Avatar Mobility in LIFE

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“My life is so great that I literally wanted a second one!”
- Dwight Schrute, The Office
256x256 m regions.
avatar mobility: who is where, when
why do we care?
research in systems support for NVE
How to **partition** a world into regions and **assign** regions to servers considering:

- communication cost
- hand-over rate
- balancing server load
On caching and **prefetching** of virtual objects in distributed **virtual environments** - all 2 versions

JHP Chim, M Green, RWH Lau, HV Leong, A Si - Proceedings of the sixth ACM international conference on ..., 1998 - portal.acm.org

... On Caching and **Prefetching** of Virtual Objects in Distributed Virtual Environments

Jimmy HP Chimi hk Green: Rynson WH Lau* Hong Va Leongt Antonio Si! ...
Cited by 51 - Related Articles - Web Search

... data management using user-based caching and **prefetching** in distributed **virtual environments** - all 9 versions

S Park, D Lee, M Lim, C Yu - Proceedings of the ACM symposium on Virtual reality software ..., 2001 - portal.acm.org

Page 1. Scalable Data Management Using User-Based Caching and **Prefetching** in Distributed Virtual Environments Sungju Park Dongman Lee Mingyu Lim Chansu Yu ...
Cited by 10 - Related Articles - Web Search

A hybrid motion prediction method for caching and **prefetching** in distributed **virtual environments** - all 3 versions

A Chan, RWH Lau, B Ng - Proceedings of the ACM symposium on Virtual reality software ..., 2001 - portal.acm.org

... **Prefetching** in Distributed Virtual Environments Addison Chan addi@cs.cityu.edu.hk
Rynson WH Lau rynson@cs.cityu.edu.hk Beatrice Ng beatrice@cs.cityu.edu.hk ...
Cited by 8 - Related Articles - Web Search

[ CITATION ] ... Leong, and A. Si,"On Caching and **Prefetching** of Virtual Objects in Distributed Virtual Environments, ...

JH Chim, M Green, RW Lau - Proceedings of ACM Multimedia, 1998
Cited by 1 - Related Articles - Web Search

**Prediction-based Prefetching** for Remote Rendering Streaming in Mobile **Virtual Environments** - all 2 versions


... **Prediction-based Prefetching** for Remote Rendering Streaming in Mobile Virtual Environments Shaimaa Lazeml Marwa Elteirl Ayman Abdel-Hamid2,3 Denis Gracanin' ...
Related Articles - Web Search

Key authors: J Chim - R Lau - M Green - H Leong - A Si
How to predict avatar movement (end therefore what a user will see next)?
A Peer-to-Peer Message Exchange Scheme for Large-Scale Networked Virtual Environments - all 10 versions
Y Kawahara, T Aoyama, H Morikawa - Telecommunication Systems, 2004 - Springer
... Y. Kawahara, H. Morikawa and T. Aoyama, A peer-to-peer message exchange scheme
for large scale networked virtual environments, in: Proc. ...
Cited by 39 - Related Articles - Web Search - BL Direct

VON: a scalable peer-to-peer network for virtual environments - all 2 versions
SY Hu, JF Chen, TH Chen - Network, IEEE, 2006 - ieeexplore.ieee.org
VON: a scalable peer-to-peer network for virtual environments Shun-Yun Hu Jui-Fa
Chen Tsu-Han Chen Inst. of Phys., Acad. Sinica, Taipei, Taiwan; ...
Cited by 25 - Related Articles - Web Search - BL Direct

... Mechanisms for Closely Coupled Collaboration in Multithreaded Peer-to-Peer Virtual Environments - all 6 versions
... Designed for peer-to-peer virtual environments in which several threads have access
to the shared scene graph, these algorithms are straightforward and ...
Cited by 12 - Related Articles - Web Search - BL Direct

Supporting scalable peer to peer virtual environments using frontier sets - all 6 versions
Page 1. Supporting Scalable Peer to Peer Virtual Environments using Frontier
Sets Anthony Steed 1 , Cameron Angus 2 Department of ...
Cited by 9 - Related Articles - Web Search

Providing full awareness to distributed virtual environments based on peer-to-peer architectures
... Environments Based on Peer-to-Peer Architectures * ... Supporting scalable peer to peer
virtual environments using frontier sets. In IEEE Virtual Reality-2005. ...
Cited by 6 - Related Articles - Web Search - BL Direct

CITATION] VON: a scalable peer-to-peer network for virtual environments. Network
SY Hu, JF Chen, TH Chen - IEEE, 2006
Cited by 4 - Related Articles - Web Search

A Hybrid Solution to Support Multiuser 3D Virtual Simulation Environments in Peer-to-Peer Networks - all 4 versions
A Boukerche, RB Araujo, M Laffranchi - Proceedings of Distributed Simulation and Real-Time ..., 2004 - doi.ieeecomputersociety.org
... the issues involved in the implementation of 3D MUVEs in hybrid peer-to-peer networks,
and ... of multi-user 3D games and multi-user virtual environments in general ...
Aol-based scheme
How many connections?

How stable are the connections?
supernode-based scheme
How to pick supernodes?

How stable are the supernodes?
how to simulate avatar mobility?
random walk
random waypoint
clustered movement
or,
small-scale implementation
no large-scale NVE available until recently
482,594

residents logged in between 2-9 June 2008
• collect mobility traces of avatars in Second Life

• what it means w.r.t. systems design for NVEs?
collecting traces
how do avatars move inside a distributed virtual environment?
how are avatars distributed within a region?
how long do they stay at a location?
do they move in groups?
etc.
Linden, can we get access to the server traces?

No.
• Wrote our own client
• Parses packets using *libsecondlife*
• Insert bots into regions
• Log positions of avatars every 10s
difficulties
running out of memory
anti-bots policy
over crowded region
inter-region tracking
• Wrote our own client
• Parses packets using libsecondlife
• Insert bots into regions
• Log positions of avatars every 10s
who is
where,
when
(doing what)
The Pharm
Isis
Mobility Patterns
Freebies: number of visits to a cell
Freebies: average pause time in a cell
Freebies: average speed in a cell
Isis: number of visits to a cell
caching/prefetching based on popularity of locations?
Isis: average pause time in a cell
pick supernodes from sticky location?
Isis: average speed in a cell
mobility model: random walk + pathway?
churn rate
Reasonably high churn (up to 6/min)
Highly skewed. Some stay for hours.
cannot pick supernodes uniformly
clustering of avatars
meeting: encounter between two avatars (within each other AoI)
Meet many different avatars.
Most meetings are short.
Meeting size is large.
high overhead in maintaining AoI neighbors
meeting stability:

avg meeting size

over

num of avatars met
Wide range of stability
other tidbits
little temporal variations can use historical information to predict future
rotate 18% of the time

Second Life’s prefetching is wasteful
25-35% revisits the same region in a day

region-based caching?
proxy-based texture caching
why textures?
62 - 81% of traffic are textures
316 MB
of textures in Isis
403 TB
of textures retrieved in Isis in a day
what caching algorithm to use?
FIFO

LRU
cache miss

FIFO

LRU
cache hit

FIFO

LRU
cache hit

FIFO

LRU
scan resistant

FIFO

LRU
3Q
FIFO

LRU

Victim Buffer
FIFO
LRU
(cache hit)
Victim Buffer
(sorted by popularity)
how to define popularity of texture?
Freebies: number of visits to a cell
little temporal variations
can use historical information
to predict future
popularity of texture = popularity of cell
## Per-byte Hit Rate

<table>
<thead>
<tr>
<th></th>
<th>2Q</th>
<th>3Q</th>
<th>OPT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ross 50 MB</td>
<td>0.58</td>
<td>0.62</td>
<td>0.70</td>
</tr>
<tr>
<td>Ross 25 MB</td>
<td>0.28</td>
<td>0.36</td>
<td>0.47</td>
</tr>
<tr>
<td>Freebies 50 MB</td>
<td>0.48</td>
<td>0.50</td>
<td>0.68</td>
</tr>
<tr>
<td>Freebies 25 MB</td>
<td>0.21</td>
<td>0.33</td>
<td>0.50</td>
</tr>
</tbody>
</table>
conclusion
understanding real avatar mobility is crucial to design good NVEs
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歡迎發問及指教