

# Network Traces of Virtual Worlds: Measurements and Applications

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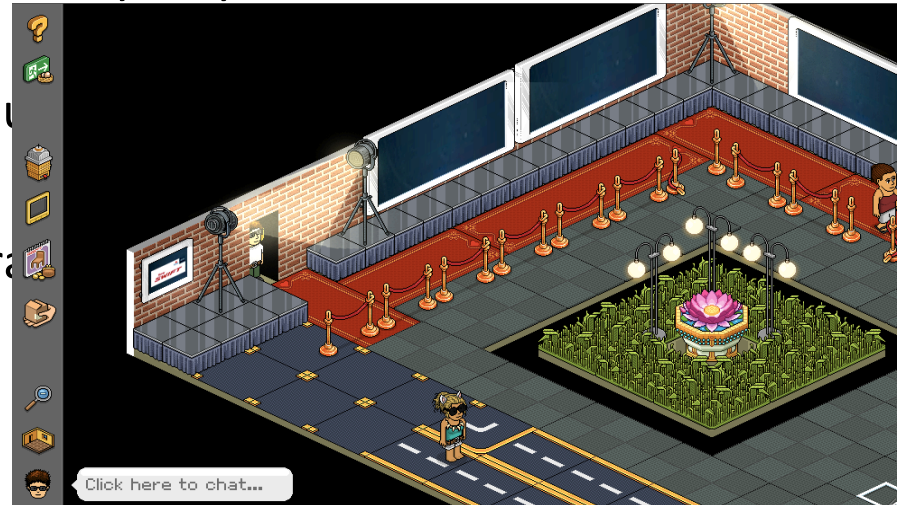
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Life is for sharing.



# Virtual Worlds

- Virtual worlds enable interesting applications.
- Popular ones: Second Life, Habbo Hotel, Sony Playstation Home



# Challenges

- High volume: peak requirement 1.4Mbps vs 20kbps for Starcraft.
- Dynamic: Traffic pattern is hard to predict and accommodate.
- Diversified: 3D meshes, texture, audio, video, and game logic.
- UGC: user generated content, uplink traffic, third party data.



## Second Life

- Virtual World developed by Linden research
  - Region: about 30000 regions
  - Resident, Avatar: up to 40-60 avatars per regions
  - Object, primitive: up to 15000 per region
- Client/Server
  - Viewer, snowglobe
  - Server (Grid): one server for one region
- Actions
  - Stand, Yaw, Walk, Run, Fly, Teleport
  - Programmable via Linden Scripting Language (LSL)



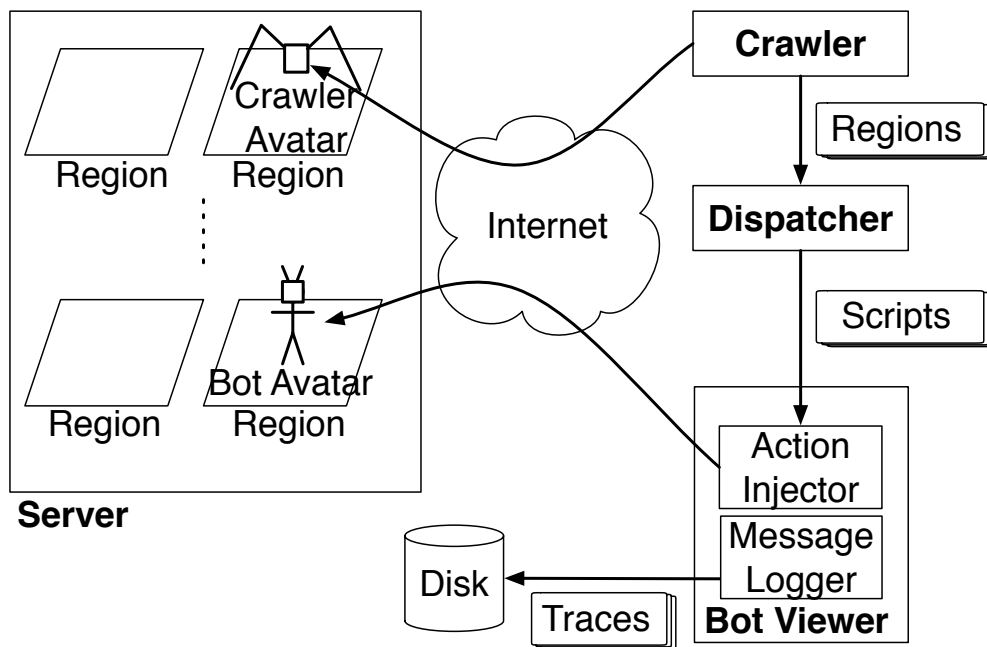
# National Geography of Second Life

- What to collect?
  - Avatar mobility
  - Object count: region and local
  - Network packet traces
- Where to collect?
  - Network crawler
  - Region classes
- How to collect?
  - Modified viewer
  - Avatar script injection



# Meet Bot Mirror

- Fully automated testbed



# Testbed Implementation

- Crawler: Command line tool, fast and lightweight
- Bot: Modified GUI viewer
  - Official GUI client, genuine network traffic
  - Inject script
  - Collect trace (both)
- Dispatcher
  - Python program to generate
    - Script for a list of region and actions
    - Bash script to drive the experiment



# Experiment

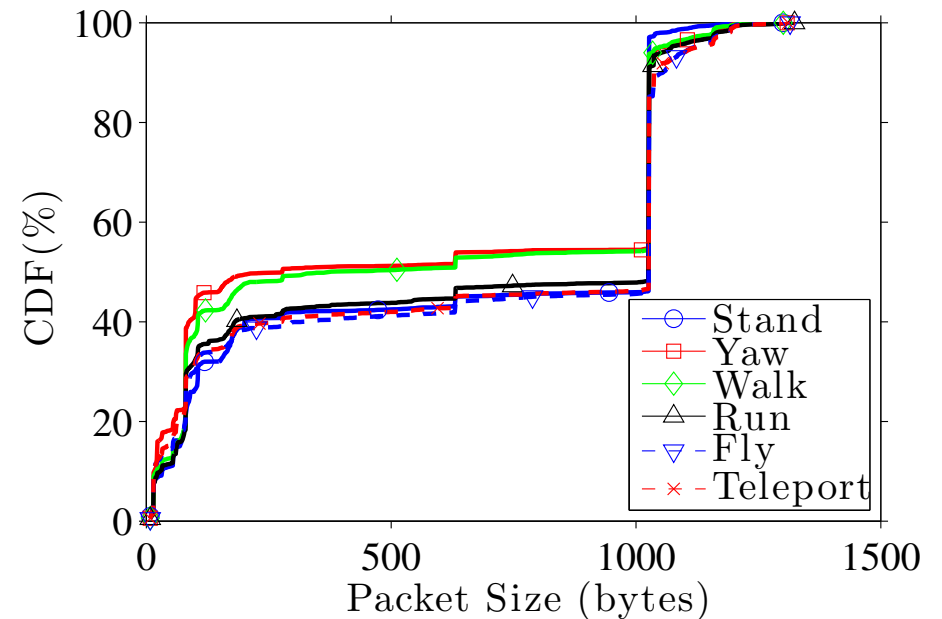
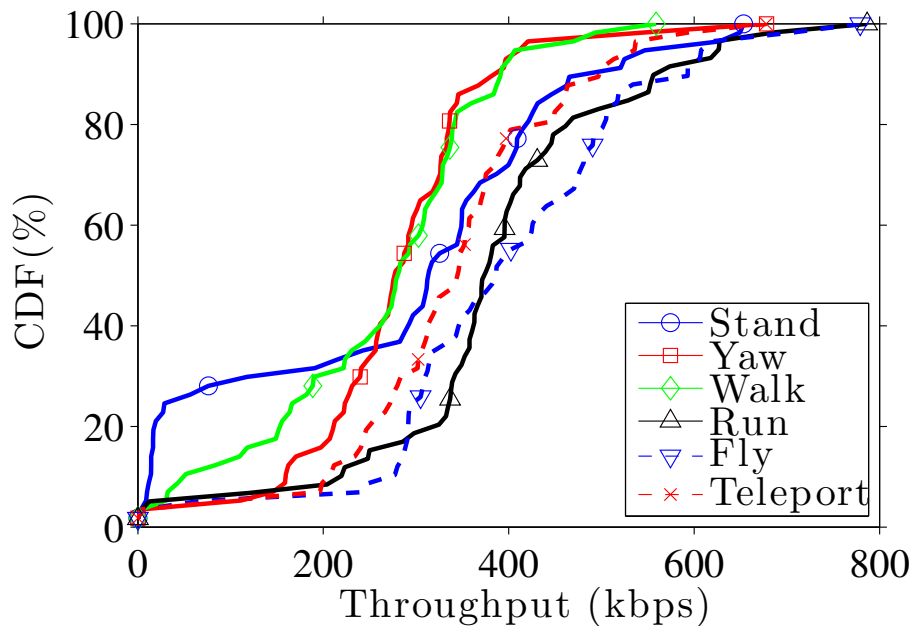
- Action script:
  - 1 min each
  - Randomly change destination/direction 5 times
  - Within region boundary
- Systemically visit 125 regions
- Cached and uncached
- Trace are processed for publication
  - Packet trace
  - Location trace
  - Statistics trace





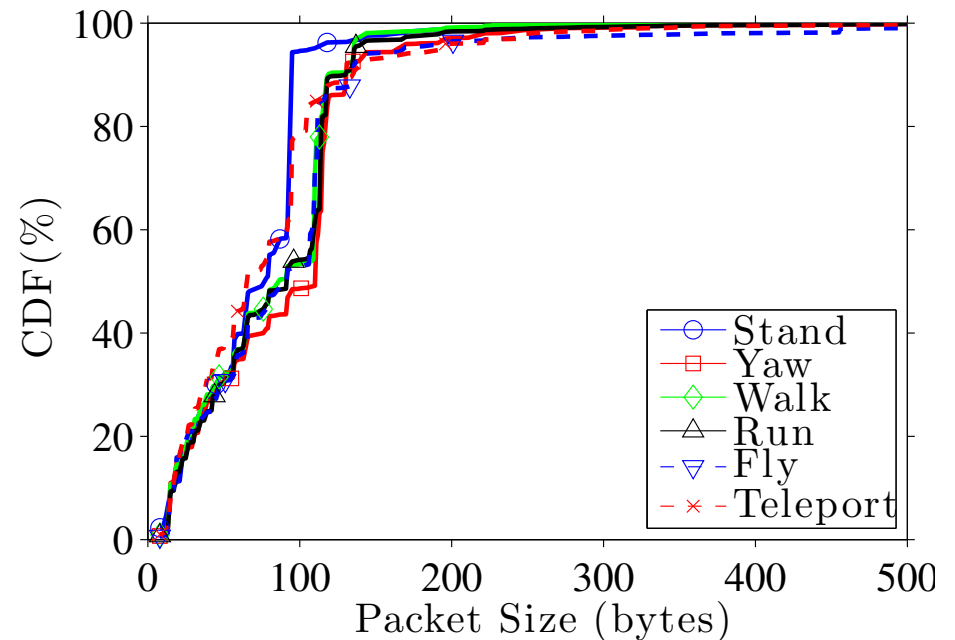
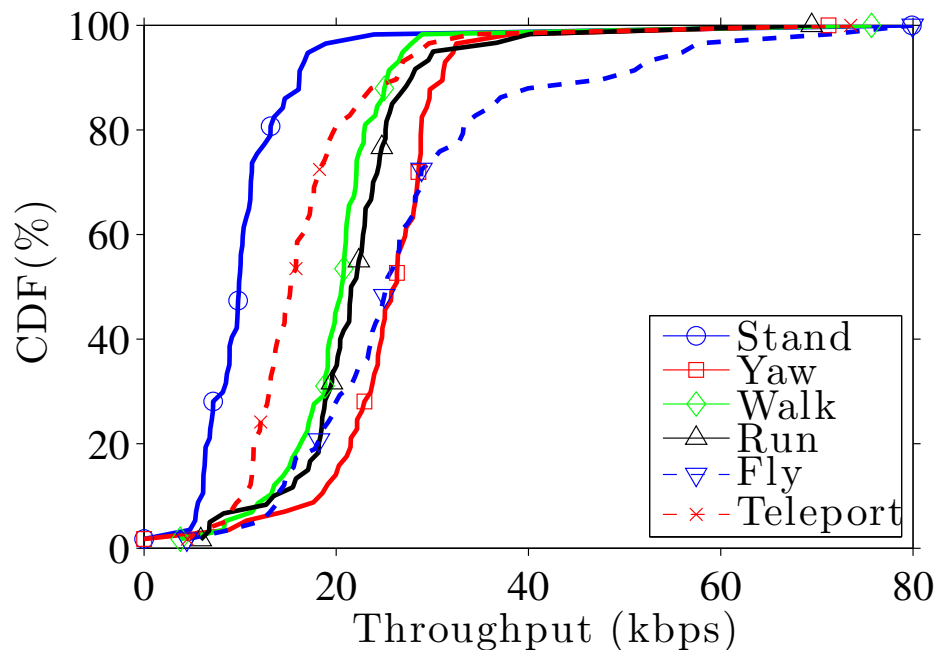
# Downlink Traffic Characteristic

- Region Tokugawa, uncached
  - High traffic volume
  - Bandwidth throttling
  - Packet type



# Uplink Traffic Characteristics

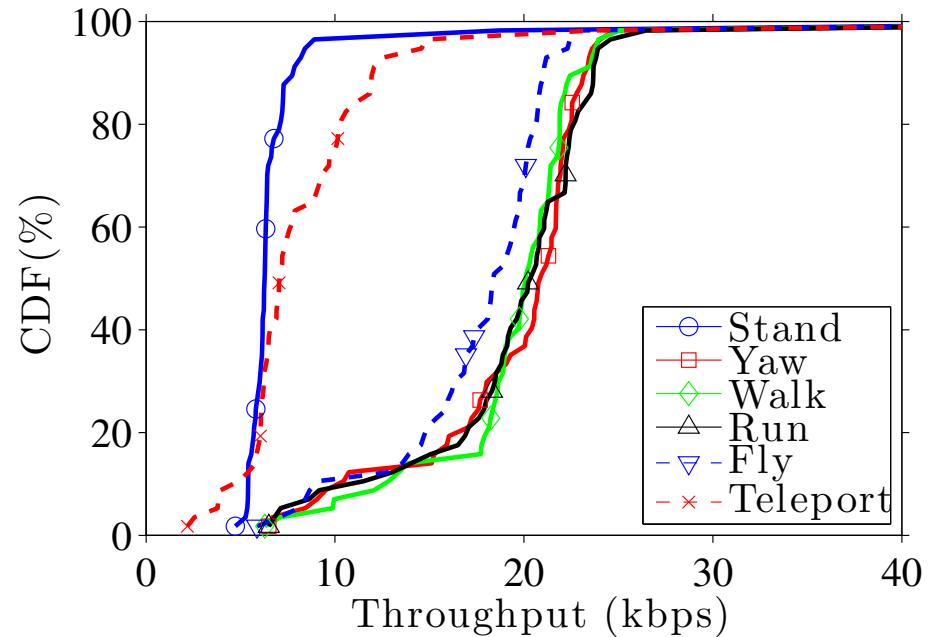
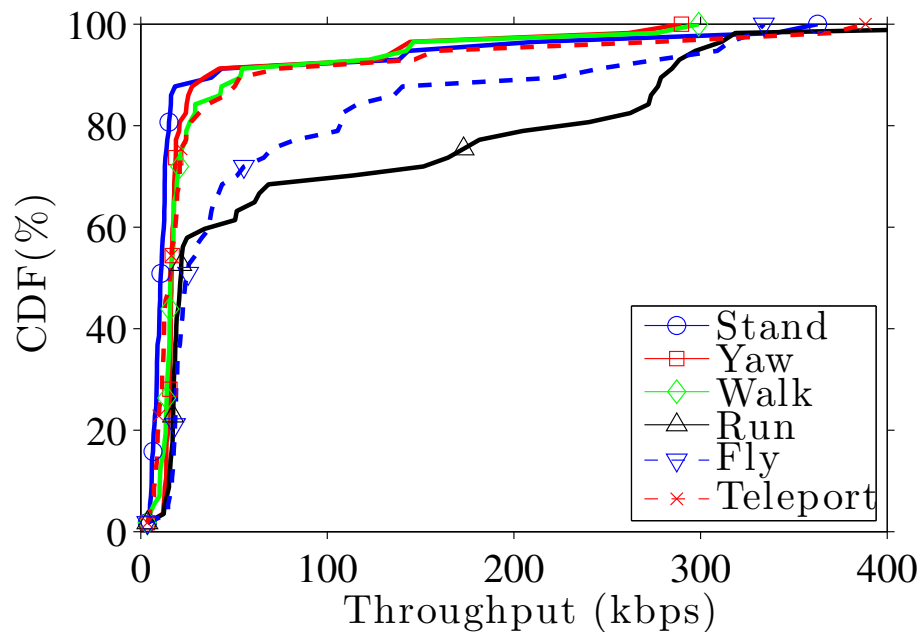
- Region Tokugawa, uncached
  - Lower traffic
  - Game logic only
  - Small packet size



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## Effect of Cache

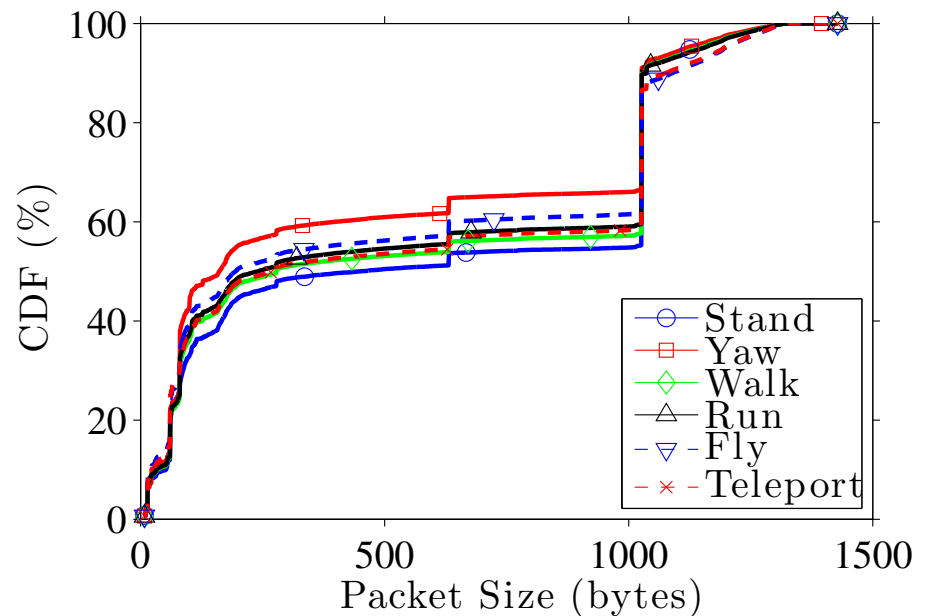
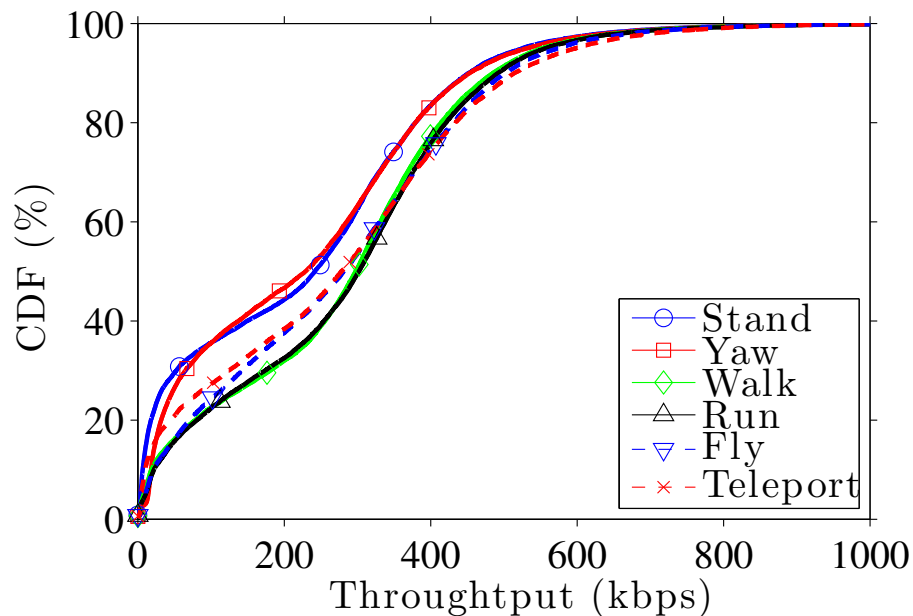
- Region Tokugawa, cached
  - Greatly lower traffic



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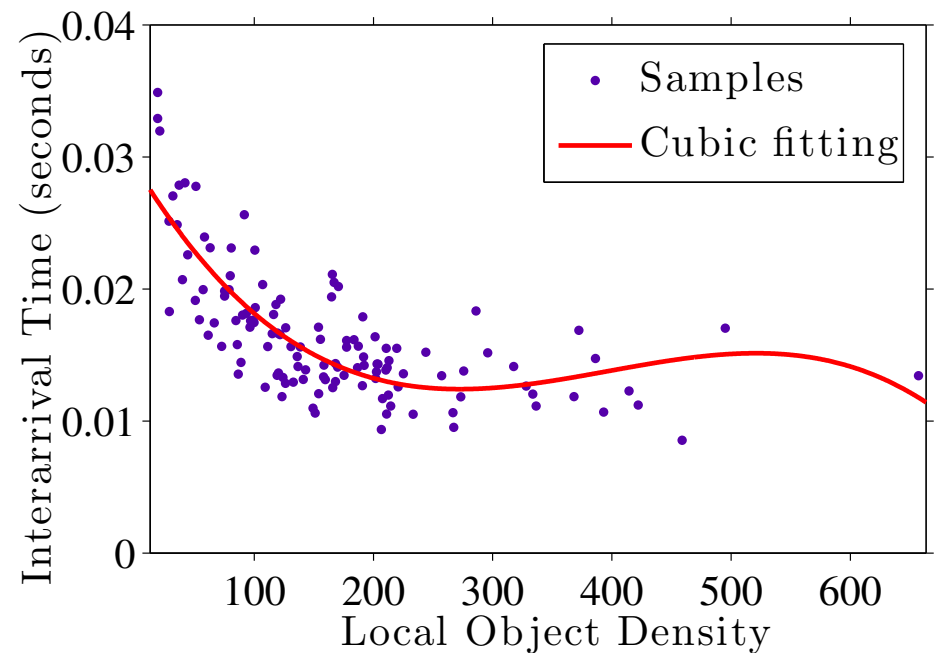
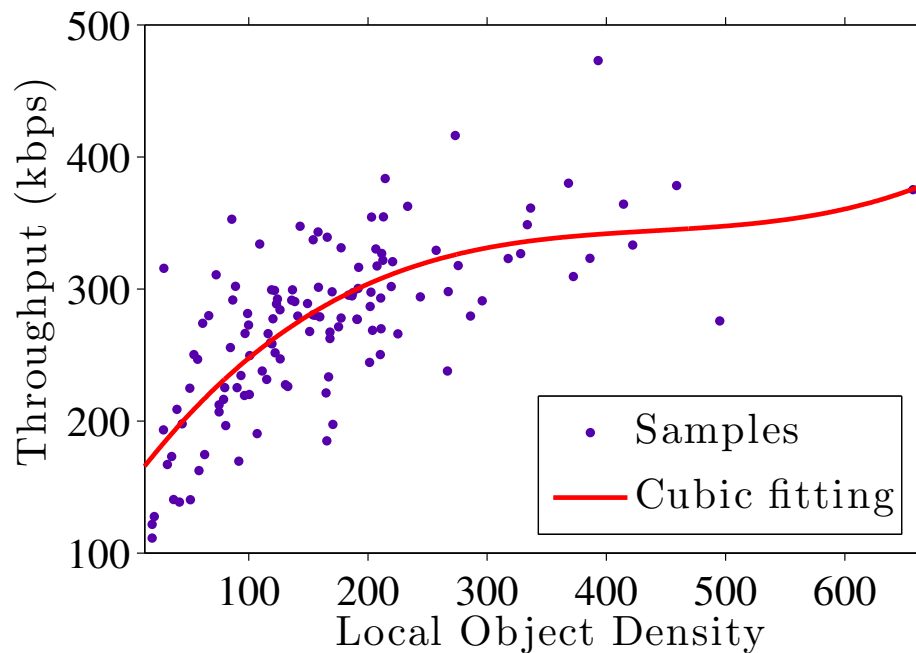
# Aggregated Traffic Characteristics

- Aggregated over 125 regions, uncached, downlink
  - In initial stage, action has insignificant effect
  - Packet size showed bimodal characteristics



# Avatar/object density correlation

- Local object count affects is correlated to traffic metrics
- Local avatar too little to statistically meaningful



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## References

- S. Fernandes, F. Antonello, J. Moreira, D. Sadok, and C. Kamienski. Traffic analysis beyond this world: the case of Second Life. (NOSSDAV'07)
- M. Ferreira and R. Morla. Second Life in-world action traffic modeling. (NOSSDAV'10)
- I. Oliver, A. Miller, and C. Allison. Virtual worlds, real traffic: Interaction and adaptation. (MMSys'10)
- J. Kinicki and M. Claypool. Traffic analysis of avatars in Second Life. (NOSSDAV'08)
- And many others, omitted due to space limitation



# Conclusion

- Applications:
  - Traffic modeling
    - Synthetic trace generation
  - Improving QoS
    - Prioritize according to packet type
    - Gateway for mobile devices
      - Texture down-sampling
- What we need: Parameterized model
  - There is no one-size-fits-all model

