
Exploiting mobility data from Nokia smartphones

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Nokia @ EPFL

- Nokia Research Centers research.nokia.com/locations
 - Bangalore, India
 - Beijing, China
 - Cambridge, UK
 - Cambridge, Ma
 - Helsinki, Finland
 - Hollywood, Ca
 - Lausanne, Switzerland (since June 2008)
 - Nairobi, Kenya
 - Palo Alto, Ca
 - Tampere, Finland

Research project

- Objective:
 - Investigate the potential of Nokia smartphones for mobility data collection
- Project Manager: Jeffrey Newman
- Research assistant: Jingmin Chen
- Steps:
 - Design and prepare the data collection campaign
 - Organize the data collection
 - Estimate behavioral models

Proposed data collection campaign

- Approximately 100 participants
- They receive a Nokia N95 phone, with data collection software preloaded
- They fill travel & activity surveys



Proposed data collection campaign

- They utilize their own personal SIM card, and are reimbursed for data-transmission charges incurred
- Data collected, and survey contents, will be coordinated between TRANSP-OR and other EPFL labs, to suit a range of current and future research needs

Nokia N95 Phone Features

- GSM (regular wireless phone network) info
- GPS tracking, network-based Assisted GPS available
- Accelerometer
- 802.11b/g WiFi
- Bluetooth
- Camera
- Calendar
- Phone / Instant Message logs

Ethical issue

- The project is currently submitted to an ethic committee
- Highly personal information is being collected
- Participants must be aware of:
 - What data is actually collected
 - What we are doing with the data
- They have the right to
 - Access the data about them
 - Drop from the survey and have the data erased

Potential data uses

- GPS and accelerometer: current position, speed and acceleration → mode and route
- When GPS signal is unavailable, position can be guessed with GSM, WiFi, historical data
- Phone book, phone log: social network
- Calendar: activities
- Audio and video samples: contextual measurements

Potential data uses

- Phone interface design and usage
- Signal processing
- Indoor positioning
- Etc.

Progress to date

- A small number (6) of phones have been received by the TRANSP-OR lab for evaluation
- An online travel review and survey tool is in development
 - Designed to be (hopefully) intuitive, simple, and fast for participants
- Custom phone software for data collection is in development

Online Personal Travel Survey

Google Maps Online Survey - TRANSPOR

http://transporpc1.epfl.ch/survey.php

Tool Box
jchen 2008-09-19 Configuration Contact Logout

search an address show activities hide

Map Map Satellite Earth

Activity:3
Purpose:shopping
Arrived at:15:50
Left:15:00
Mode:walk
Delete

11:11 -- 11:22
go to work BY transit
[Edit]
[Delete]

11:25 -- 12:00
personal business BY car as a passenger
[Edit]
[Delete]

15:00 -- 15:50
shopping BY walk
[Edit]
[Delete]

From: 05:00 To: 22:00

00:00 03:00 06:00 09:00 12:00 15:00 18:00

GPS tracking layer appears in Google Maps

Adjustable time slider to limit display to certain time periods

Online Personal Travel Survey

Google Maps Online Survey - TRANSPOR

rpc1.epfl.ch/survey.php

Participants enter activity and travel information

search an address show activities hide

Map Map Earth

Avenue Jules Gonin

Avenue Jean-Jaques Mercier

Avenue Jean-Ja

Avenue Jules Gonin

Avenue de Montbenc

Avenue de Montbenc

Avenue Louis Ruchonnet

Chemin de Mornex

Activity:2

Purpose:personal business

Arrived at:12:00

Left:11:25

Mode:car as a passenger

Delete

Personal history from previous days' data can assist in prompted recall

Edit Activity Information

What was your purpose of coming here? personal business

How did you come here? car as a passenger

Time period of staying:

Arrive 11:25 -- Leave 12:00

Update Cancel

Activity History

You have come here for 1 times,
1 times for personal business,
1 times by car as a passenger,
1 times at morning,
0 times at afternoon,
0 times at evening.

Last time you came here was at date: 2008-09-19 time: 11:25:00 for personal business by car as a passenger. And you stayed here for 00:75:00.



Battery Problems

- Standard Nokia phone batteries:
 - BL-5F (N95) provides 950 mAh
 - BL-6F (N95 8GB) provides 1200 mAh
- Autonomy: 6 hours
 - with GPS tracking enabled continuously
 - Obviously unacceptably short
- **But:**
 - the phone has other position-identifying tools (GSM, Wifi, etc.)
 - Not necessary to collect GPS info continuously

GPS Switching

- Software development:
 - algorithm for switching the GPS receiver on and off at appropriate times
- Objectives:
 - minimize the loss of relevant positional data (when the subject is moving)
 - only drop unnecessary data (when the subject is stationary)

GPS Switching

- Issue:
 - The GPS unit when switched on will take some time to acquire a fix (a few seconds to a few minutes).
- Possible solution:
 - The use of the Nokia Assisted-GPS feature reduces this time
 - but it requires an active internet connection (GPRS or 3G), with concomitant battery usage

GPS Switching

- Experiment:
 - We are collecting GPS data simultaneously from the Nokia phone and a second, dedicated GPS receiver
- This will allow comparison of switched and continuous tracks, to evaluate different switching algorithms

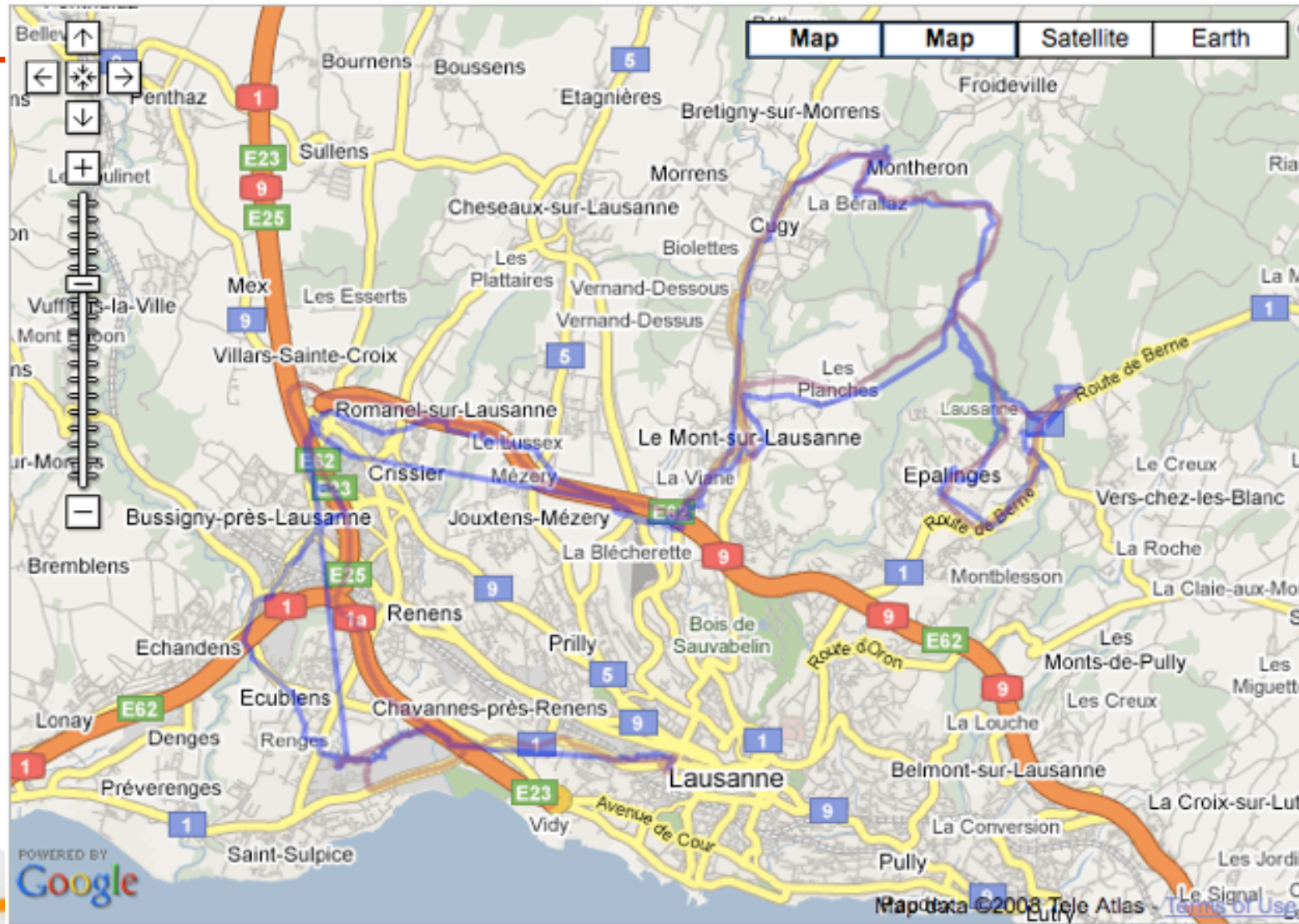


GPS Switching

- As a side effect, we discovered that the GPS accuracy for Nokia phones is pretty low...

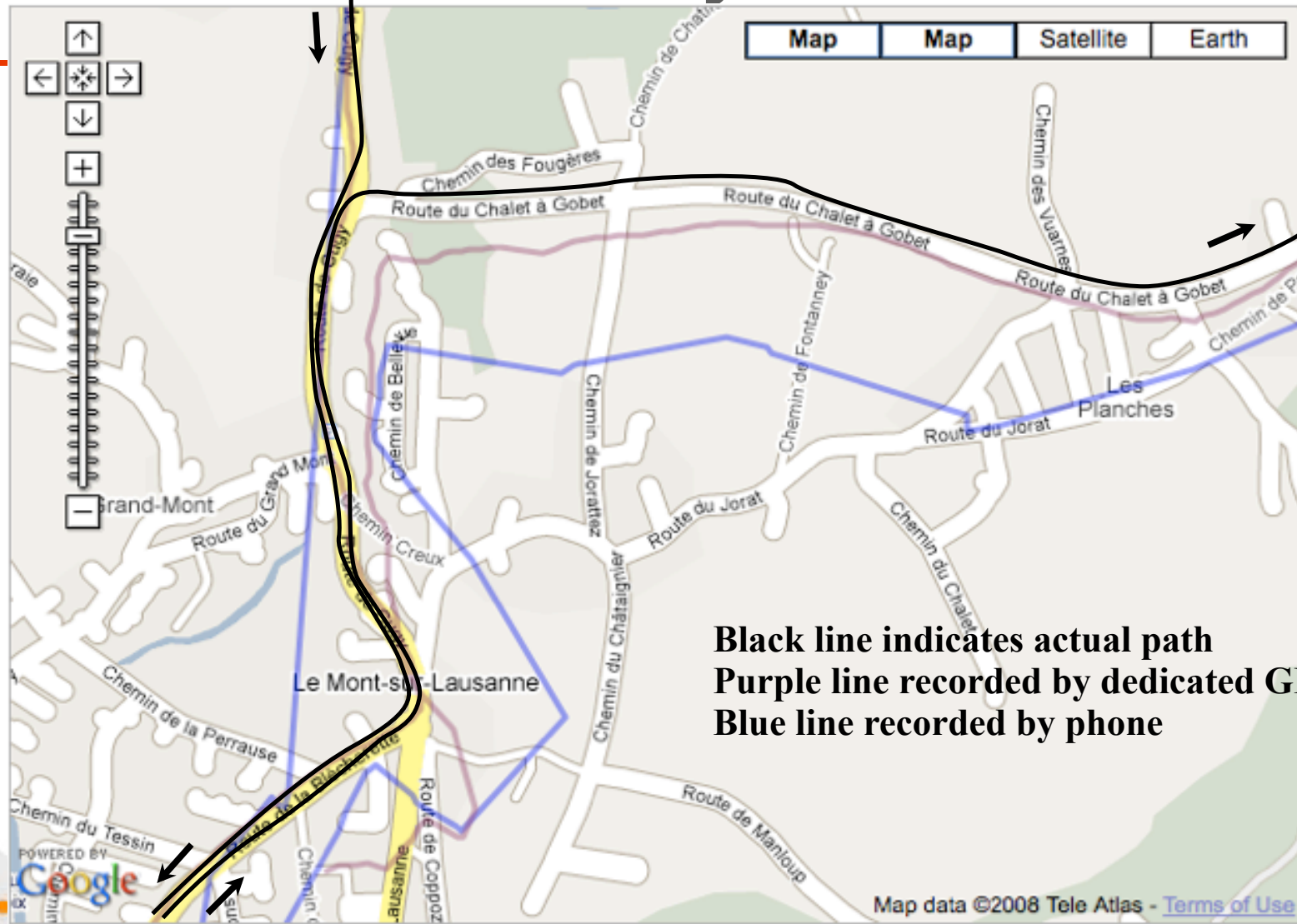


Phone GPS Accuracy is Low



Purple line recorded by dedicated GPS
Blue line recorded by phone

Phone GPS Accuracy is Low



GPS Accuracy

- Low accuracy
 - not great for users
 - but provides opportunity for mathematical research: how can we account for the poor quality of GPS service?
- Traditional map matching of low quality GPS tracks could introduce large biases, creating inaccurate routes for trips
- Proposed solution: use of measurement equations

Future Plans

- Integration of phone software and web survey system
 - the phone automatically uploads each day's data over wireless connection
- Spring 2009: pilot data collection campaign
 - about 30 participants
 - test the system for functionality and bugs
- Summer 2009 (?):
 - Rolling out to 100 (or more) participants for a full scale data collection effort