Pithos: A State Persistency Architecture for Peer-to-Peer Massively Multiuser Virtual Environments

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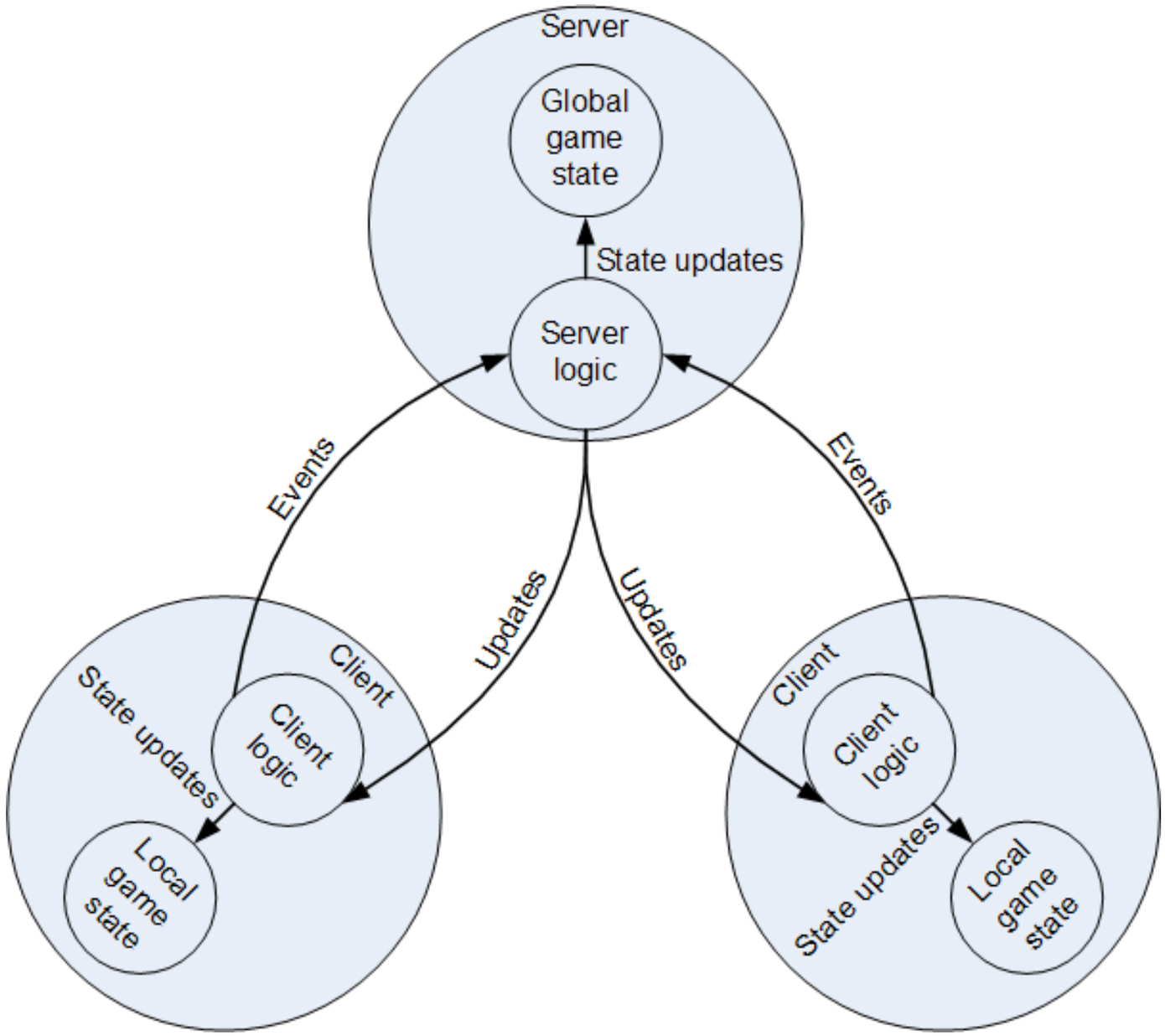
Overview

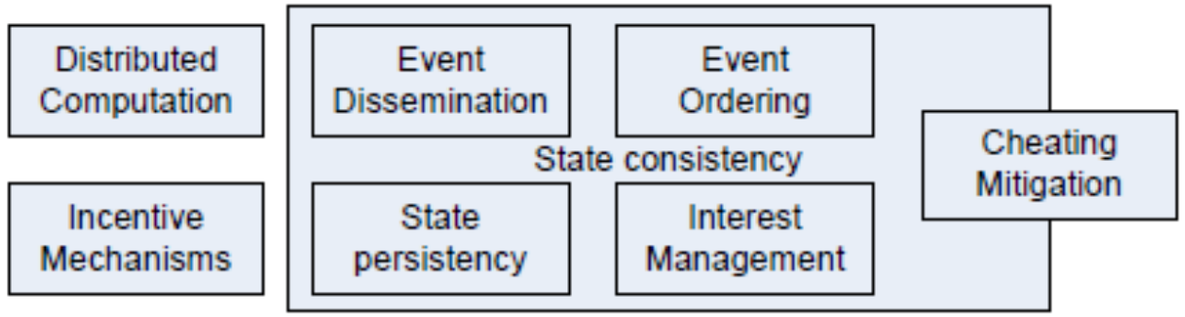
- Consistency model and challenges
- State persistency overview
- Pithos design
- Results
- Conclusion

Update-based consistency model



Consistency challenges

- Event dissemination
- Event ordering
- State persistency
- Interest management
- Cheating mitigation



State persistency

- Storage of game objects
- Game objects can be stored in primary (state management) or secondary storage
- State persistency is treated as a sub-domain of state consistency
- State persistency remains relatively unaddressed

State persistency requirements

- Scalability
- Reliability
- Fairness
- Responsiveness
- Security

State persistency types

- Super peer storage
- Overlay storage
- Super peer-overlay hybrid storage
- Distance-based storage

Storage type comparison

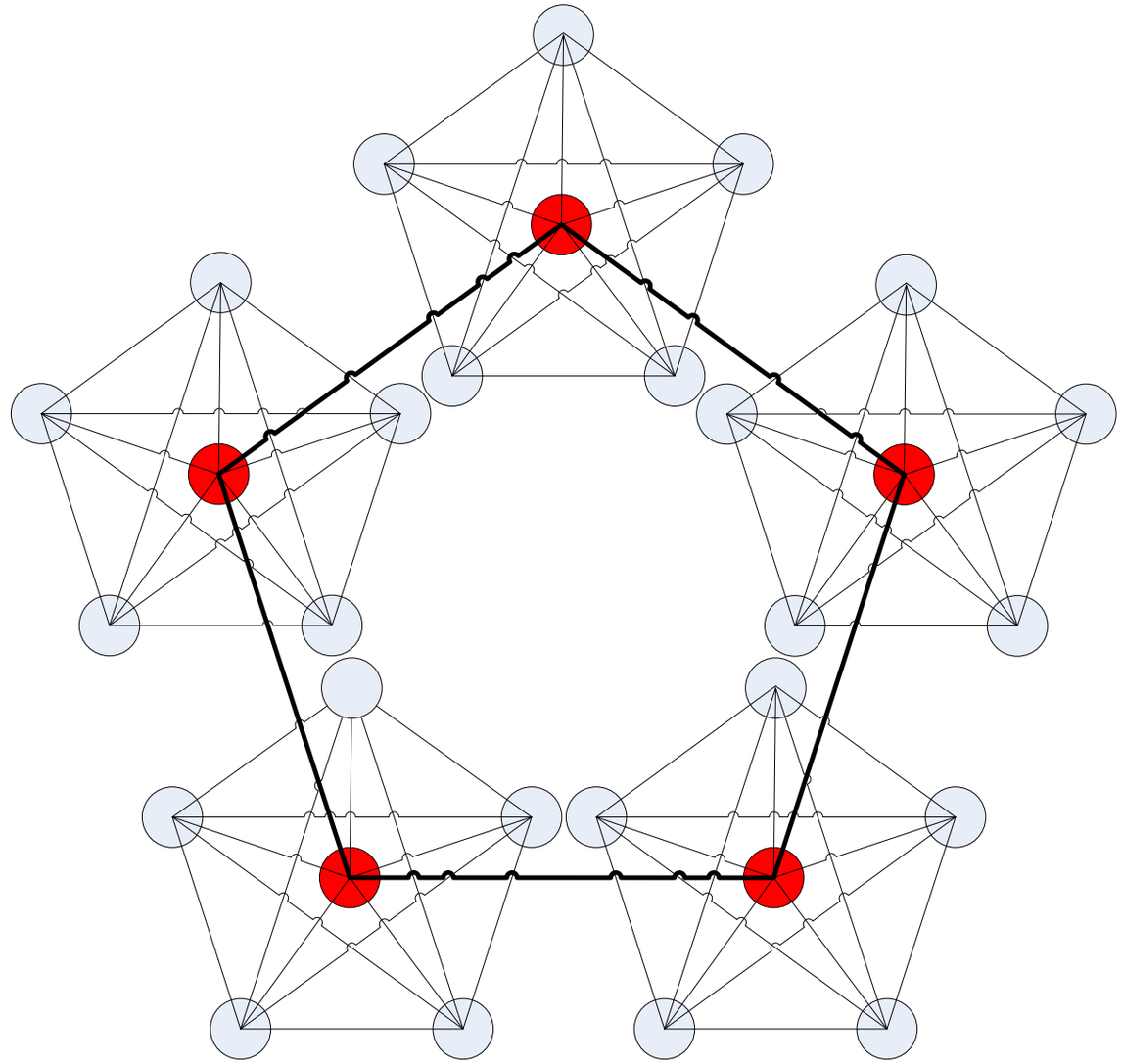
Type	Reliability	Fairness	Responsiveness	Security
Super peer	Yes	No	Yes	No
Overlay	Yes	Yes	No	Yes
Super peer-overlay hybrid	Yes	No	Yes	Yes
Distance-based	No	Yes	Yes	No

Pithos characteristics

- Grouping
- Replication
- Distance-based storage
- Secure storage and node ID assignments

Grouping

- Allows for scalable distributed model with low latency.
- Cluster-based
- Region-based



Replication

- Every object is replicated k times
- replication addresses churn and malicious users
- k depends on the percentage of malicious users and the churn rate

Distance-based storage

- Exploits player grouping architecture to improve latency
- Players interested in objects have direct access to the objects
- Group level distance-based storage
- Group-based reduces security risks

Secure node ID assignment

- All node IDs are assigned by a trusted certification authority
- Prevents nodes from deliberately hosting files of interest

Identified storage

- Anonymity does not allow for identification and elimination of malicous nodes
- Custom Certification authority
- All actions are signed with public certificates

Pithos evaluation

- Simulation model description
- Responsiveness
- Fairness

Model description

- Implemented in Oversim, running on Omnet++
- Pastry used for overlay routing
- Simulation driven by a game module
- Uses Oversim simple underlay with euclidean latency matrix

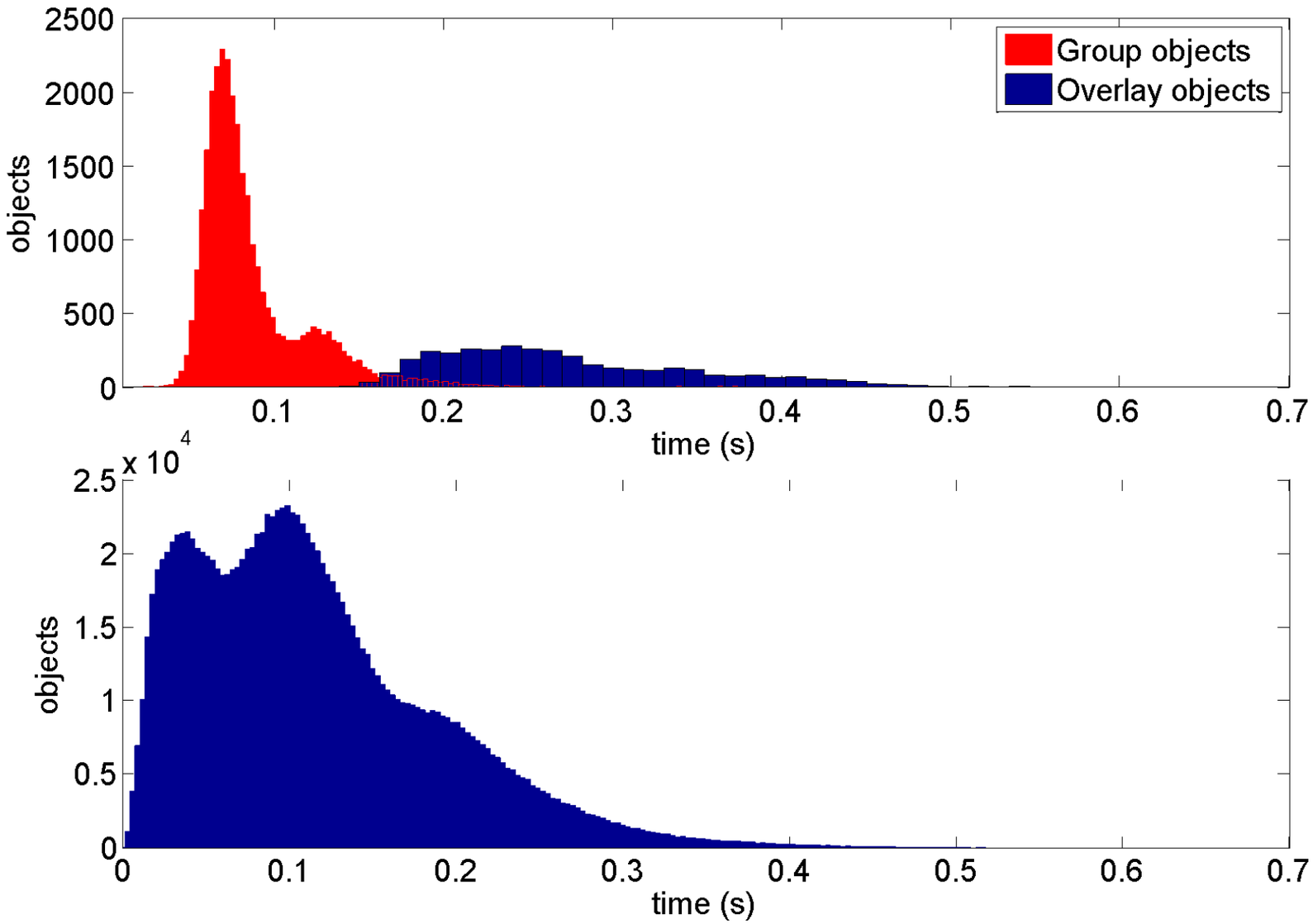
Model parameters

- One request every 10 s
- Request size of 10 KB
- Three replicas for every object stored
- 14999 peers, 500 super peers and 1 directory server

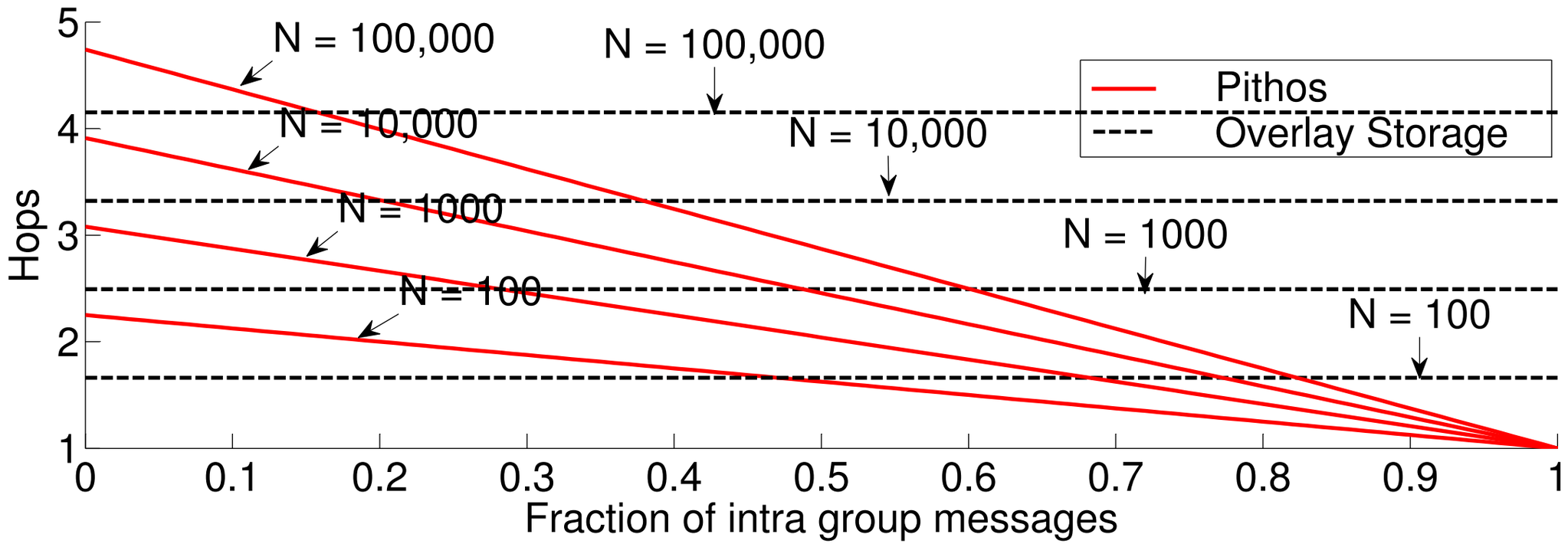
Responsiveness

- Two levels of responsiveness:
  - Intra-group and
  - Inter-group
- Calculate responsiveness as weighted average of the two levels.
- Compare theoretical number of hops

Time distribution of objects



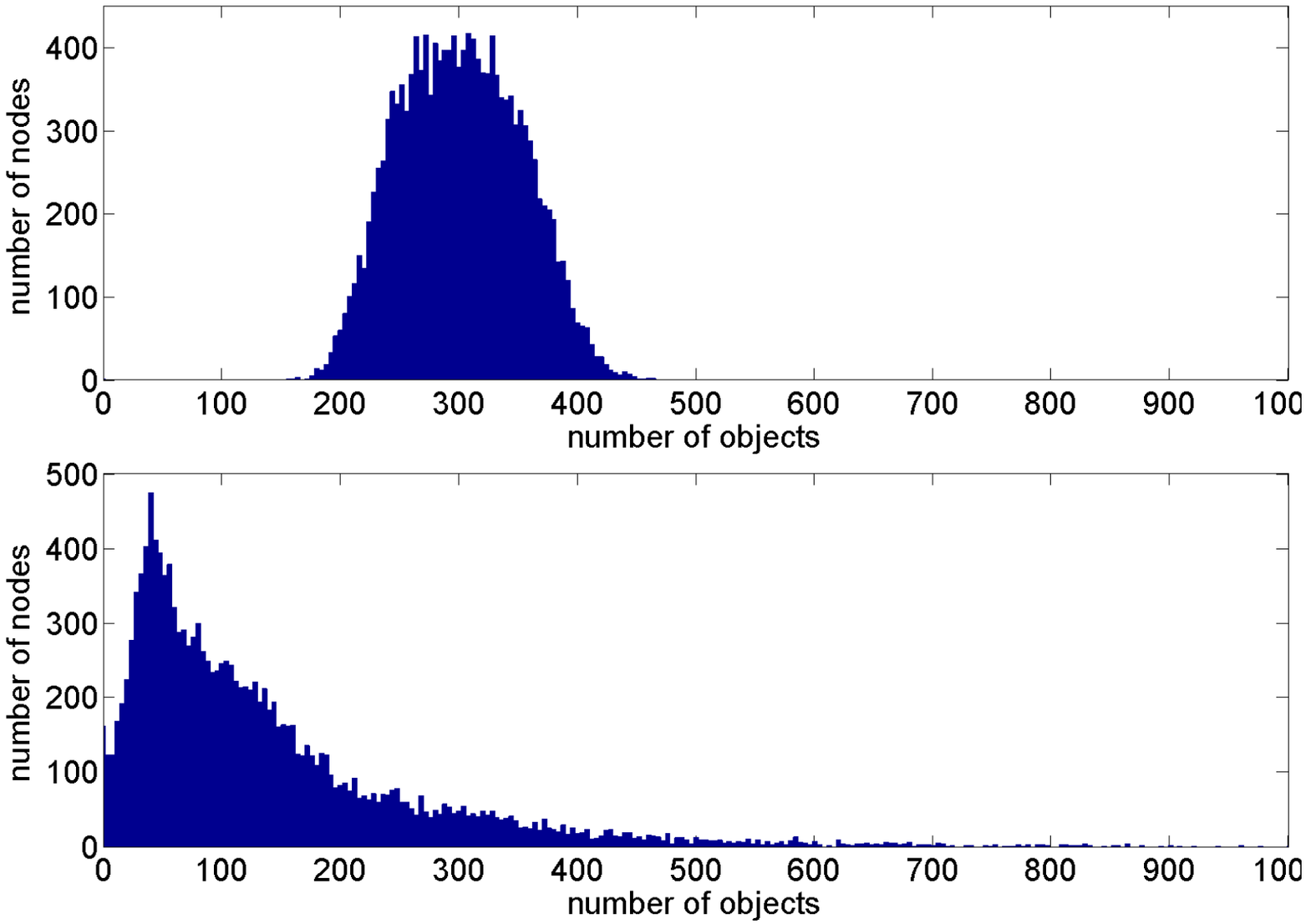
Expected number of hops



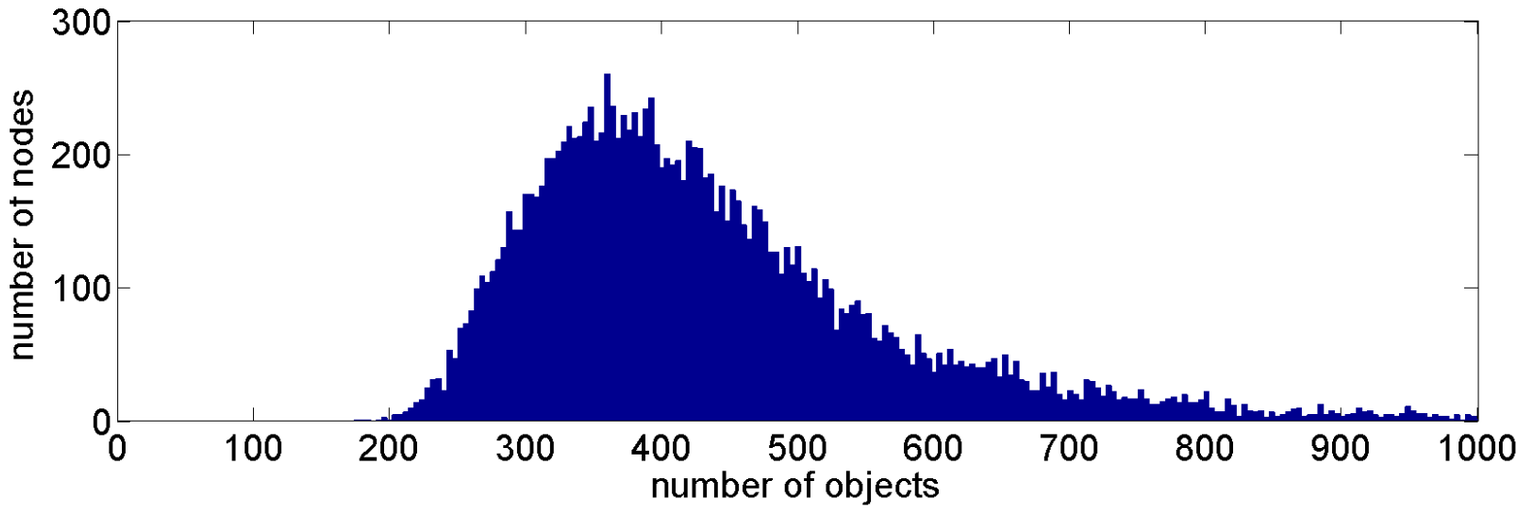
Fairness

- Standard deviation of objects stored per peer.

Object number distribution



Combined object number distribution



Conclusion

- None of the previous state persistency schemes satisfy all MMVE storage requirements
- Pithos was presented which satisfies all requirements by design
- Initial simulation results look promising

Future work

- Pithos still needs to be completed, both as a simulation model and an actual implementation
- Novel grouping algorithms is still required to satisfy Pithos's goal.
- Pithos should be tested under MMVE levels of churn.


Thank you!


Any questions?