Scalable Data Distribution for Virtual Worlds

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Problem:

Today's virtual world systems are characterized by centralized control and limited by the level of scalability they can support. Improved architectures for virtual worlds can enable them to operate more efficiently and scale better to handle millions of users.

Solution:

Scalability may be achieved by capping the output rate of each virtual world server. We are building a network infrastructure that uses the geometric nature of virtual world interactions to achieve constant bit-rate data traffic from each virtual world server. This approach is physically motivated – humans can perceive a bounded amount of information in real physical spaces, so we could expect similar behavior in a virtual world.

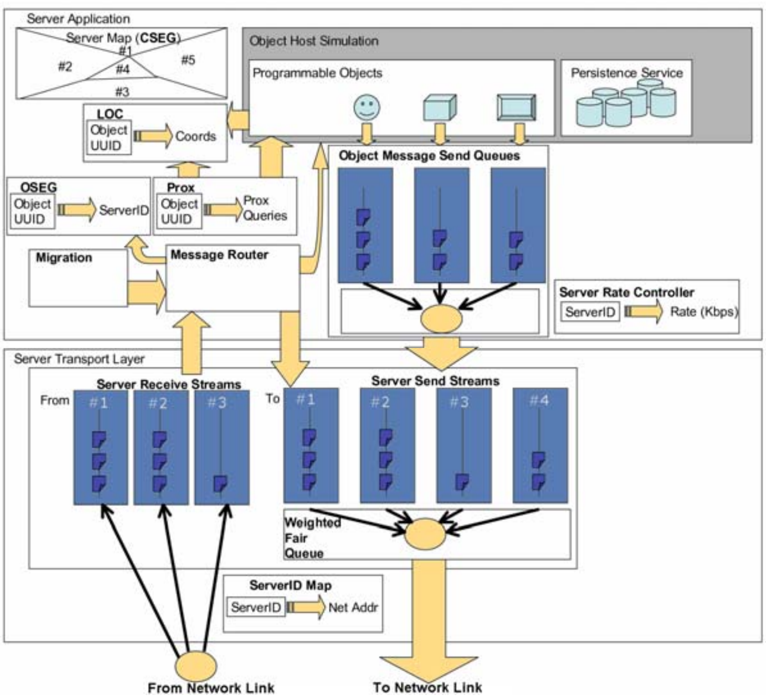
Constant Bit Rate Servers

Server Map
Maps sub-regions (spaces) of the virtual world to servers managing them

OSEG
Gets the server on which an object resides

Migration
Objects migrate when their location changes across regions

Load balancing
Server map can change dynamically to balance load across servers



Object Hosts
Objects and clients reside here. In a complete implementation, these would be hosted on remote servers.

PROX
Introduces nearby objects to each other

Server Rate Controller
Calculates and controls the rate at which this server can send to another server

Weighted Fair Queues
Weights proportional to the rates allocated to each server, as given by the Bandwidth Integral

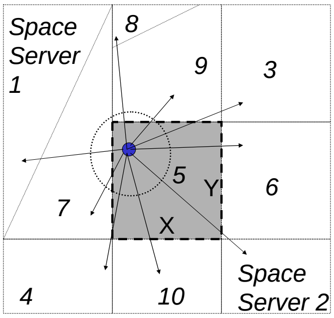
The Bandwidth Integral

Assume data rate between two objects at distance *r* apart = *f(r)*

Total Outgoing Data Rate = $\int_0^X\int_0^Y\int_0^\infty\int_0^{2\pi} f(r)\, r\, d\theta\, dr\, dy\, dx \le constant$

Converges if $f(r) \le (r^2 \log^{1+\varepsilon} r)^{-1}$

$f(r)$ is the data rate allocated for communication to server at distance r



Performance Metrics

- Location Error – average difference between actual location and sampled location
- Latency of an update through the system
- Data Rate and Fairness of the Weighted Fair Queues

Work In Progress

- Finish implementation of a full CBR system
- Deploy and evaluate on a large cluster
- Integrate the CBR architecture into the Sirikata virtual world

* Poster Title Background taken from S. Chaudhuri, D. Horn, P. Hanrahan and V. Koltun, "Distributed Rendering of Virtual Worlds", Stanford University Computer Science Technical Report, CSTR 2008-02, on which many ideas of this work are based.