

Mining Second Life: Characterizing User Mobility in a Popular Virtual World

Chi-Anh La - Pietro Michiardi

ACM WOSN 2008
Seattle, WA, U.S.



Outline of the talk

- 1 Introduction
- 2 Mining Second Life
- 3 Measurement Methodology
- 4 Results
- 5 Conclusion

Characterizing human mobility:

Objectives of this work:

Define a novel methodology to carry out experiments on human mobility with the following goals:

- Affordable experiments
- No logistic organization
- Wireless technology independent
- Scalability of experiments

Related works

Objectives of prior works:

- Build mobility **models** from traces
 - Performance evaluation of forwarding strategies in DTNs
-
- Chaintreau *et. al.*: IEEE Trans. Mobile Computing 2007
 - Karagiannis *et. al.*: ACM Mobicomm 2007
 - Rhee *et. al.*: IEEE Infocom 2008

Related works: Experimental Methodology

- Select hardware → **exhausting task**
- Neighbor discovery → **hard for wifi in ad-hoc mode**
- Prepare / finalize the experiment → **logistic problems**

Related works: Restrictions

- Available traces are **difficult to use** (and debug)
- Experiments are **bound to specific wireless hardware**
- In general, only **“temporal” information** is available
- GPS-based experiments only for out-door scenarios
- Number of participants to experiments is **fixed**

The idea

Exploit Virtual Worlds

Networked Virtual Environment are a tremendously popular concept of on-line communities:

- User interaction is **synchronous**
- Contrast with Social-Networking applications such as FaceBook: **asynchronous** interaction

In this work we use **Second Life** and capture user interaction as well as user spatial distribution.

Our Playground: Second Life

- Second Life architecture:
 - Flat, Earth-like world simulated on a large **server farm**
 - World is divided into 256x256 m “lands”, one server per land

→ **Limitation on number of concurrent users** on each land

- Each land has attributes:
 - private
 - public
 - sandbox

→ **Limitations** on user-generated content deployment

Monitoring Architectures

- Measurements in Second Life can be approached under different angles
 - Use Second Life to build and deploy monitoring probes
 - Use Second Life to mimic real world experiments
 - System approach: connect to Second Life and get data
- We built a **lightweight client** with **crawls** a selected land
 - *Input:*
 - Valid Login/passwd
 - Target Land
 - Measurement granularity
 - Measurement duration
 - *Output:*
 - Anonymized user ID
 - (x, y, z) of **every user** on the target land every τ seconds

The Crawler Approach

Observations:

- The crawler **is a user** → should not introduce bias in experiments
- **One crawler per land** is sufficient
 - All users concurrently connected to the target land can be tracked: we override a method used to build maps
 - Multiple lands can be tracked using an “army” of crawlers
- **Limitation**: maximum number of concurrent users

Measurement Methodology

We present results for the following lands:

- Open Spaces:
 - Apfel Land: a german-speaking arena for newbies
 - Island of View: Valentine's day **event**
- Confined areas:
 - Dance Island: a virtual discotheque

Note:

- Selecting lands is a tedious manual exercise
- Automate the process

Using SecondLife Traces

How do we use the traces?

Using the coordinates of users connected to a target land we create several snapshots of **radio networks**

- Given a communication range r , a link between two users u_i, u_j exists if their distance $d(u_i, u_j) \leq r$
- We build snapshots every measurement interval $\tau = 10$ sec
- $r \in \{r_b, r_w\}$, where $r_b = 10$ m (bluetooth) and $r_w = 80$ m (WiFi at 54 Mbps)

Metrics

Temporal:

- Contact Time
- Inter Contact Time

Spatial:

- Node degree distribution
- Network diameter
- Clustering Coefficient
- Zone occupation

Mobility:

- Cumulative traveled distance
- Login time

Results: Some Numbers

24-hours traces

Apfel Land:

- Unique visitors: 1568
- Average concurrent users: 13

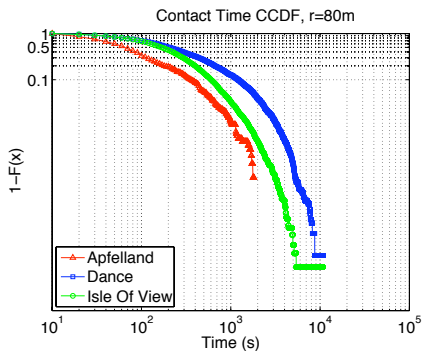
Dance Island:

- Unique visitors: 3347
- Average concurrent users: 34

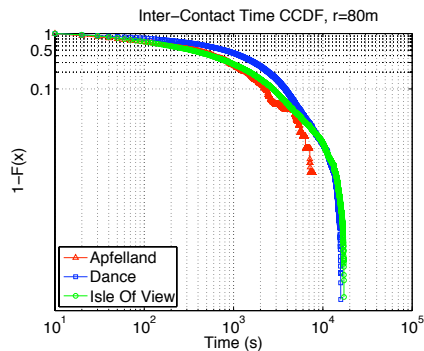
Isle of View:

- Unique visitors: 2656
- Average concurrent users: 65

Results: Temporal Analysis (1)

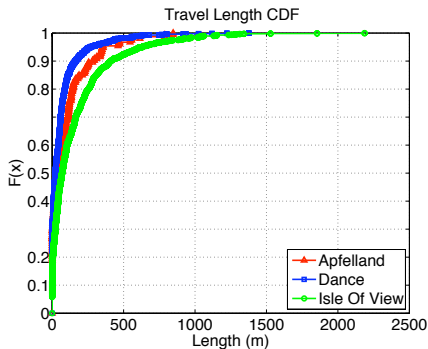


- Contact Time = transfer opportunities between users
- Large values are good

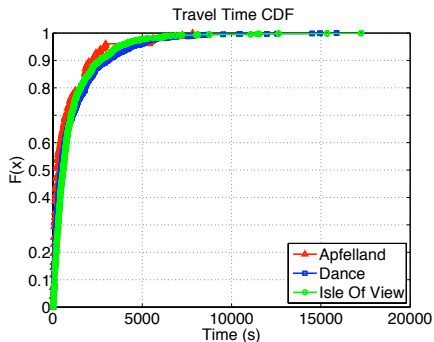


- Inter Contact Time = time to wait before **a pair** meets again
- Large values are supposedly bad

Results: Trip Characteristics



- Users do not exercise a lot!
- Closed vs. open spaces

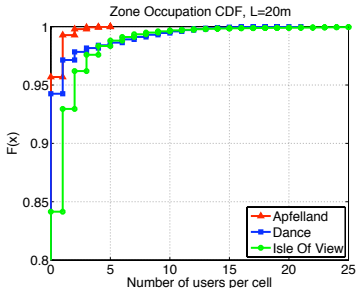


- Max on-line time ~ 4 h
- 90-th perc. on-line < 1 h

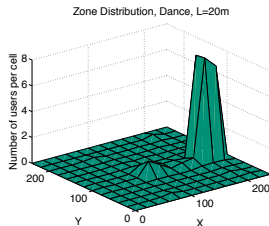
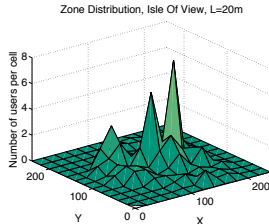
Our explanation:

Quite obvious (and similar to real world): users do not move when they chat!

Results: Spatial Distribution



- **Not** a uniform distribution
- Most of the users are grouped
- Closed vs. open spaces



Concluding remarks

- Novel approach to study mobility
- Do real people walk like avatars?

Beyond mobility analysis

- Epidemiology
- Sociology
- Virtual playground to test applications

Thank you!

Need traces?

Contact: Pietro.Michiardi@eurecom.fr

Web: www.eurecom.fr/~michiard