Collecting mobility data with smartphones: challenges and opportunities

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Outline

- Data recording
- Modeling mobility patterns
- Data visualization

Opportunities, Challenges and Solutions

DATA RECORDING ON CELL PHONES

Opportunities

- Rich data available on smart phones.

Context

Opportunities

- Rich data available on smart phones.

Usage of the phone

1. **Calendar Entries**
2. **Phone Log**
3. **Media Play Log**
4. **Contacts**

Opportunities

- Rich data available on smart phones.

Others

1. **Accelerometer**
2. **Snapshot of the screen**

Opportunities

- Rich data available on smart phones.
- Data is collected from individuals.
- Data is constantly recorded, because users take along their cell phones all the time.

Challenges

- A cell phone software recording all available data.
- Huge battery consumption by GPS data retrieving.
  - Only works less than 6 hours continuously.
- Privacy issues concerned by cell phone users.

Solutions

- A symbian S60 software records data constantly and sends data automatically via wireless network to a remote data server.

- The software combines data from accelerometer, GSM, BT and WIFI to determine when to start and to stop recording GPS data. With this improvement, the software can run a day with normal usage.

Data Collection Campaign

- In collaboration with Nokia Research Center at Lausanne, a data collection campaign has been launched since September, 2009. It will last until summer 2010.
- Currently >75 participants. We expect 120 in the near future.
- An agreement is signed by participants concerning privacy issues. And the data is anonymized before usage.

MODELING MOBILITY PATTERNS FROM DATA

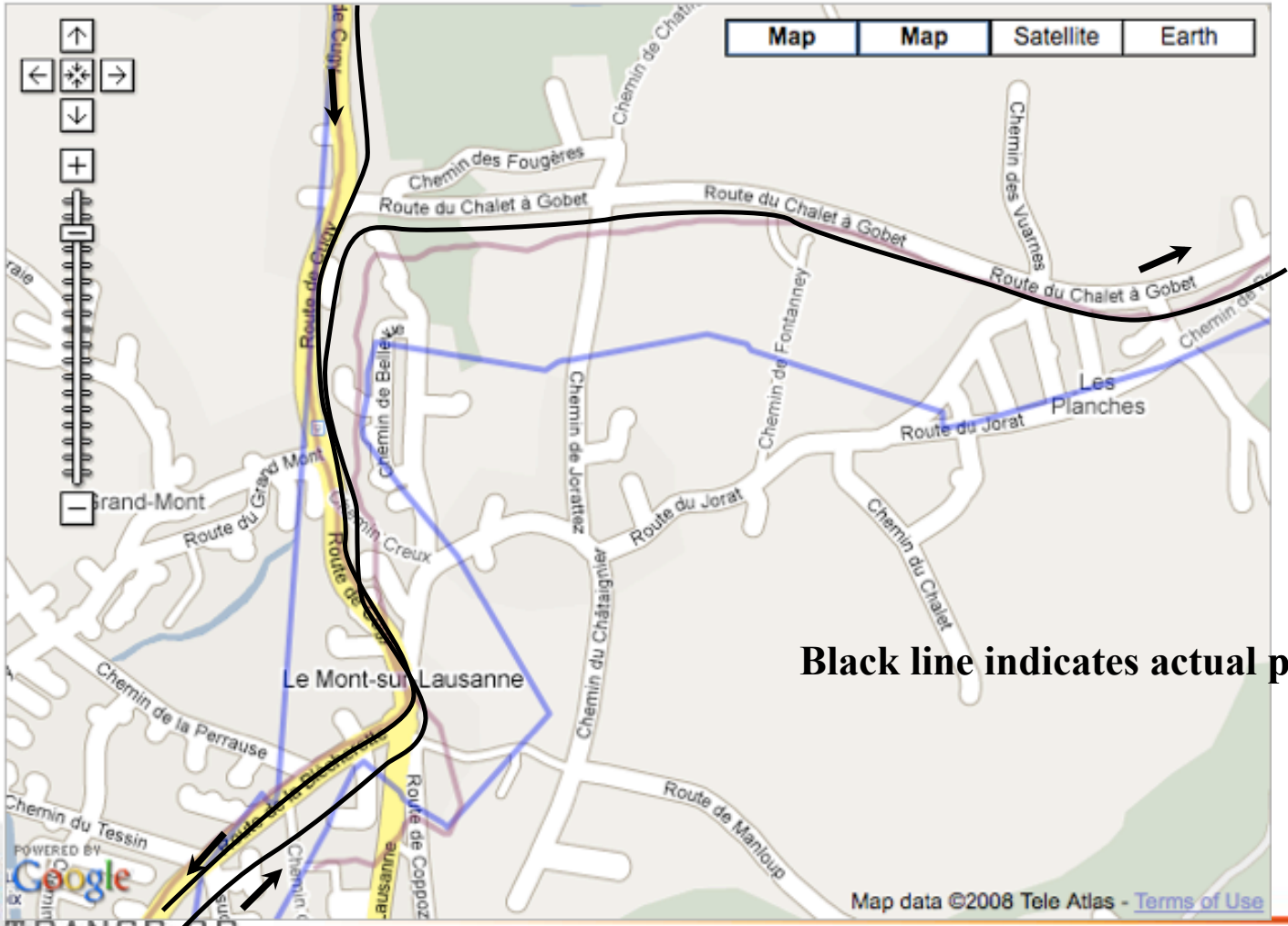
Opportunities

- Some pieces of data are available to transportation researchers for the first time .
- Rich data reflects individuals' mobility patterns, surroundings and characteristics.
- With location data, other data can be tagged with locations.

Challenges 1

- Inferring the travelled path from GPS data.
  - GPS data collected from cell phones is not as accurate as dedicated GPS devices.
  - Map matching doesn't work well for inaccurate GPS data.

GPS device VS Cell phone



Black line indicates actual path

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Ongoing work

- A new methodology takes advantage of
  - the spatial relationship between GPS points and network elements, and
  - the temporal relationship underlying the observations and network structures.
- It accounts for poor quality of GPS data.
- It generates probabilistic path observations from GPS data. (Bierlaire et al., 2009)

Challenge 2

- How to infer mobility patterns from various kinds of data?
  - Nearby Bluetooth devices, WIFI stations, GSM towers reflect the environment?
  - Media play history reflects a user's characteristics?
  - Phone log and calendar entries?
  - Others?

Inferring users' activity

- Each individual has the habit that he performs a certain kind of activity (e.g. work),
  - with a certain group of people, (nearby cell phones by BT)
  - in a certain environment (nearby computers and wifi spots by BT and WIFI),
  - at a certain location (location by GPS),
  - in certain time range (time stamp).

Ongoing work

- Estimating activities by using Bluetooth data (Hurtubia et al., 2009).
  - With activity survey data and land use data, Bayesian inference and random utility models are used to infer the activity type of a user at a location and time.

Future works

- Fuse various kinds of data to infer user's activity type.
- Use generated path observations to model users' route choice and transportation mode choice behavior.
- Fuse various kinds of data to model users' mobility patterns under different situations (modeled from context data).

Servers and Tools

VISUALIZING DATA TO USERS

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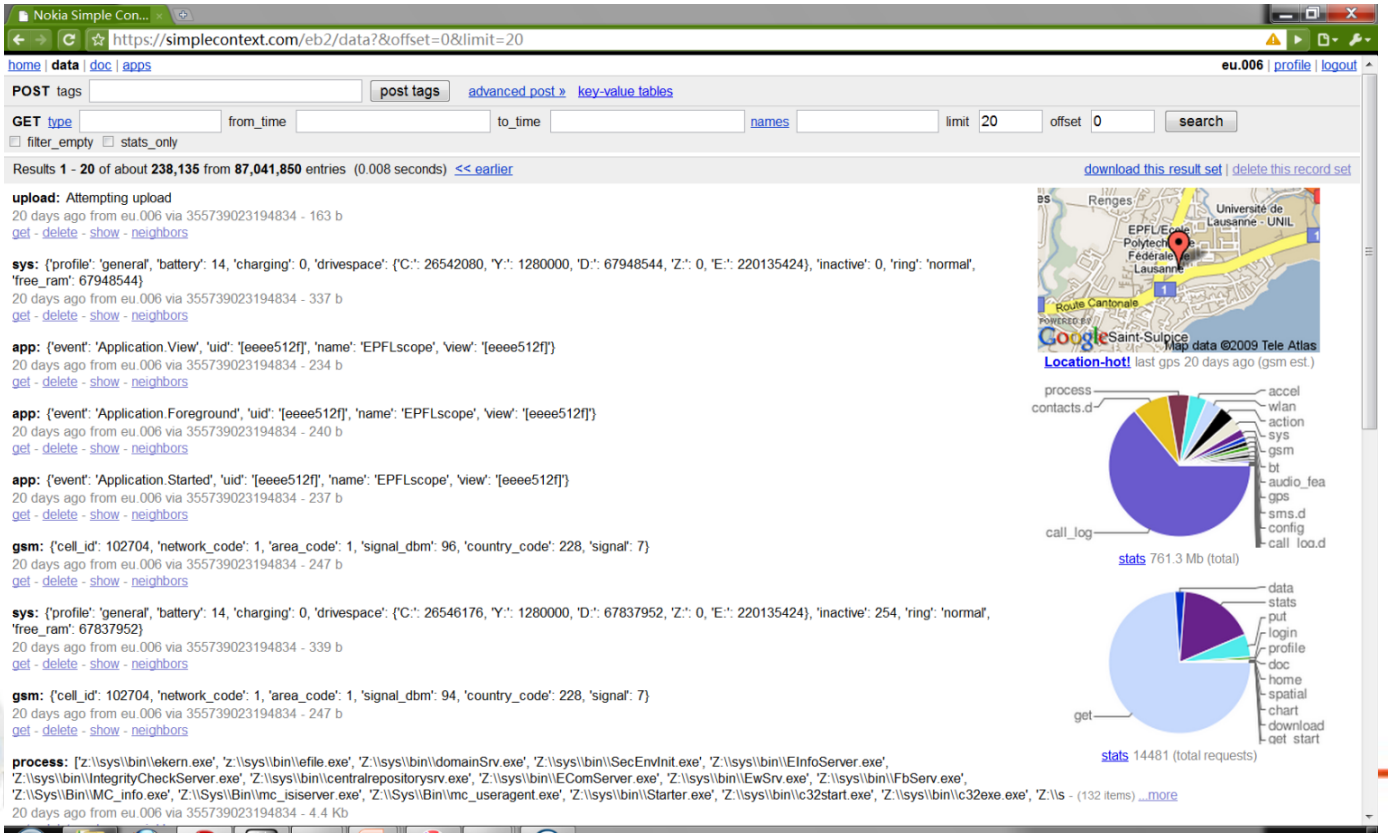
Developed Tools

- A data storing server.
- A GPS track visualization page with activity survey function.
- A page visualizing friends' GPS tracks.
- Pages visualize statistics of data in different areas.

Data Server

- Data is sent from cell phones to a remote server. A website is used to retrieve data from the database.



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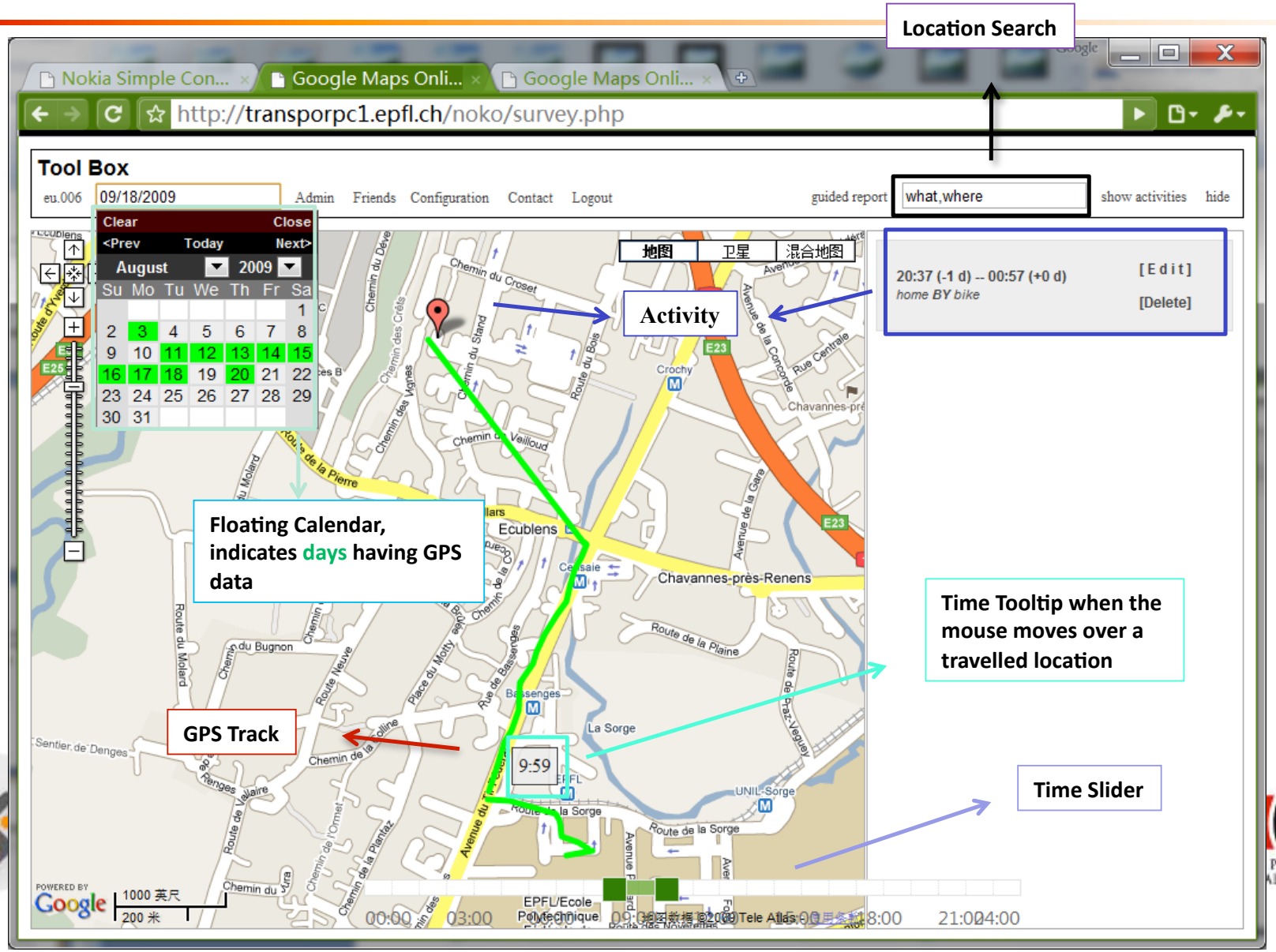
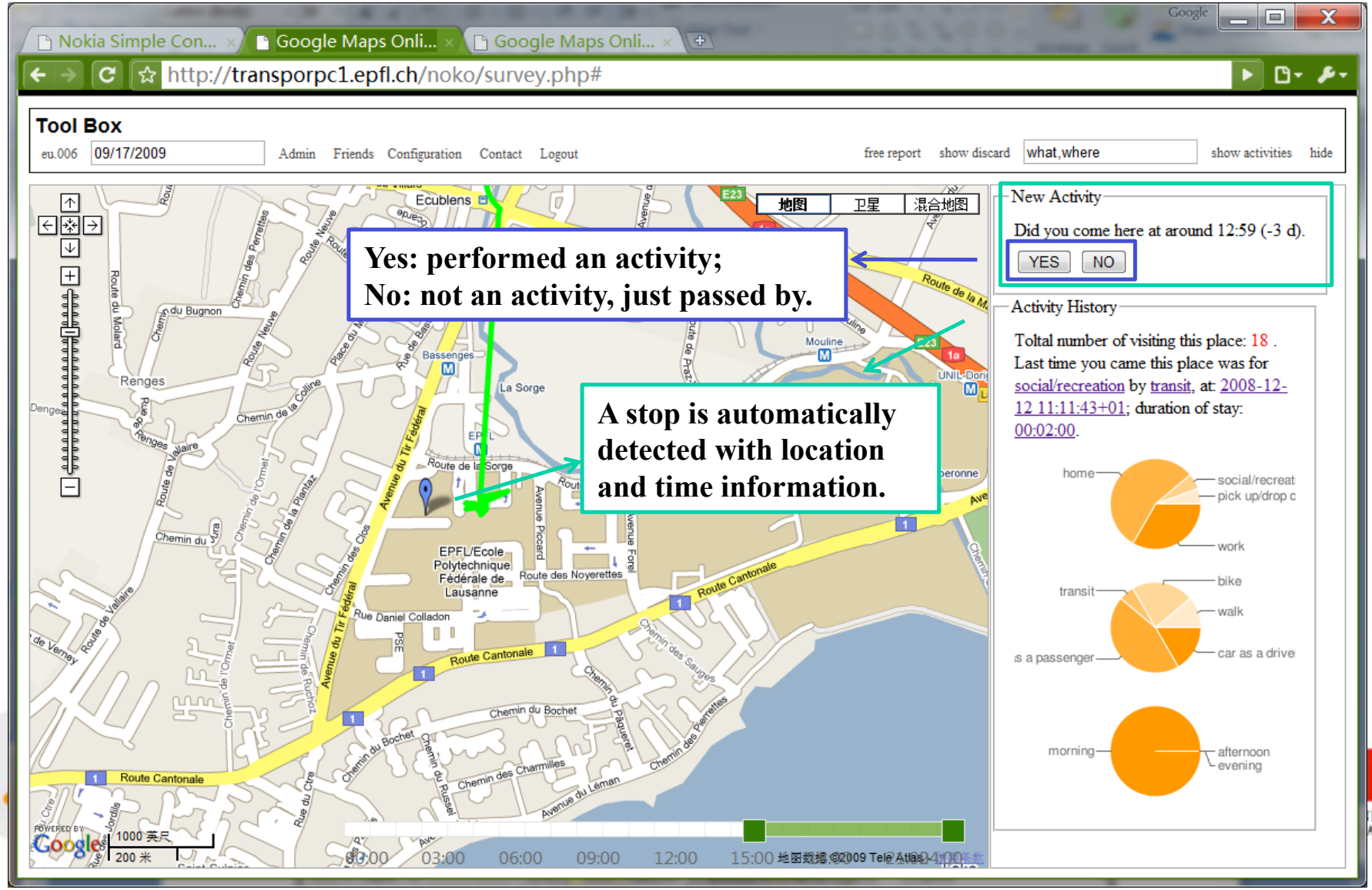
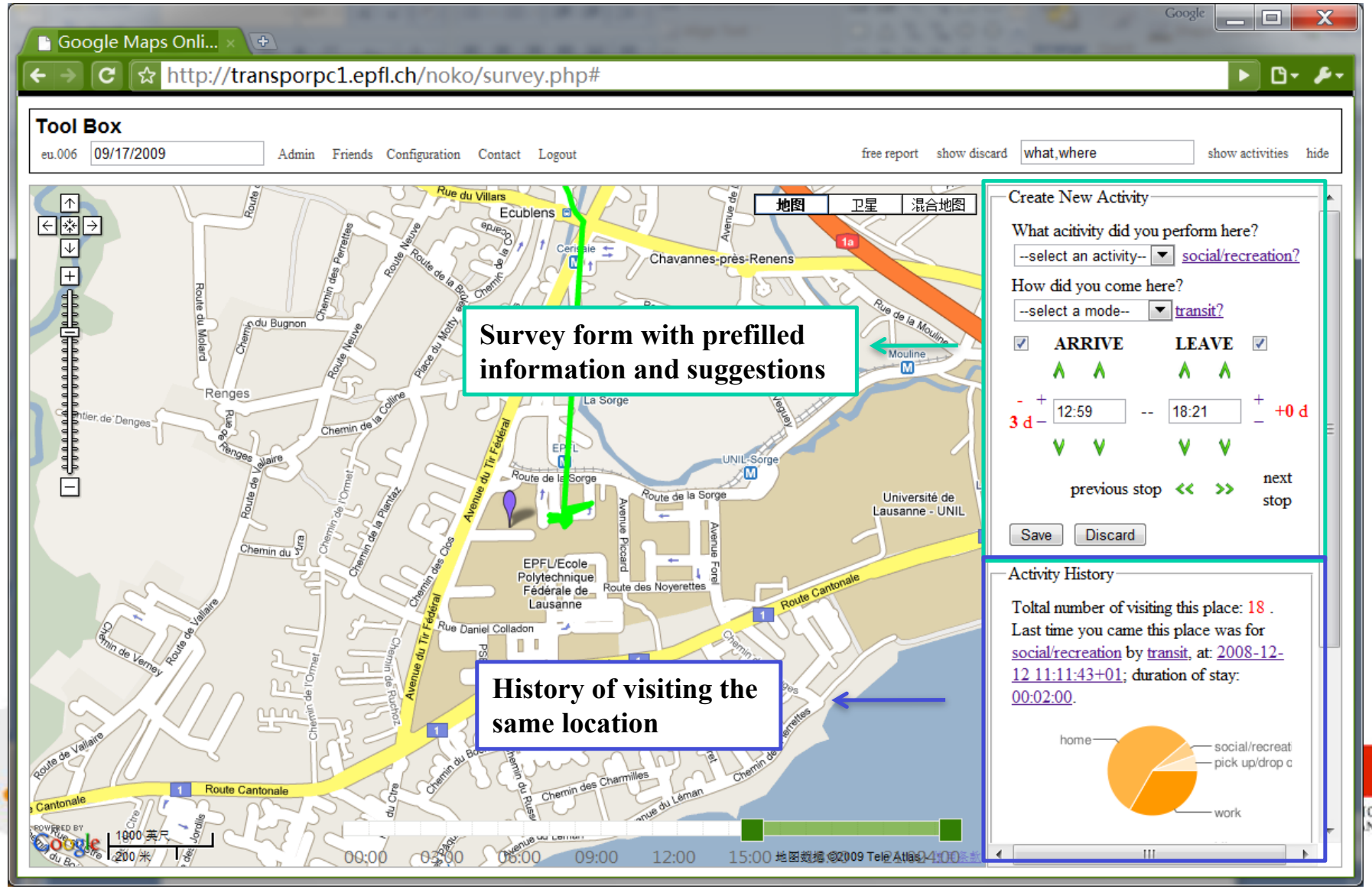
Visualization Tools (Activity Survey)



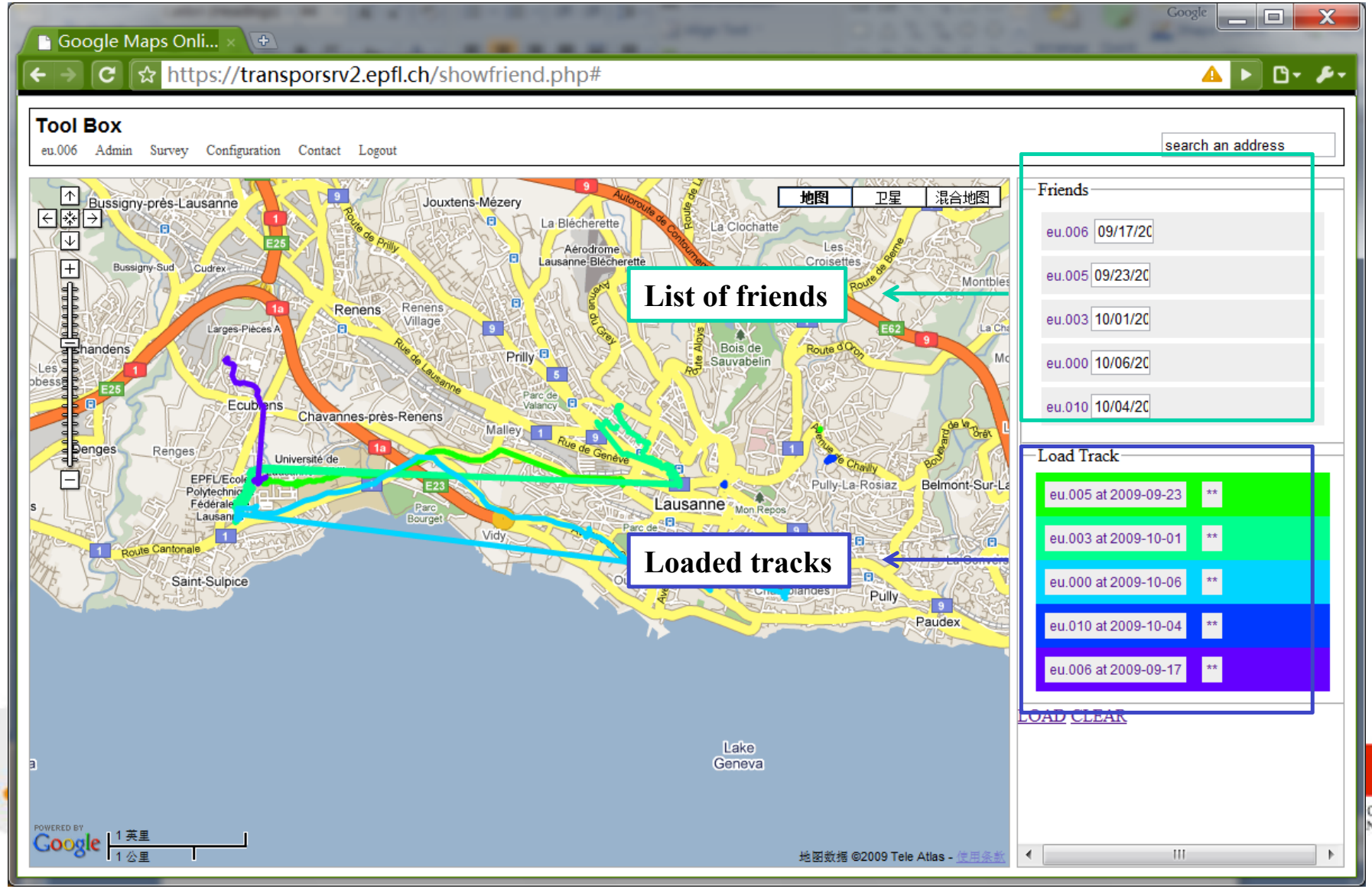
Visualization Tools (Activity Survey)



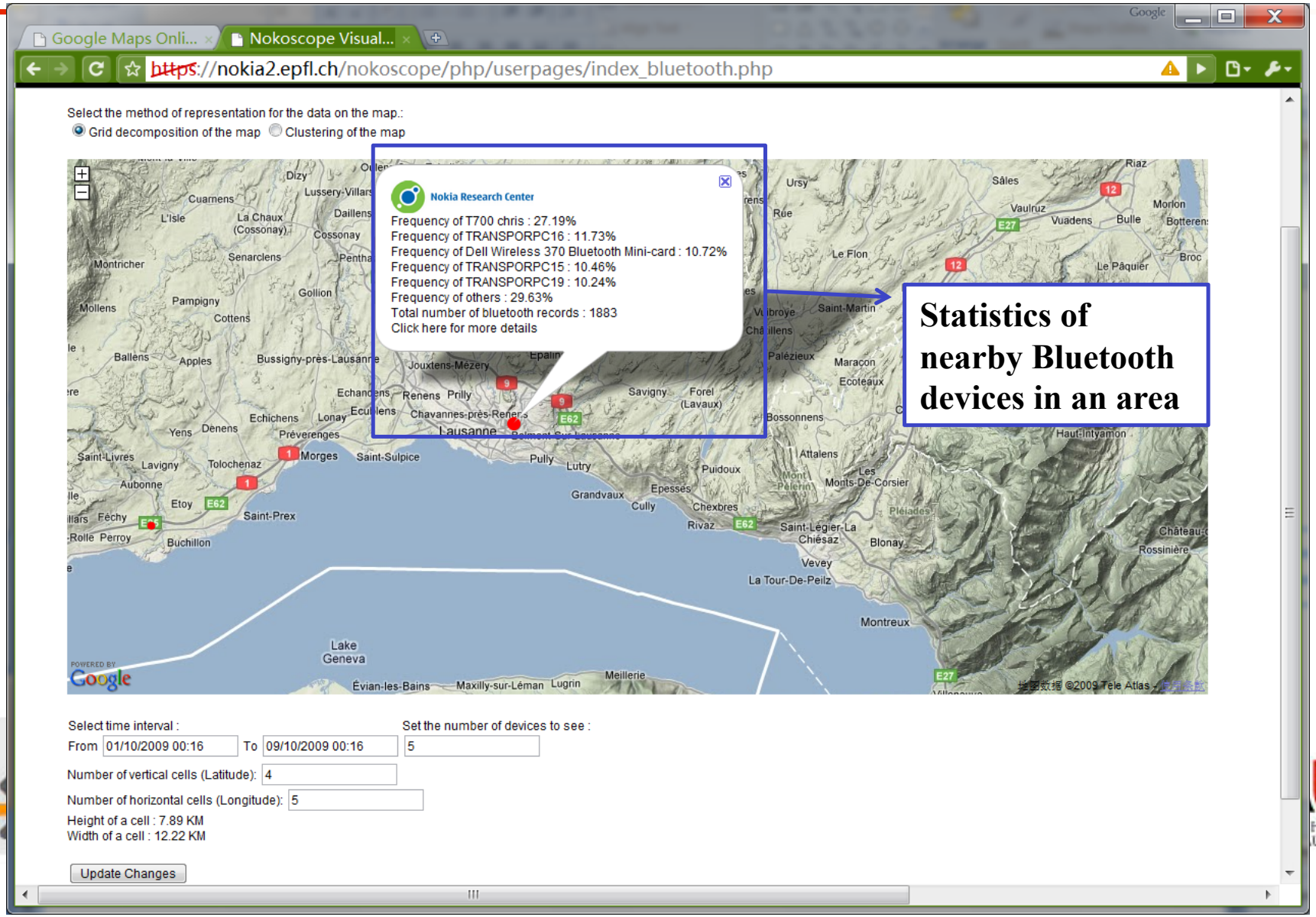
Visualization Tools (Activity Survey)



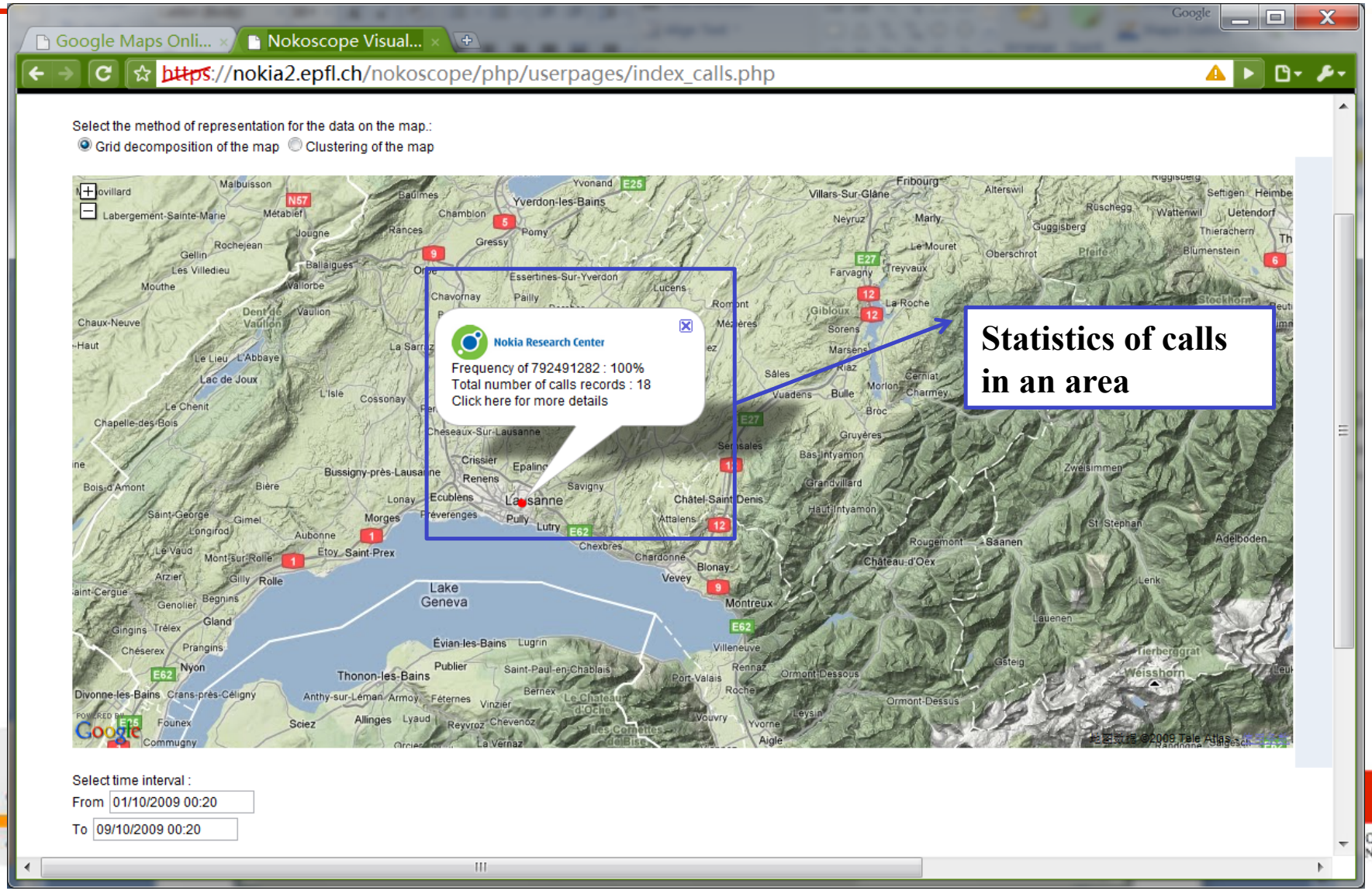
Visualization Tool (Friends' Tracks)



Visualization Tools (Nearby BT)



Visualization Tools (Calls)



Ongoing works

- Visualizations of other data.
- Visualization on google earth with trip animations.