From Simulation to Games
Architectures for Large Scale MMOGs

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Outline

1. From Visual Simulation to Virtual Reality to Games
   - Creating a Science of Game
   - Game Research Agenda
2. An Architecture for Distribuited Simulation Games
   - Drivers & Requirements for the Architecture
   - An Architecture for Distribuited Games
3. An Architecture Supporting Large Scale MMOGs
   - Requirements
   - An Overlapping Zone-Based Architecture

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- Researchers who want their work to remain relevant must realign to focus on game research and development. Research in the games arena affects not just the entertainment industry but also the government and corporate organizations that could benefit from the training, simulation, and education opportunities that serious games provide.

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A physical or mental contest, played according to specific rules, with the goal of amusing or rewarding the participants.

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A Video Game Definition

A game played against a computer, which would more accurately be worded as a game played with a computer.

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A mental contest, played with a computer in accordance with specific rules, that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives.

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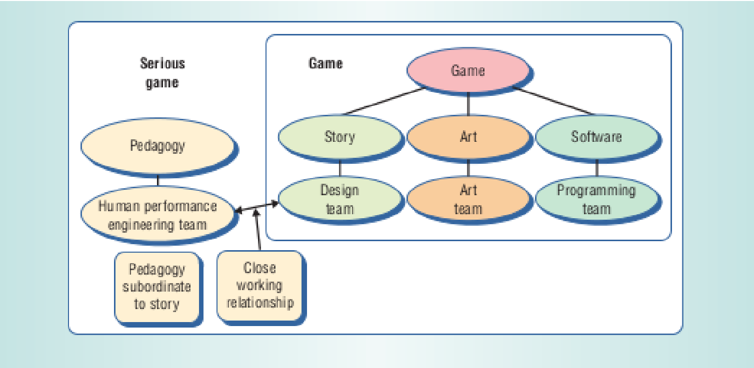
A Developer Definition

Bing Gordon, chief creative officer of video and computer games developer at Electronic Arts, once told that he defines video games as "story, art, and software".

What is a serious game?

Serious games have more than just story, art, and software, however.



Creating a Science of Games
Growing Interest

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- Those who have grown up playing games indicated that a game-centered research and educational program could offer many positive benefits.
- The announcement of America's Army at the 2002 Electronics Entertainment Expo (E3) prompted the US Army to commission a study of the game to see if it could be used for training.

Creating a Science of Games
An America's Army History

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"Street finds its own use for things"

The sergeant had bypassed the Army's requirements documents and formal studies and deployed the game on his own initiative.

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Game Research Agenda

To influence the future of both serious and entertainment games

Developers must create a research and development agenda with three components:

- Infrastructure;
- Cognitive game design;
- Immersion.

Game Research Agenda
Infrastructure

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This work, of interest to gaming in general, has special relevance for the large governmental game-based simulation sector.

Game Research Agenda

Cognitive Game Design and Immersion

Cognitive Game Design:

- modeling and simulating computer characters, story, and human emotion;
- analyzing large-scale game play;
- innovating new game genres and play styles;
- integrating pedagogy with story in the interactive game medium.

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Immersion:

- computer graphics, sound, and haptics;
- affective computing-sensing human state and emotion;
- advanced user interfaces.

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Drivers for the Architecture
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The question is:

Why? To what extent have the technological developments of the last decade improved understanding and acceptance?

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A Second Driver

Incorporating these technologies provides opportunities to construct a more complex and realistic environment.

A Third Driver

Allows to embed algorithms for operational decision making in simulation games.

Requirements for the Architecture
The three U's

When considering simulation games, there are three "U"'s that are important: the usefulness of the tools and methods, their usability, and finally their usage.

Requirements for the Architecture

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Usability

User interfaces placed on top of generic services.

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Other Requirements

Other requirements are related to reliability, robustness, credibility and adaptivity.

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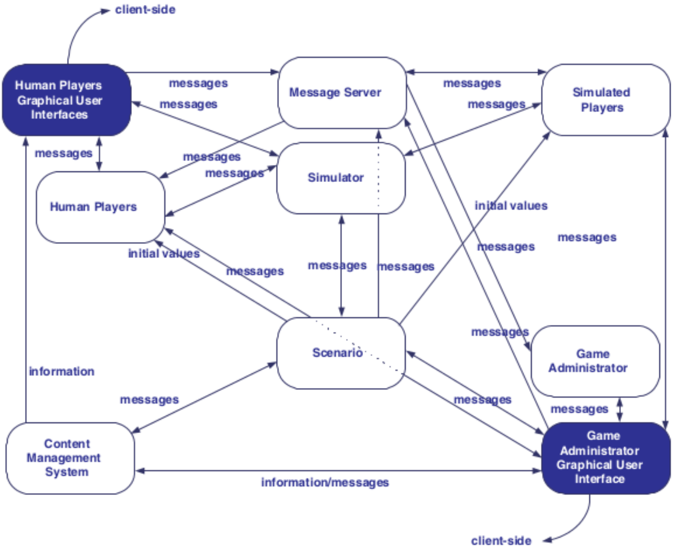
An Architecture for Distribuited Games

An Overview of the Architecture



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- The Java Message Service is used for the message service.

- Highly interactive virtual reality systems such as massively multiplayer online games (MMOGs) necessitates highly robust and efficient architectures.

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- Distributed implementations must deal with challenges such as: supporting very large numbers of users, the need to maintain robustness, balancing the processing load, reducing user latency, and minimizing thrashing effects. There are no unified methods that attack these problems cohesively.

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Requirements for Large-scale, Distribuited System

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Reduction of User Latency

Game systems must avoid unacceptable latencies between the user clients and the servers.

Related Work

Other Architectures

Distributed MMOGs and other multi-server, large-scale VR systems use a variety of methods to address the four desired capabilities mentioned above.

- Sharding method.
- Zoning methods.
- Peer-to-Peer (P2P) paradigm.

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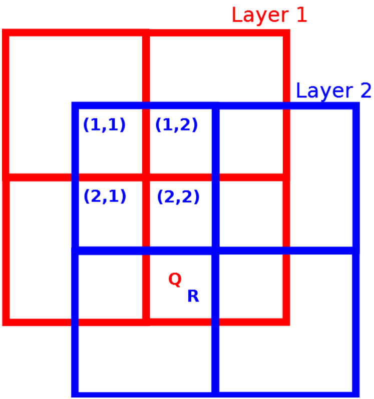
- The cell overlap provides a mechanism for redundancy to protect against server crash, it facilitates a system for seamless migration across cell boundaries, and it allows load balancing methods.
- Cells are pre-distributed amongst the servers for processing.
- Entity (object and user data in the environment) are assigned to a cell based on the location of the object in the world, and the server managing that cell can be considered the master host of such objects.

An Overlapping Zone-Based Architecture
Loose Cell Overlap Pattern

The master-slave relationship is determined by the overlap.

Server 1 (Layer 1) is master to object Q and slave to object R.
Server 2 (Layer 2) is master to object R and slave to object Q.



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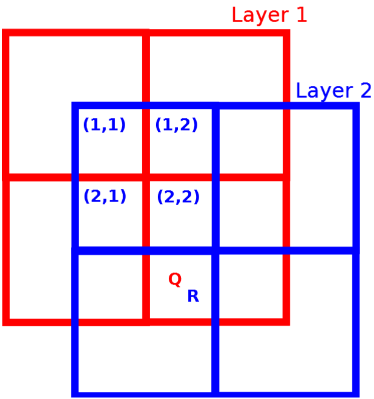
Each cell is divided into four quadrants:
$(1,1); (1,2); (2,1); (2,2)$.



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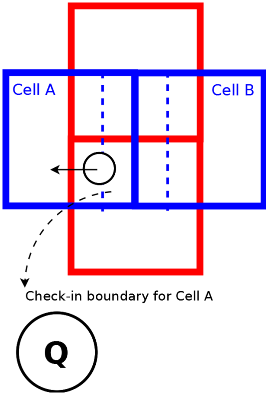
Update Responsibilities & Area of Interest

Update responsibilities of entities are transferred between servers as those entities are repositioned throughout the world.



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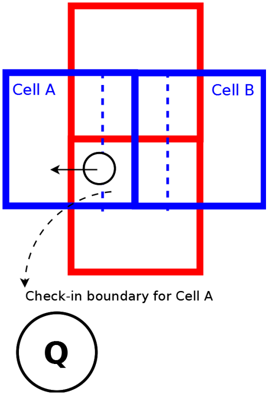

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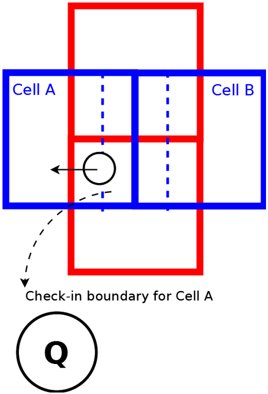
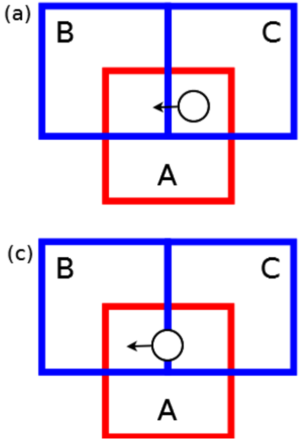
Area of Interest

Area of Interest (AoI) is defined around an entity, and when that AoI intersects the boundary, management of the entity is shifted.



An Overlapping Zone-Based Architecture
Entity Motion



An Overlapping Zone-Based Architecture

Entity Motion

Table : Favorable Server-Motion allocation for Cost minimization.

For direction of motion of entity	Master server of entity should be that which is the master of the cell that hold the entity
$\longrightarrow$ $\downarrow$ $\searrow$	(1,1)
$\longleftarrow$ $\downarrow$ $\swarrow$	(1,2)
$\longrightarrow$ $\uparrow$ $\nearrow$	(2,1)
$\longleftarrow$ $\uparrow$ $\nwarrow$	(2,2)

An Overlapping Zone-Based Architecture

Server Crash & Dynamic Allocation

Server Crash

- A natural fault tolerance is accomplished in this design because of the redundancy provided by overlapping cells.
- When a server crashes, any entities over which it had master control are already replicated on at least one other server.
- The system must merely transfer master control and needn't seek data from a crashed machine.

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Dynamic Cell Allocation

Dynamic cell allocation methods between servers must accomplish a multitude of things with reasonable efficiency.

References

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