Thrifty Tracking: Smooth and Accurate Online GPS Tracking with Low Uplink Utilization

Troy Hernandez, James Biagioni, Jakob Eriksson
University of Illinois at Chicago

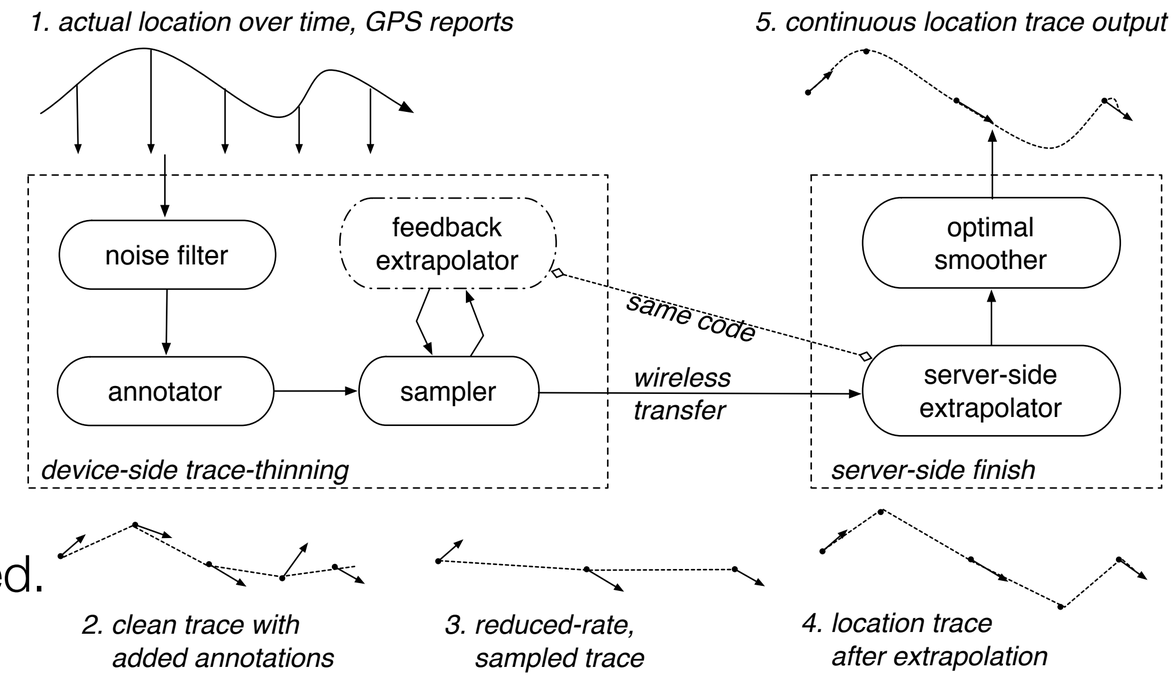
Motivation

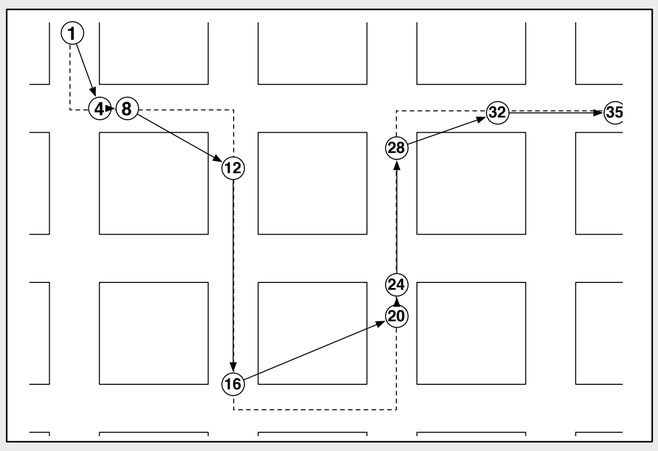
- GPS tracking can consume considerable bandwidth
- Location accuracy vs. data usage optimization needed.

Main Contributions

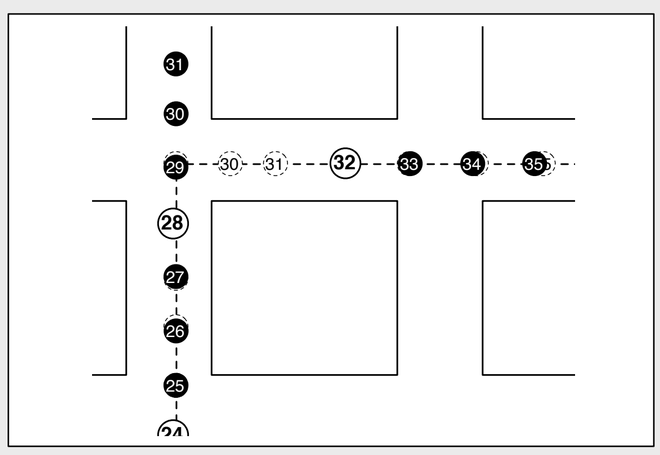
- An end-to-end framework improving efficiency of GPS
- 46 tracking methods evaluated on 1,200 hours of data.
- Billing policies for data usage on AT&T's network analyzed.

Architecture

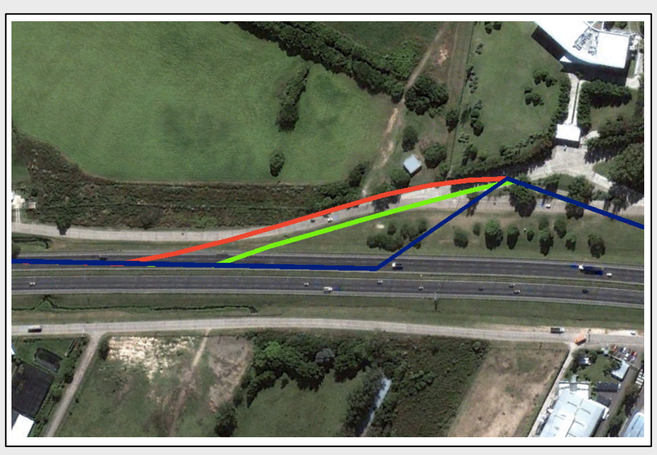




Result of time-interval sampling. Interval is 4 time steps.



Constant velocity extrapolation.



Iterative smoothing: Extrapolation (blue), smoothed trajectories (red, green).

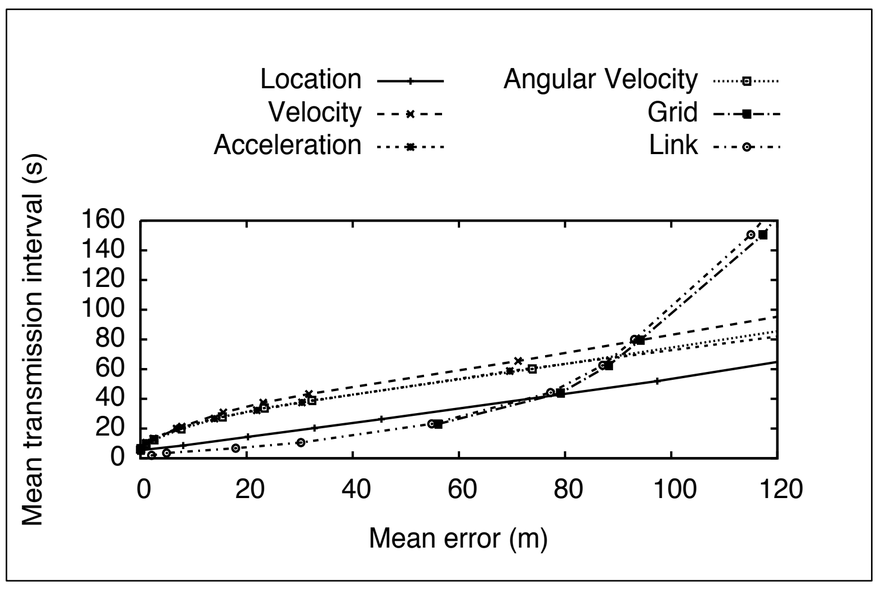
Sampler \ Extrapolator	Location	Velocity	Acceleration	Angular Velocity
Distance Error	3.9	0.7	0.9	0.8
Budget	5.5	0.8	1.2	1.1
Time Change	5.1	1.3	1.5	1.7
Time, Bearing & Location Change	4.5	4.1	4.4	4.2
Time & Location Change	4.3	5.0	6.2	3.6
Bearing Change	53.8	70.7	1125.3	20.9
Speed Change	16.7	12.1	14.2	10.2
Location Change	3.7	18.7	179.9	5.5
Acceleration Change	29.2	19.6	70.4	51.6
Time & Bearing Change	6.2	2.8	5.4	5.2
Time & Speed Change	5.0	1.2	6.3	2.1

Comparison of Sampling Rules and Extrapolation Methods

OpenStreetMap (OSM) data at 25m threshold. Values represent error incurred per second of additional transmission interval. Distance-based error sampler and the velocity-based extrapolators performed best.

Distance Error Sampling

Shuttle data: velocity/link-based extrapolation performs best with low/high error allowance; respectively.



NSF
UIC UNIVERSITY OF ILLINOIS AT CHICAGO
Bits Networked Systems Laboratory
COLLEGE OF ENGINEERING