

Technical Challenges of the Metaverse

Anthony Steed

Department of Computer Science
University College London

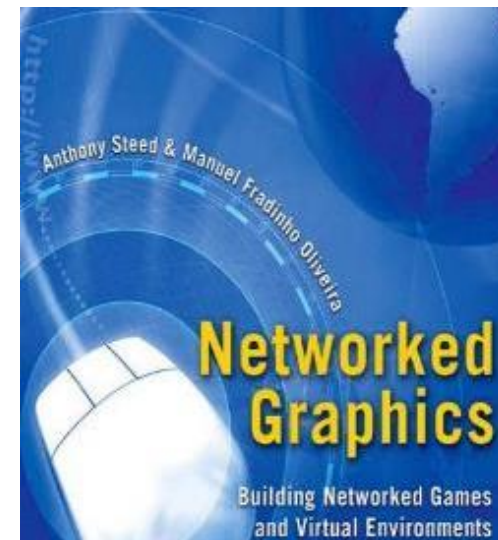


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Precedents

- MUDs & MOOs
- SIMNET
- Habitat
- Alphaworld
- Meridian 59, Ultima Online
- Doom, Quake
- Blaxxun (VRML)
- SecondLife
- Grand Theft Auto Online
- Fortnite



High Level Features



- **Awareness**

- Primary awareness: real-time social VR
- Secondary awareness: access as a group to a large space
- Tertiary awareness: access to a “universe” of people and places

- Diverse interactive and editing capabilities

- Publishing and persistence

- Access, governance and ownership

More Metaversey



Ideals



- Open, completely flexible platform supported by hundreds of groups
- Supporting academic research, teaching
- Compliant with security standards, auditable
- Supporting all the types of application we want to build

.... a long way off

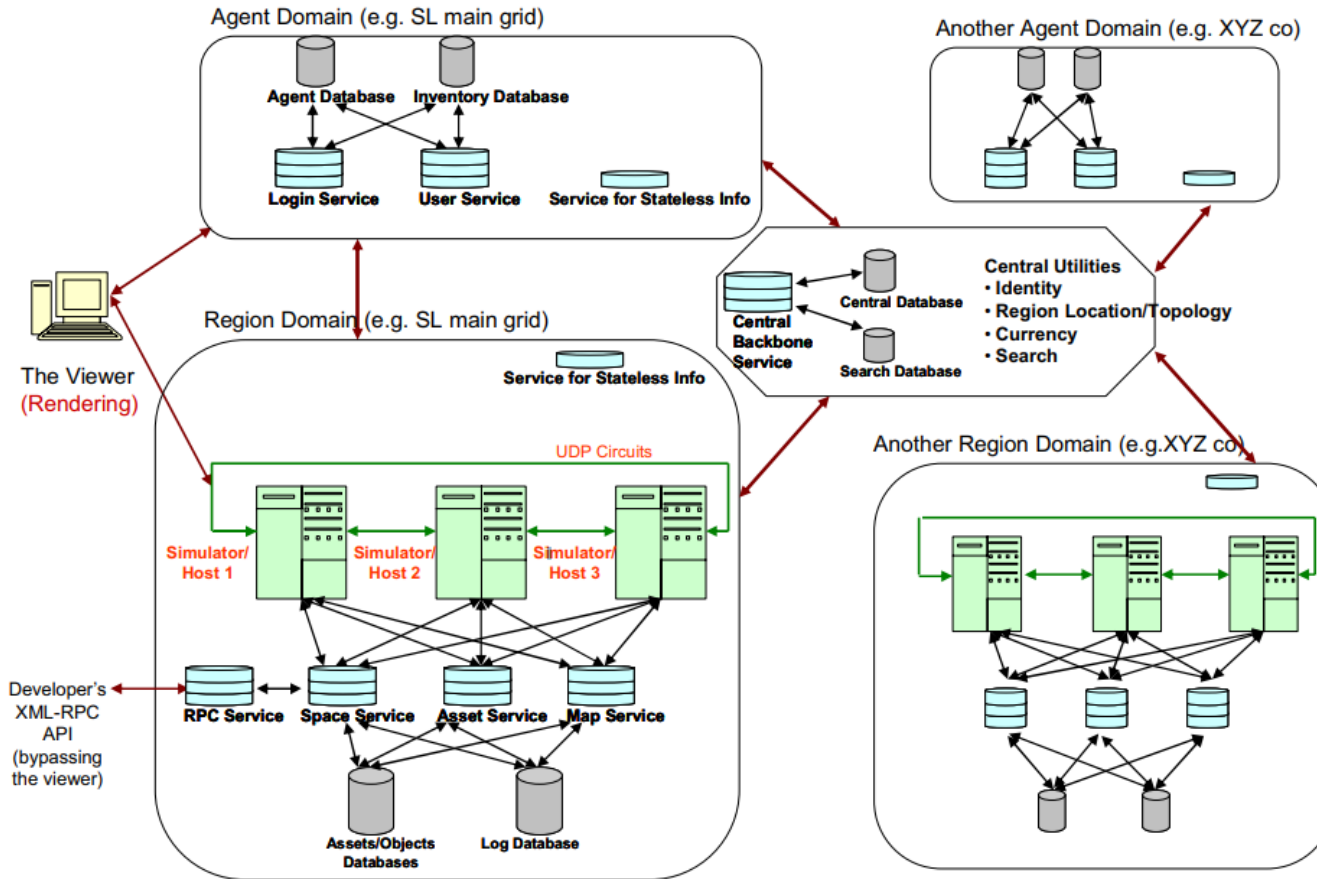


Challenges & Overview

1. Software architecture
2. Internet
3. Current Status
4. What Next?



1. The Software Architecture



S. Makineni, et al. "Evaluating implications of Virtual Worlds on server architecture using Second Life," doi: 10.1109/HIPC.2009.5433182.

Analysis Domain Model for Shared Virtual Environments



Manuel Oliveira¹, Joel Jordan¹, Joao Pereira², Joaquim Jorge² and Anthony Steed¹

¹VE and CG Group, University College London, UK

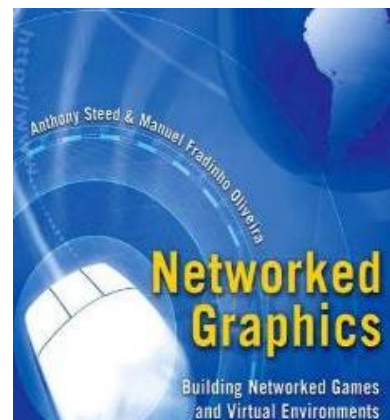
²Department of Computer Science and Engineering, IST, Portugal

Abstract—The field of shared virtual environments, which also encompasses online games and social 3D environments, has a system landscape consisting of multiple solutions that share great functional overlap. However, there is little system interoperability between the different solutions. A shared virtual environment has an associated problem domain that is highly complex raising difficult challenges to the development process, starting with the architectural design of the underlying system. This paper has two main contributions. The first contribution is a broad domain analysis of shared virtual environments, which enables developers to have a better understanding of the whole rather than the part(s). The second contribution is a reference domain model for discussing and describing solutions - the Analysis Domain Model.

Index Terms—Analysis Domain Model, Virtual Environments.

matures, there is an absence of a common VE platform and code interoperability between different systems continues to be a challenging research issue. An imposing barrier to surpass is the complex problem domain associated with VEs, with system requirements that in some cases have contradictory constraints and very few practitioners have the integrated perspective of the many facets of the problem domain.

There have been attempts to establish a standard aimed at VE system interoperability as in the case of High Level Architecture (HLA) [124]. However, as pointed by [14], the steep learning curve coupled with overly complex architecture with performance constraints and semantic interoperability problems, has limited the adoption of HLA to military simulations. The web3d consortium took also the *de jure* approach to promote interoperability of 3D content by means of eXtensible 3D (X3D) [290] but the gaming industry has lent



Key Lessons / Requirements



- No one architecture fits all
- It is a long way to an open architecture for all the services
- Most “Metaverse” companies are attempting to control some piece of the system
 - Naming
 - Location
 - Item brokerage
 - Governance
- If they build “it” then publishers and users will *need* to use their software



2. The Internet



Why Metaverses Will Be Technically Unique



- Real-time graphics applications are not “standard” network applications
- Unlike video/audio streaming, or web browsing, networking is NOT the main client-side activity
- Some information changes very quickly and smoothly (player locations)
- Some changes are important (score, kills), some are not (a single position update)
- AI services will have profound impact, but require resources (on client, on edge, in cloud)



Key Lessons / Requirements



- Internet is built to move bulk traffic, but not for end to end speed
- You can't reserve bandwidth (some exceptions)
- Latency and bandwidth will vary
- Streaming for audio and video will buffer significantly and loss is not so important
- **The Internet wasn't built to deliver synchronous experiences**



3. Current State



Every Platform is Different

- What buttons do what?
- How do I find people?
- How do I message people?
- Can I have a private conversation?
- Can we jointly manipulate objects?







Social Virtual Reality Platform Comparison and Evaluation Using a Guided Group Walkthrough Method

Qiaoxi Liu¹ and Anthony Steed^{2*}

¹UCL Interaction Centre, University College London, London, United Kingdom, ²Department of Computer Science, University College London, London, United Kingdom

As virtual reality (VR) headsets become more commercially accessible, a range of social platforms have been developed that exploit the immersive nature of these systems. There is a growing interest in using these platforms in social and work contexts, but relatively little work into examining the usability choices that have been made. We developed a usability inspection method based on cognitive walkthrough that we call *guided group walkthrough*. Guided group walkthrough is applied to existing social VR platforms by having a guide walk the participants through a series of abstract social tasks that are common across the platforms. Using this method we compared six social VR platforms for the Oculus Quest. After constructing an appropriate task hierarchy and walkthrough question structure for social VR, we ran several groups of participants through the walkthrough process. We uncover usability challenges that are common across the platforms, identify specific design considerations and comment on the utility of the walkthrough method in this situation.

Keywords: collaborative virtual environment, cognitive walkthrough, usability inspection methods, consumer virtual reality, social virtual reality

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- Compared six platforms: Rec Room, AltSpace, VRChat, Big Screen, Spatial, Mozilla Hubs
- Pairs and groups doing joint tasks

Reveals Usability Issues



- In (Mozilla) Hubs
 - Active user not apparent
- Every platform has usability problem
- Some problems seem to be common
 - e.g. Group rendezvous

Key Lessons / Requirements



- Platforms vary a lot, none has the design “right”
- Very open area for novel design, once you have a working system
- Simple problems, such as privacy bubbles still not solved
- General problem of bridging between secondary and tertiary awareness



4. Where to Work Now



Open Problems



- What avatars? What interaction styles?
- What system, avatar and place features support trust formation?
- How to make these systems more accessible?
- How will secure systems be built? What is the attack surface for the metaverse?
How do we build a multi-code browser?
- How do we make animation and interaction reusable?
- What will “publishing” mean in large scale systems?
- What network protocols need to be developed?



Routes to Exploration

- Can work with commercial platforms
 - Hard to make the exact scenario you want
 - Risk of (fast) code rot
 - Risk to services
 - Privacy concerns
- WebXR can provide some necessary features
 - Currently difficult to extend
 - Relatively limited architectural choices
- Hence Ubiq
 - UCL's extensive social XR platform
 - <http://ubiq.online>



To Discuss



- Is the metaverse just enabled by a smarter web browser?
 - The model has its limitations, especially around multi-hosting and publishing
- Will a game engine win?
 - This is probably the wrong level of abstraction: is there a lower level engine?
- Will a new publishing engine win?
 - Unlikely and only if it is trivial to build content from
- Perhaps we think of the problem in the wrong way ...
 - Why is any “XR” app inherently single user?
 - Can we view multiple apps? (c.f. “Pokemon Go” problem)
 - Somewhat similar to the window manager problem



Conclusion



- Metaverses are formed of a large number of services that will have very different service-level agreement
- The Internet isn't really architected to support metaverses
- There are many, many research questions to address before a “standard” platform emerges
- Open source may help

