EVALUATION OF THE HYPERVERSE AVATAR MANAGEMENT SCHEME BASED ON THE ANALYSIS OF SECOND LIFE TRACES

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MOTIVATION

• HyperVerse project

• Massive Multiuser Virtual Environment (MMVE)
  • Global-scale
  • Open
  • Similar to the Web
  • 3D Web
TWO TIER INFRASTRUCTURE

Client overlay:
• Data distribution

Public Server overlay:
• Reliable hosting
• Client management
AVATAR INTERACTION

- By default the backbone interconnects avatars
- Tracking required
  - Sending movement updates
- Hotspot region
  - High backbone load
  - Unburden backbone by P2P mechanism
d = Field of View (FoV)
\( \Delta \) = Area of Interest (AoI)
\( \Lambda \) = Prefetch Radius
INTEREST MANAGEMENT
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REDUCE UPDATE FREQUENCY

• Movement updates along with AoI updates

• Interconnection guaranteed
REDUCE UPDATE FREQUENCY

- Movement updates along with AoI updates
- Interconnection guaranteed
REDUCE UPDATE FREQUENCY

- Movement updates along with AoI updates
- Interconnection guaranteed
HYBRID AVATAR MANAGEMENT

- Two situations:
  - A clients AoI fringe is not covered
    - Backbone mode
    - Send updates to backbone
  - A clients AoI fringe is completely covered
    - Cluster mode
    - Stop sending updates to backbone
HYBRID AVATAR MANAGEMENT

• Two situations:
  • A client's AoI fringe is not covered
    • Backbone mode
    • Send updates to backbone
  • A client's AoI fringe is completely covered
    • Cluster mode
    • Stop sending updates to backbone
CLUSTER MODE

- Decision on local information
- Movement updates to neighbors
- Neighbors responsible for interconnection
CLUSTER MODE

• Decision on local information
• Movement updates to neighbors
• Neighbors responsible for interconnection
CLUSTER CORE
CLUSTER CORE
CLUSTER BORDER
OPTIMIZATION

• Sufficient Condition

• Necessary and sufficient condition
  • Required: Fix and uniform AoI radii
  • Allow ‘small’ gabs
OPTIMIZATION

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OPTIMIZATION

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EVALUATION

• Analysis of Second Life traces

<table>
<thead>
<tr>
<th></th>
<th>Avatars</th>
<th>Average Avatars</th>
<th>Average Density</th>
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<tbody>
<tr>
<td>Freebies</td>
<td>3153</td>
<td>84.63</td>
<td>14.67</td>
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<tr>
<td>Isis</td>
<td>2735</td>
<td>83.10</td>
<td>14.32</td>
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<tr>
<td>Ross</td>
<td>560</td>
<td>24.49</td>
<td>4.31</td>
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<tr>
<td>Pharm</td>
<td>1537</td>
<td>93.01</td>
<td>16.05</td>
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</tbody>
</table>
CLUSTER NODE RATIO

Region: Freebies

Number Of Nodes Online
Cluster-Node Ratio (Sufficient Cond.)
Cluster-Node Ratio (Necessary Cond.)

Percent / Number of Nodes
Time in seconds

Region: Isis

Number Of Nodes Online
Cluster-Node Ratio (Sufficient Cond.)
Cluster-Node Ratio (Necessary Cond.)

Percent / Number of Nodes
Time in seconds

Region: Pharm

Number Of Nodes Online
Cluster-Node Ratio (Sufficient Cond.)
Cluster-Node Ratio (Necessary Cond.)

Percent / Number of Nodes
Time in seconds

Region: Ross

Number Of Nodes Online
Cluster-Node Ratio (Sufficient Cond.)
Cluster-Node Ratio (Necessary Cond.)

Percent / Number of Nodes
Time in seconds
ABSOLUTE NUMBER OF NODES IN BACKBONE MODE

![Graph showing the number of nodes in backbone mode over time for different categories: Freebies, Isis, Pharm, and Ross. The y-axis represents the number of nodes, ranging from 0 to 50, and the x-axis represents time in seconds, ranging from 0 to 80,000. The graph illustrates the fluctuation of node counts over time for each category.]
CLUSTER STABILITY

Region: Freebies
- Cluster Mode Duration (Sufficient Cond.)
- Cluster Mode Duration (Necessary Cond.)

Region: Isis
- Cluster Mode Duration (Sufficient Cond.)
- Cluster Mode Duration (Necessary Cond.)

Region: Pharm
- Cluster Mode Duration (Sufficient Cond.)
- Cluster Mode Duration (Necessary Cond.)

Region: Ross
- Cluster Mode Duration (Sufficient Cond.)
- Cluster Mode Duration (Necessary Cond.)

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## CLUSTER STABILITY

<table>
<thead>
<tr>
<th></th>
<th>Average Cluster Period (Sufficient Cond.)</th>
<th>Average Cluster Period (Necessary Cond.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freebies</td>
<td>276 sec.</td>
<td>309 sec.</td>
</tr>
<tr>
<td>Isis</td>
<td>385 sec.</td>
<td>382 sec.</td>
</tr>
<tr>
<td>Pharm</td>
<td>1739 sec.</td>
<td>1730 sec.</td>
</tr>
<tr>
<td>Ross</td>
<td>675 sec.</td>
<td>704 sec.</td>
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</tbody>
</table>
CUMULATIVE DISTRIBUTION FUNCTION

Cluster Stability CDF (Sufficient Cond.)

Cluster Stability CDF (Necessary Cond.)
CLUSTER RATIO PROGRESSION

Region: Freebies

Region: Isis

Region: Pharm

Region: Ross

Ratio vs. AOI Radius

Sufficient Condition

Necessary Condition
STABILITY PROGRESSION

Region: Freebies

Region: Isis

Region: Pharm

Region: Ross

Average Cluster Period

AOI Radius

Average Cluster Period

AOI Radius

Average Cluster Period

AOI Radius

Sufficient Condition

Necessary Condition
CONCLUSION

• Hybrid Avatar Management Scheme
  • Unburden Backbone Servers
  • Self-organized
• Second Life Trace Analysis
  • High Cluster Ratio
  • Stable Clusters
THANK YOU FOR YOUR ATTENTION ...

... QUESTIONS