Unwinding spatial and transpatial networks

Vassilis Kostakos
University of Oulu

17 December 2012, Lorentz Center, Leiden, Netherlands
Workshop on Computational Models of Physical/Virtual Space Interaction.

Who

Vassilis Kostakos
Prof. Computer Engineering
in Ubiquitous Computing

vassilis@ee.oulu.fi
www.ee.oulu.fi/~vassilis

UBI program
http://www.ubioulu.fi

UNIVERSITY of OULU
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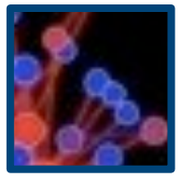
What



Social and complex networks

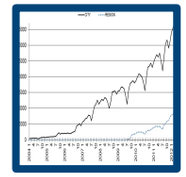
Sensing urban mobility

Public interactive displays

Security and privacy

How

Instrumenting mobile platforms



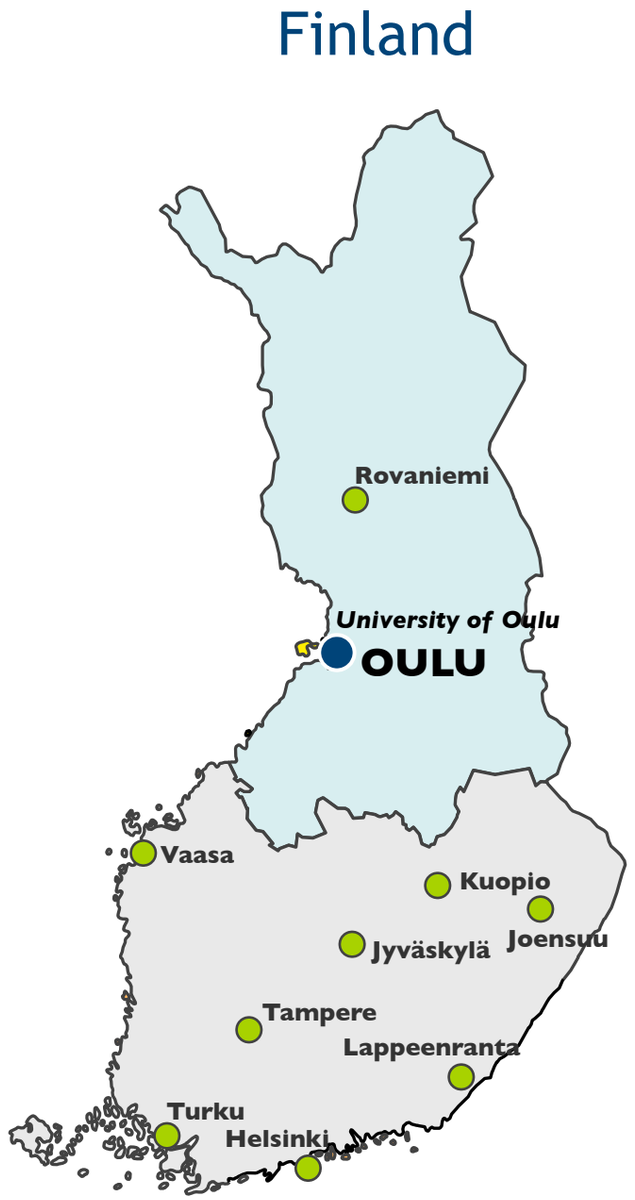
Real-time city-sensing

Human subjects studies

Large scale deployments

University of Oulu

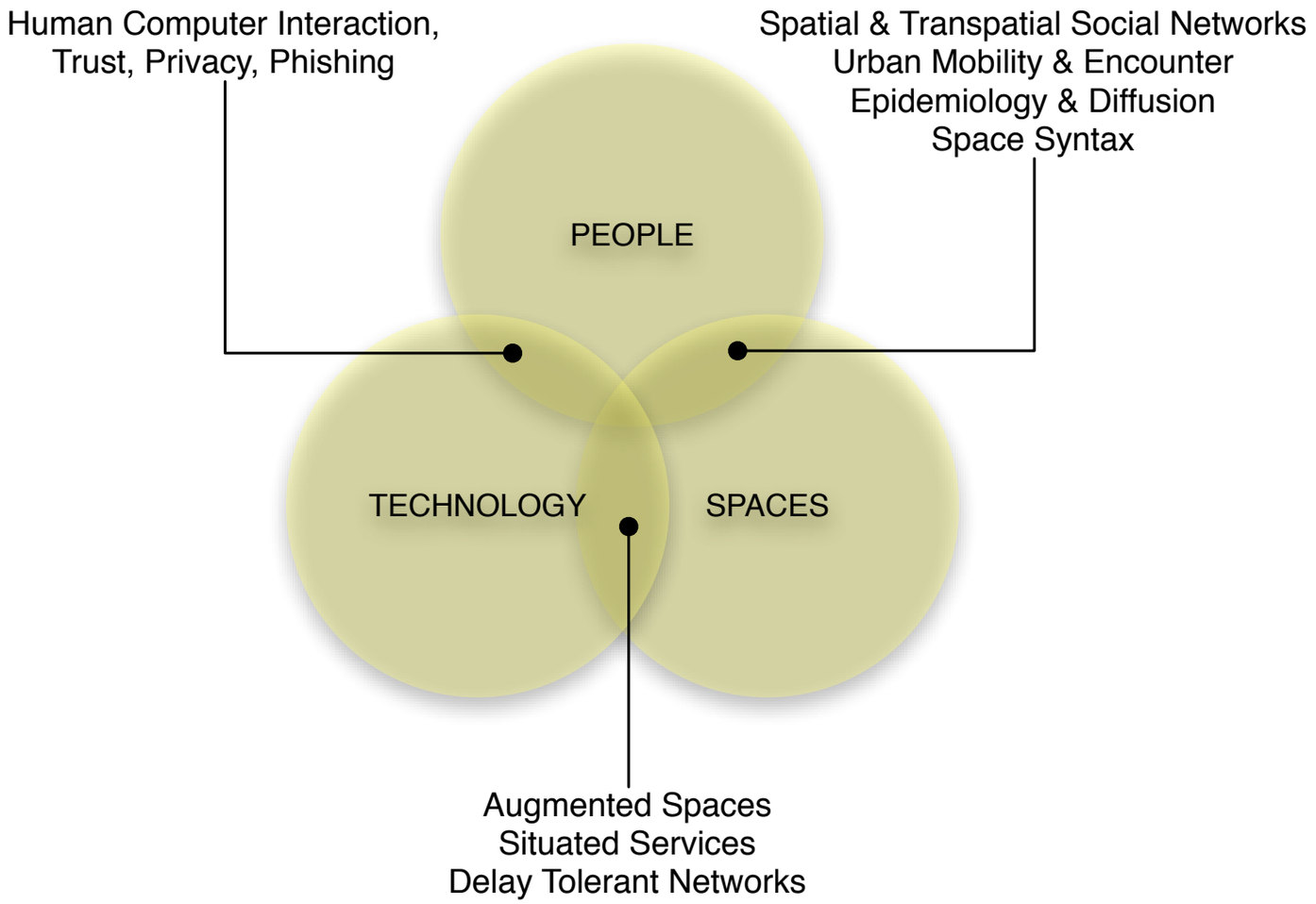
- Founded in 1958
- 6 faculties
- 16 000 students
- 2900 employees
- Total funding EUR 226 million
- Four research focus areas:
  - Information Technology
  - Biosciences and Health
  - Cultural Identity and Interaction
  - Environment, Natural Resources and Materials



Overview

- MediaTeam Research Group (Urban Interactions)
  - 4 professors, 50 researchers & staff
- Multidisciplinary
  - Computer Science (HCI, ubiquitous computing)
  - Anthropology
  - Sociology
  - Architecture (urban)
  - Design

Ongoing work

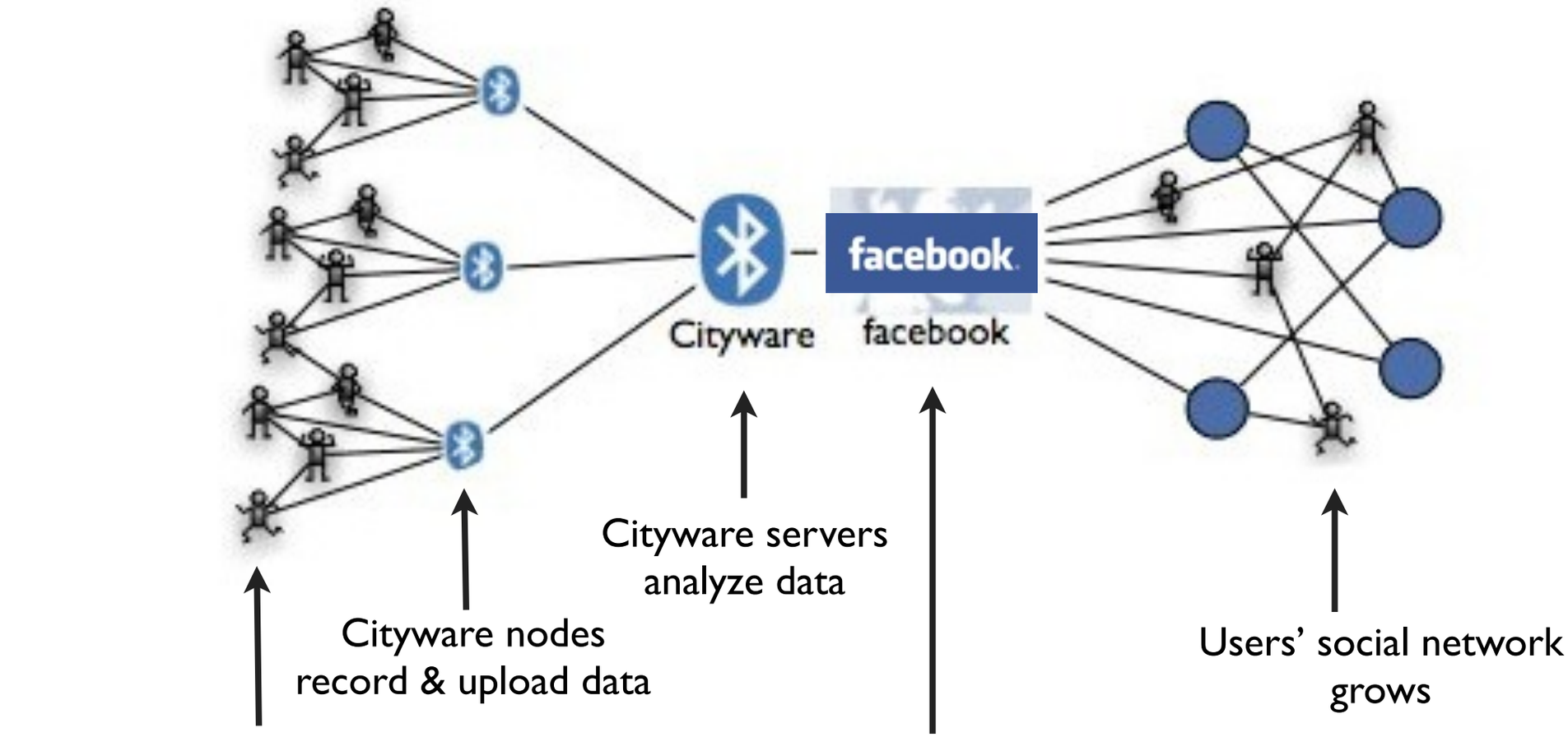


- Real vs. Virtual "Space"
- Think of online space as a version of the "real" world
- Think of the urban space ("real" world) as a version of online space: data & numbers
- People: the link

Outline

- How do online and face-to-face networks relate to each other?
- How do networks effect trust in location-sharing?
- Ongoing work: the real-time city

Study I


Cityware
facebook
facebook
Cityware servers analyze data
Cityware nodes record & upload data
Users' social network grows
People with Bluetooth devices bumping into each other(school,shopping,work)
Facebook application presents data

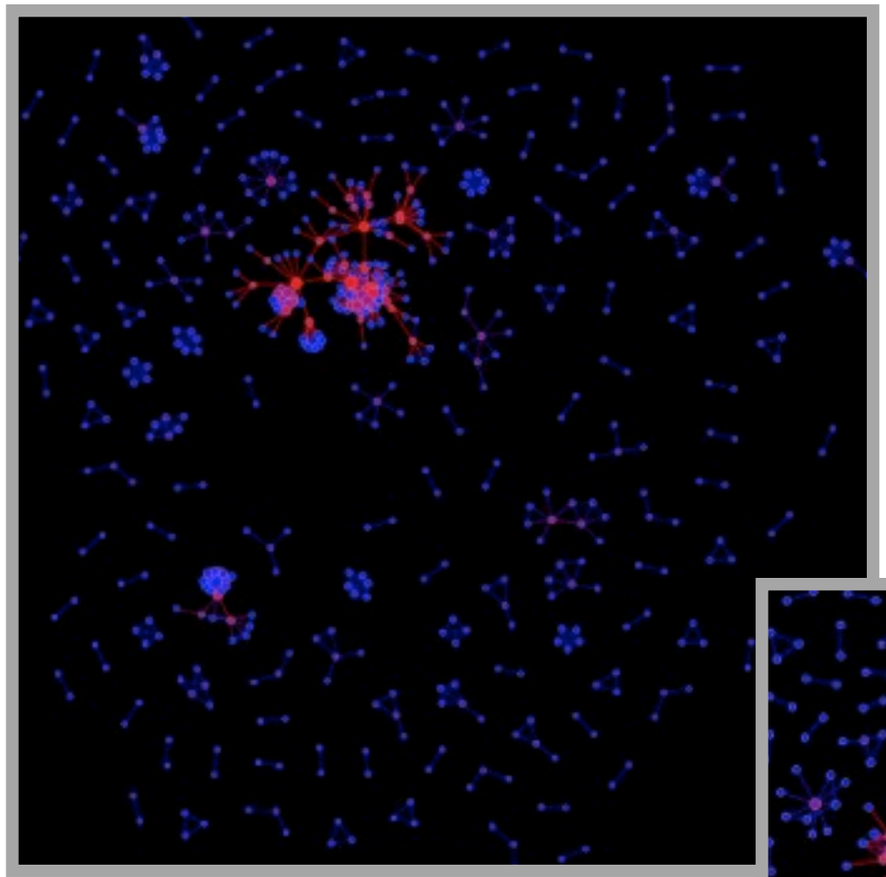
Data

- 2602 participants
- Co-presence data [‘A’ was co-located with ‘B’]
  - Subset of actual physical encounters, March 2007
- Facebook friendship network [‘A’ is friends with ‘B’]
  - recorded after bluetooth data collection

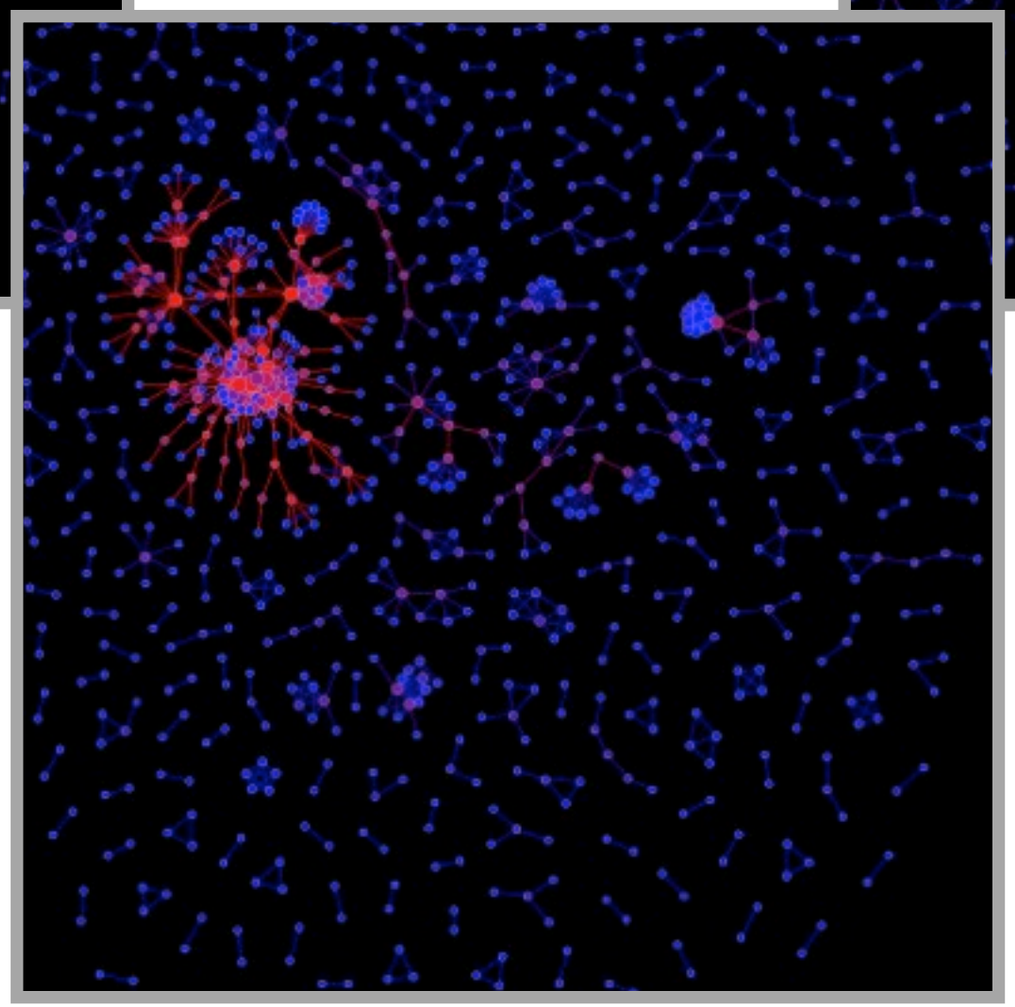
Data coding

- **Encounter network (Spatial network)**
  - Users linked if they were co-located during the study
- **Facebook network (Transpatial network)**
  - Users linked if they were friends on Facebook
- **Fused network**
  - Encounter and Facebook networks fused
  - 3 types of ties : Encounter, Facebook & ‘Fused’

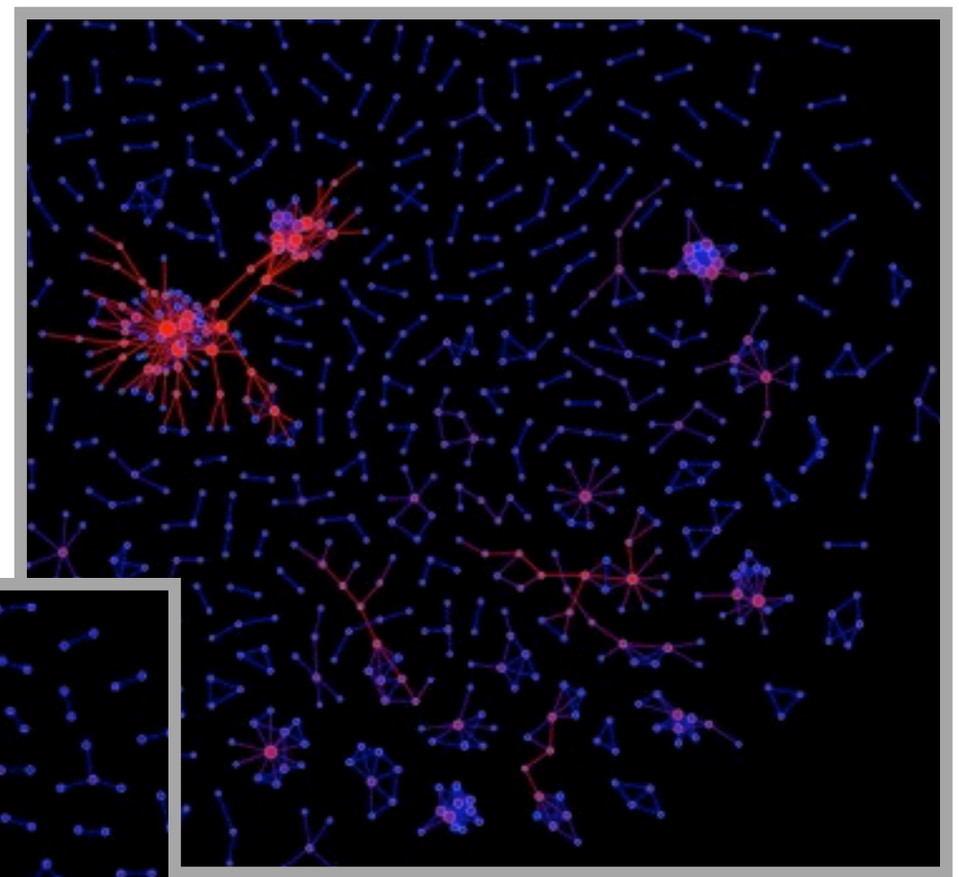
Facebook



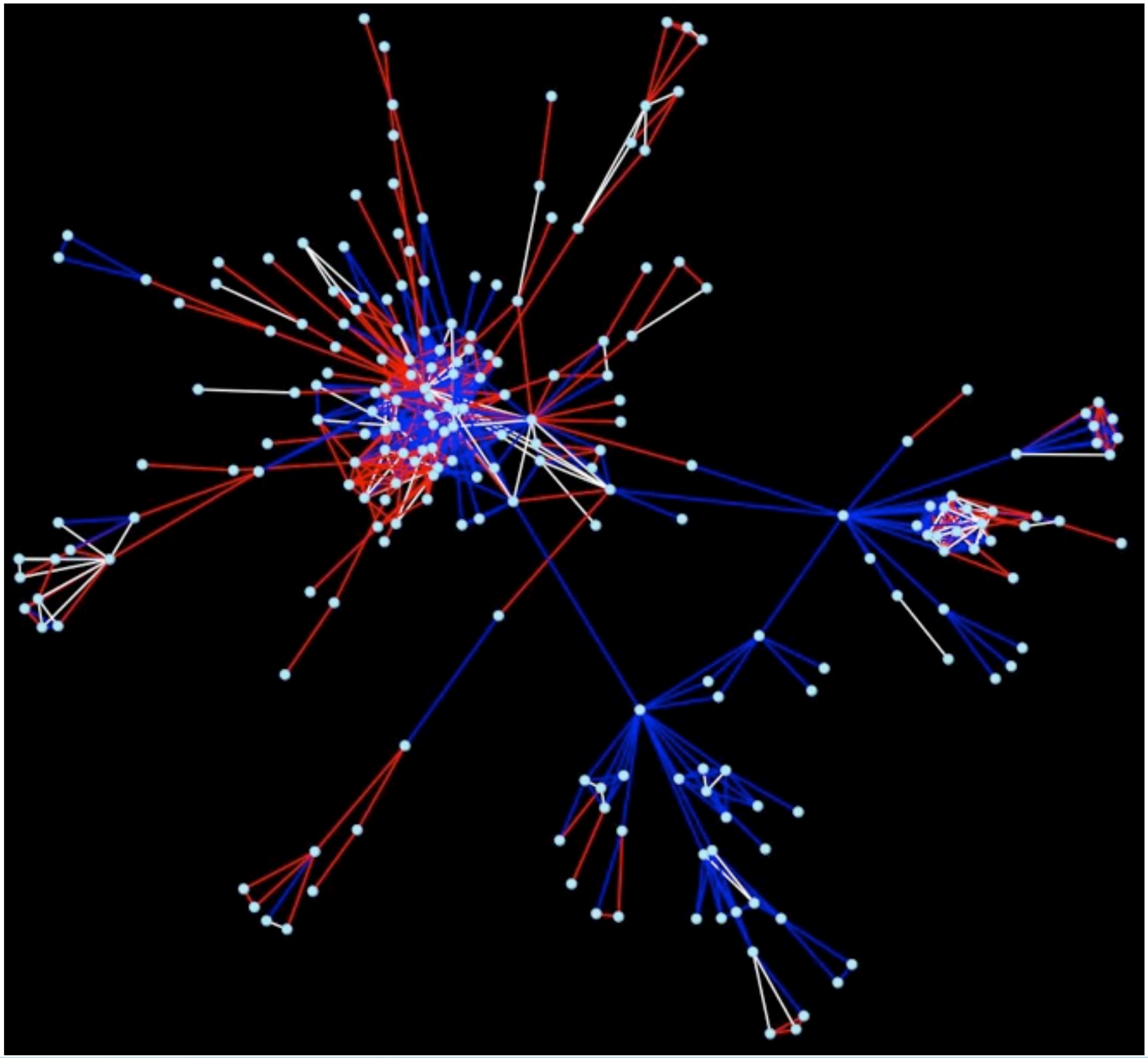
Fused



Encounter



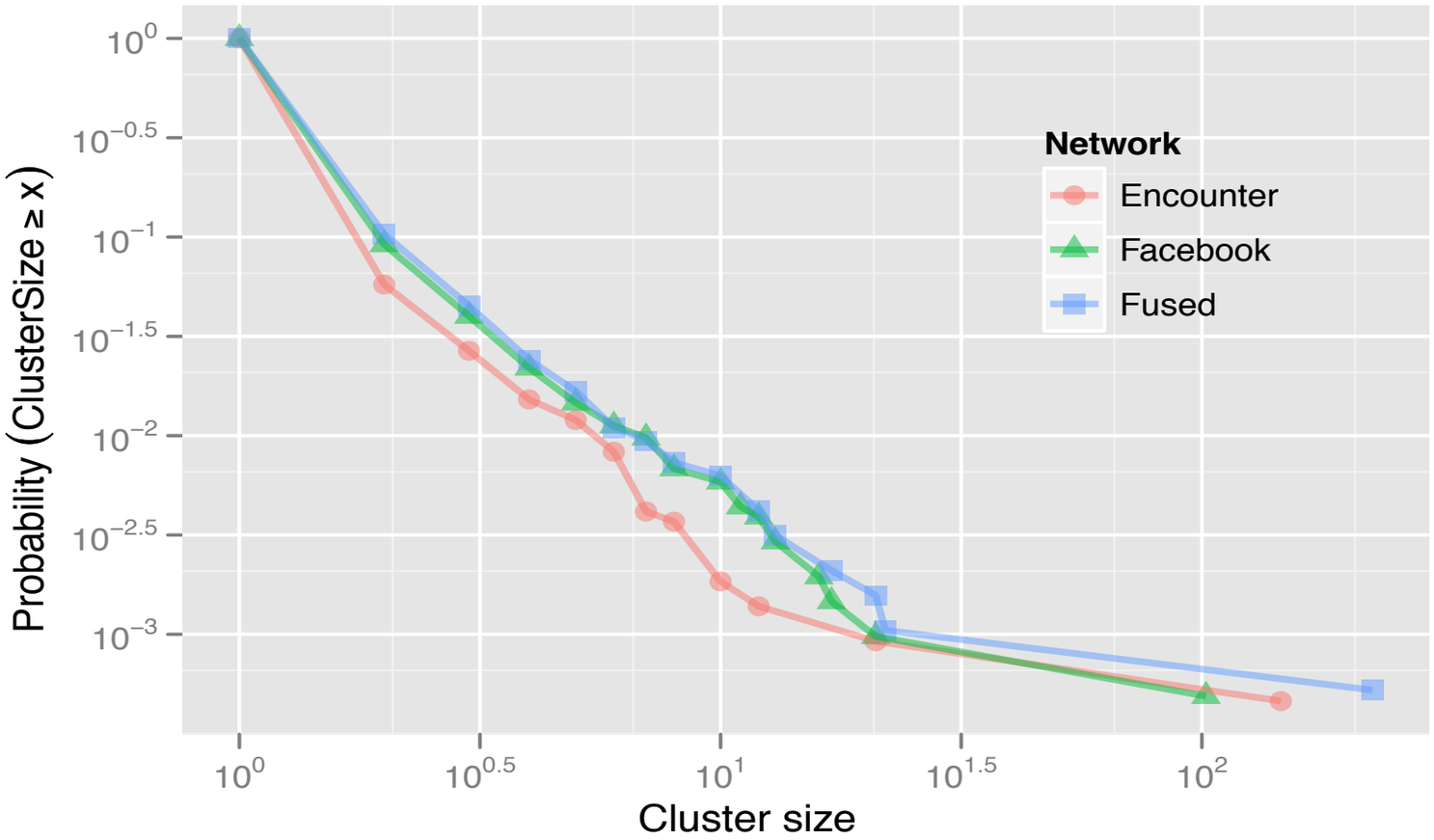
Fused



Results

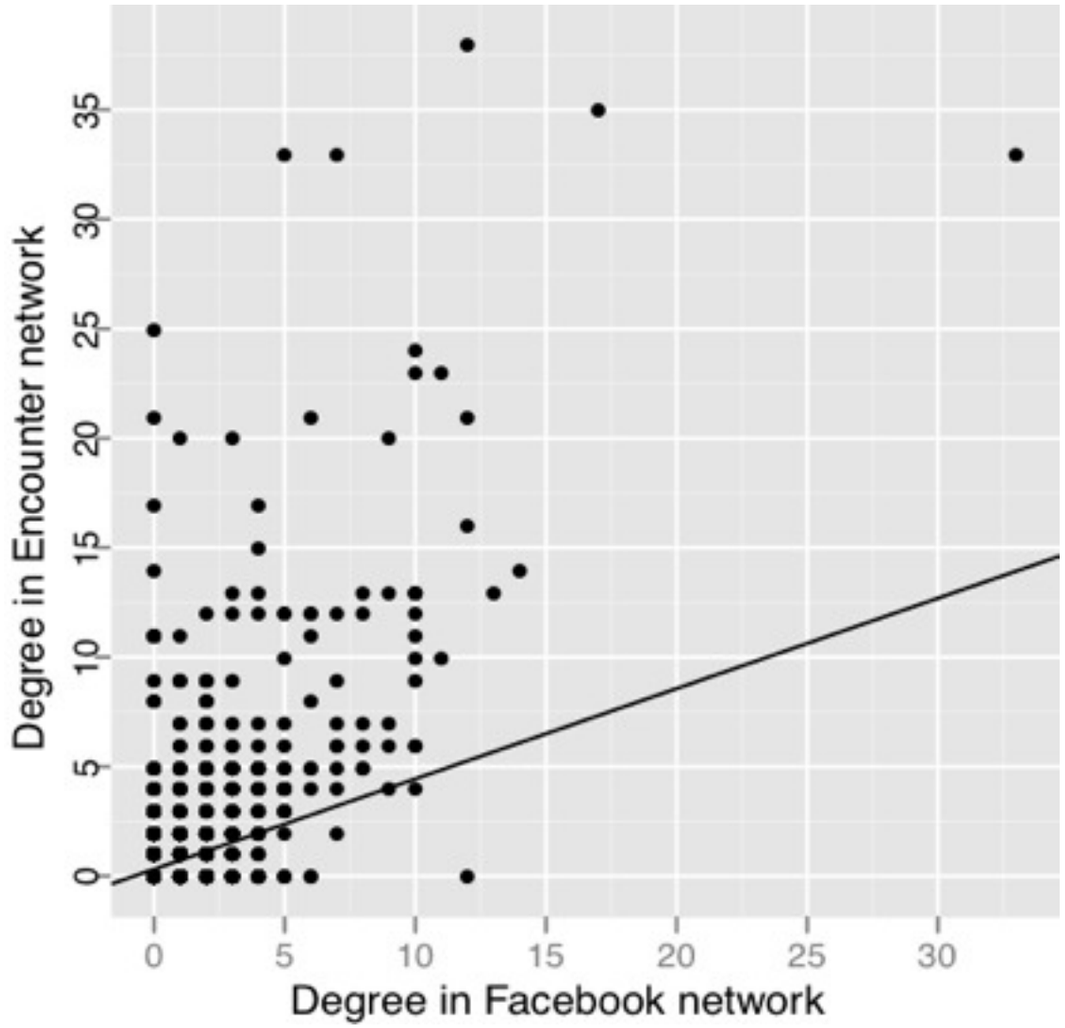
Structural Characteristics

- Multiple connected components



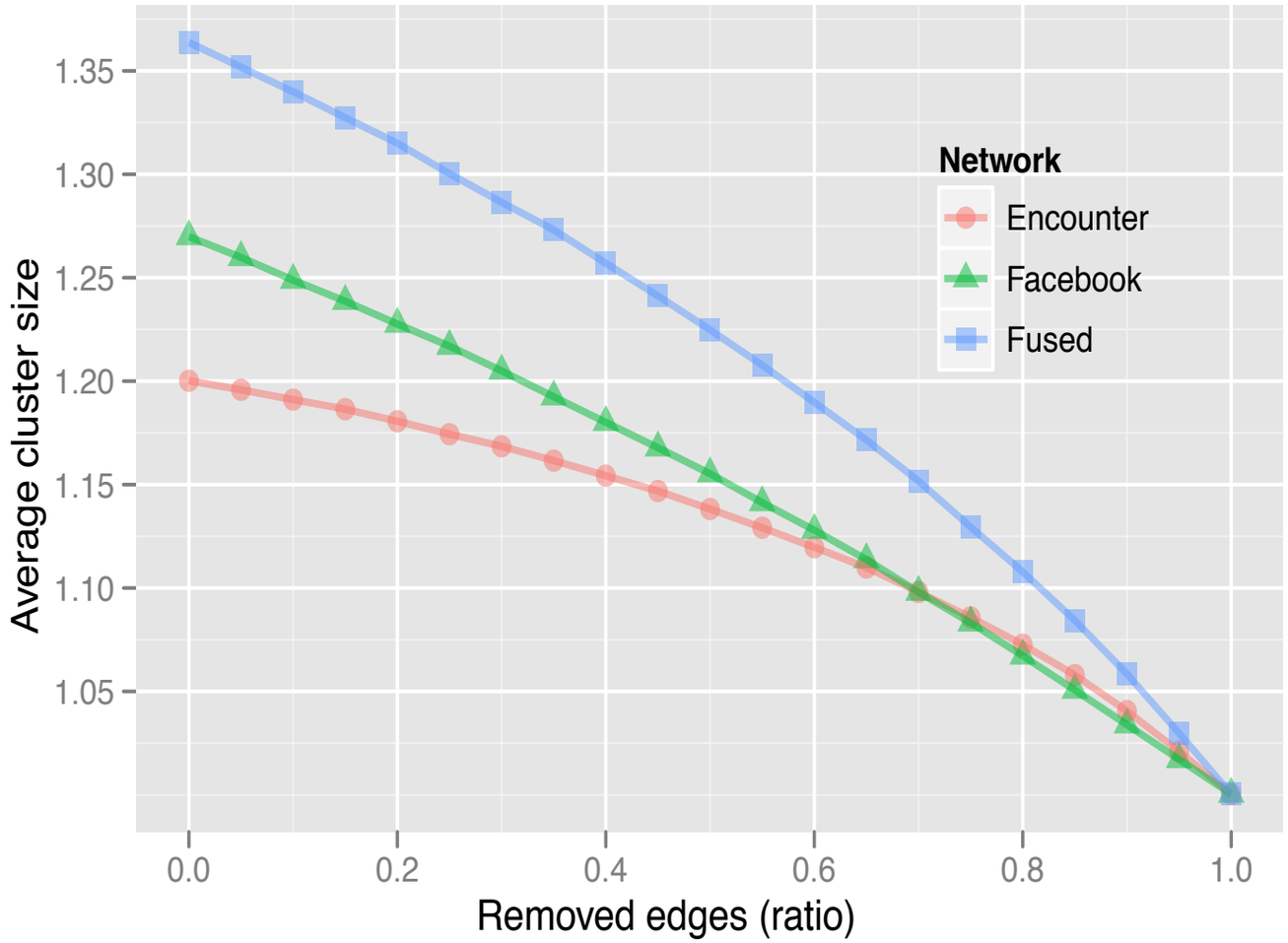
Structural Characteristics

- Correlation of Structural Features of nodes
  - Degree - 0.68
  - Closeness - 0.46
  - Betweenness - 0.24
  - Clustering Coeff. - 0.46



Resilience

- Average size of clusters as edges are removed

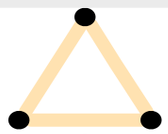
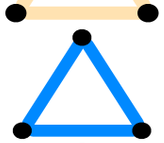
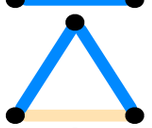
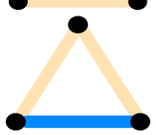
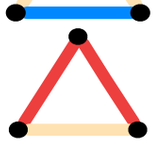
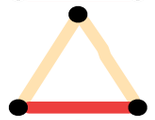
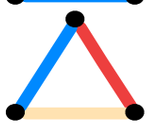


Links

- Significant effect of link type on link betweenness ($p<0.0001$)
  - In the fused network
  - Types of links in order of importance: Encounter, Facebook, Fused

Triads

- **Triad**: A set of nodes that are mutually connected
- **Observed**: Frequency of each type in our network
- **Expected**: Frequency in a random assignment of edge types

Triad	Observed	Expected	Popularity
A 	220	45	4.9
B 	587	171	3.4
C 	650	329	2.0
D 	270	211	1.3
E 	103	152	0.7
F 	34	54	0.6
G 	85	143	0.6
H 	81	349	0.2
I 	43	237	0.2
J 	64	447	0.1

A generative model

1. Assume a fixed number of locations and people
2. At each location people encounter each other randomly
3. If two people encounter each other, there is a probably that they become friends on Facebook
4. People may become friends on Facebook even if they have not met face to face
5. Some Facebook friends may visit each other
6. People may travel to locations even if they know no- one there

Take-away points

- Bluetooth and Facebook networks exhibit similar structural characteristics
- Suggests that as users' proxies to actual social networks, they reflect similar aspects
- Fused ties least important
  - Further reflects Granovetter's ties strength hypothesis: Fused ties are more likely with close relatives or colleagues
- Spatial ties more 'important' than transpatial - might sound counterintuitive
  - Bluetooth has the potential to record "familiar strangers" relationships

Kostakos, V. and Venkatanathan, J. (2010). Making friends in life and online: Equivalence, micro-correlation and value in spatial and transpatial social networks. In proceedings IEEE SocialCom, Minneapolis, USA, pp. 587-594

Study 2


facebook
Places


foursquare

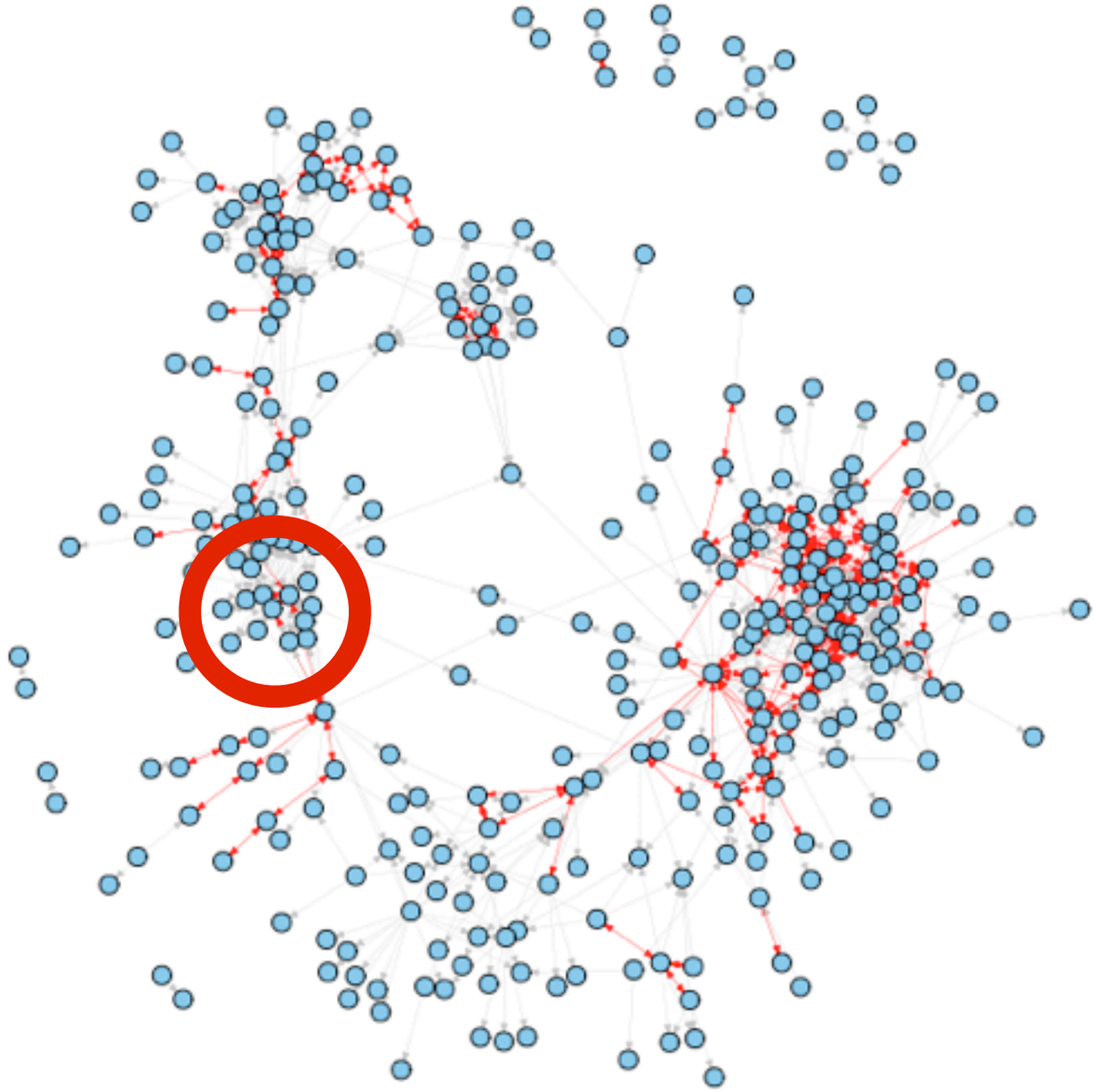

Gowalla


WHERE ARE YOU?


Google Latitude
E Pike St
Madrona
Yesler Terrace
E Yesler Way
S Jackson St
©2009 Google - Map data ©2009 Tele Atlas - Terms of Use
Get Google Latitude on your phone.
Brady f
Seattle, WA 13 days ago
in Seattle, WA
view profile »

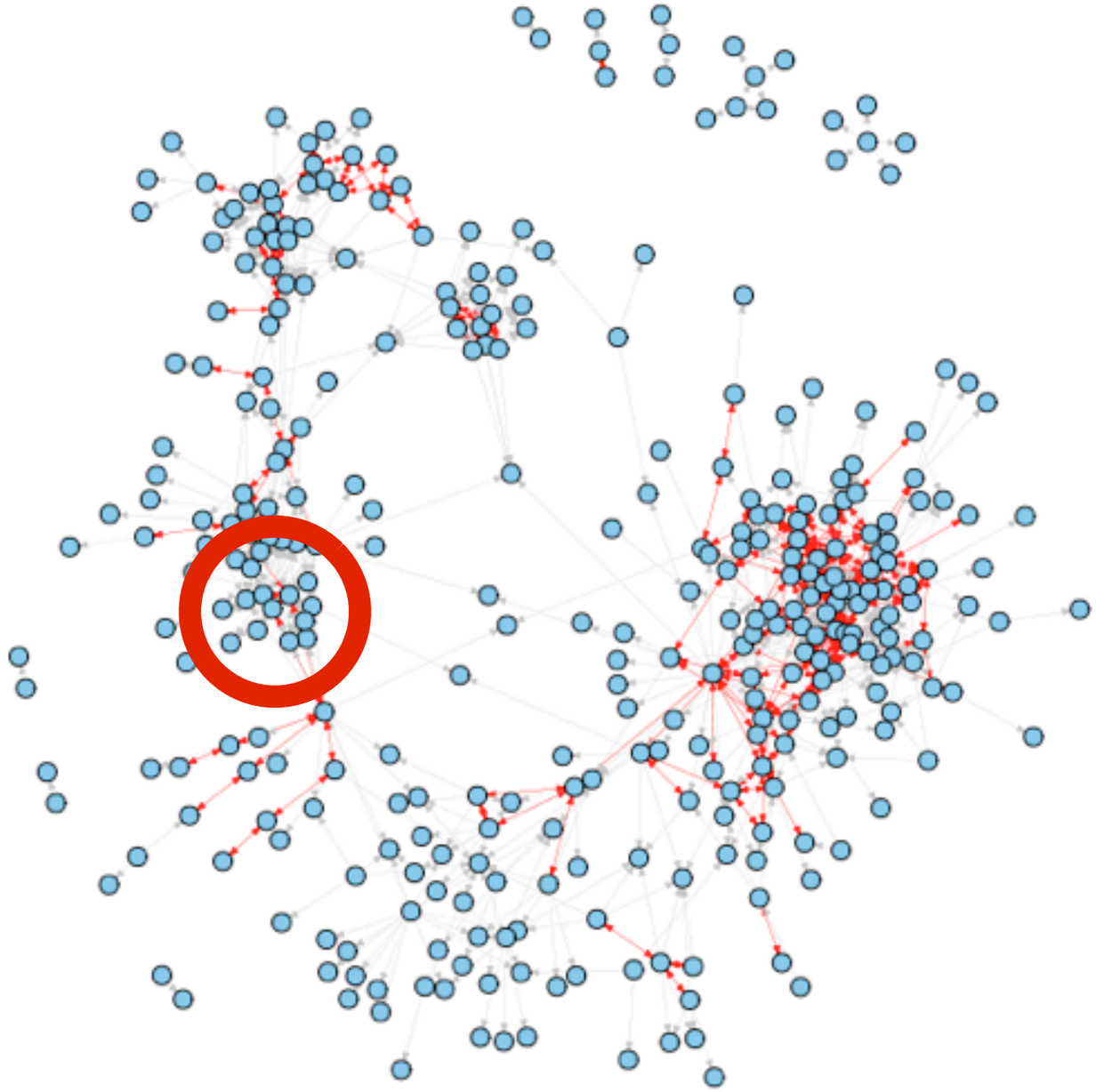
Question 1

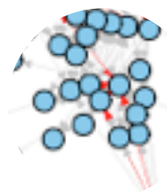
- Given a group of users and the social ties amongst them
- is it possible to predict which of these users is likely to
- reveal the most about their whereabouts?

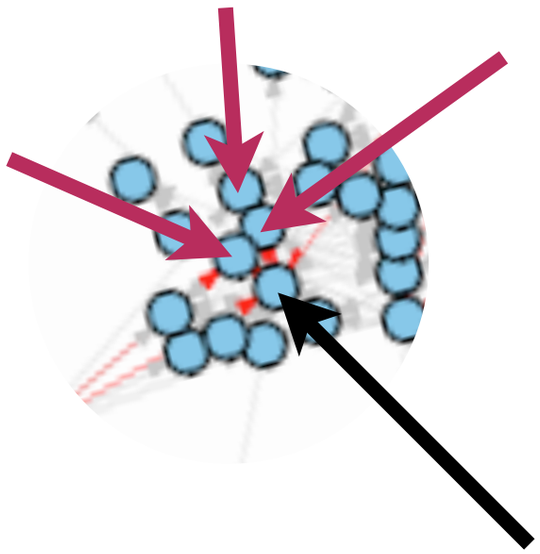


Question 2

- Given a "target user", is it possible to predict which of his friends knows most about his whereabouts?








facebook
Home
Profile
Friends
Inbox
Norman Sadeh
Settings
Logout
LOCACCINO
HOME
PRIVACY SETTINGS
WHO'S VIEWED ME
DOWNLOAD
INVITE
HELP!
Location
[close]
Approximate location:
456 S Craig St, Pittsburgh, Pennsylvania 15213
Map data ©2009 MapLink, Tele Atlas
Janice Tsai
11:50 AM-12:14 PM, Fri, Mar 13
456 S Craig St, Pittsburgh, Pennsylvania 15213 [map]
Deny
Offline
Allow

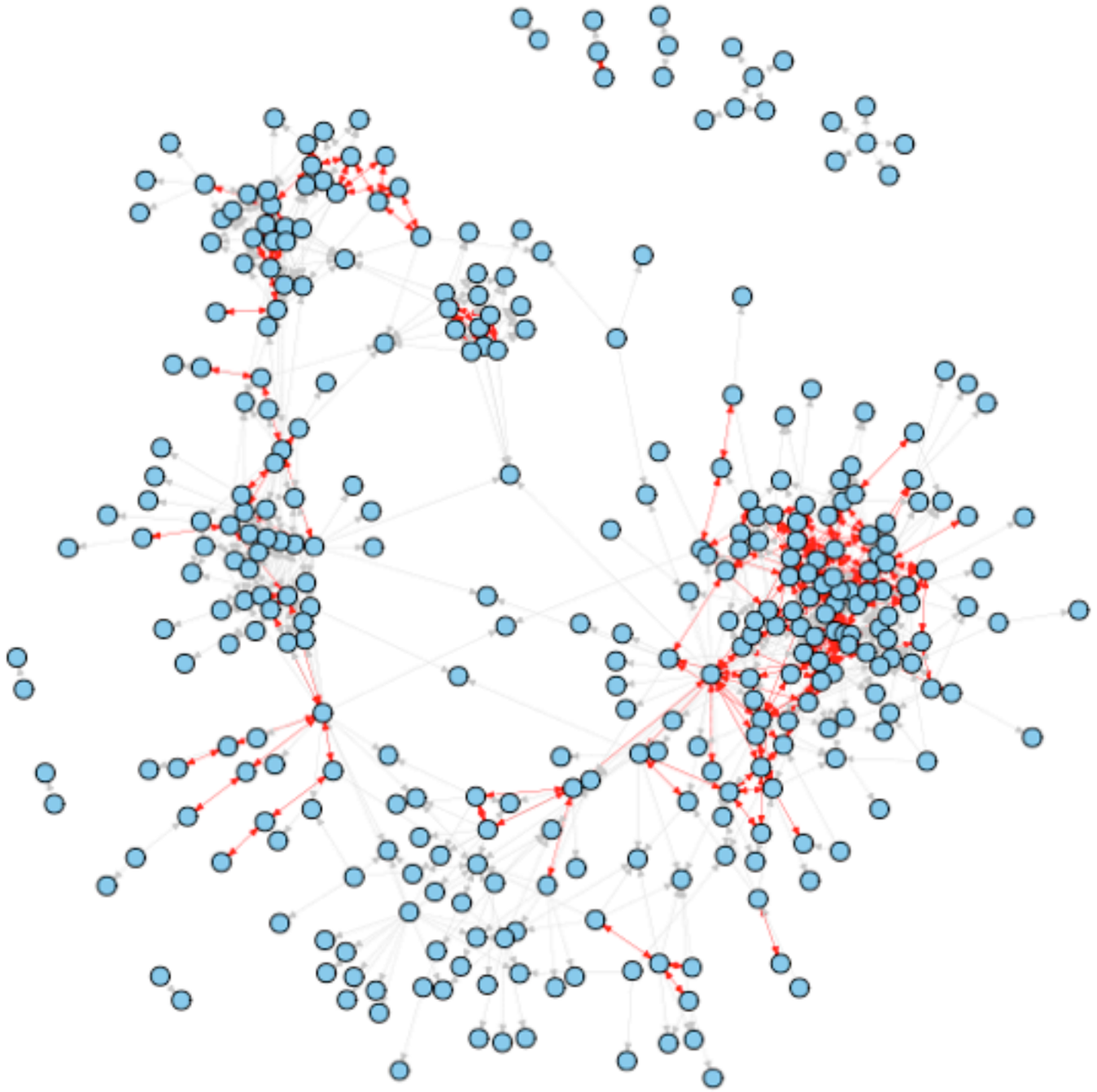
Collected data

- Study running for 1 year +
- For each user:
  - Friends (via Facebook)
  - Privacy preferences (policies)

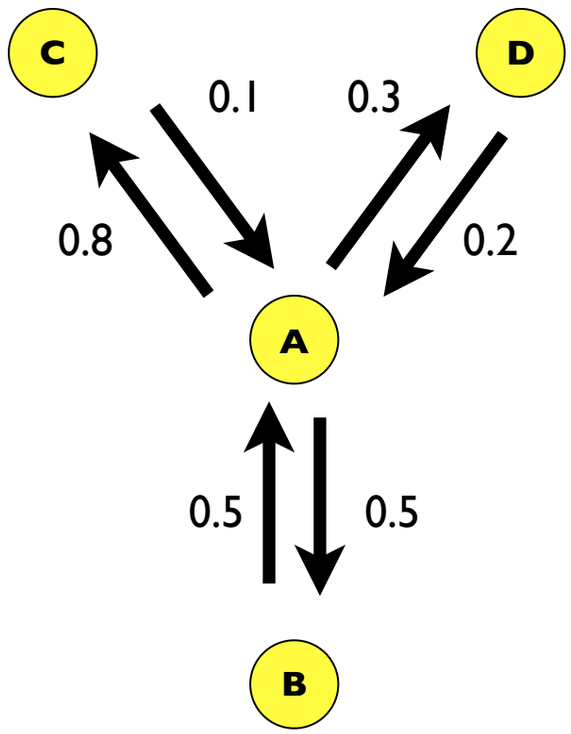
- 340 users
- 889 friendship pairs
- 1778 policies (=889*2)

Policy definition

- Probability that user A will share his location with user B
- Values: 0 ~ 1

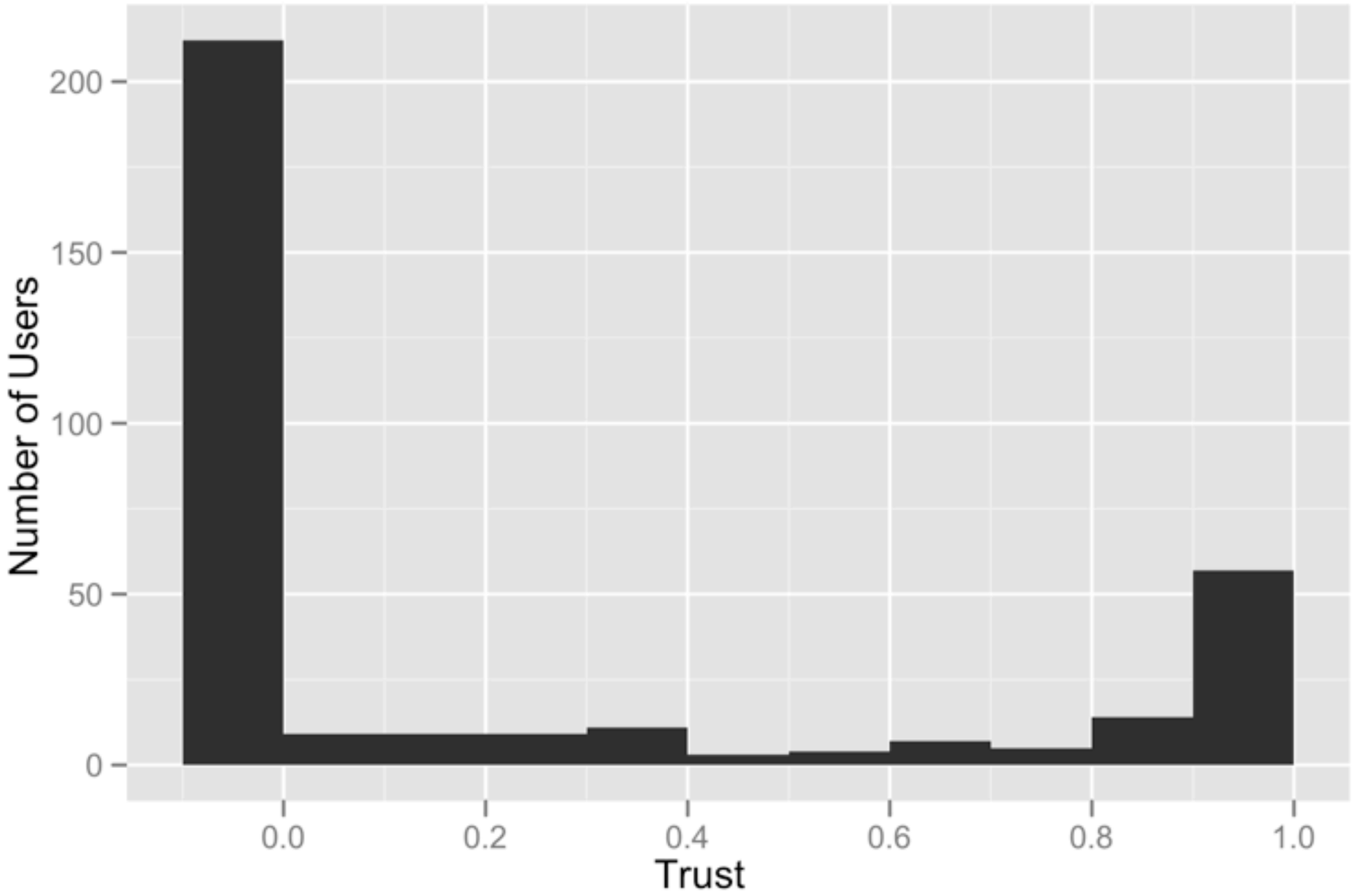


Trust vs. Trustworthiness

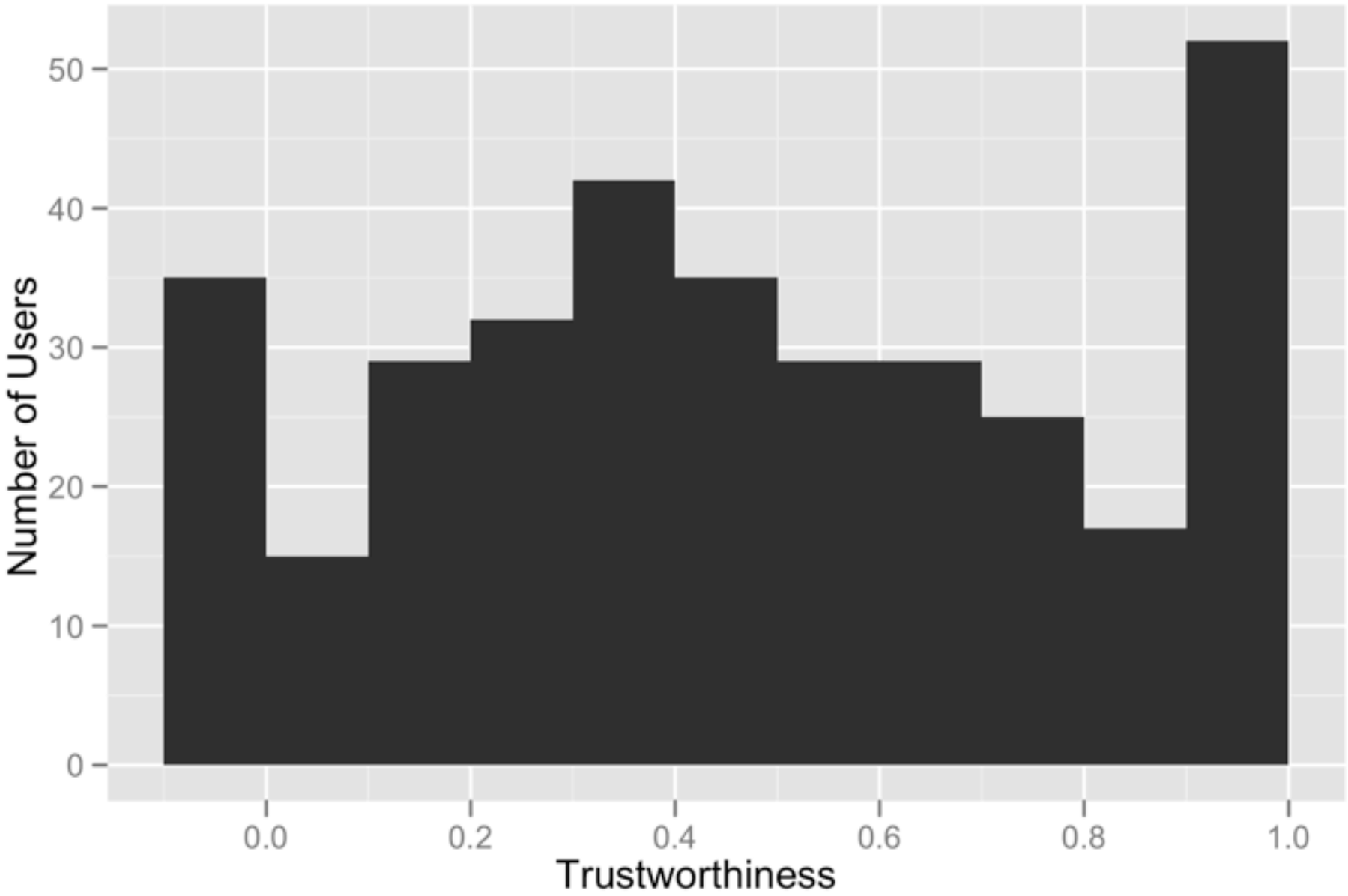


- User A's average **trust** towards others
  - (0.8 + 0.3 + 0.5)/3 = 0.53
- User A's average **trustworthiness**
  - (0.1 + 0.2 + 0.5)/3 = 0.27

Distribution of trust



Distribution of trustworthiness



Take-away points

- Q1: Given a group of users, which one is most likely to reveal their location?
  - The most central user
  - People that trust others more are more central in the network
  - People that are trusted more are less central in the network
- Q2: Given a "target user", which of their friends is most likely to know the location of the "target"?
  - The person with most friends
  - The person with most common friends with the target

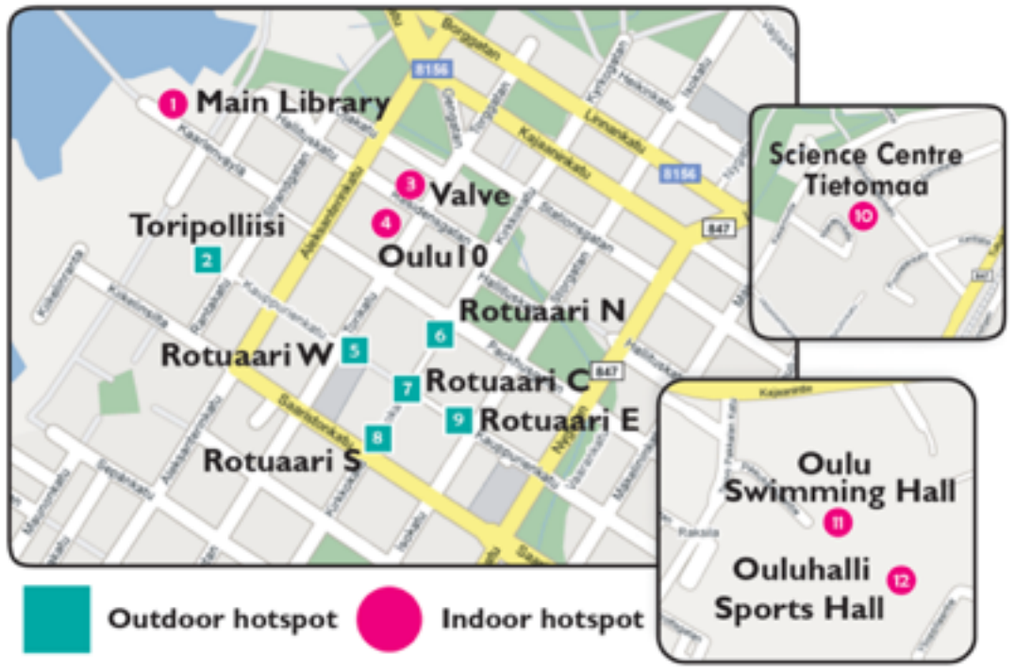
Kostakos, V., Venkatanathan, J., Reynolds, B., Sadeh, N., Toch, E., Shaikh, S. A., Jones, S. (2011). Who's your best friend? Targeted privacy attacks in location-sharing social networks. In proceedings of Ubicomp 2011, Beijing, China, pp. 177-186.

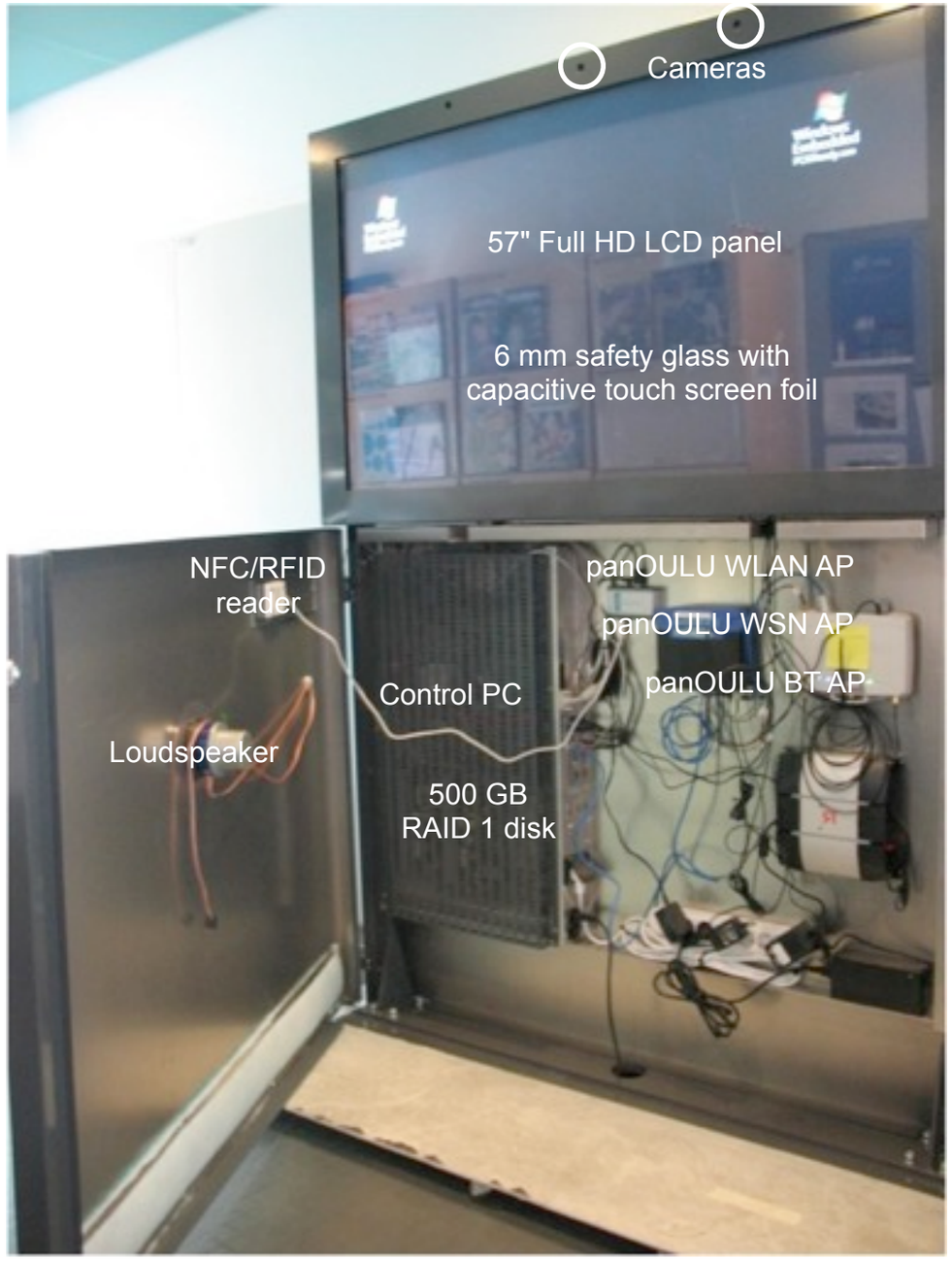
Ongoing work: the Real-time city

Leverage from the EU 2007–2013

European Union
European Regional Development Fund

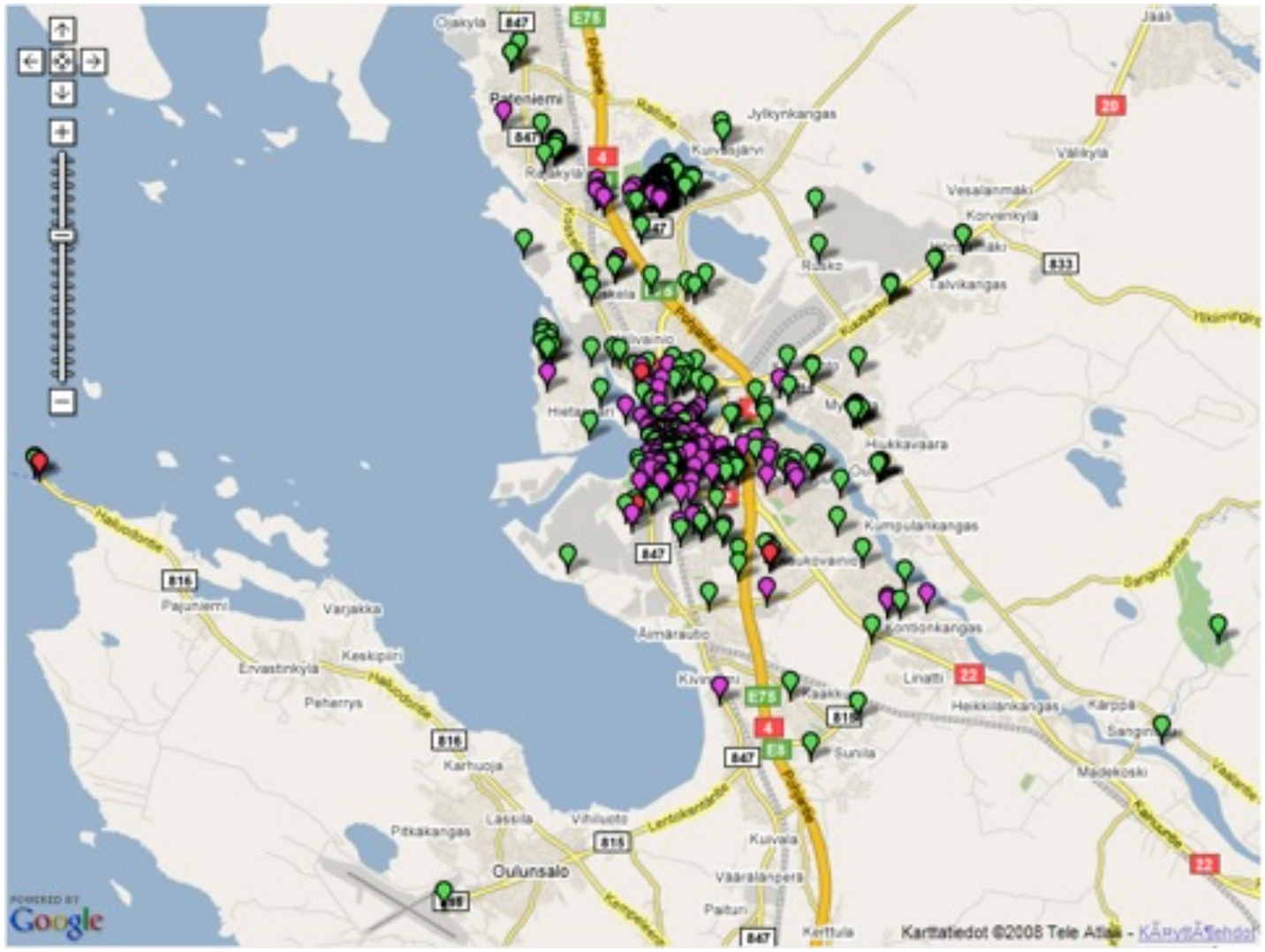
Public interactive displays



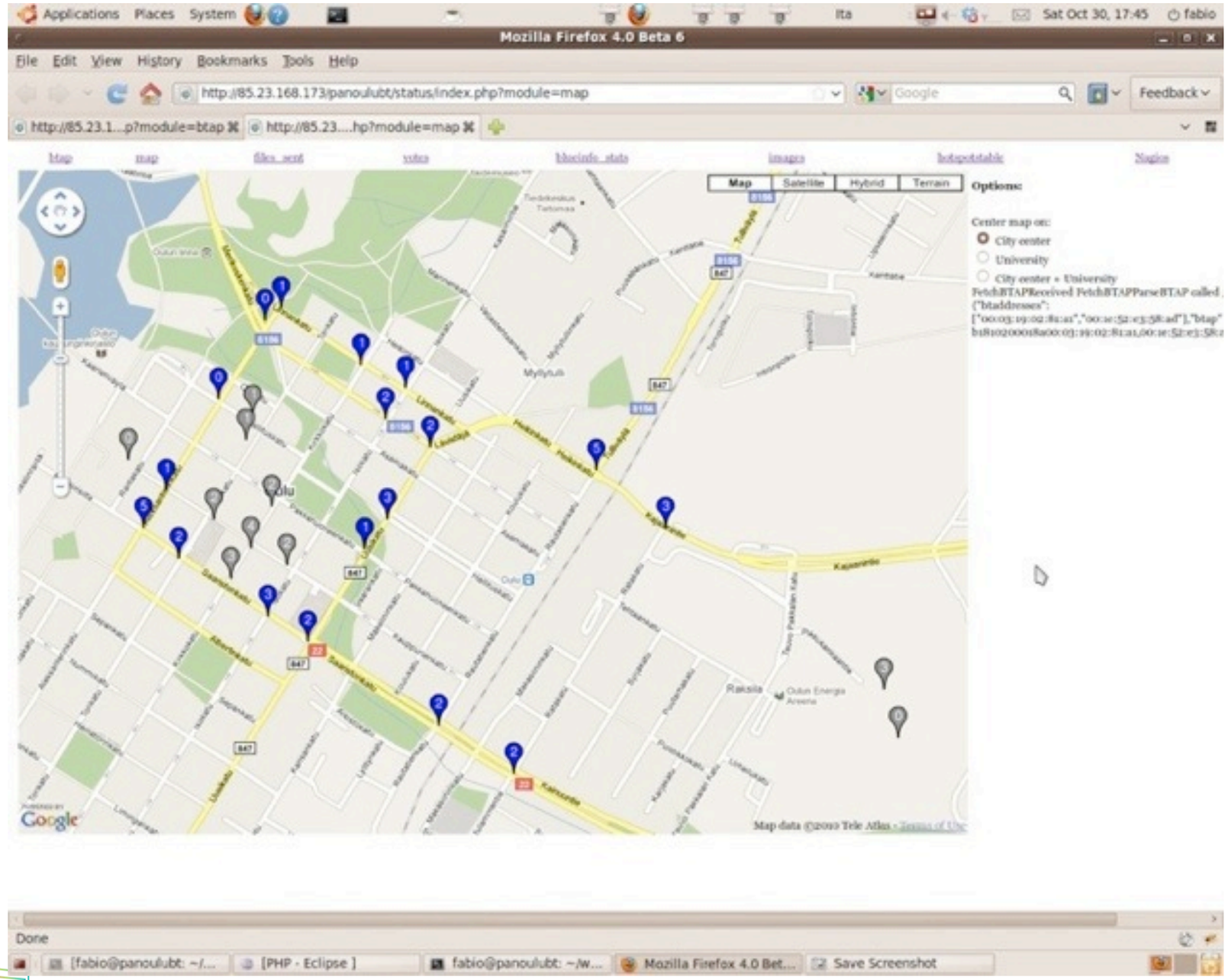



OULU

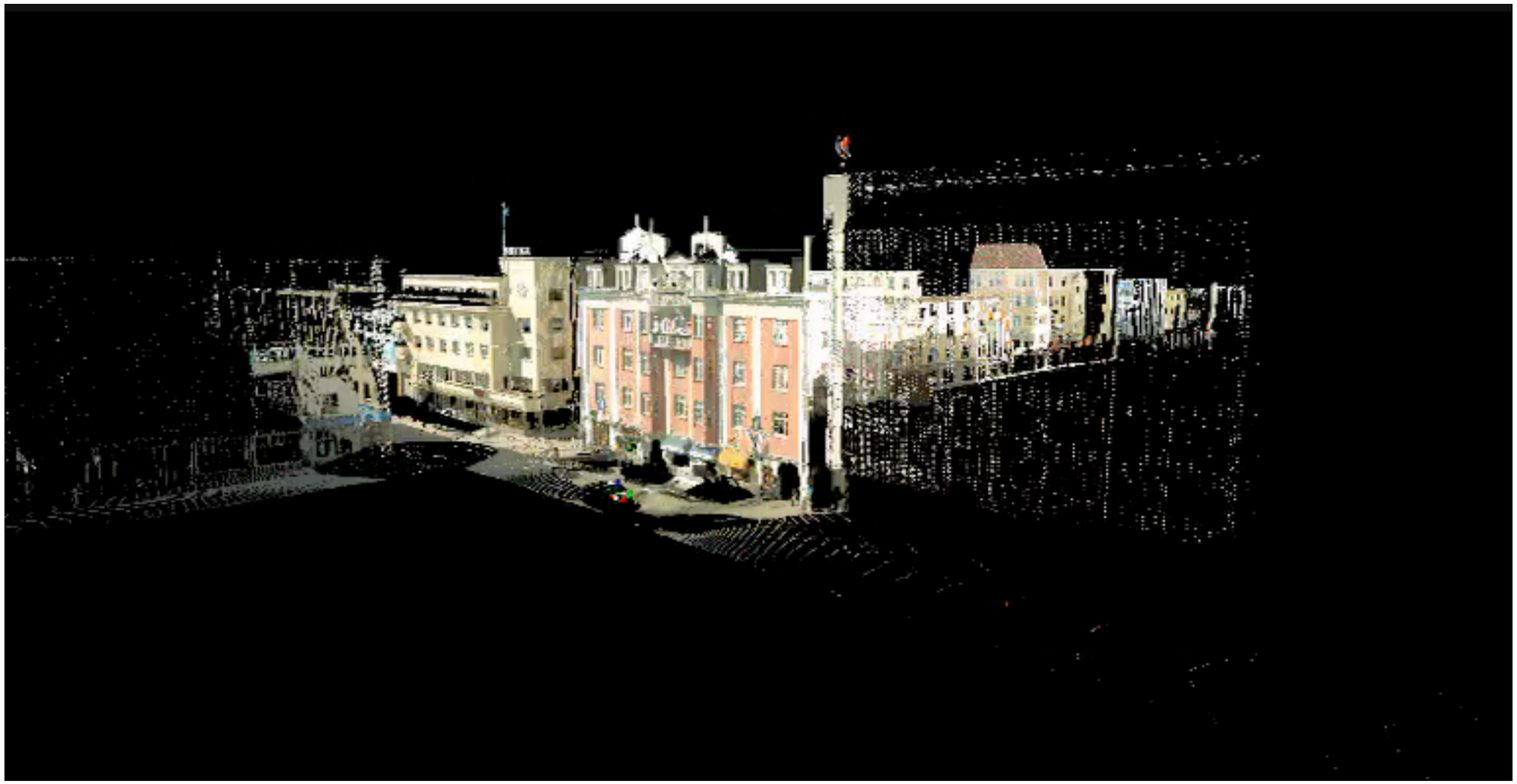
panOulu WiFi



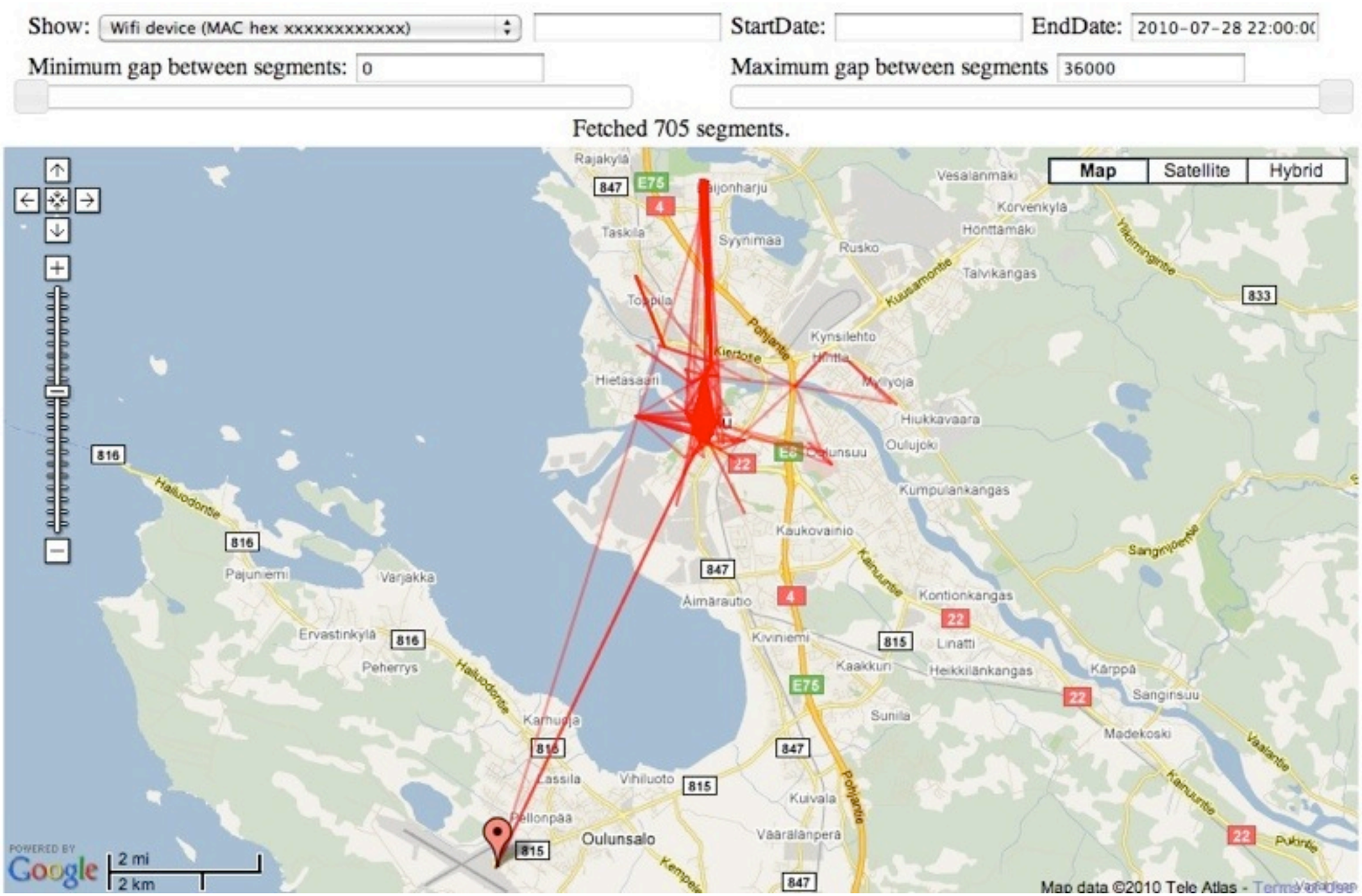
Bluetooth network



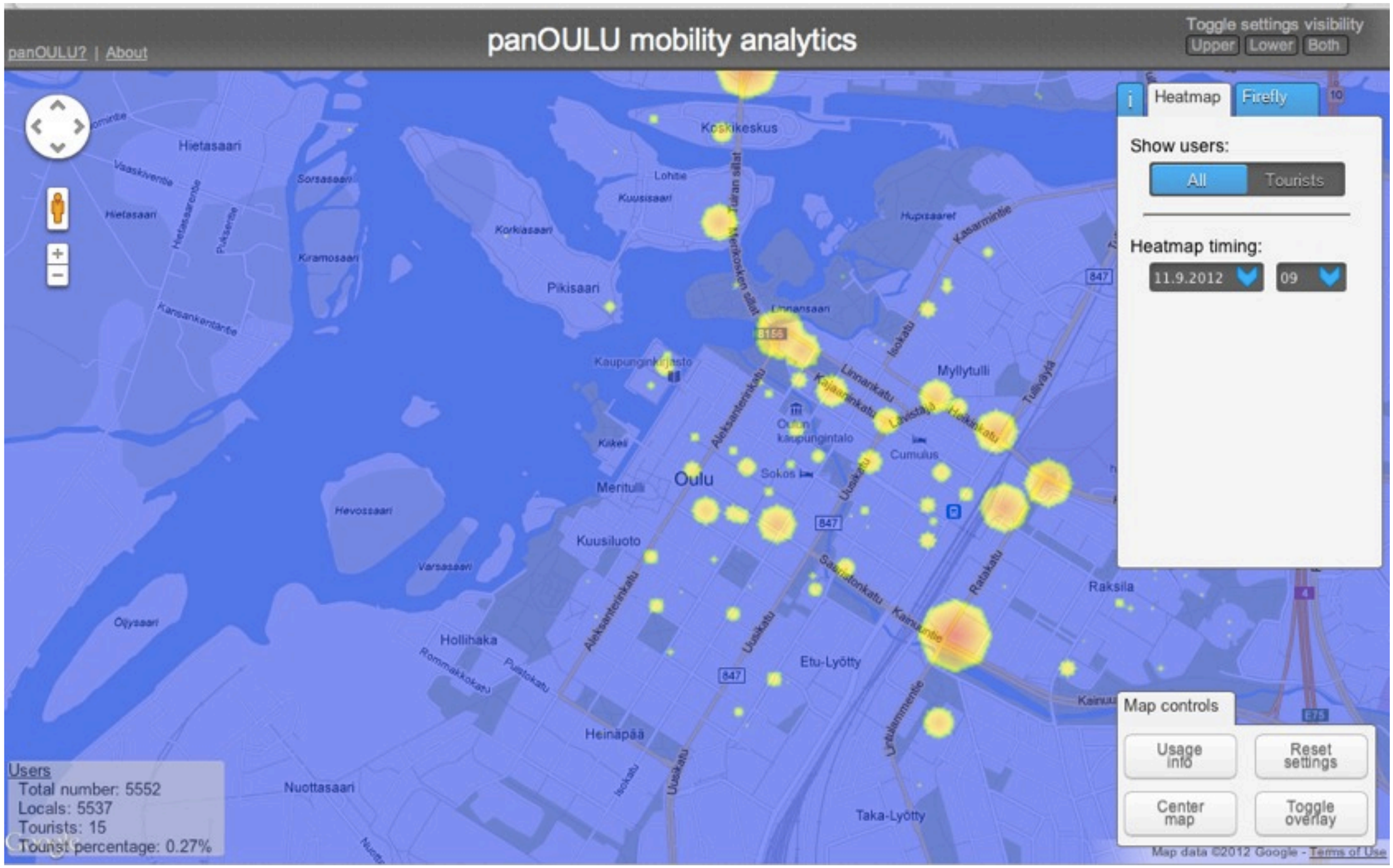
3D Oulu



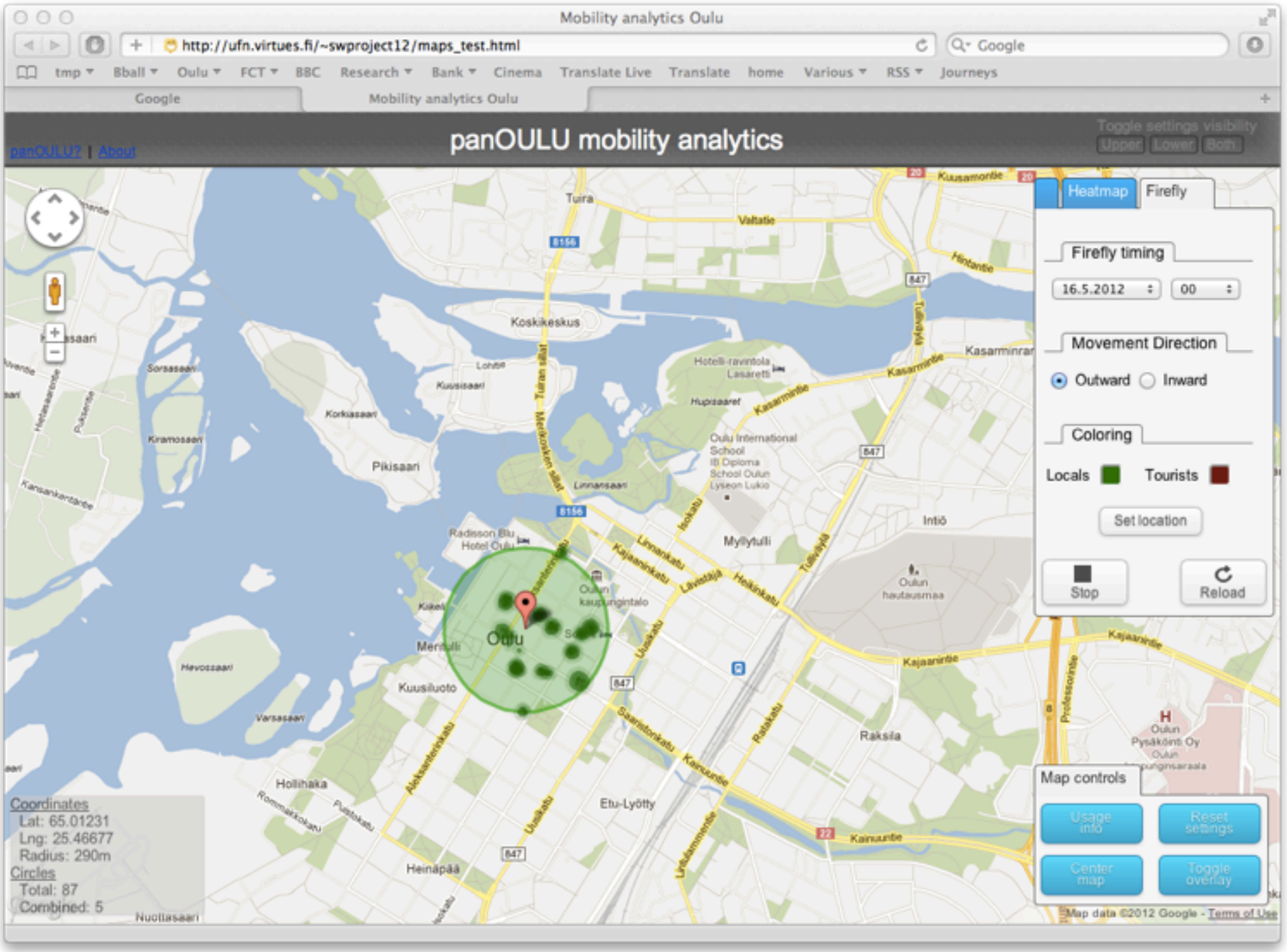
Reconstructing movement



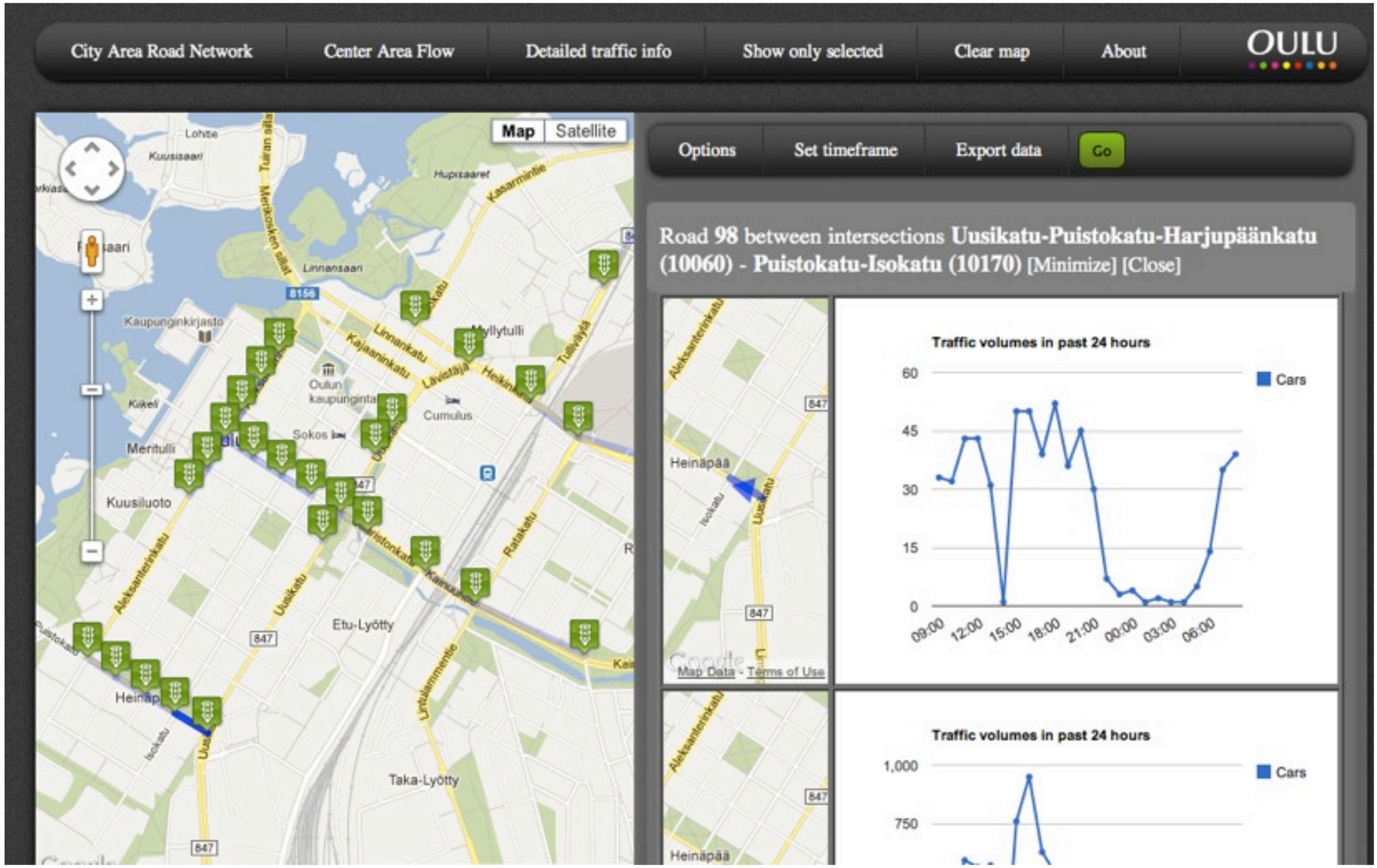
Where is it busy now?



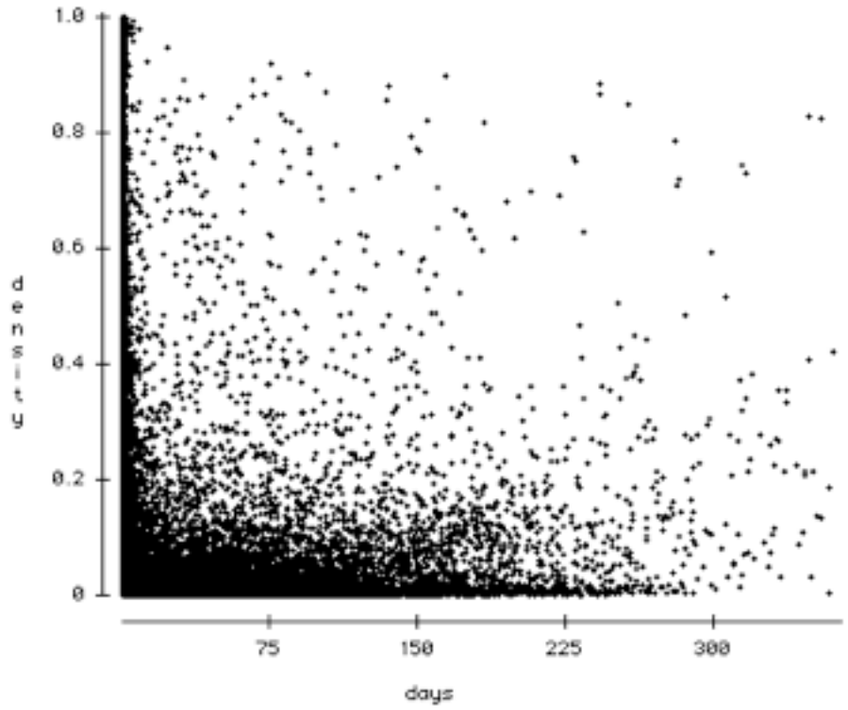
Catchment areas

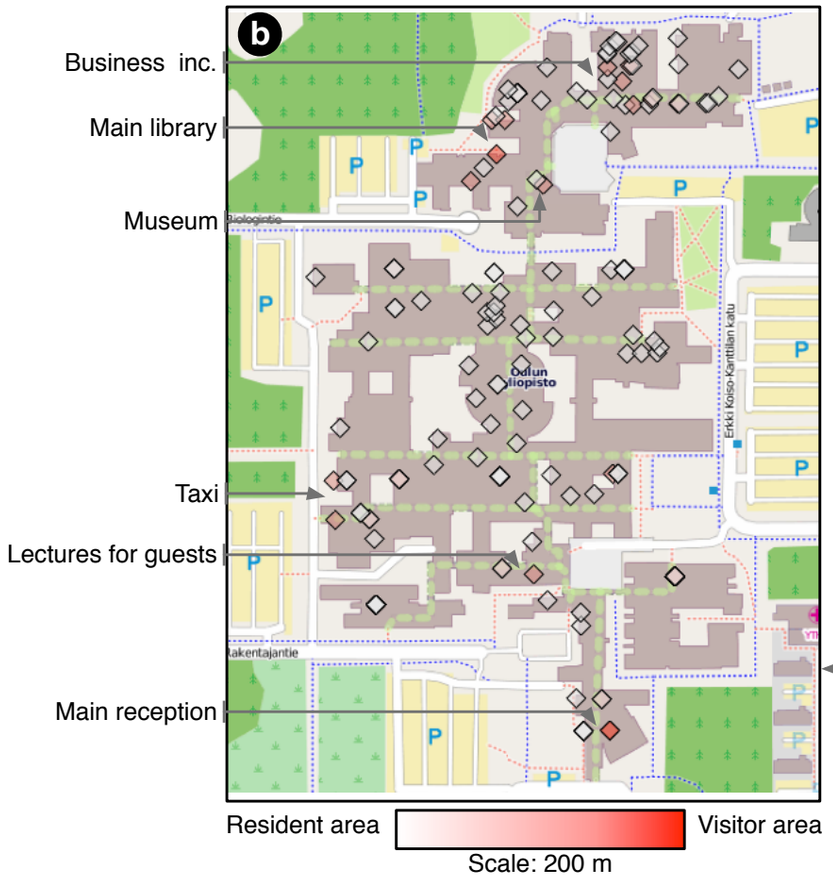


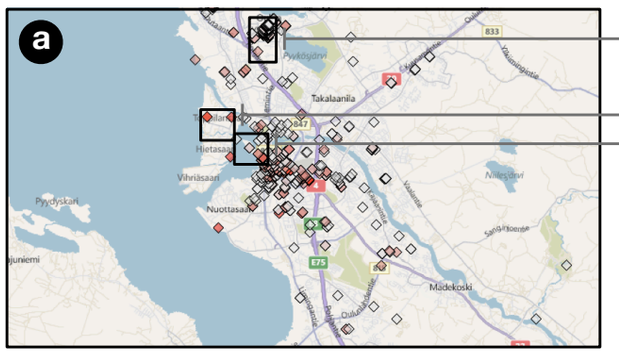
Explore historic traffic patterns

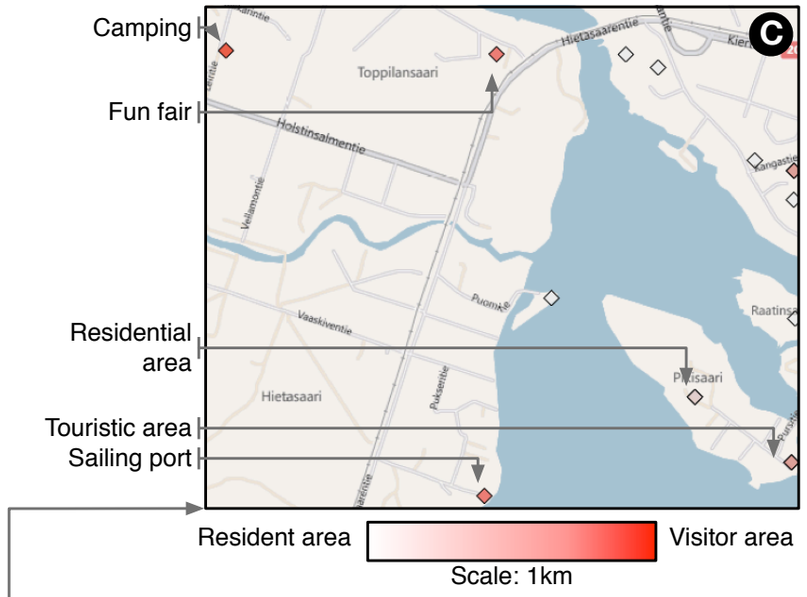


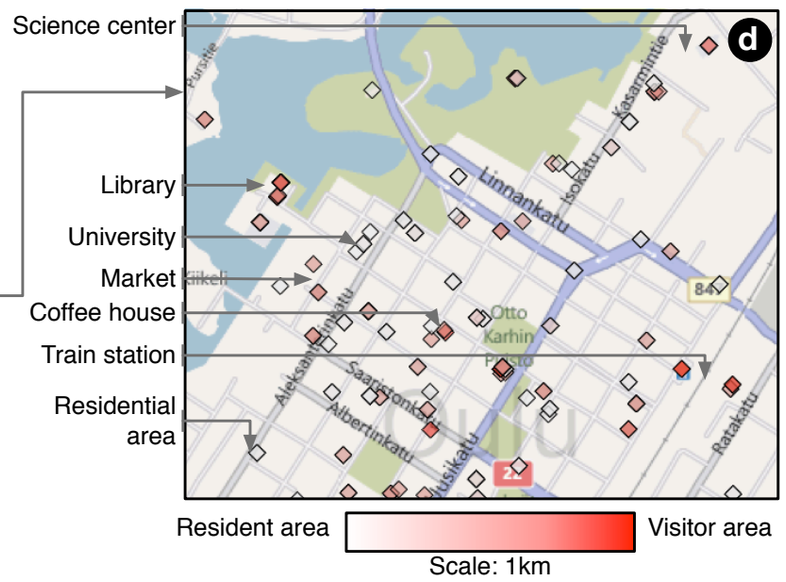
Find visitors & visitor locations



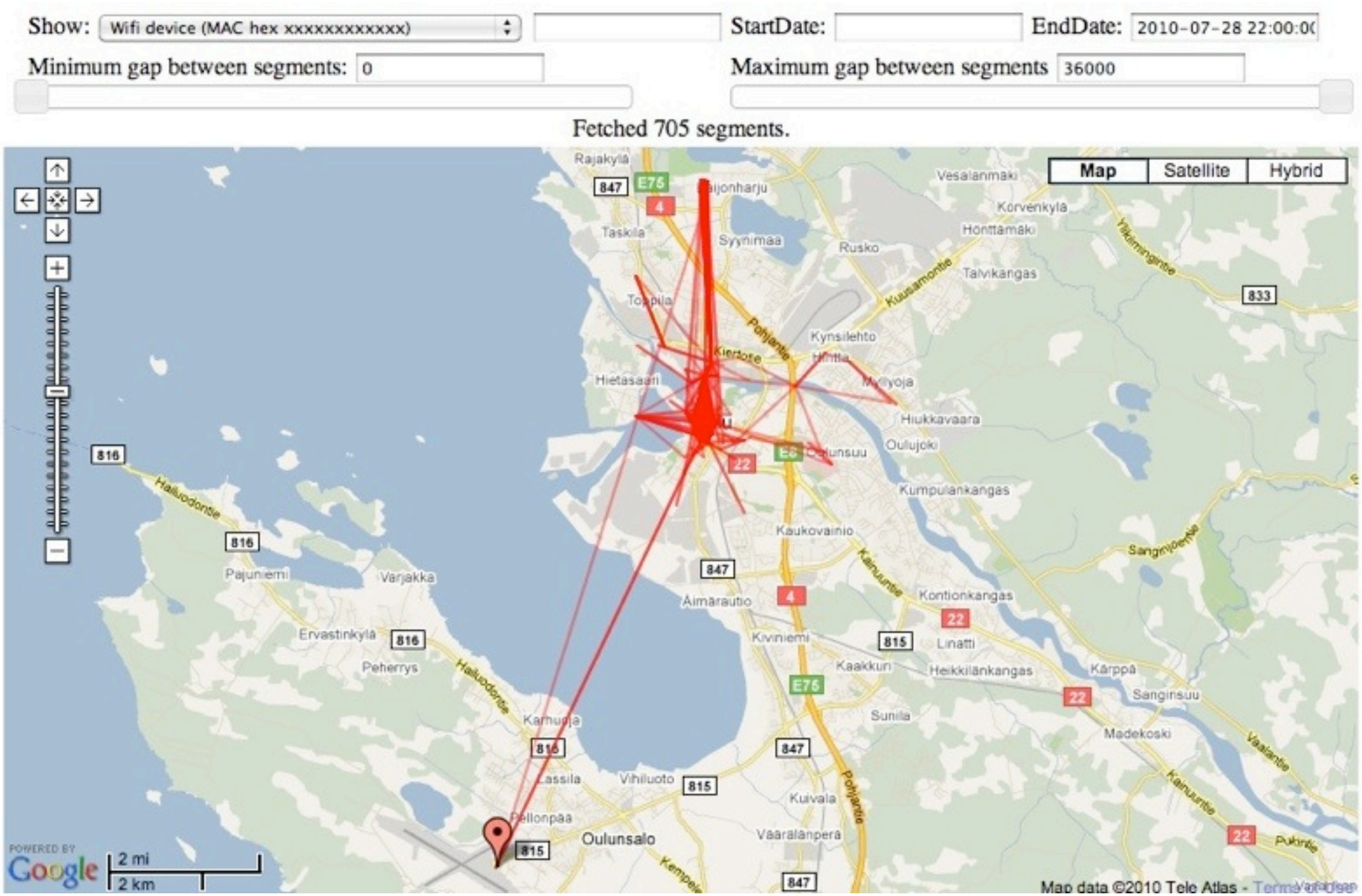




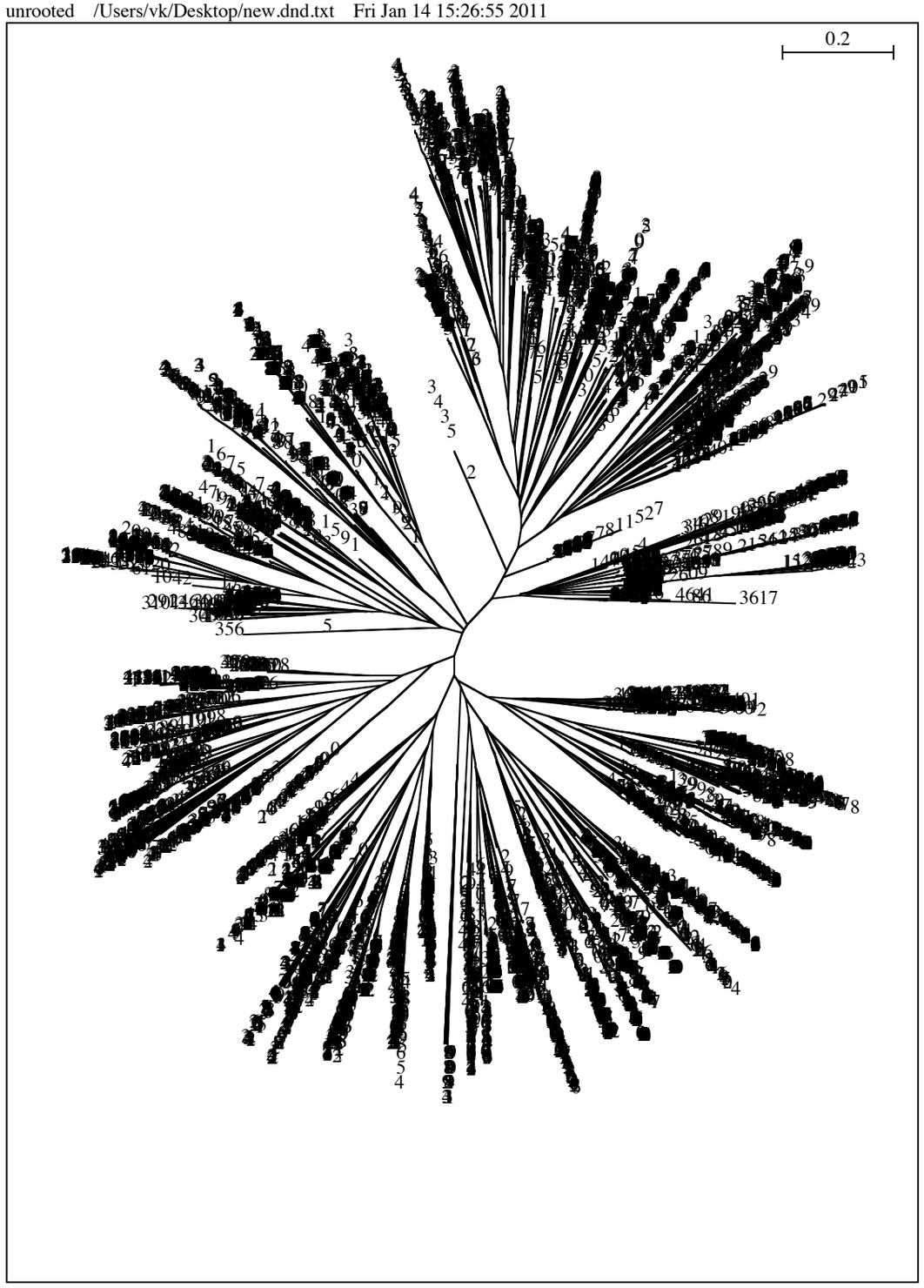


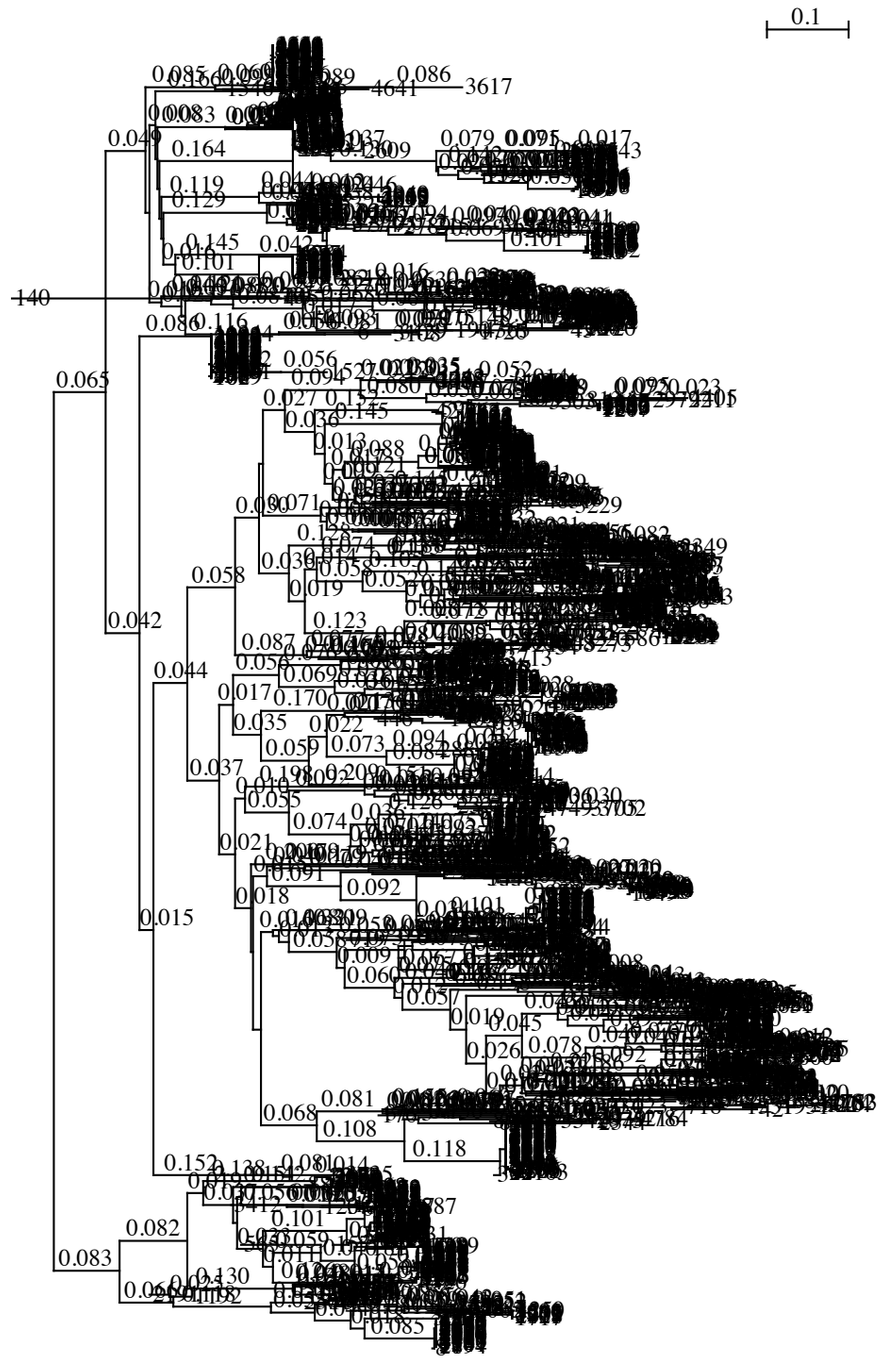


Finding “shoals”



unrooted /Users/vk/Desktop/new.dnd.txt Fri Jan 14 15:26:55 2011



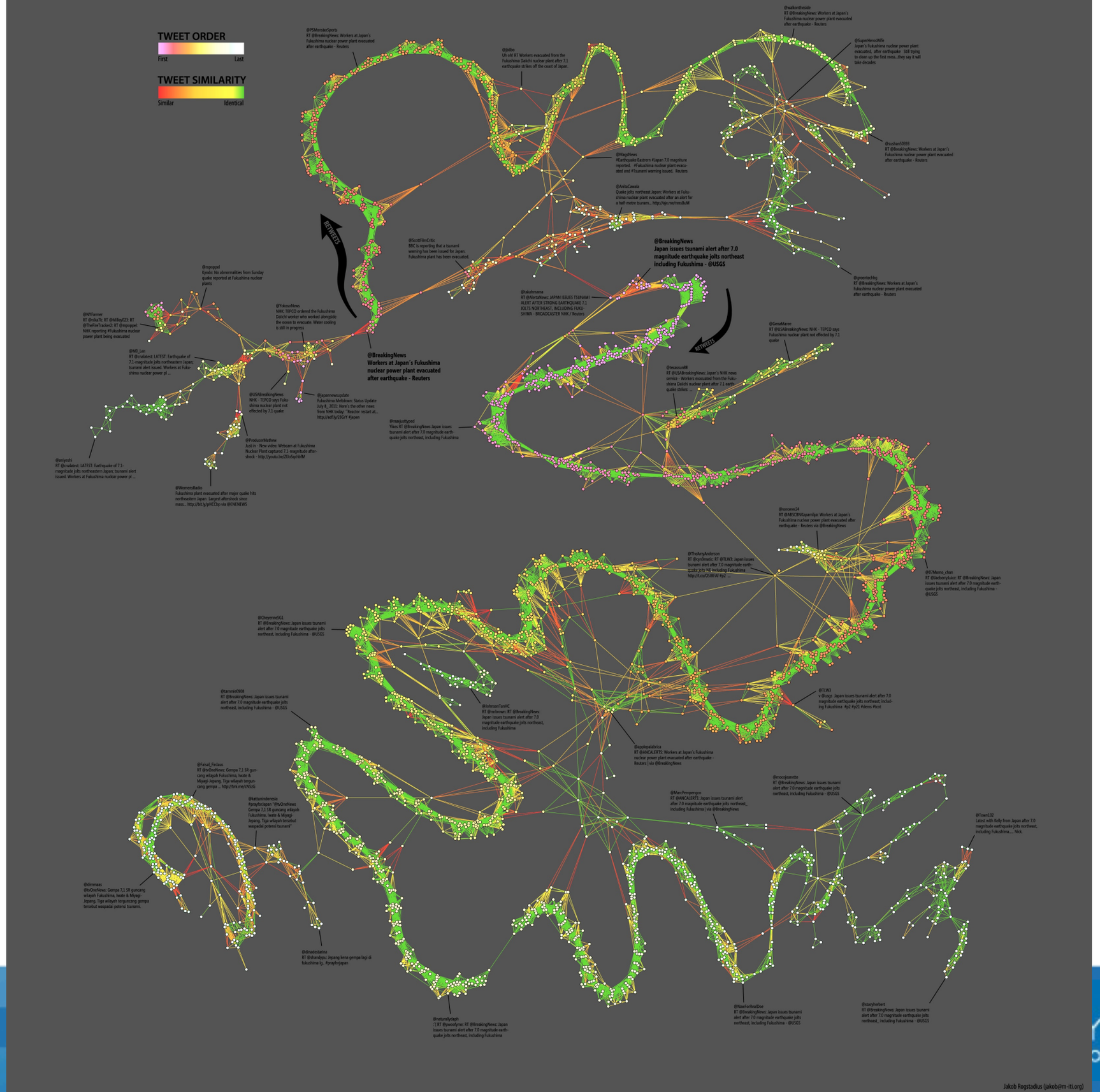


Twitter realtime analysis

Information Propagation on Twitter

Spread of news regarding earthquake outside Japan on July 10, 2011

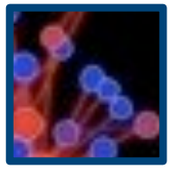
(internal structure of a 3766 node story from CrisisTrackerPrototype)



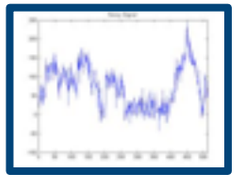
WP4

October 12, 2011

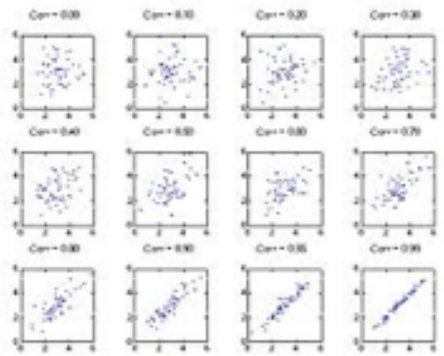
Instrumenting mobile platforms



Capture data on phone
(Instrumentation)

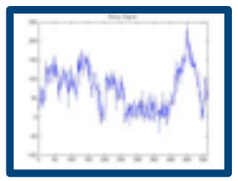


Calculate metrics



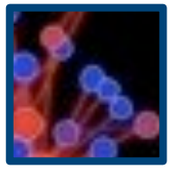
Establish correlations
Describe behavior

Capture behavior vector
(Questionnaire/Automated)

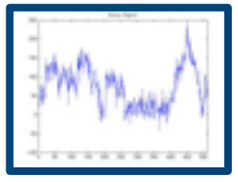


Calculate metrics

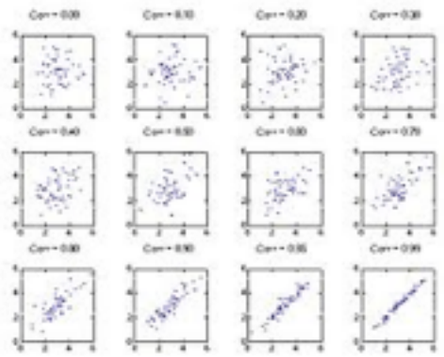
Instrumenting social networks



Capture social network
(Instrumentation)

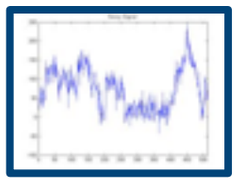


Calculate metrics



Establish correlations

Capture behavior vector
(Questionnaire)



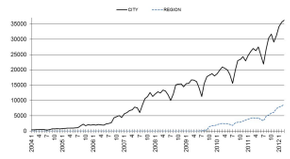
Calculate metrics

Closing thoughts

- We do a lot of instrumentation
  - Social
  - Mobility
  - Smartphone
- A lot of data describing individual & community-level behavior
- Great potential for combining with other metrics (health, economy, education, etc)

More information

UBI program
http://www.ubioulu.fi



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Vassilis Kostakos
vassilis@ee.oulu.fi