provide rich data sets for the analysis systems in terms of the role-play dialogue and events, and it should provide a more generalisable policy simulation framework.

7.3.1 Role-playing and Game-Theory

The research presented above in the application of role-play for simulation is closely related to the field of Game Theory. Game theory is not about 'games', it is more concerned with 'strategy' and decision-making. Game Theory was originally developed by John von Neumann (1903-1957). He explained a 'game' like this:

> *"Chess is not a game. Chess is a well-defined form of computation . . . in theory there must be a solution, a right procedure in any position. Now real games are not like that at all. Real life is not like that. Real life consists of bluffing, of little tactics of deception, of asking yourself what is the other man going to think I mean to do. And that is what games are about in my theory."*

Game theory is a study of situations involving conflict between thoughtful and potentially deceitful opponents whose actions affect each other. This is primarily about the choices taken by people involved in a decision-making process. In the context of +Spaces this decision-making process could be a serious game or role-playing exercise involving a number of different people. In a game, one must make a choice knowing that others are making choices too, and the outcome of the conflict will be determined by all the choices made. In Game Theory there are two types of game:

> (1) Sequential-move games, where the players alternate in making their choices, one player following another; and
>
> (2) Simultaneous-move games, where each player makes a choice not knowing the choice(s) of the other player(s).

A role-play scenario would probably be of type (1) as the purpose of the role-play is to ensure that the users see and hear all the decisions being made by the different people assigned to the different roles.

Game Theory provides a way of structuring the different choices and individual pay-offs into a table or graph. This provides a way of analysing the options available to each 'player' and informing the decision making process. Payoff numbers are very useful because they allow us to analyse a game by focusing on the players' preferences, and to predict the outcome of this game.

Figure 10 provides an example from a conflict situation from the opera Tosca:

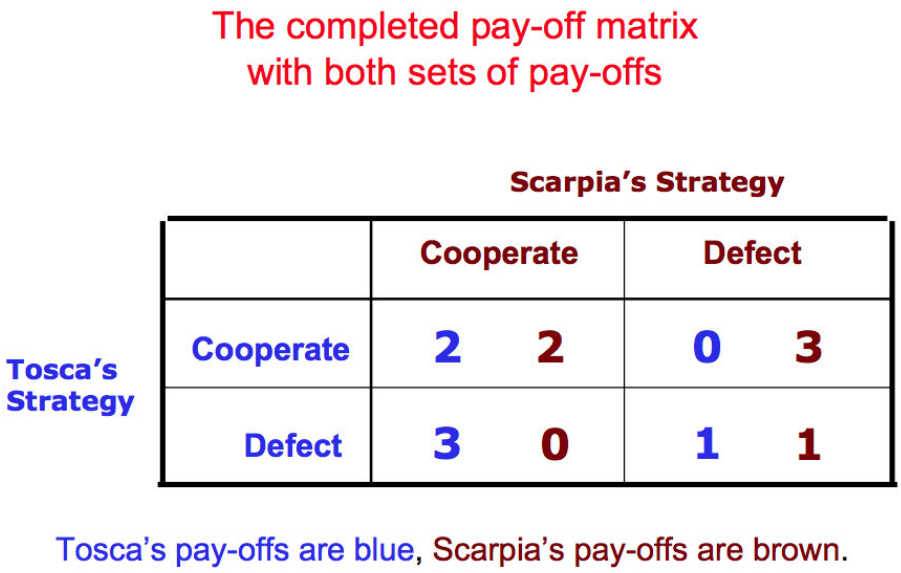


Figure 10. Game Theory pay-offs from Tosca

In this example, Tosca has a choice between two possible strategies:

(a) Cooperate, i.e. submit herself to Scarpia's lust, or

(b) Defect, i.e. refuse to keep her part of their bargain.

Scarpia can also choose one of two strategies:

(a) Cooperate, i.e. really save the life of Cavaradossi, or

(b) Defect, i.e. deceitfully ensure Cavaradossi's execution.

We can use game theory to predict the outcome from a scenario involving 2 or more 'players'. The outcome will depend on which strategy each player selects. For example, a dominant strategy is a strategy which gives a player the best outcome whatever the other player's strategy – but it may not always lead to the best outcome, as cooperation may be better for both players. In this situation when each player has a dominant strategy and chooses it, the outcome is called *dominant strategy equilibrium*.

The implication of Game Theory to the use of role-playing as a simulation framework within the +Spaces project are that in order for a simulation scenario to be analysed in this way 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 (ie. 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' like Pivote, which require this level of pre-planning. However, it does not easily support unstructured dialogue based role-play scenarios.

8 Conclusions

This document presents the results from task 4.1.1 'Virtual Worlds Environment Analysis'. The purpose of this task was to study a range of commonly used virtual world environments that are candidates to be used in the project, identifying any issues and make appropriate recommendations that can feed into the +Spaces design activity.

The outcome from this study forms the special requirements and characteristics that +Spaces applications must address in order to integrate with each virtual world. This document provides an initial definition of the testbed environments, and the virtual world adaptors into which the core +Spaces policy simulation applications will be deployed.

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