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Distributed Avatar Management for Second Life

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Introduction to Second Life

- **Second Life (SL) is a synthetic world where multiple participants interact via the Internet**
  - Users meet, communicate, play and trade
  - 16 million registered users (September 2009)
- **The virtual world is made of independent *regions***
  - Regions are filled with *objects* (cars, trees and buildings)
  - Users interact through their a*vatars*
- **Client/Server (C/S) architecture**
  - One region per server

Motivations

- **Current Second Life C/S design does not scale**
  - Maximum 100 concurrent avatars per server
  - World simulation is very often “slowed down” [CONEXT’08]
- **Peer-to-Peer (P2P) can solve scalability issues**
  - How would Second Life perform in P2P?
  - How to design efficiently a P2P virtual world?

Outline

- Distributed Avatar Management
- The Delaunay Network
- Experimental Evaluation
- Results
- Conclusions and Future Work

Distributed Avatar Management*

- **Problem**
  - Neighbor avatar discovery
  - Dissemination of avatar state updates
- **Many candidate solutions**
  - Distributed Hash Table, Delaunay/Voronoi Network, Multicast Tree, etc.

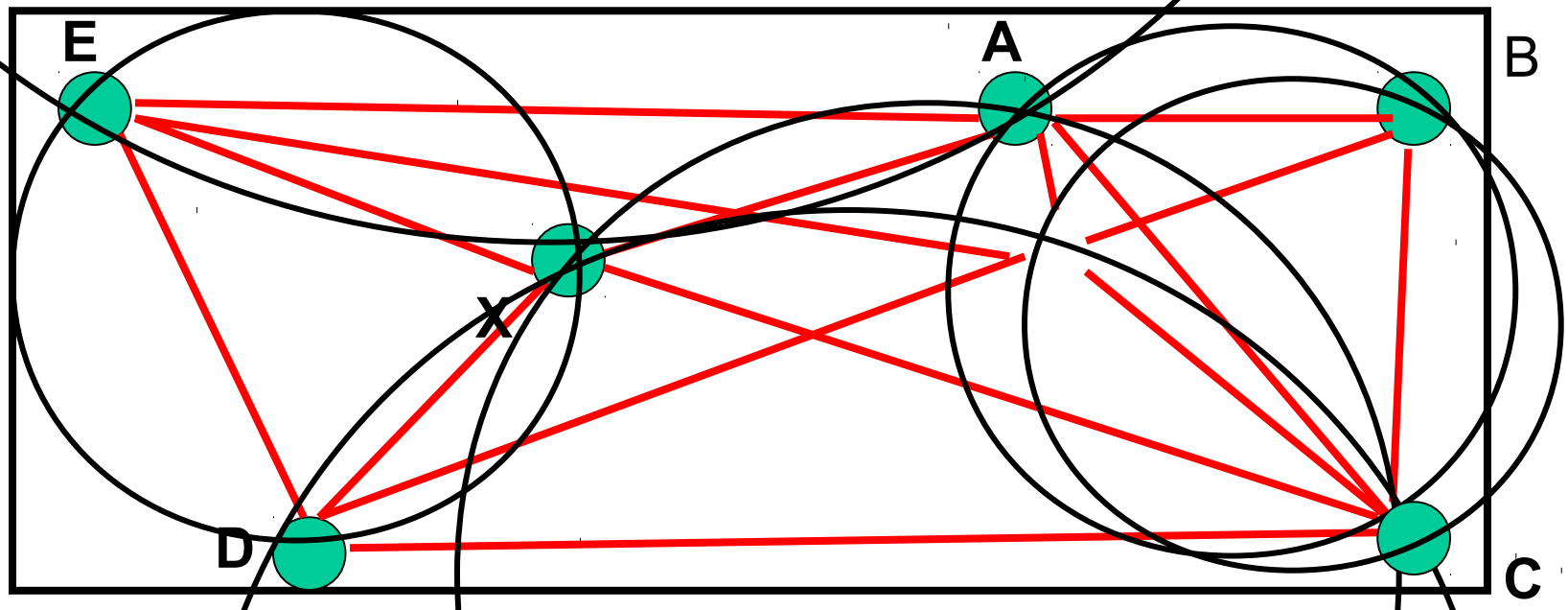
*Distributed Object Management was presented in [INFOCOM'09]

The Delaunay Network

- **Why?**
  - Popular design for distributed avatar management
  - Convenient for Second Life [CONEXT'08]
  - Missing experimental evaluation!!
- **What?**
  - P2P network topology based on the *Delaunay triangulation*
  - The Delaunay triangulation of a set of N points in $\Re^2$ is a triangulation of points DT(N) such that no point p lies inside the circumcircle of any triangle in DT(N).

The Delaunay Network (cont'd)

- Avatar coordinates are used to construct the Delaunay triangulation

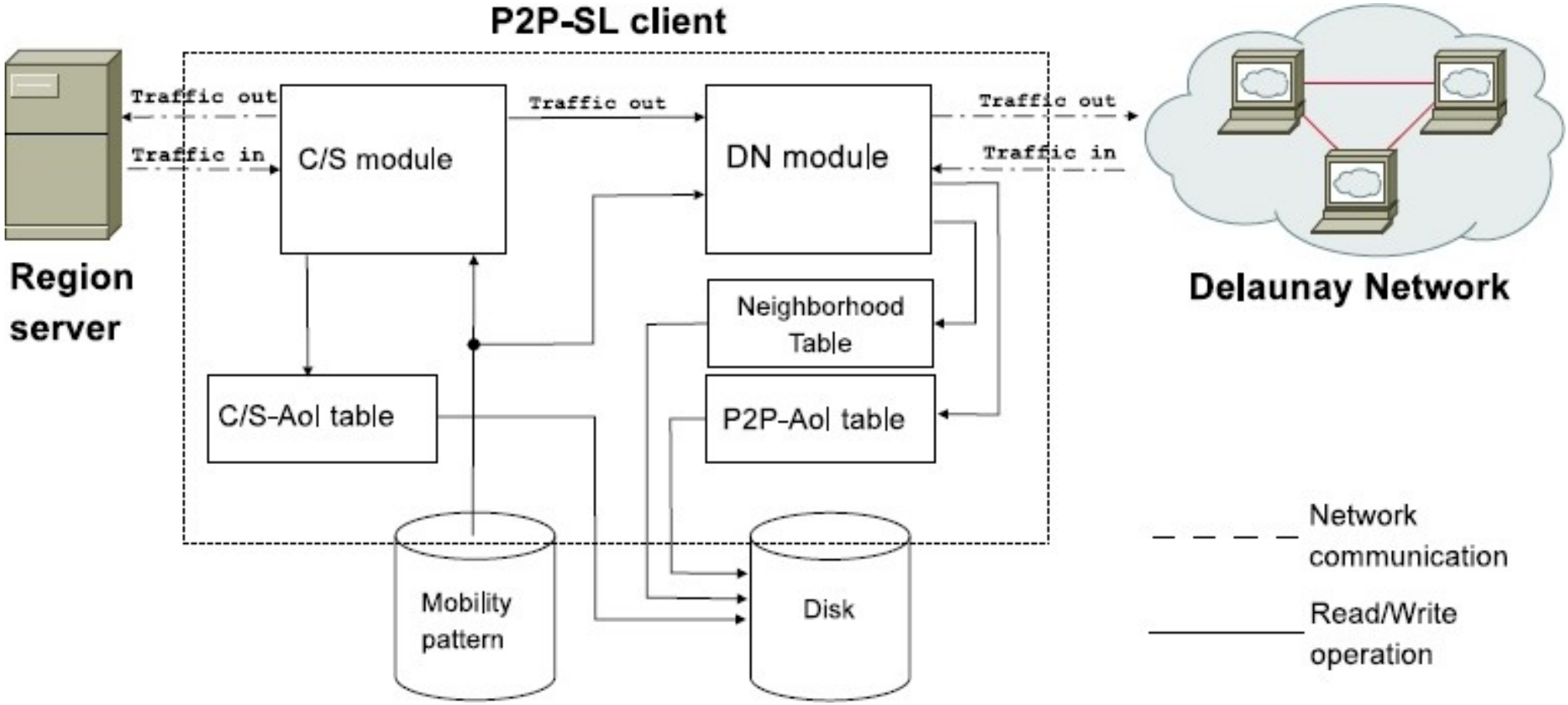


Can we achieve better QoE with Delaunay? (than with C/S)

Experimental Evaluation

- **Instrument open source SL client [libsecondlife]**
- **Avatar traces**
  - SL crawler [CONEXT'08]
  - 207 avatar sessions over one hour
- ***Empty* and *unpopular* SL region as a playground**
- **Planetlab machines as hosts**

Evaluation – *The P2P-SL Client*



Evaluation – *Metric Definition*

- ***Inconsistency***
  - It is the fraction of wrong avatar information contained within an avatar Area of Interest (AoI)
  - It takes values between *0* and *1*

- ***Inconsistency Duration***
  - It is the time an avatar needs to achieve a consistent view of the avatars in its AoI

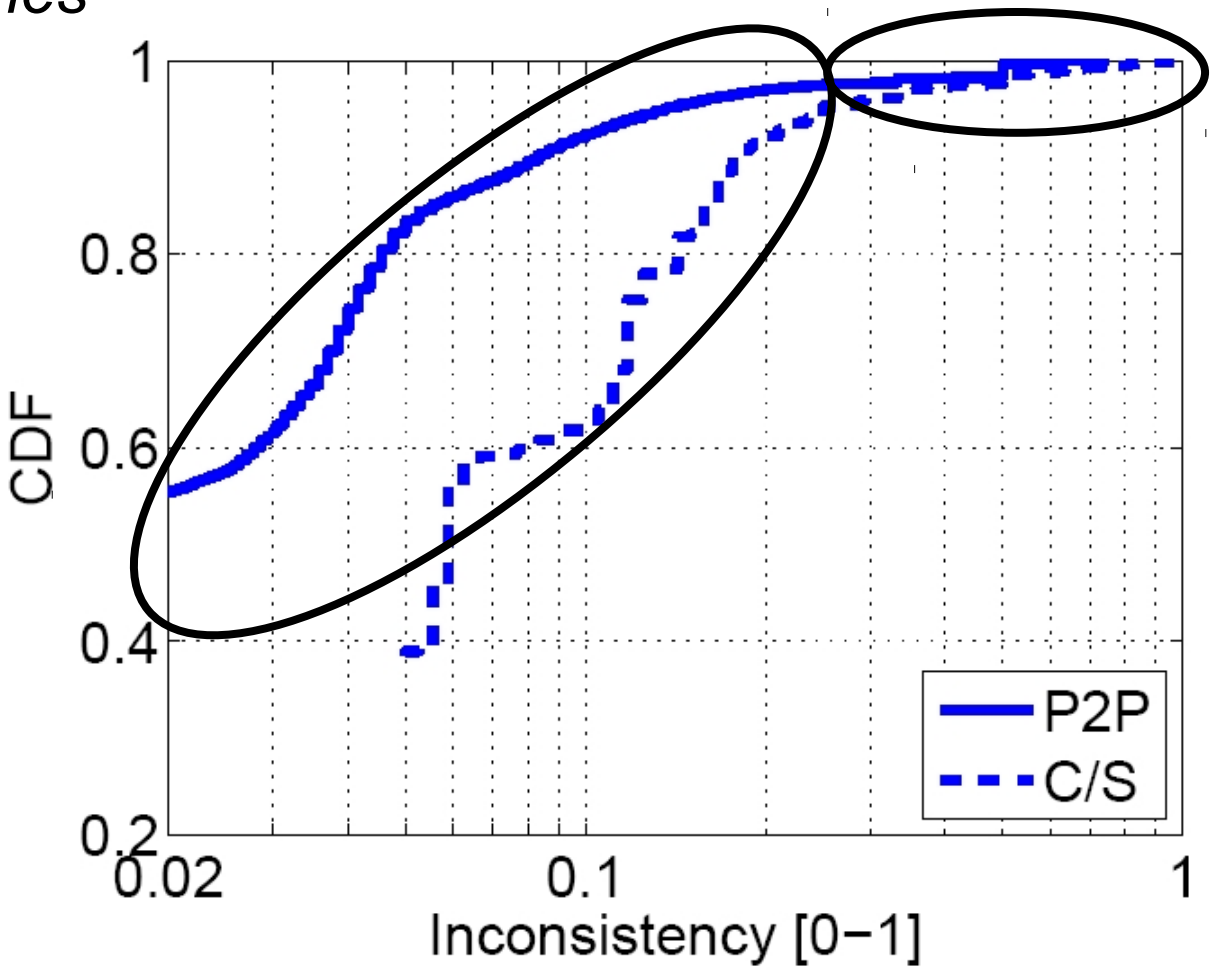
Evaluation – *Limitations*

- Experimenting on *empty* region is in favor of C/S
- We measure user QoE “re-playing” real (monitored) avatar behaviors using *bots*
  - Avatar behavior changes according to factors such as perceived performance
  - Lack of human feedback

Results – *Inconsistency*

P2P is more consistent 20-40% of the times

Comparable Inconsistency



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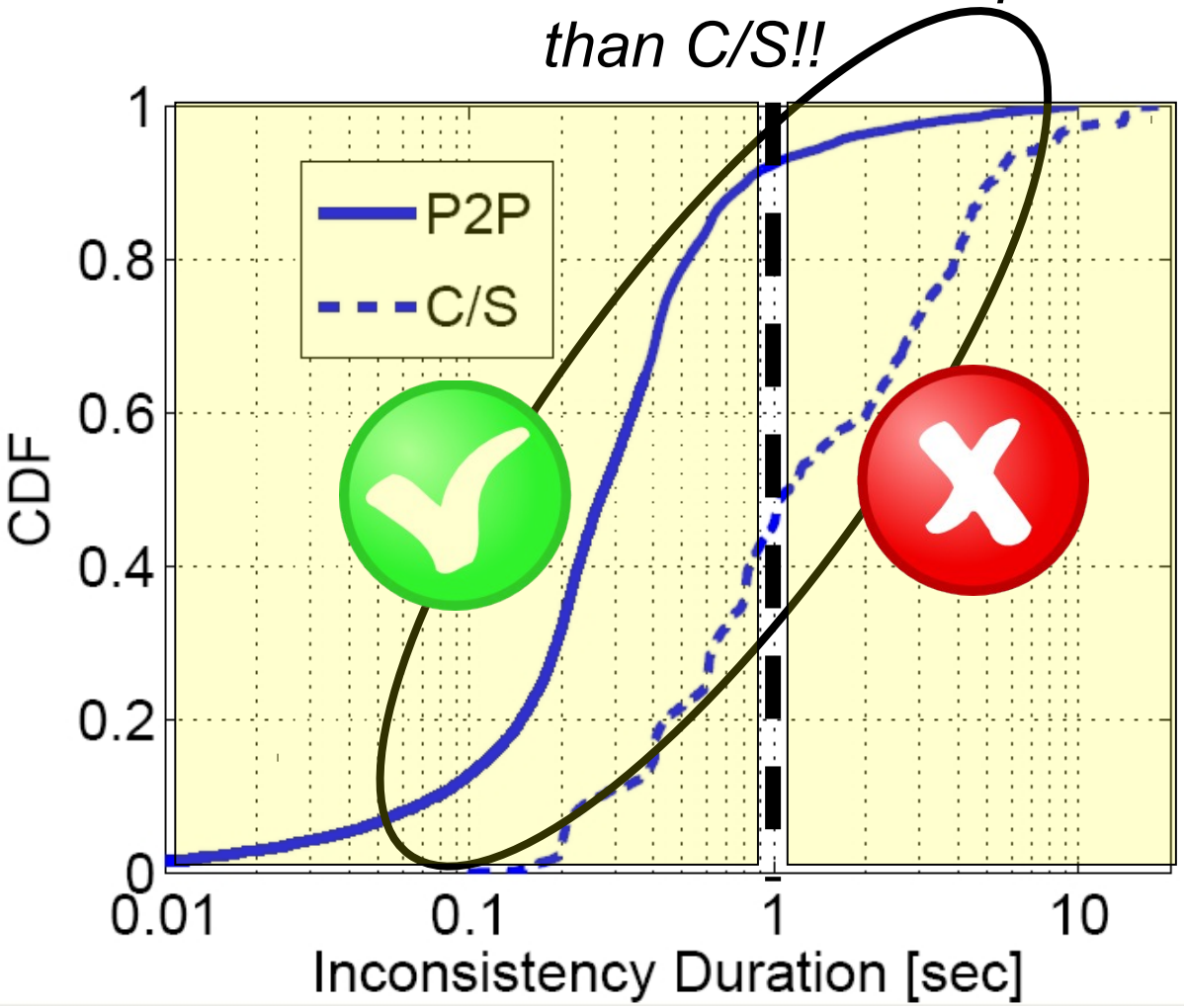
Results – *Inconsistency Duration*

P2P is about 5 times more responsive than C/S!!



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Conclusions and Future Work

- **We evaluate P2P versus C/S Second Life**
  - P2P makes avatar experience more *correct* and *interactive*
  - Slow responsiveness in presence of churn, fast avatar movements and groups
- **Future Work**
  - Improve performance of the Delaunay Network
  - Integrate in the P2P-SL client a distributed object management

Questions?