Efficient 3G Budget Utilization in Mobile Participatory Sensing Applications

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Big Picture: Mobile Participatory Sensing

Mass Media

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wimax

Connectivity

Game Consoles on Internet

Cell-phones

Sensors

Glucose monitor

Cars on Internet

GPS

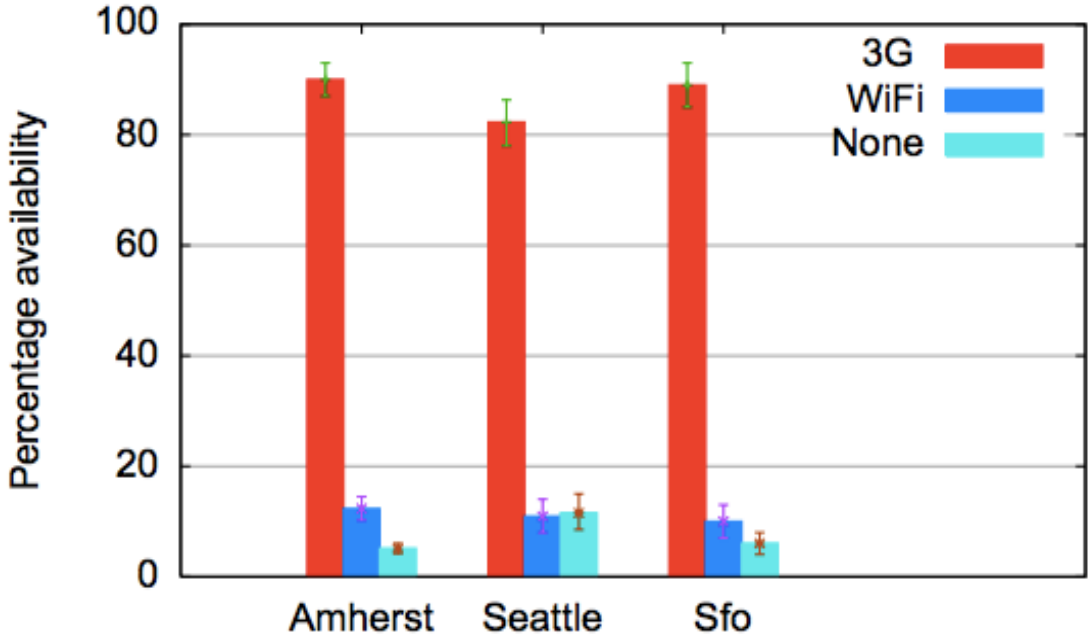
Sportsware

Pulse oximeter

Smart Meter

Problem

- Data collection
  - WiFi: unlimited usage, small coverage
  - 3G: limited usage, big coverage

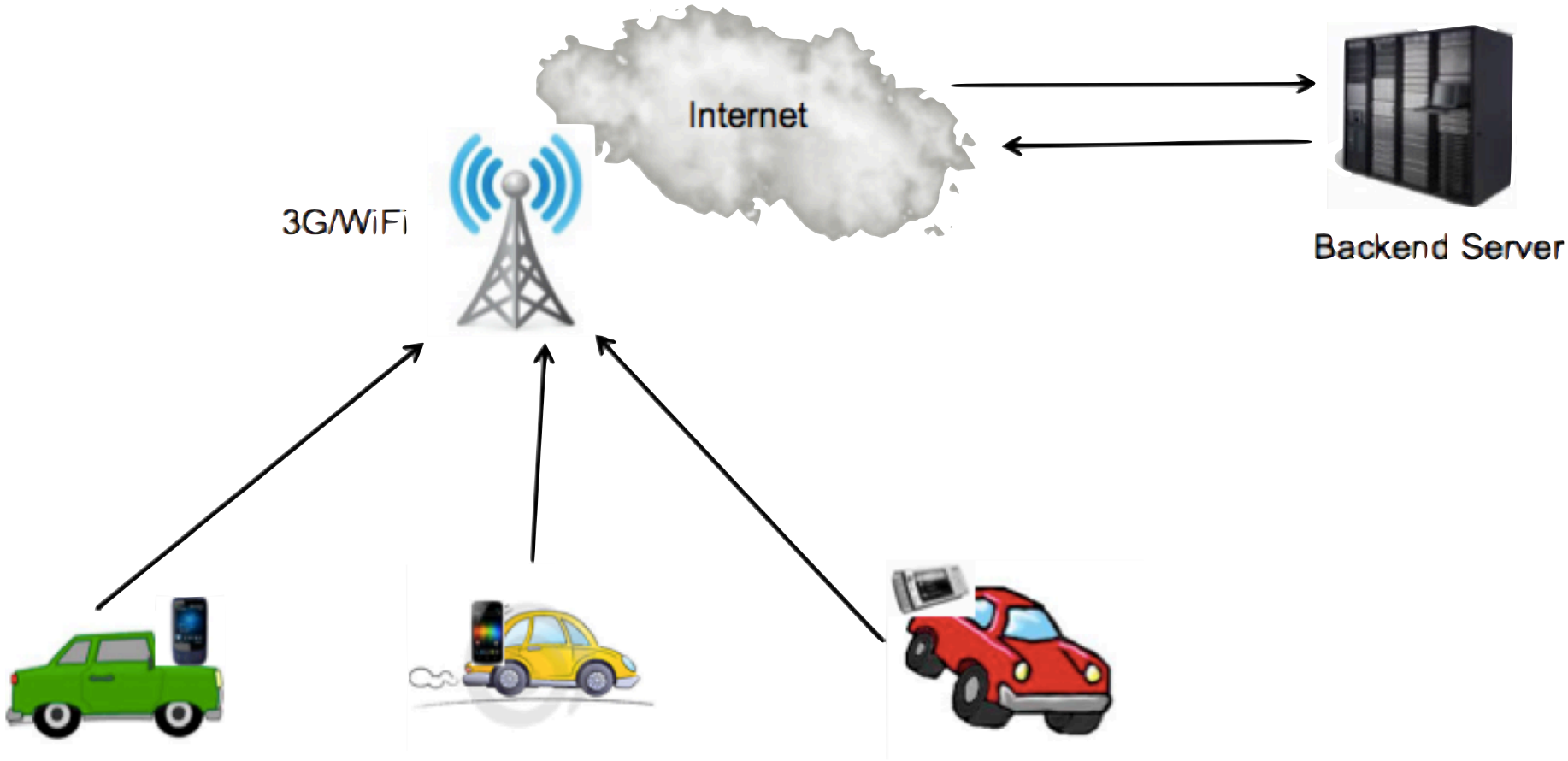


[1] Balasubramanian et al. Augmenting Mobile 3G Using WiFi, MobiSys 2010.

Contributions

- A novel communication framework in Mobile Participatory Sensing
  - Each participant assigns a 3G budget
  - Decision making algorithms for optimization
  - Evaluation from 30-participant deployment

System Model



Goal

- Compute in real-time the per-application 3G offloading schedules that maximize the total offloading utility expectation
  - Balancing current data + future data?
  - When is the next WiFi encounter?
  - Data generated from now on?

Online Algorithm

- Collected sensor data in queue to upload
- If WiFi is available
  - Upload via WiFi
- Otherwise
  - Estimate the data generated in the future and their utility based on historical pattern
  - Upload via 3G data packets in current queue with larger utility compared to projected data packets (data with smaller utility will not be uploaded to reserve resource for future data)

Heuristic Algorithm

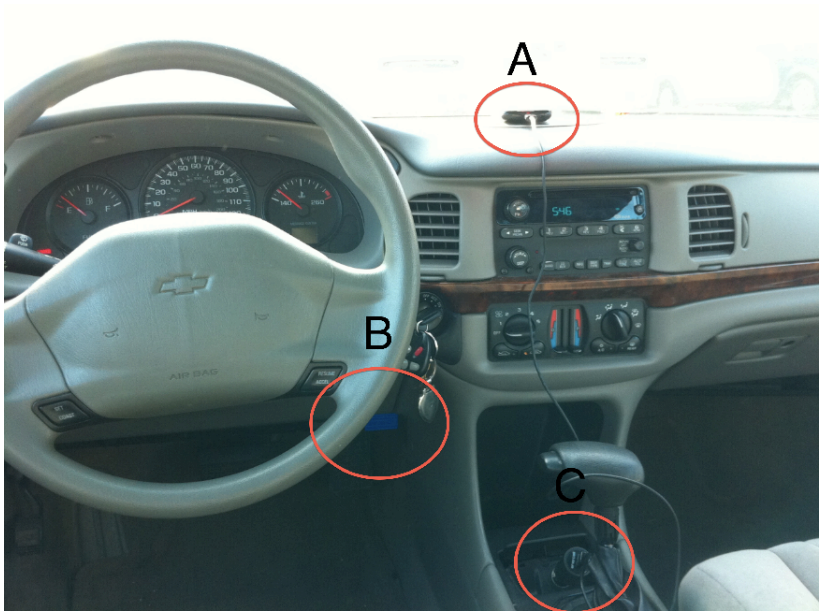
- The online algorithm requires extra storage and computation
- Split the overall 3G budget in each cycle
  - Reserved budget, B_1, SENSITIVE
  - Flexible budget, B_2, NON-SENSITIVE
- Only runs at time points when new data are generated and the budget is not empty

Evaluation

- Fully implemented and deployed
- User study
  - 30 participants
  - Fully autonomous
  - 2 months
- Trace replay & analysis
- Candidates: Baseline, 3G-budget, and Heuristic
- Metrics: Utility of data offloading

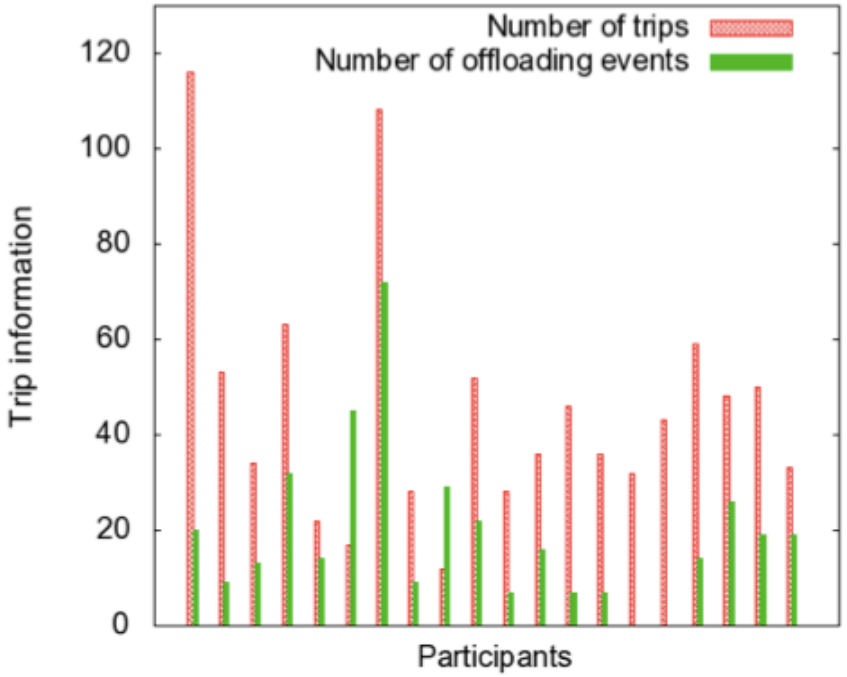
Experimental Setup

Hardware

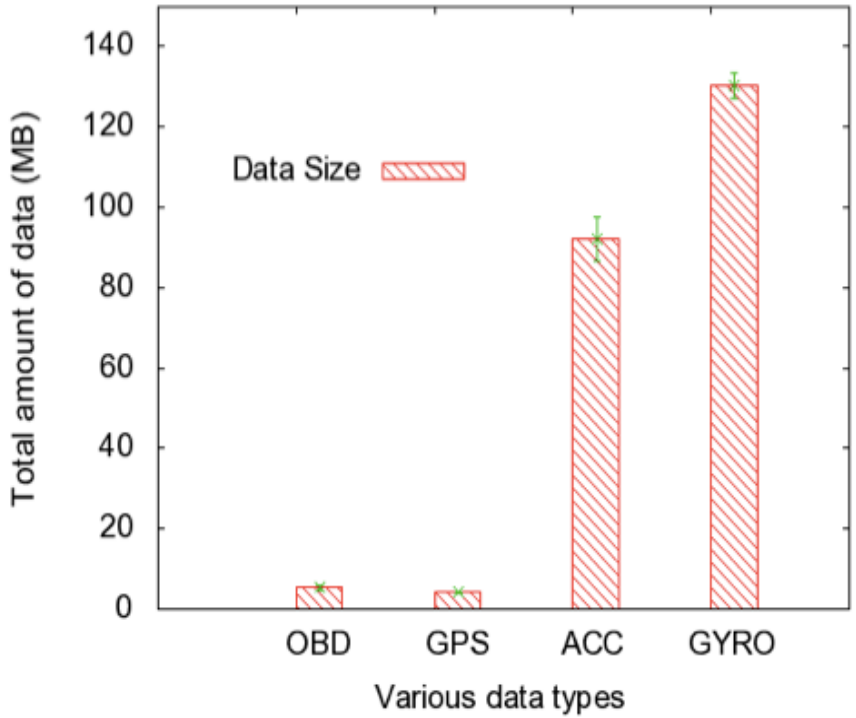


In-Car Deployment

Results – Data Statistics

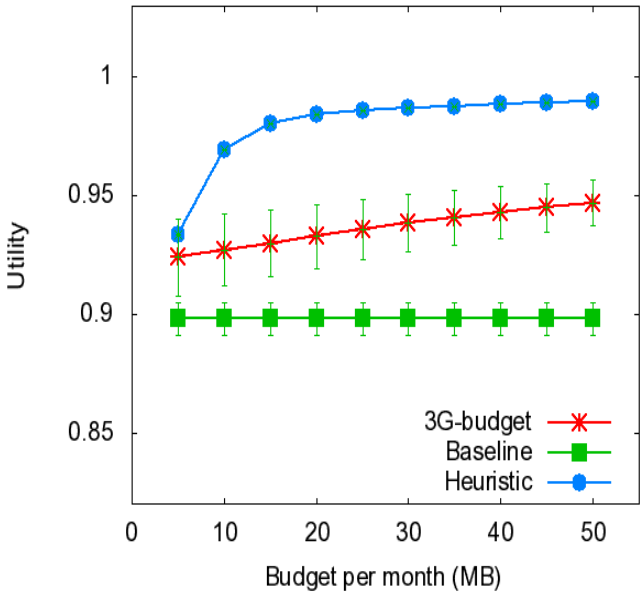


Trips & WiFi-Offloadings

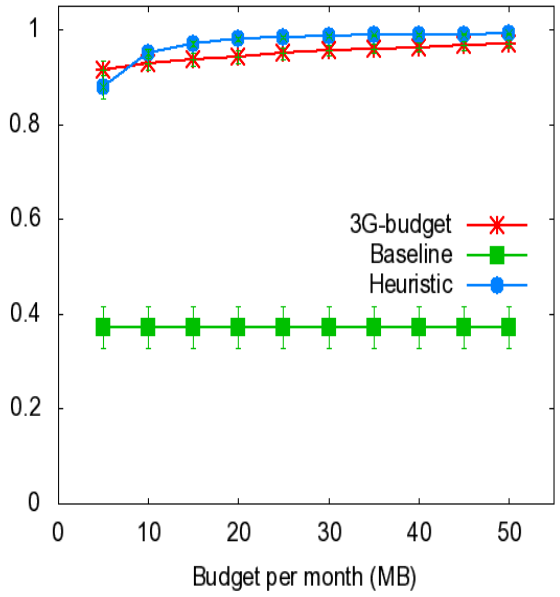


Data Sizes

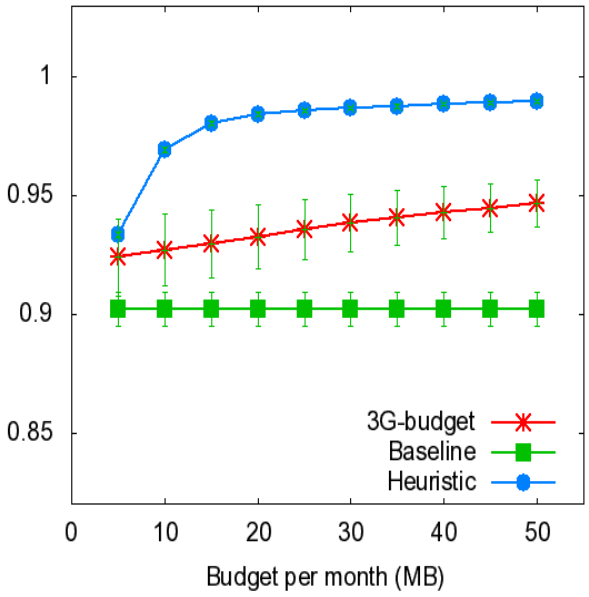
Results – Utilities



Overall

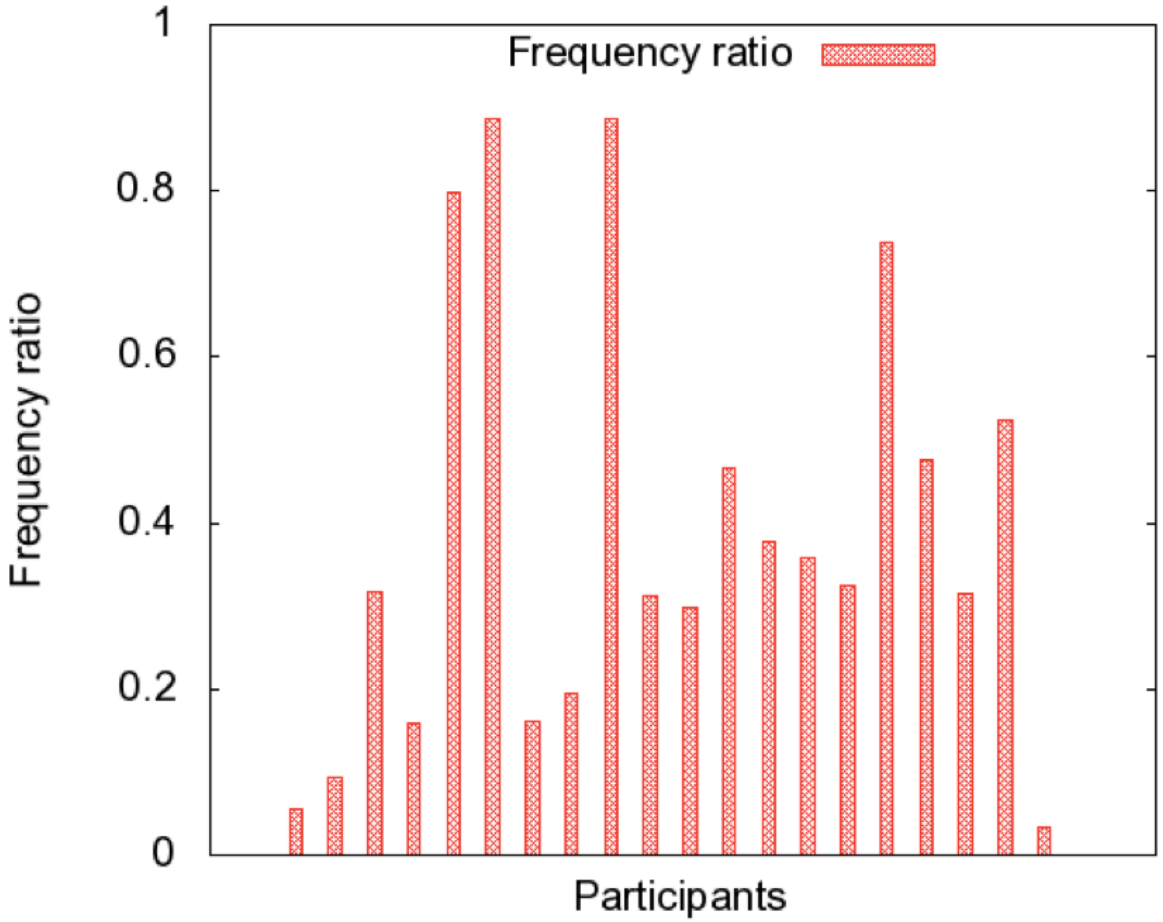


SENSITIVE



Non-SENSITIVE

Results – Heuristic/3G-Budget



Conclusion

- Data collection in mobile participatory sensing
  - Important
  - Challenging
- Optimizing the use of 3G budget
  - Online algorithm
  - Heuristic algorithm
- A 30-participant 2-month deployment
- Experiment results show improvements of utility for sensor data offloading

Thanks!

Background

- Mobile participatory sensing applications
  - Nericell, GreenGPS, SignalGuru, ……
  - Rely on WiFi access points
- DTN style
  - Wiffler, MosoNet, VIP-delegation, MultiNets.
- 3G network overloaded
  - AT&T, T-Mobile, ……