

Solipsis: A decentralized Architecture for Virtual Environments

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Overview

1. Introduction
2. Background and Requirements for online VEs
3. Decentralized Virtual World Management
4. Navigator
5. Conclusions

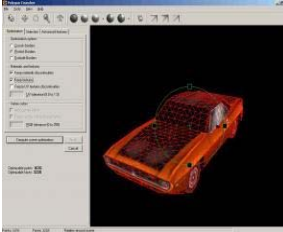



« Hiro is
approaching the
Street. It is the
Broadway, the
Champs Elysees of
the Metaverse. It
does not really exist.
But right now,
millions of people
are walking up and
down it »

***Neal Stephenson,
Snow Crash [p24]***

1

Introduction

What is the Metaverse? (1/4)

stand-alone	<ul style="list-style-type: none">■ Data / Content A single virtual object display of a single 3D object, 2D websites, or any multimedia contents	
Centralized - Server(s)	<ul style="list-style-type: none">■ MetaWorld (aka Virtual world) Perceived as single location space (world) Either single user or massive multi-user Example: Second Life, There, WOW	
Group of Servers	<ul style="list-style-type: none">■ MetaGalaxy A group of MetaWorlds More than likely massive multiuser Interconnected (not stand-alone) Example: Active Worlds	
Decentralized - World scale infrastructure	<ul style="list-style-type: none">■ Metaverse Multiple MetaGalaxy systems Linked within a perceived Virtual Universe, Although not existing on a central server	

What is the Metaverse? (2/4)

- Similar designation

« VERSE » Virtual Earth Realtime Simulation Environment

Internet = network of networks
inter**verse** = network of VERSEs

PR5

- ... or simply call it **Web 3.0**

- Warning:



the hype term 'Web 3D' is far too limited to embrace the whole notion

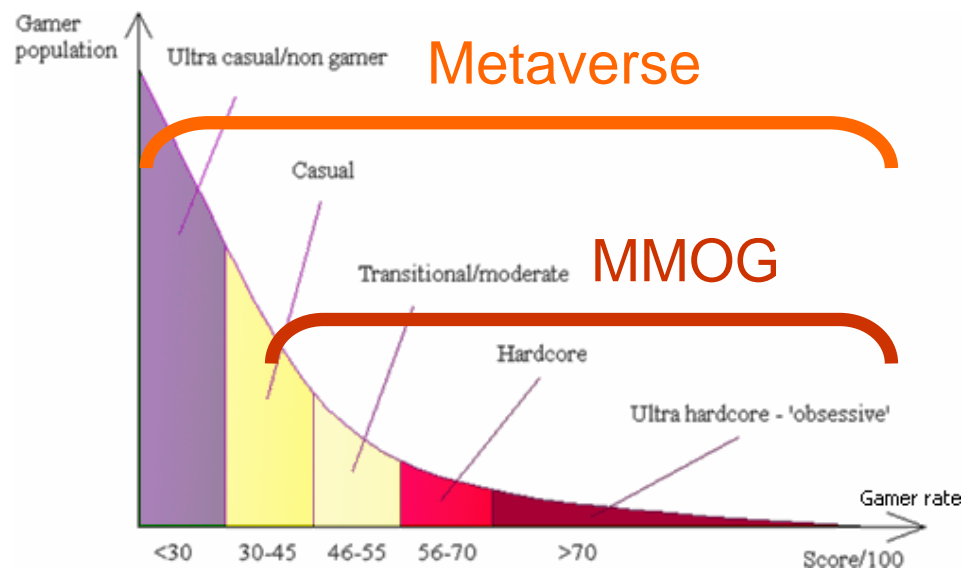
PR5

The name "VERSE" or Virtual Earth Realtime Simulation Environment was first coined by Peter Finn at IBM in 2006 during the establishment of the Virtual Universe Community. Source : Wikipedia.

PIEGAY Romain; 20.02.2007

What is the Metaverse? (3/4)

- It is NOT an MMOG [massively multiplayer online game]
- Because:
 - Tremendously bigger
 - No pre-existing contents nor a scenario to respect (UGC)
 - Maybe as many different business models as inner virtual worlds
 - For everyone, especially no gamer, and not hardcore gamers only



What is the Metaverse? (4/4)

■ In a word

- A world scale infrastructure
- Vast amount of **virtual worlds** linked together
- Accessible via a single common user interface (browser)
- Not marking a break with the actual flat 2D web: but a smooth transition towards an immersive Internet making the most of both 2D and 3D



Snow Crash, Neal Stephenson © 1993 Bantam Books

■ We need three things to reach this cyberpunk authors' dream, also known as *Cyberspace* :

- A way to sustain the incredible amount of data and MIPS involved
- A set of protocols to provide interoperability PR2
- Tools to build virtual worlds as easily as a traditional HTML page

PR2

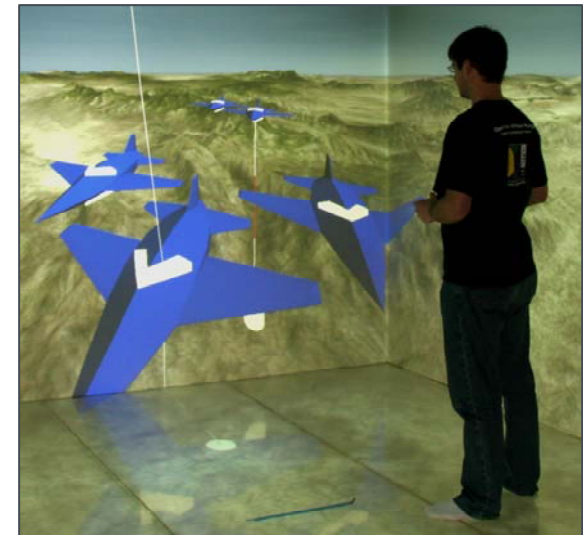
MIPS : The number of MIPS (million instructions per second) is a general measure of computing performance and, by implication, the amount of work a larger computer can do. For large servers or mainframes, MIPS is a way to measure the cost of computing: the more MIPS delivered for the money, the better the value. Historically, the cost of computing measured in the number of MIPS has been reduced by half on an annual basis for a number of years.

Source: WhatIs.com

PIEGAY Romain; 19.10.2007

After all, what is a virtual world?

- Strictly speaking: a simulation of space
- Originally used by virtual reality experts
- A simulation of **persistent** space **connected** via a network, in which users can interact with each others and are embodied by virtual **projections of themselves**
- We abusively take it as axiomatic that all virtual worlds are:
 - Persistent to some degree
 - Massively shared
 - Avatar-based



Virtual world diversity

- We can classify VW according to thirteen main characteristics:

- Targeted purpose
- Real life simulation, fiction or both
- Scenario-driven or UGC
- Business model(s)

Intended purpose

- 3D, 2.5D, 2D or textual
- Mobility
- Integration into the 2D Web
- In-world 2D Web integration

Technical distinctions

- Degree of Persistency
- With or without instances
- Control and moderation
- Generic and openness
- Scalability

Design distinctions

1) Targeted purpose

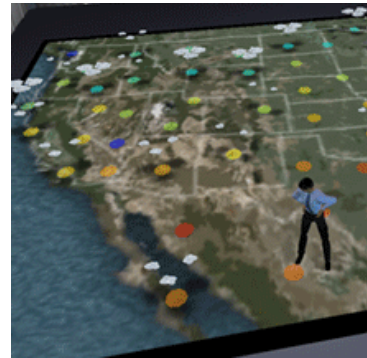
Entertainment

Business application



Games (MMOG MMORPG)

*Starwars
galaxies, World
of Warcraft, City
of Heroes, the
Sims Online...*



Serious games, Education or Training

*Astroversity,
NOAA Weather
Reporting in SL,
...*



Social spaces

*The Palace,
imVu, Club
Penguin, vSide...*



Branded worlds and virtual market places

*MTV's VW (There),
Pepsiworld,
MyCoke,
BarbieGirls...*

2) Real life simulation, fiction or both

Real life experiences

Fictional environments



Geographical Information Systems (GIS)

Google Earth, Microsoft Virtual Earth, Ville en 3D...



Simulation for training purposes

SNCF SOFI and FIACRE, VRS HAPSAT...



Fiction in real life contexts

Le deuxième Monde, Second Life, Red Light Center, Habbo Hotel...

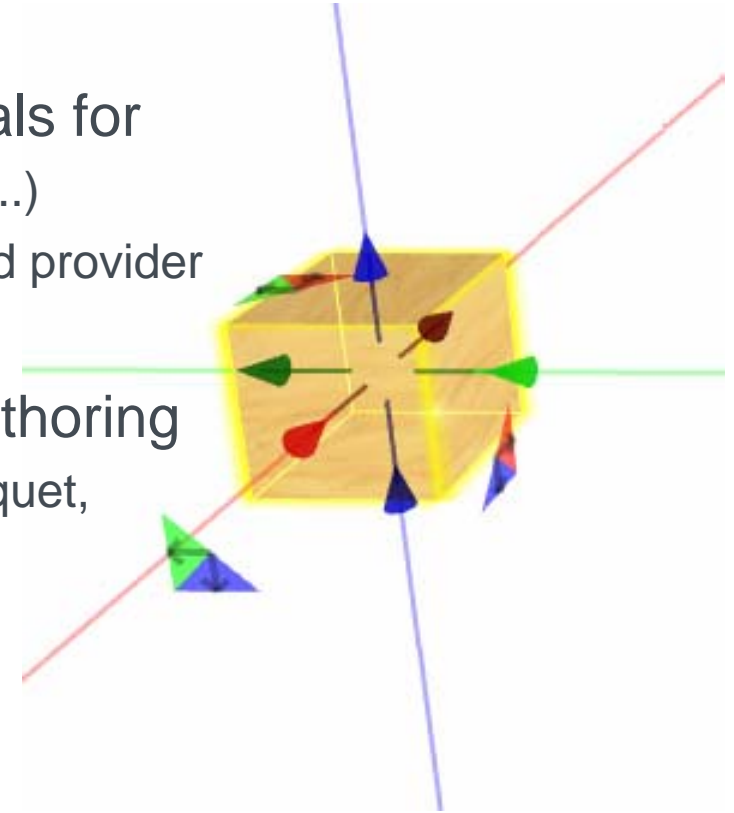


Fantasy to pure fiction

Lord of the Rings Online, Fishing Champ, EVE Online...

3) Scenario-driven or user generated content (UGC)

- Scenario-driven worlds have clear goals for users to achieve (to reach level 70 in Wow..)
 - so world contents are provided by the world provider according to these goals
- UGC worlds provide the users with authoring tools to create their own contents (Croquet, VastPark, Second Life, Metaplace..)
- Intellectual property on UGC contents
 - can be made over to users (Second Life)
 - Or remains to the provider (There)
- Tendency
 - According to the Web 2.0 new usages, more & more systems are UGC
 - Raph Koster: « *user participation is a natural evolution as costs rise* »



4) Business model(s)

■ Major models overview

- Retail sale (initial package)
- Subscription fees
 - Pay to access
 - Pay for premium account
- Microtransaction / item selling
- Ad-funded
- Media franchise
- Revenue-sharing

■ Tendency

- Subscription-based models are progressively disappearing

5) Full 3D, 2.5D, 2D or textual

Visual immersion / long learning process



Text-based
Yes, MUD (Multi-User Dungeon/Domain) are virtual worlds!



2D
Lucasfilm's Habitat, Fake Town, VZones, Gaia Online, Club Penguin...



2.5D / isometric
Meridian 59, Habbo Hotel, CyWorld...



Full 3D
So many examples from AlphaWorld to Second Life...

6) Mobility

Desktop applications

Ubiquitous systems



Personal computers or video games consoles only

96% of the virtual world market



Few interactions with the world are possible via mobile (API)

Mankind...



Function-limited dedicated client for mobile

Sony's Home on PSP & Sony Ericson mobile...

PR7

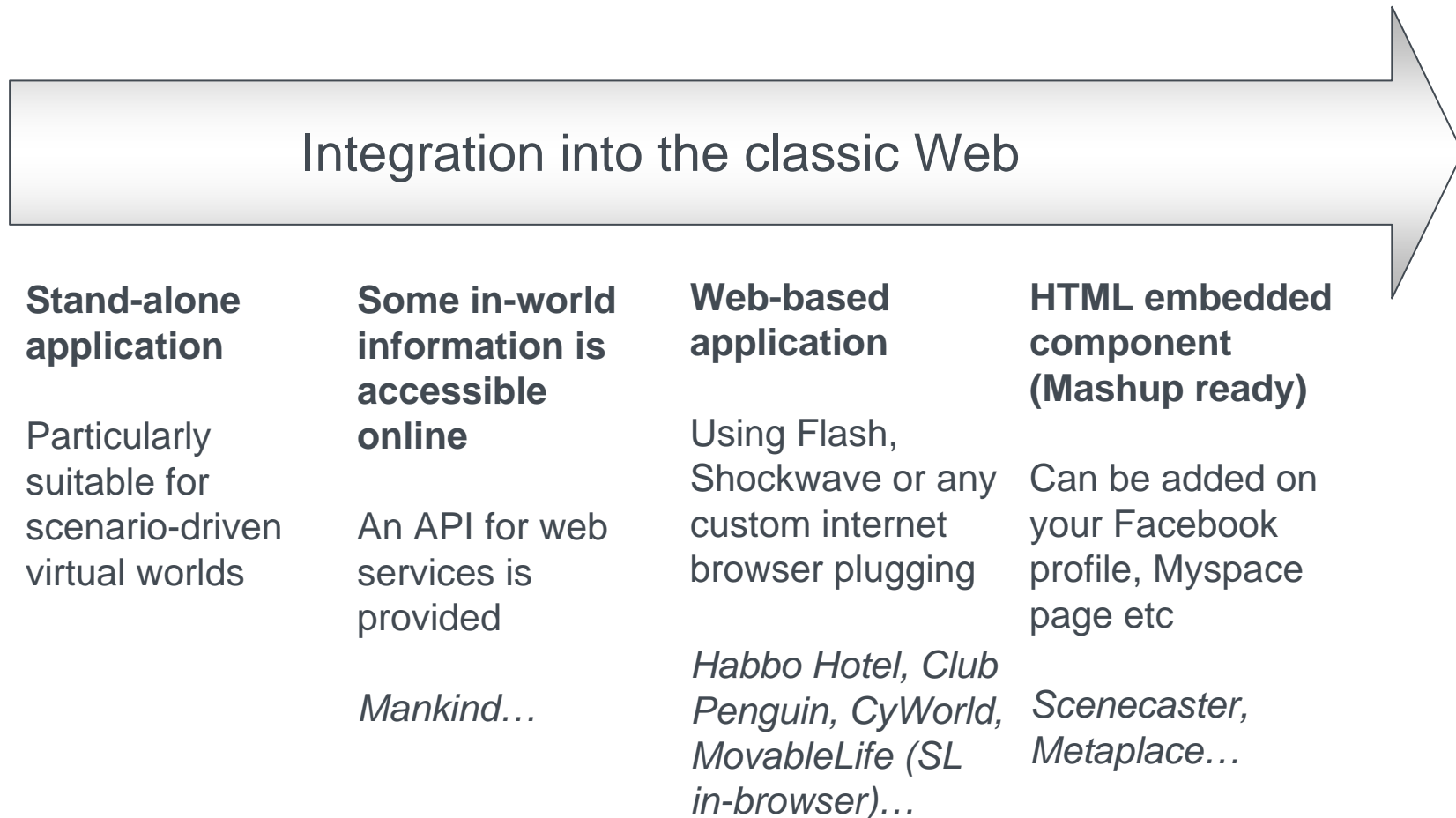
Workshop MMVE



Iso-functionality on mobile devices

Sulake's Mini Friday (Habbo Hotel mobile), SNCF's Pocket PC Treenor...

7) Integration into the 2D Web



- These categories are not mutually exclusive PR8

PR8

Viewing inDuality: IBM-backed startup debuts fully-functional Web-based Second Life viewer :
<http://nwn.blogs.com/nwn/2007/10/viewing-induali.html>

PIEGAY Romain; 29.10.2007

8) In-world 2D Web integration



- Is it possible to use 2D classic web as an interactive texture?
- Tendency
 - Very old idea but it starts to work for real..

9) Degree of persistency

- Persistency is the system ability to save virtual elements durably

Degree of persistency



Places only
Ex: The Palace

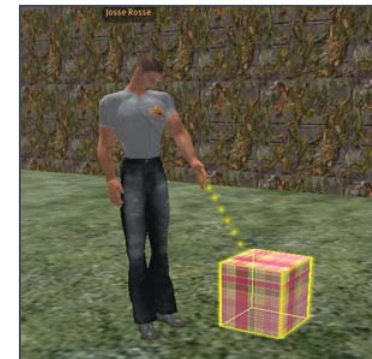


Places + avatars characteristics

Ex: AlphaWorlds



**Places + avatars
+ some objects**
Ex: EverQuest



**Whole world's state
saved in real time**
Most of actual VW

10) With or without instances

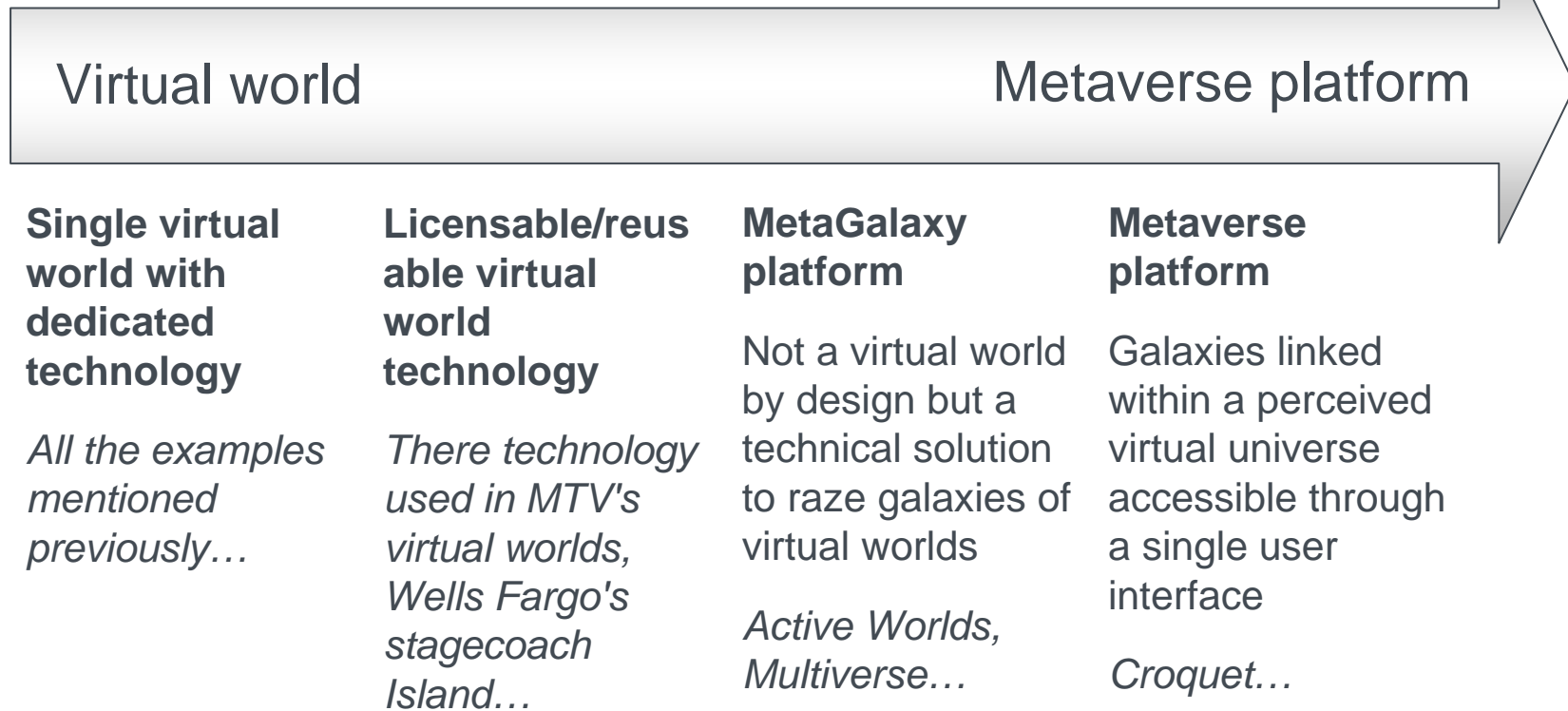
- Instance: a technique duplicating a special area of the world for each person or group that enters it
- Typically used in MMORPGs [instance dungeon]
 - to reduce unhelpful competition in game, preserve the gaming experience and save server work
- Also appropriate for virtual chat rooms
 - to ensure privacy
- Famous examples
 - with instances: World of Warcraft
 - without any: Eve Online

11) Control and moderation

- In UGC worlds providers can choose to:
 - Impose an a priori control on user generated content (ex: There)
 - Impose an a posteriori control (ex: HiPiHi)
 - Let users create freely anything according to a *Terms of Service*
 - Ex: Second Life Terms of Service: tolerance, non-harassment, non-assault, disclosure, decency and peace
- Different levels of moderation
 - Moderation by users themselves
 - Moderation by super users
 - Moderation handled by the provider's team
 - 'Automatic' moderation (ex: club penguin)

12) Generic and openness

- The virtual world's technology could be designed for a single use, or made generic to handle multiple universes



- Openness: platforms could be made available under a free license (Croquet) or not (VastPark)

13) Scalability

- The capacity to sustain a large number of users and/or contents with the guarantee of satisfying QoS
- **This is the key for a UGC virtual world platform to become theoretically a *Metaverse platform***
- Decentralized systems, despite some weaknesses, are well known to allow a high degree of scalability

Client/server approach

Centralized vs decentralized

■ Strengths

- [deceptive?] algorithmic simplicity
- Light client application (< 70Mo for Second Life)
- Unilateral control over the world (Rules set by provider)

■ Weaknesses

- Scalability (Second Life: 7,000 servers, one for 40 active users!)
- Latency (SL: everything is calculated on servers, even basic physics)
- Specific routing services required (SL: Internap, not the usual Internet)
- Vulnerability to attacks
- Strong responsibility for contents (Familles de France sues SL & ISP)
- Not environment-friendly (SL: Avatars consume as much electricity as Brazilians : 1.752 kWh/year for one SL avatar compare to 1.884 kWh)

Decentralized approach (P2P)

Centralized vs decentralized

■ Strengths

- Scalability: peers provide resources (CPUs, storage capacity...)
- Can potentially sustain the incredible amount of Metaverse data
- No marginal cost, production costs only
- A self-organizing unstoppable software (Medusa head)
- Distributed responsibilities
- Censorship-resistant systems
- Promotion of high bandwidth access offers
- And even more environment-friendly!

■ Weaknesses

- Persistency: needs critical mass
- Security: Peer-to-Peer architectures are more complex to protect
- Still needs a bit of R&D work

« A Metaworld is nothing more than an advanced, collaborative, realtime 3D website - the **Metaverse** can be everything you see on the Internet today, in a wholly new and remarkable form of media »

William Burns

2

Background and Requirements for online VEs

Existing modes of 3D transmission

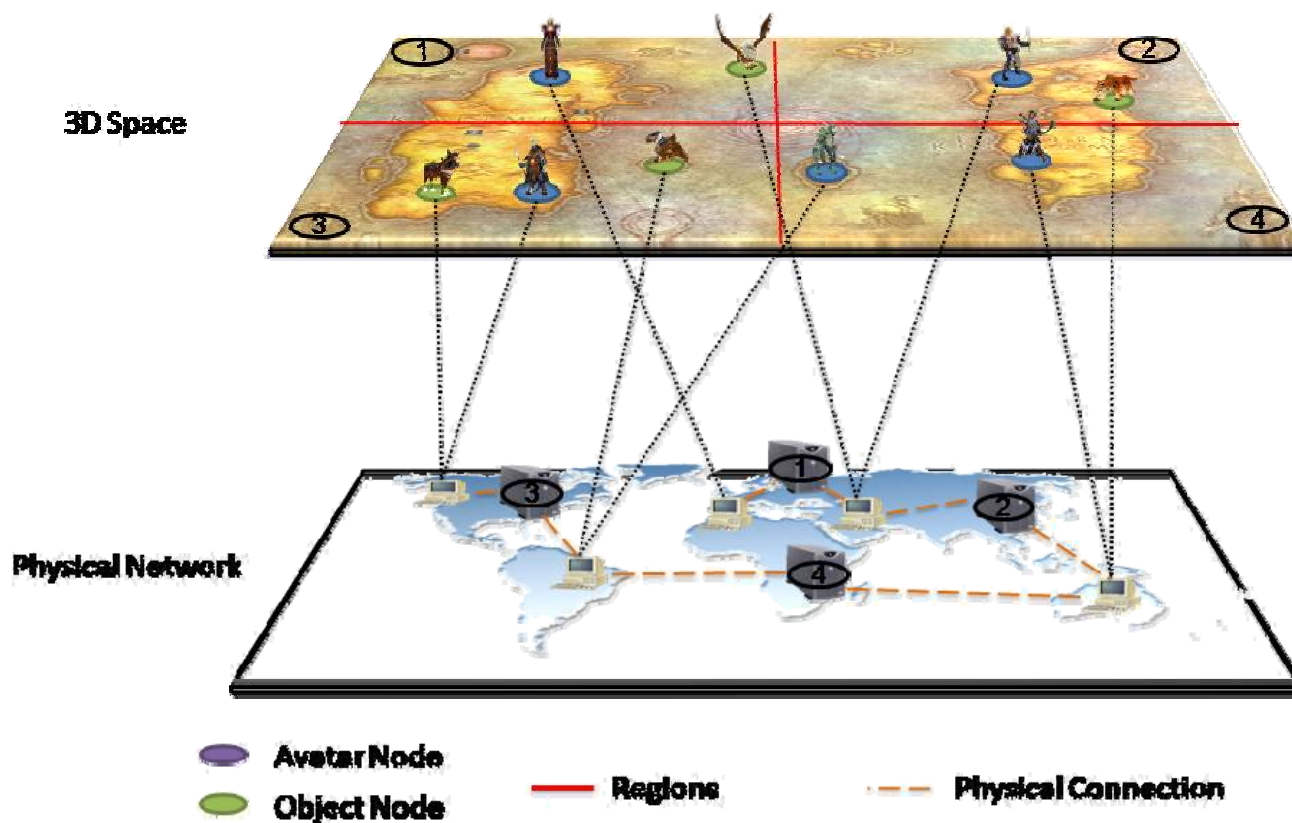
- Install from a dvd and play
 - User Generated Contents is not possible
 - Scene updates need patches
- Download and play
 - Long delay before navigation
 - Scene updates not so easy
- Stream and play
 - Progressive download
 - UGC is possible
- Adaptive Streaming and play
 - Adapt resolution of content according to the viewpoint
 - Generally used for textures, terrain geometry and ... that's all !!!

Existing 3D representation

- Parametric or procedural
 - Compact representation
 - Specific to a type of data (avatars, vehicles, buildings)
 - Really intuitive for the general public
- Prims based
 - Relatively compact
 - Well-suited for UGC, limited features for computer graphics designers
- Mesh based
 - Required compression algorithms for transmission
 - Authoring tools not so intuitive for the general public
 - restricted to computer graphics designers
 - More realism

Existing network architectures (1/2)

- Generally based on region servers for huge environments



Existing network architectures (2/2)

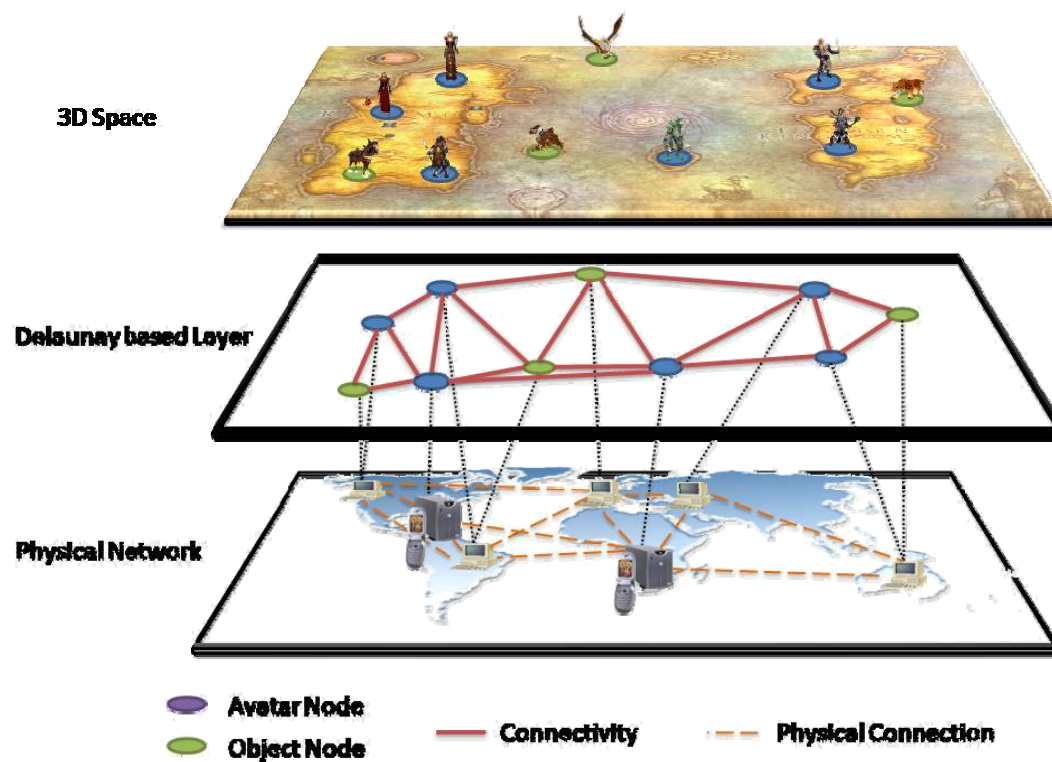
- Region servers execute heavy processes for synchronization:
 - Collision Detection
 - Physics animations
 - Anticipation
 - Etc
- Region servers are the only source to download scene models:
 - Require a important upload Bandwith
- Servers are overloaded, audience is limited (50-70 clients on SL)
- No scalability for a Huge Web 3D (10 millions servers required ?)

P2P Architecture for full scalability (1/3)

- Two close viewpoints require nearly the same data for visualization
- Peers are connected according to their proximity in the 3D space

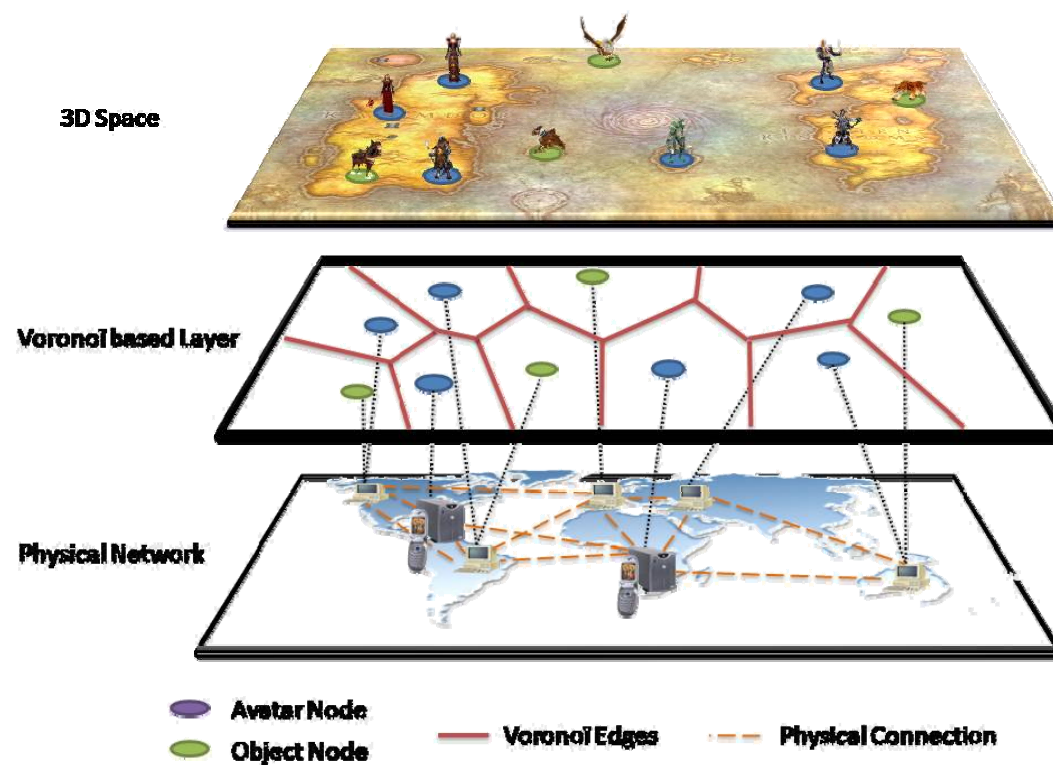
P2P Architecture for full scalability (2/3)

- Delaunay Based Layer [J. Keller, G. Simon, 2003]



P2P Architecture for full scalability (3/3)

- Voronoï Based Layer [J.-Y. Hu, G.-M. Liao, 2004]



Requirements for next generation of online virtual environments

- A P2P Architecture
 - Scalability to Scale up next Web3D or metavers
- Accept any kind of 3D representations
 - For UGC and realistic contents
- Adaptive streaming of compressed 3D models
 - To reduce the required upload bandwidth and download delays
- VE integrated to Web, Web integrated to VE
 - Web 2.0 and Web 3D are complementary
- Metaverse should not belong to any organizations and users
 - GNU/GPL v2+

« interesting virtual
worlds are ultimately
going to be **so huge** that
they couldn't possibly
take the centralized
approach »

Linden Lab CEO

3

Decentralized Virtual World Management

Definitions

- Metaverse = set of entities
 - **Avatars** (representing the user, attached to a viewpoint)
 - **Objects** (can be moveable, interactive, picked up by an avatar, etc)
 - **Sites** (represent portion of the Metaverse occupied by avatars and objects)
- A content can be associated to entities (3D, video, text, etc)
- Descriptors are associated to entities (representing its state)
 - Position, speed, etc
 - Users information for avatars
 - Key frame for animated objects or videos
 - Perceptible area to filter visualized content (spheres, BSP, PVS, etc)
 - Selection areas for Level of details (continuous or not)
 - etc

Descriptors

■ Example of a simple descriptor

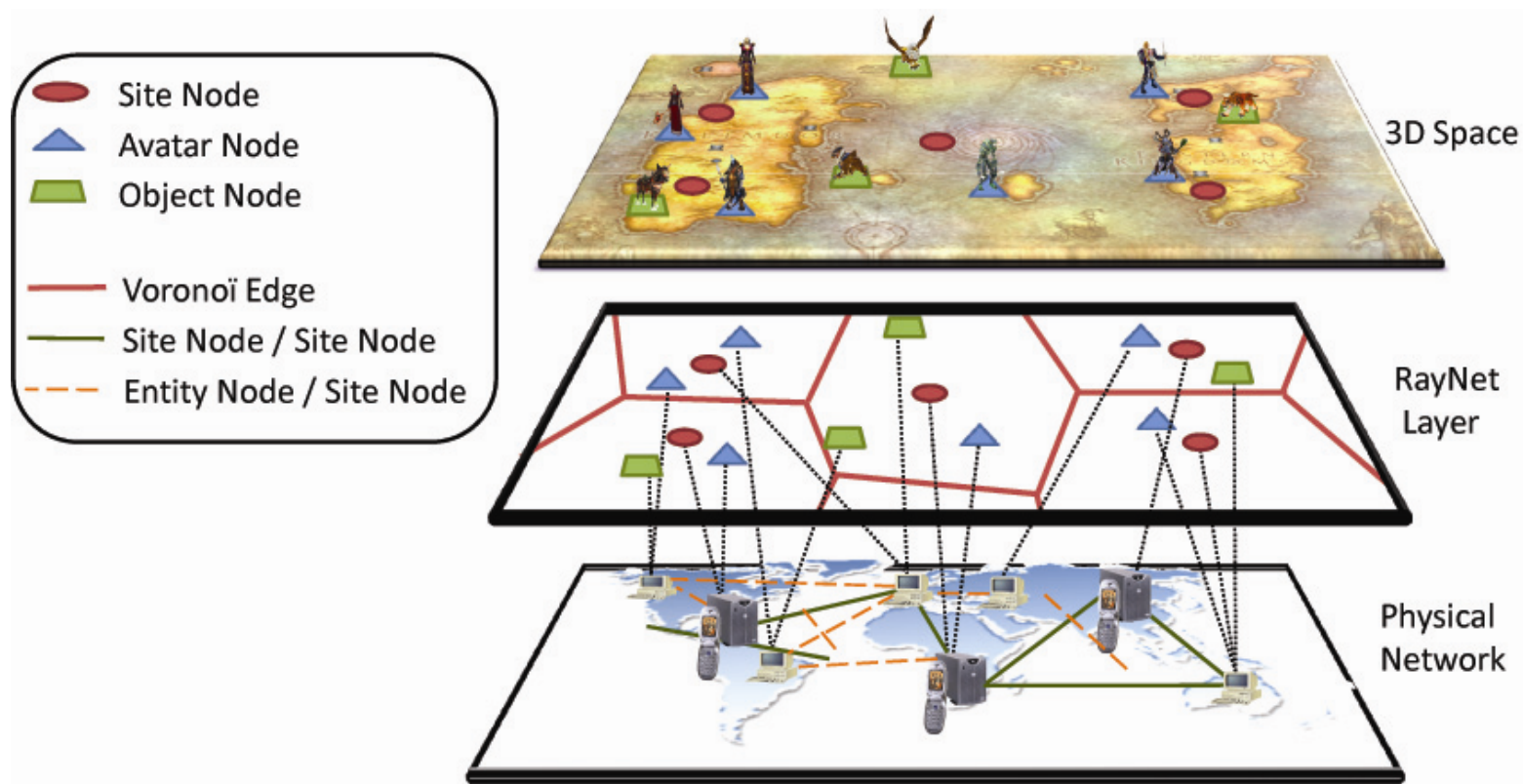
UID	universal identifier of the entity
seqNum	sequence number
owner	identifier of the node managing the entity
type	site, avatar or object
loc	location in the 3D space
ori	orientation in the 3D space
shape	shape from a predefined set
box	bounding box of the object
R_p	perceptibility radius: distance from which the object is visible in the absence of obstacles
R_b	radius of smallest sphere enclosing the entity
objs _a	list of entities attached to the current one
f_1	first file of 3d-description
v_1	version number for first file
c_1	list of hosts that have cached v_1 of f_1
...	...
f_n	n-th file of 3d-description
v_n	version number for n-th file
c_n	list of hosts that have cached v_n of f_n
...	additional fields for progressive levels of details

P2P Architecture (1/2)

- RayNet Overlay
 - Multi-dimensional space overlay
 - Based on an approximation of the Voronoï tessellation
 - Organize only Site Nodes
- Key Idea: Only routing matters
 - The exact structure Voronoï is not mandatory
 - An approximation is enough to discover “good” neighbours

P2P Architecture (2/2)

■ RayNet Overlay



Adaptive communication frequency

- According to
 - entities type: to reduce site communication
 - entities proximity: to ensure interactivity between close entites
- Between **Sites**
 - Low frequency with propagation
- Between **Site** and **Avatar/Object** entities
 - Low frequency
 - All Avatar/Object Entities into a Site's cell communicate with it
 - Entities have a knowledge of their neighborhood
- Between close **Avatar/Object** entities
 - High frequency
 - heartbeat mode (propagation)
- Between very close **Avatar/Object** entities
 - Very high frequency
 - For Collision detection

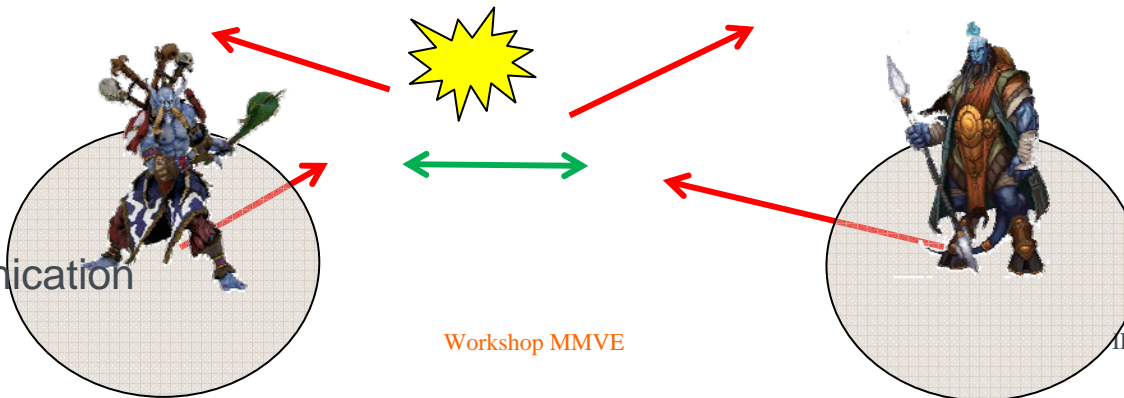
Decentralized physics computation

- Each entity owner has to compute its own position according to physical properties
 - Mass, momentum
 - Forces applied by entities in its surrounding
- Collision Detection Area (CDA) is defined by a sphere
- Entities having their CDA in collision launch a detection collision communication with anticipation

→ Force

○ CDA

↔ Collision Communication



Dynamic Object Management

- Animated Objects have an animation script
- Every hosts (PC, server, etc) can take the responsibility of an object (according to its rights), and must animate it
- If an avatar use an object, its host is responsible of the object animation
- Avatar can throw out a object (with its animation script), that will become passive, and will be attached to the Site node

« There is something new: A globe about the size of a grapefruit, a perfectly detailed rendition of Planet Earth, hanging in space at arm's length in front of his eyes. Hiro has heard about this but never seen it. It is a piece of CIC software called, simply, Earth »

**Neal Stephenson,
Snow Crash - 1992**

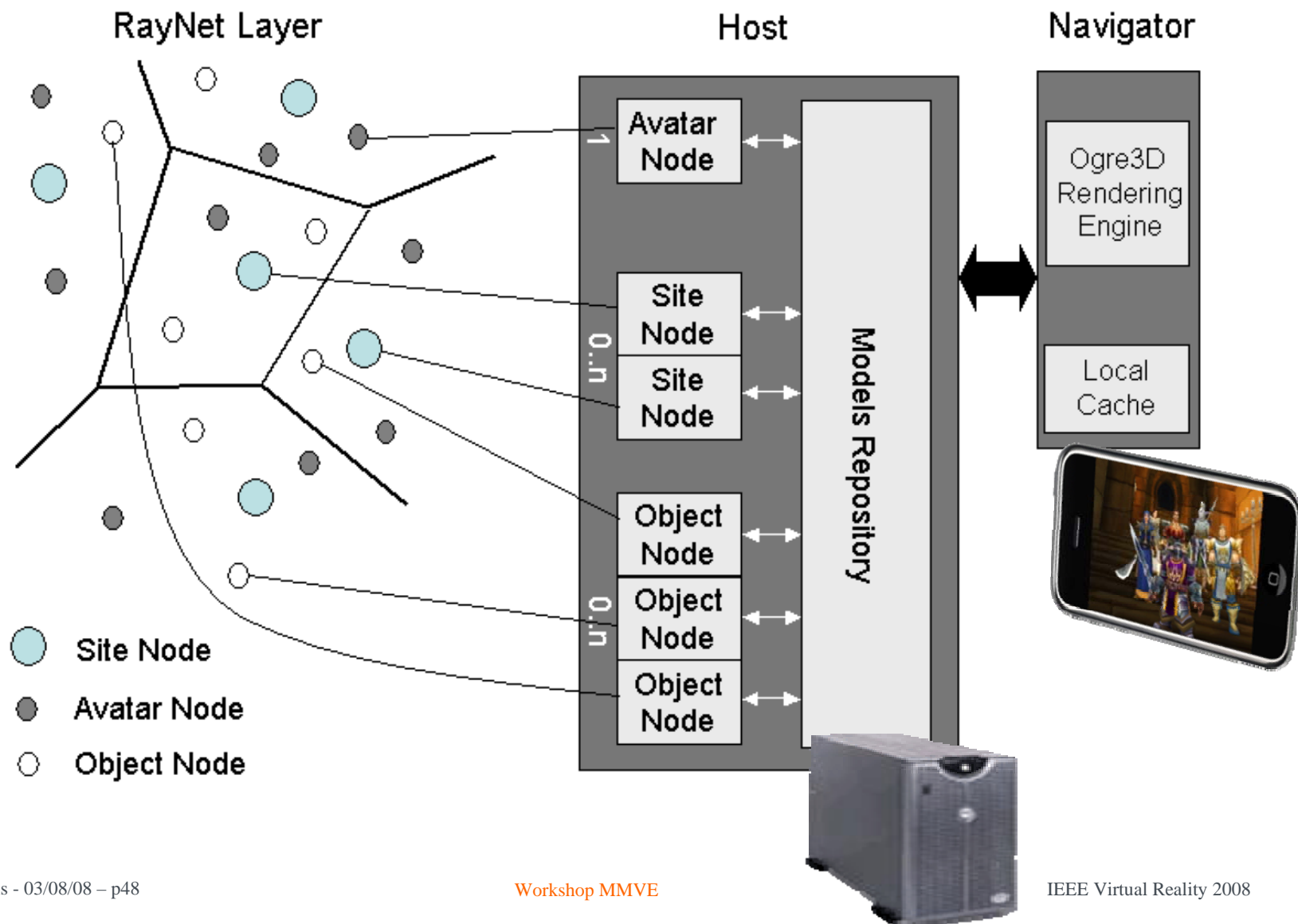
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The Navigator

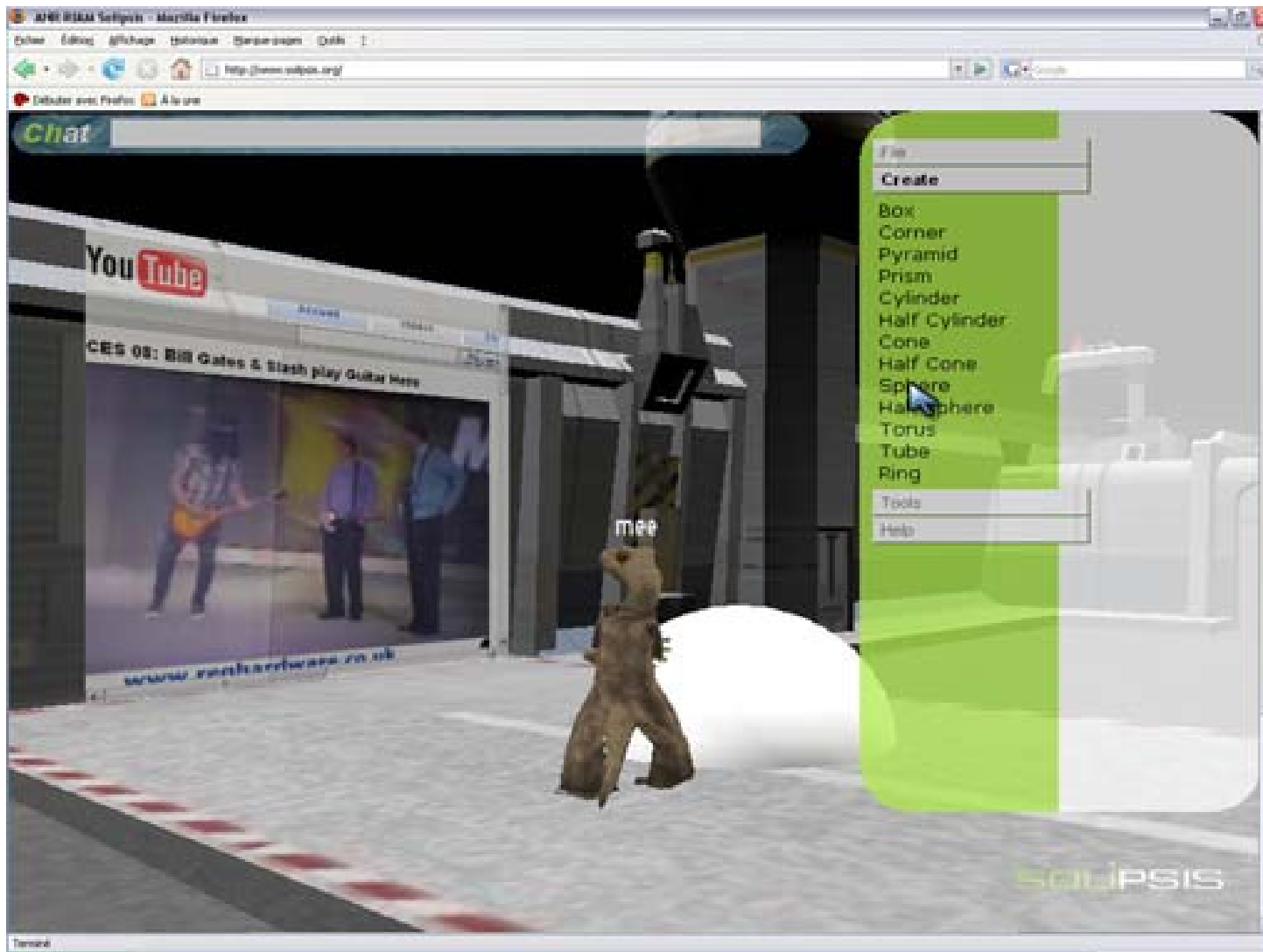
Navigator (1/3)

- Ogre 3D for rendering engine
- Integrated to Web 2.0
 - ActiveX
 - Plugin Mozilla
 - Etc ...
- Integrate Web 2.0
 - Interactive web pages mapping (Navi based on Gecko)
- Integrate modeling tools for UGC
 - Declarative modelling software
 - Automatic generation of 3D contents
- Nodes and navigator can be executed on different Hosts

Navigator (2/3)



Navigator (3/3)



«In a closed system, the world is bounded by the imagination of the people working in the company that owns the world.. If your system is open, a lot of ideas will flourish »

Joaquin Keller

5

Conclusions

Conclusions

- Our solution is based on an n-dimensional Voronoï-based peer-to-peer network, called RayNet
- The architecture enables the decentralization of complex tasks related to physic-realistic modeling and supports dynamic objects
- It enables adaptive streaming of 3D models in a completely decentralized fashion while adapting streamed data to avatars' viewpoints
- Access to the Metaverse is made possible by a navigator that may run as a stand-alone platform or embedded within a web page

Acknowledgment

- Solipsis is an ANR-RIAM project leaded by *Orange Labs*, funded by ANR and Media and Networks cluster of Brittany
- In collaboration with:
 - *IRISA* - Peer to peer networks & distributed systems
 - *Archivideo* - automatic generation of 3D contents
 - *Artefacto* - enhanced 3D modelling tools
 - *University of Rennes 2, Upper Brittany* - Sociology of Community
- We will open our source code repository (GNU/GPL v2+) to everyone before April 2008
- More info here: www.solipsis.org
- Contact: romain.piegay@orange-ftgroup.com



Chat

You Tube
Broadcast Yourself™

Videos

Categories

World Of Warcraft: Dancing



share



replay



Where WoW Dances Came From

05:33

From: Avrilite

Views: 637572



Made WoW history!! OMG

01:19

From: Annalauine

Views: 946



piegaro

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