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VIRTUAL ORGANIZATIONS IN EMERGING VIRTUAL 3D WORLDS

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Abstract. Our paper explores virtual organizations supported by emerging virtual world platforms, analysing them in the perspective of the supporting technology. The shortcomings of the used paradigms are identified as well as new directions for research. The paper concludes that, in order for virtual organizations to take full advantage of virtual world platforms, a new architecture based on open standards is needed, a new in-world paradigm to secure intellectual property and an agent-web service gateway to allow the composition of services between virtual worlds and Web.

1. The Problem

Emerging virtual worlds (VW) push the experience from 2D to 3D, from flat to immersive, from one-on-one to social. As all human beings live in a 3D real world (RW) and our experiences in virtual VW closely parallel our real life experiences, we witness an accelerated acceptance speed of VW platforms and 3D GUIs. The mix of grid computing, physics engine and spatial data, that enable virtual worlds, is also becoming also more powerful and well-fit to disrupt the present social and economic landscape. The anticipated huge impact on IT, business, and society in the very near future makes this field worth researching.

In the last few years, based on these new VW platforms, new virtual organization (VO) models have been developed. Our paper explores these new models analysing them in the perspective of the supporting technology.

2. The Concepts

As there is no large agreement in the available literature on the terminology, we've considered useful introducing the following definitions.

Real World (RW): Physical World, Universe

Digital World (DW) 2D Web, Internet

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2000 *Mathematics Subject Classification.* 68N30.

1998 *CR Categories and Descriptors.* D.2.9 [**Software Engineering**]: Management – *Software process models*.

Key words and phrases. Virtual organization, Virtual worlds, Metaverse.

Virtual World (VW): a fully immersive 3D virtual space. VWs use the metaphor of the real world, but without its physical limitations.

Avatar (AV) A 3d representation of an agent, operating in a VW, also called "digital persona". Avatars with facial expressions and body language provide a virtual experience almost as rich as real-life.

3D Web: VW interconnected

Metaverse: A Virtual World that has primarily social and economic role. Users (represented in-world by agents/avatars interact with each other (socially and economically) and with other software agents. Metaverse characteristics:

- Scalability
- Access levels: from low quality to very high
- Face to face (F2F) communication
- Code protocols as law: coding protocols define what can and cannot be done, what is legal, what is not
- Economics

Paraverse: A Virtual World linked to regions and/or bodies in the RW (e.g. Google Earth, virtual surgery or virtual shared meeting places)

Intraverse: A Virtual World built behind a firewall (concept similar to 2D intranet). A grid of a company, the region domain only allows agents from their agent domain to connect, and they can be sure that all those people in their agent domain are actually employees.

Open Ended VW (OEVW): A Virtual World in which **residents** (represented by avatars) use communication, available co-operation services and their skills to involve in social and/or economic activities. These virtual worlds exist simply as places to explore, experience, create and, based on IP Intellectual Property, to exchange goods and values (i.e. to conduct commerce).

Open Ended VW are currently developing relationships (economic, social, cultural and legal) with the RW. Here are some similarities between RW and OEVW socio-economic features: Innovation and Intellectual property (IP), market (goods and values exchange, from both RW and VW), currency, financial organizations, face to face (F2F) communication, identification and authorisation, mass-media, education organizations, political organizations.

The technological features available now in OEVW which support co-operation are: voice communication, audio and video feeds, instant messaging, file exchange, encryption.

Closed Ended VW (CEVW): A Virtual World (the stage) in which **players** (represented by avatars as alter egos) use communication, available co-operation services and their skills to involve activities related to a **scenario**. These virtual worlds have as goal or purpose a **game**.

In this paper, we will analyse only virtual organizations operating in open-ended virtual worlds.

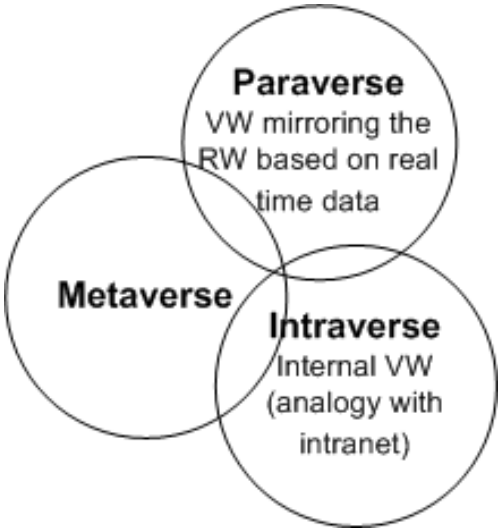

FIGURE 1. Open-ended virtual worlds

The paper addresses virtual organizations (VO) in open ended virtual worlds. The VO definition with which we operate is:

Virtual Organization (VO) is an organization with the following characteristics [1]:

- spatial: operates within geographically distributed work environments
- temporal: has a limited life span, until it performs its tasks or actions
- configurational: uses information and communication technology ICT to enable, maintain and sustain member relationships

VO in VW are those virtual organizations which allow its members to work in a 3D immersive environment by emulating face-to-face communication with colleagues.

3. The Platform

We start from a generic architecture [2] of a VO operating in 2D and 3D (Figure 2) the dotted line representing the focus area of this paper.

Most of the VW run on proprietary collaboration platform, not open yet (only the client); exception OpenSimulator and collaboration services run with disruption.

The OpenSimulator Project is an open source Virtual Worlds Server which can be used for creating and deploying 3D Virtual Environments, able to run both in a standalone mode or connected to other OpenSimulator instances through built in grid technology. It can be extended to produce more specialized 3D interactive applications via plug-in modules. Several OEVW were

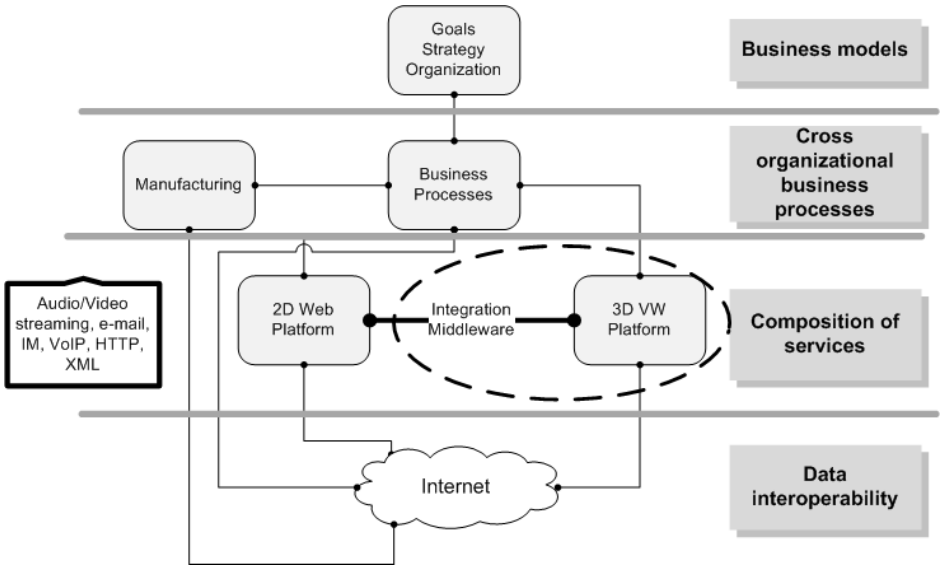

FIGURE 2. A generic architecture of a VO operating in 2D and 3D

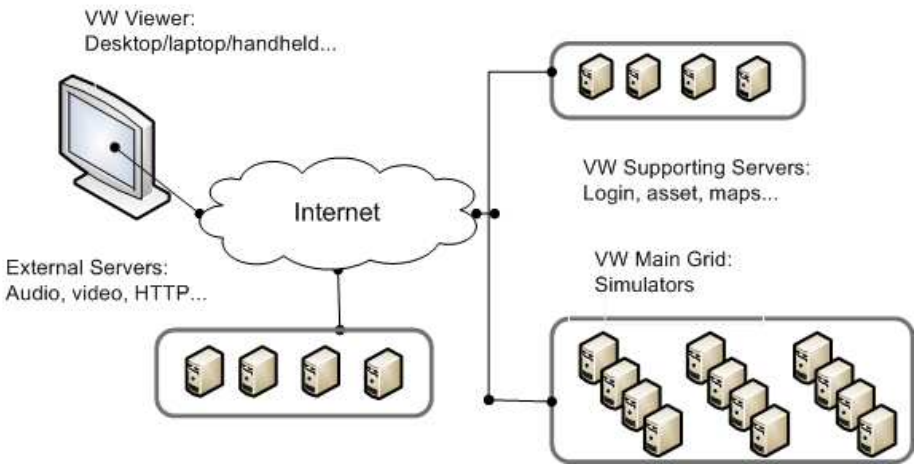

FIGURE 3. A generic, proprietary VW infrastructure

built with open source technology from the open simulator project (Openlife Grid, DeepGrid, OSGrid, 2008)

OpenSimulator uses *libsecondlife* to handle communication between the client and server, so it is possible to connect to an OpenSim server using the

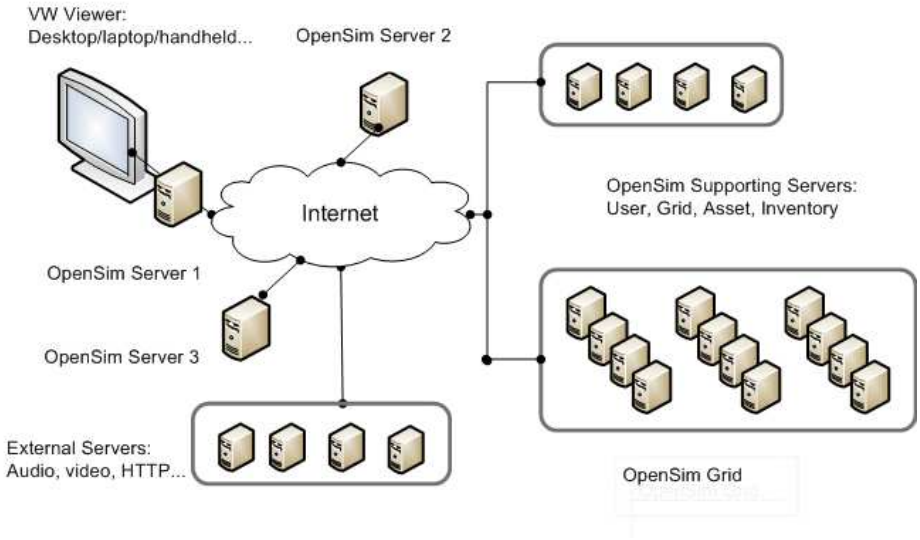

FIGURE 4. A generic, open VW infrastructure

Linden Lab Second Life viewer. Second Life (SL) is the largest proprietary metaverse, owned by Linden Research, Inc.

OpenSimulator operates 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. In grid mode, responsibilities are divided among five servers: the user server, the grid server, the asset server, the inventory server and the simulation server.

3.1. **Platform features supporting collaboration. Security:** All VW platforms include a number of security levels. One is based on the ability to secure the deployment and access of the collaboration infrastructure. The second level is based on the collaboration session itself and the ability to secure the access to a session and/or encrypt the data communication channel. You can encrypt IM/Chat and/or Video and/or Audio from your viewer to the grid. Second Life (SL) uses standard JAVA encryption libraries (JCE).

Communication: Many VW platforms are voice enabled adding more to the "realism" of F2F communication. Text Chat, Instant Messaging, and E-mail are common features in almost all VW platforms.

Movement: Features like teleport and location are also common.

Transfer: Notes, Files/objects/money transfer are available

Interface with 2D Web: Audio-video streaming, instant messaging, e-mail, VoIP, XML from 2D Web to virtual worlds are available

3.2. **Platform issues with regard to collaboration. Scalability:** Present VW architectures present a limited scalability which does not support the expected increased number in regions, users/residents and concurrency (number of users simultaneously connected to the VW). Second Life estimates for the next ten years a growth to 50 million regions, 2 billion users and 50 million concurrencies. As a first step, scalability was addressed by the subdivision of the metaverse into fix sized regions, of 256x256 m, each being emulated by a simulator running on one CPU core. At this moment, the simulator handles everything that happens in the region, avatar agents included. Because there's a limit in what a processor can handle, Linden Lab is considering as a next step be a separation between agents and regions into two separate domains: the agent domain and the region domain. The agent domain knows everything about an agent: name, profile, inventory etc. This halves the load of the CPU. The agent domain consists of some web services which allows to login, to retrieve inventory etc. The region domain consists of a number of simulators and knows everything about regions: their name, location, and what's on them. The viewer needs to connect to both domains to first login the agent and then connect to the region.

Standards: There's no standard yet for VW; you cannot host your own simulator connected to a different main region grid (than the one you belong to and which "recognises your avatar: its identity, inventory, and payment info.

The solution is obviously an open standard for VW, an open architecture allowing the development of 3D Web, grid architecture similar to the web where everybody can connect their own server.

Interoperability: The metaphor used in 2D Web is that of services [3], while the one used in VW is that of agents. The two domains use different directory services, different transport services and different languages (syntax and semantics). Web services aim is to enable dynamic service discovery, composition, invocation, execution and monitoring. Software agents – on the other hand – are designed as autonomous, proactive entities. Software agents have been envisioned as potential user of semantic Web services in order to interact with semantic descriptions of SWS to autonomously discover, select, compose, invoke and execute the services based on user requirements [4]. The communication gap between the two worlds resides in the fact that software agents are not compatible with widely accepted standards of Web services. Research is conducted [4] to make multi agent systems compatible with existing Web services standards without changing the existing specifications and implementations.

At the moment, with no interoperability between software agents and semantic Web services, most of VOs operate either in 2D Web basing their

processes on Web services or completely in-world. Further research and standardisation is needed on the Agent-Web gateway, to enable interoperability between 2D and the future 3D Web.

4. Virtual organizations in virtual worlds

Open ended virtual worlds are platforms for three key functions: social interactions, business, and entertainment. Social interactions and entertainment are the most visible. In SL for instance, there are16 million users, almost 50000 concurrent users at any given moment, millions of dollars businesses, hundreds of universities, virtual embassies, thousands of companies. An entire economy exists, facilitated by intellectual property and virtual world banks.

Social events participation is limited only by the simulators concurrency limit. They are so successful because they are face to face (F2F), voice enabled events, with interactive sharing, allowing an almost real life interaction.

The most visible reasons for businesses for establishing a presence in VW are:

- to extend their brand into a virtual world (information centres, training, interactive demonstrations, virtual 3D stores, collecting data on shopping experience, customer feedback, free market research)
- to brand engagement (e.g. witness the construction of your own laptop or desktop computer while you interact and select components)
- to engage in virtual worlds specific new businesses (e.g. terra-forming, building, creation and scripting)

The real huge advantage for virtual organizations is face to face, voice enabled real time communication.

We can distinguish between virtual organizations which processes are based entirely on the interoperability provided by the virtual world platform and virtual organization whose processes span over both virtual world and digital world.

4.1. **Virtual data centre.**

IBM had built a 3D data centre application in an effort to leverage VW capabilities to RL business processes, thus gaining a competitive edge. RW data centres (serviced by IBM) are connected to a VW data centre which mirrors the real environment. The virtual world platforms that render the 3-D environment is based on the OpenSim Application Platform for 3D Virtual Worlds. The VW data center comprises of models of RW equipment and facilities such as servers, racks, network equipment, and power and cooling equipment. The VW models receive data from live RW enterprise management systems (IBM Director, Enterprise Workload Manager, Tivoli Omegamon, and MQ Series). Live RW information is aggregated (using VW SDK) and presented in 3D. Functions like power control and virtual machine migration can be performed completely in world, managers being able to respond quickly to alerts and events on demand. The 3D data center allows an

intuitive visual inspection of how the real data centre is performing. Specific VW effects (sounds, particle effects) are used to visualize if there are network or server issues allowing event location in a timely manner [5]. Multiple users collaborate in-world, explore the operations in 3D in near real time, take part in the analysis and the decision making process. The Intraverse solution (privately hosted VW) was adopted for security reasons. Interoperability between RW and VW is provided by a proprietary virtual world middleware, named Holographic Enterprise Interface (HEI).

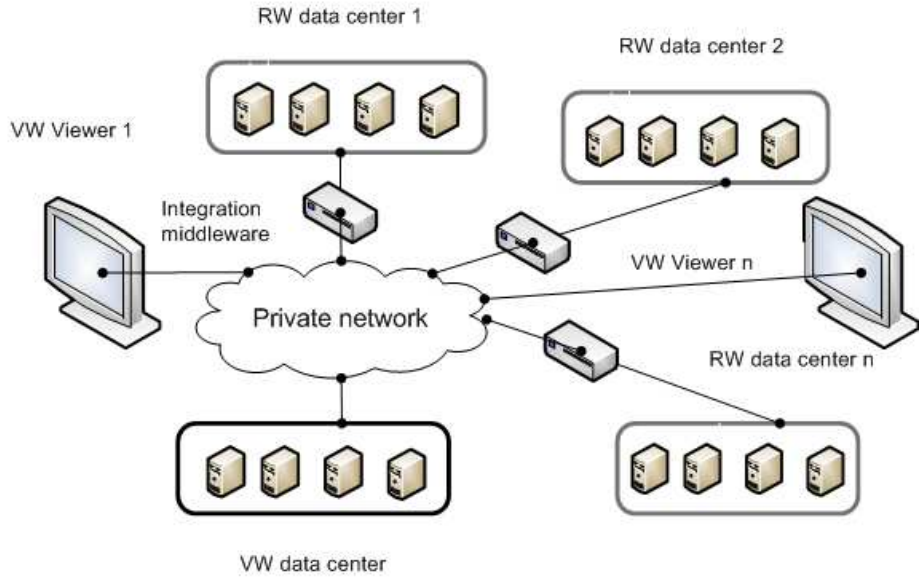

FIGURE 5. Intraverse 3D data centre architecture

IBM has more than 5,000 employees using VW for purposes such as sales training or collaborating across different geographic regions, showcase for different offerings, meetings with clients in current projects (virtual conferences), sales meetings, presenting concepts in a manner not attainable in RW or 2D Web (e.g. manipulation of 3D models).

5. COMMENTS, PRELIMINARY CONCLUSIONS AND FURTHER RESEARCH

To the above mentioned issues (3.2), we can add some more, like the limited access to VW (residents have a single access point, the PC, cross-platform online access from the large range of converged consumer electronics

devices is still in the research phase. Yet, despite all these challenges, for many VW communities (e.g. SL) a certain kind of virtual economy has evolved.

Gartner [6] has opined that, by 2011, 80 percent Fortune 500 companies will have some kind of virtual world presence meaning that major transformation into how the organizations will interact in the near future will occur in the near future. It seems that at least for a good time from now on, the 3D platform will be completing the current web platform, rather than replacing it.

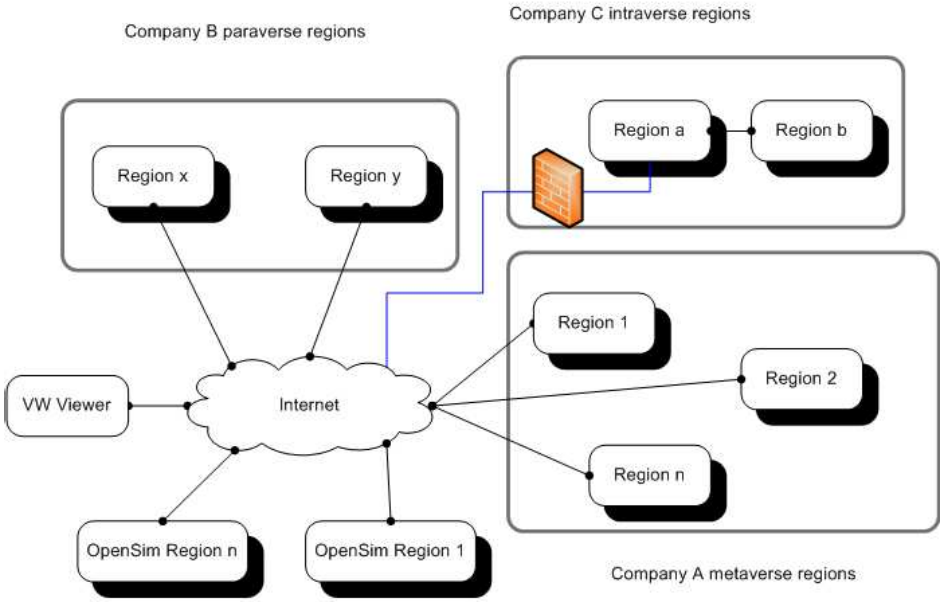

FIGURE 6. 3D Web topology

3D Web topology will look probably like the one depicted in Figure 6, with the enterprise-class virtual worlds running behind firewalls.

For such a topology to exist, a number of issues must be addressed:

- New trustful, open architecture enabling viewers to handle assets and inventory services
- Standard libraries used in communication with the viewer
- Portable identities (the same AV can travel in different virtual worlds); probably associated with an AV certification system (maybe through vendors of trusted agents)
- Standard interfaces between worlds

- O standardized software stack that will be portable outside and beyond VW
- Open standards for the representation of information
- Business level quality of in-world services (security, performance, reliability, stability, availability)
- API and SDK for developing custom business applications in-world
- A new way to address intellectual property, presently handled through permissions

Permissions represent a crude way to enforce licenses and can't anticipate all possible licensing scenarios. For instance, SL provides about everything needed to copy about anything in-world, excepting scripts. So, in an open 3D Web, if we attach permission to an object, that object permission could get ignored in some regions.

Virtual Worlds Web Integration is a growing research field which might lead to intertwining between the two despite the huge difference between the metaphors they are built on: agents vs. services. A detailed discussion of the research status in this area is behind the scope of this paper. But we can only imagine the impact it will have on the web as we know it: web pages empowered with immersive, presence-based features.

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