RESILIENCE AND MULTICAST ASPECTS OF THE STRUCTURED NETWORK OVERLAY GP3

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MOTIVATION

• HyperVerse project

• Massive Multiuser Virtual Environment (MMVE)
  • Global-scale
  • Open
  • Similar to the Web
  • 3D Web
THE IDEA OF A 3D WEB
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3D Web =
THE IDEA OF A 3D WEB

3D Web = Online Communities
THE IDEA OF A 3D WEB

3D Web = Online Communities + Virtual Globes
THE IDEA OF A 3D WEB

3D Web = Online Communities + Virtual Globes + Web Content
TWO TIER INFRASTRUCTURE

Public Server overlay:
• Reliable hosting
• Client management

Client overlay:
• Data distribution

Tuesday, February 16, 2010
BACKBONE OVERLAY - GP3

- Interconnect Public Servers
- Tailored to DVE scenario
  - Data locality in DVEs
- Spatial index
- Resilience
- Multicast
GP3 - BASIC

- Subdivide world surface into rectangles with increasing order
- One k-order rectangle $\rightarrow$ 4(k+1)-order rectangles

Order: 1
GP3 - BASIC

- Subdivide world surface into rectangles with increasing order
- One k-order rectangle → 4(k+1)-order rectangles

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GP3 - BASIC

- Subdivide world surface into rectangles with increasing order
- One $k$-order rectangle $\rightarrow$ $4(k+1)$-order rectangles

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GP3 - BASIC

- Distributed and decentralized algorithm
- No perfect distribution

![Diagram with rectangles of different orders: Second Order Rectangle, Third Order Rectangle, Fourth Order Rectangle]
GP3 - RECTANGLE ORDER

• Links to m-order neighbors

• Links into adjacent k-order rectangles (k<m)
GP3 - LINK STRUCTURE

• Links to m-order neighbors

• Links into adjacent k-order rectangles (k<m)
GP3 - UNIFORMITY

- Worst case order variation: $O(\log_4 n)$
GP3 - JOIN NODES

- Worst case hop count: $O(\log_4 n)$
GP3 - NODES LOCKUP

- Worst case hop count: $O(\log_4 n)$
REORGANIZATION

- Keep structure in case of failure
- Consider random node failures
- Failed node is replaced by the m-order neighbor with the highest order
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REORGANIZATION

- Average order variation while removing random nodes

![Graph showing order variation against nodes removed.](image)
REORGANIZATION

• Average number of nodes involved in reorganization
MULTICAST

- Sending messages to a certain region in the virtual world
- Virtual Geocast
- Geographic routing
- Similar to unicast routing
- Efficient
MULTICAST

- Unicast routing into surrounding rectangle $T$ with order $t$
- Forward into all $t+1$ rectangles intersecting with the target region
- Repeated till end of cascade
MULTICAST - EVALUATION

- Multicast receivers vs. immediate nodes:

Fit: \( r(n) = \frac{\text{Target Region Size}}{\text{World Size}} \times n \)
MULTICAST - EVALUATION

- Hops per receiver

![Graph showing the relationship between network size and hops per receiver.]
MULTICAST - EVALUATION

- Average and maximum path length
CONCLUSION

• Highly-structured overlay GP3

• Interconnect Public Servers

• Simple and efficient reorganization scheme

• Efficient Geocast
THANK YOU FOR YOUR ATTENTION!

... Questions?