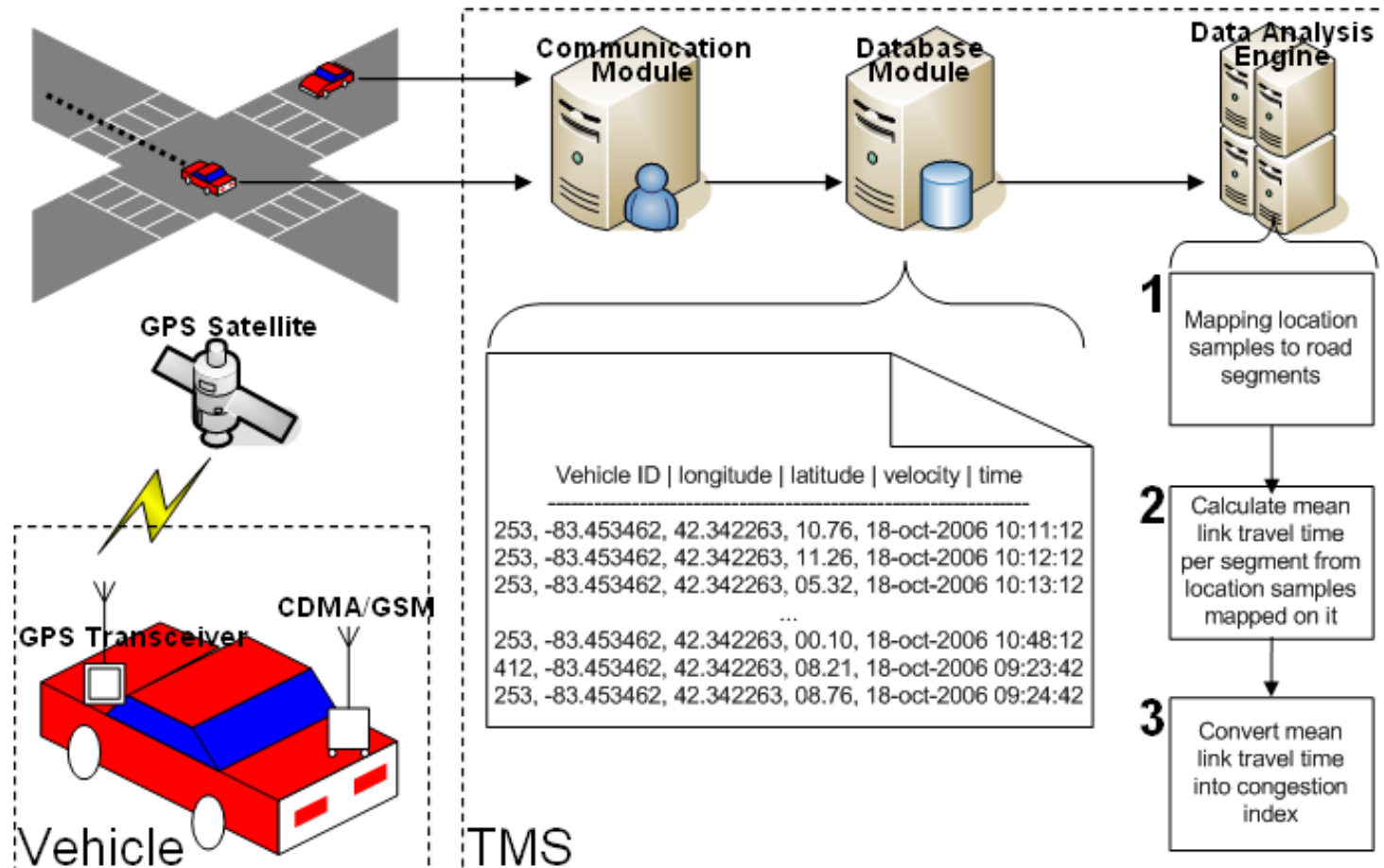


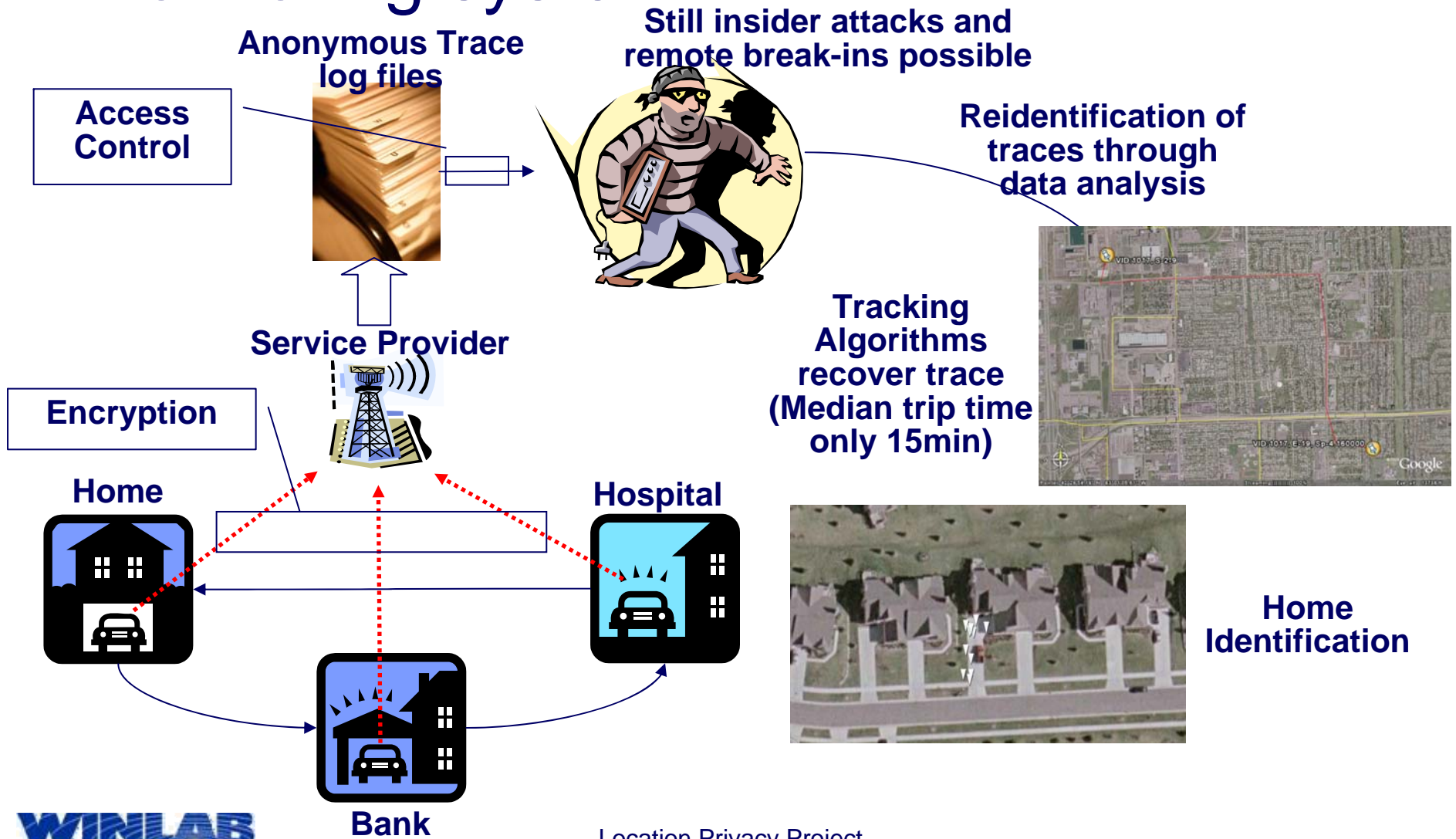
Preserving Privacy in GPS Traces via Uncertainty-Aware Path Cloaking

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Motivation: Traffic Monitoring Through Probe Vehicles



Location privacy challenges in traffic monitoring system





Objectives

□ Objectives

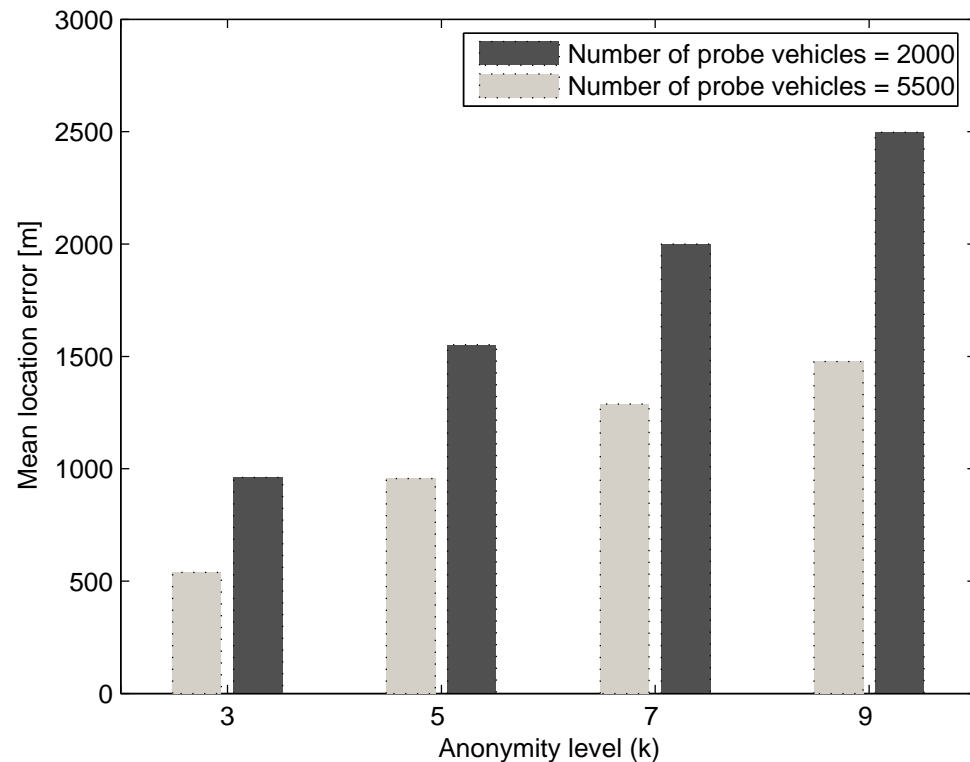
- Strong anonymity: protection against tracking and reidentification for all drivers, regardless of vehicle or building density
- Maintain data accuracy sufficient for traffic monitoring

□ Assumptions:

- Trustworthy privacy server available to execute centralized algorithm
- Adversary has no prior information about the subjects being tracked

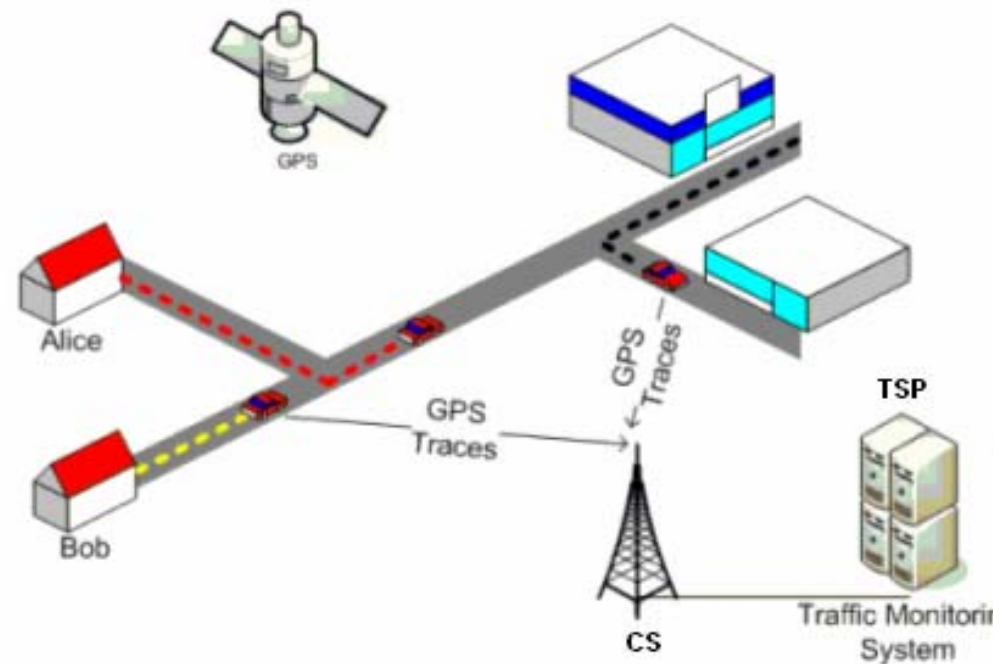
Prior Approaches

- K-anonymity provides privacy guarantees but does not meet accuracy requirements
- Best effort algorithms do allow outliers (long tracking), thus do not meet privacy requirements
 - Subsampling
 - Swing & Swap
 - Mix Zones
 - Path Confusion

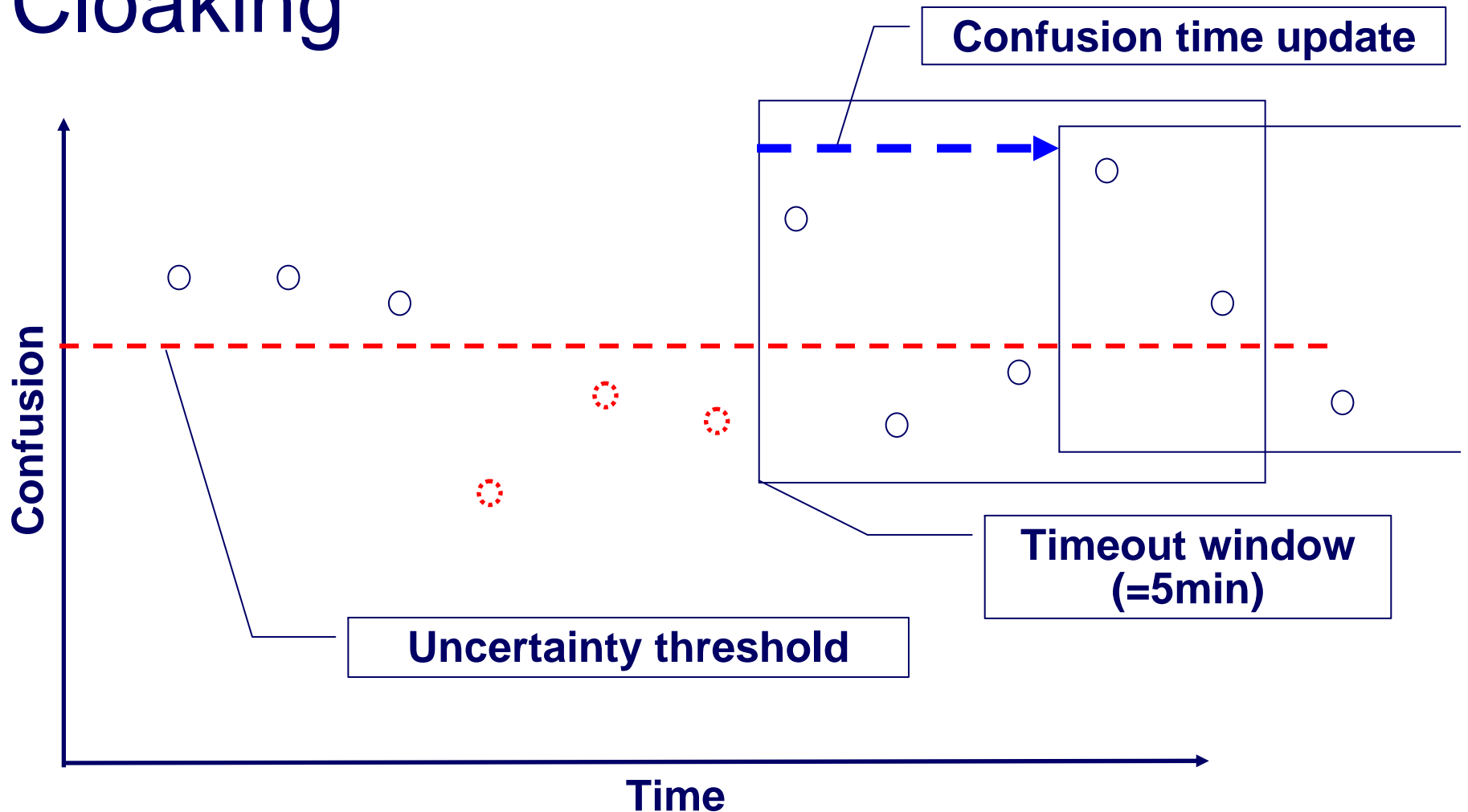


Approach: Guaranteed Time-to-confusion

- Insight: Degree of privacy risk strongly depends on how long an adversary can follow a vehicle
- Time to confusion (TTC) measures time between two points where a tracking uncertainty remains lower than a confusion threshold
- Tracking Uncertainty can be define based on entropy and
 - Target tracking algorithm uses spatio-temporal correlation to choose the next location sample of an anonymous user

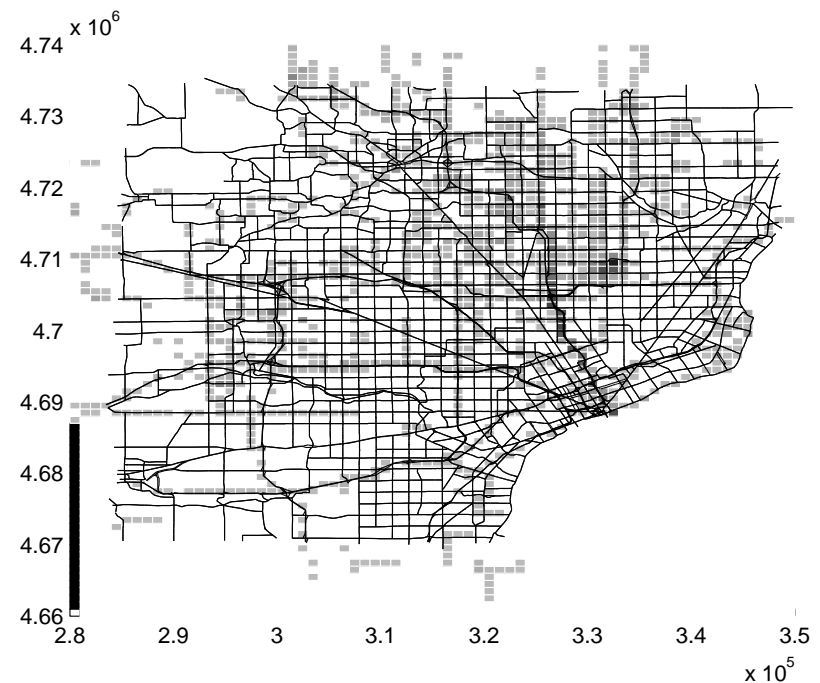
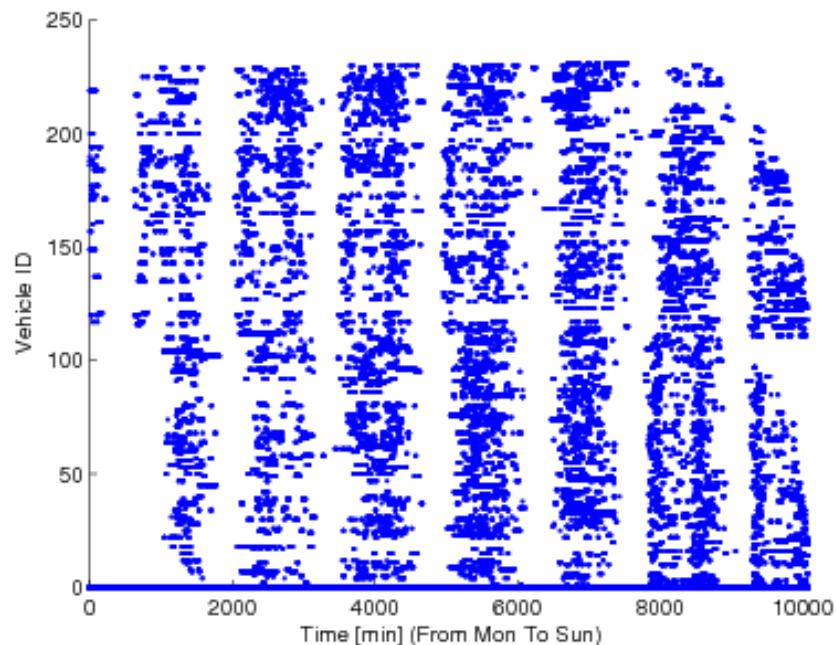


Algorithm: Uncertainty-aware Path Cloaking

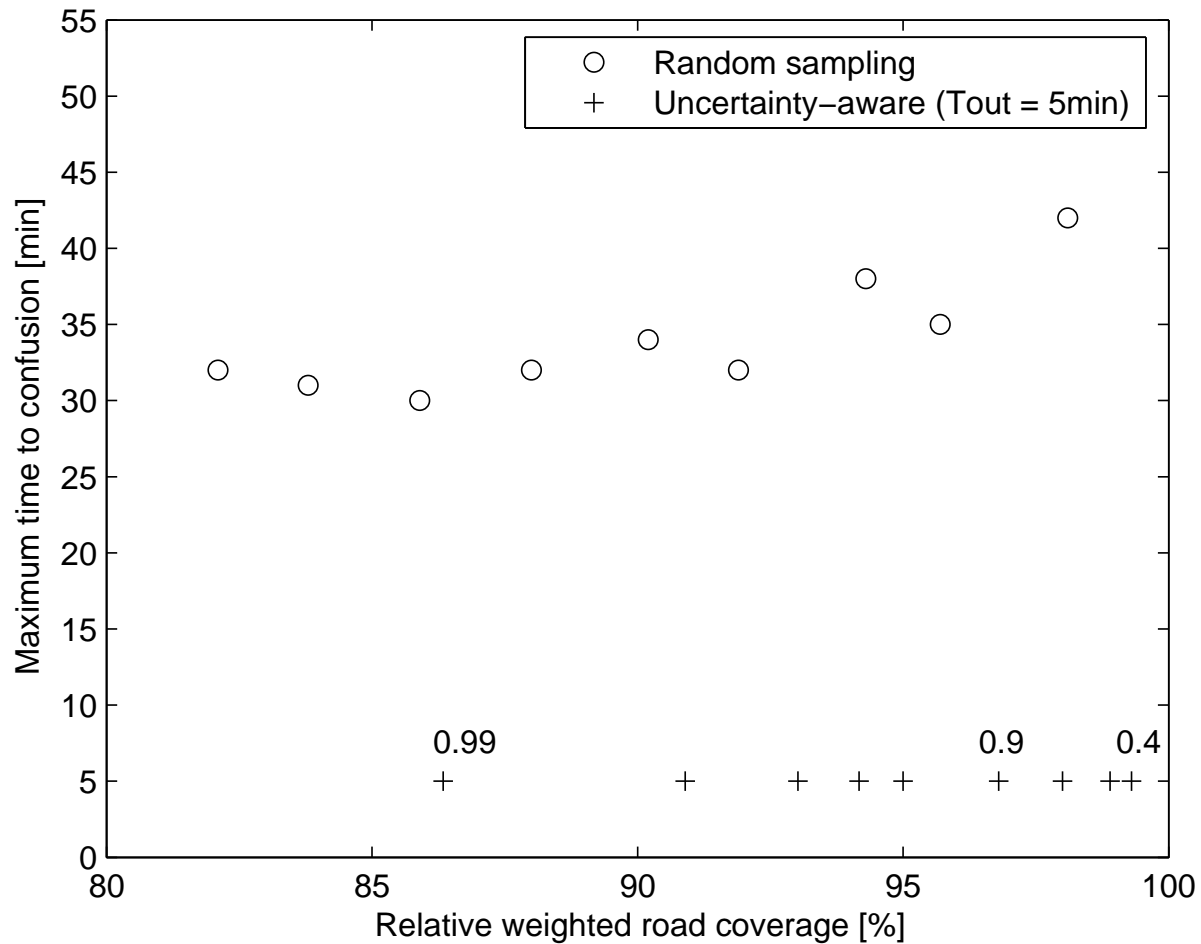


Evaluation

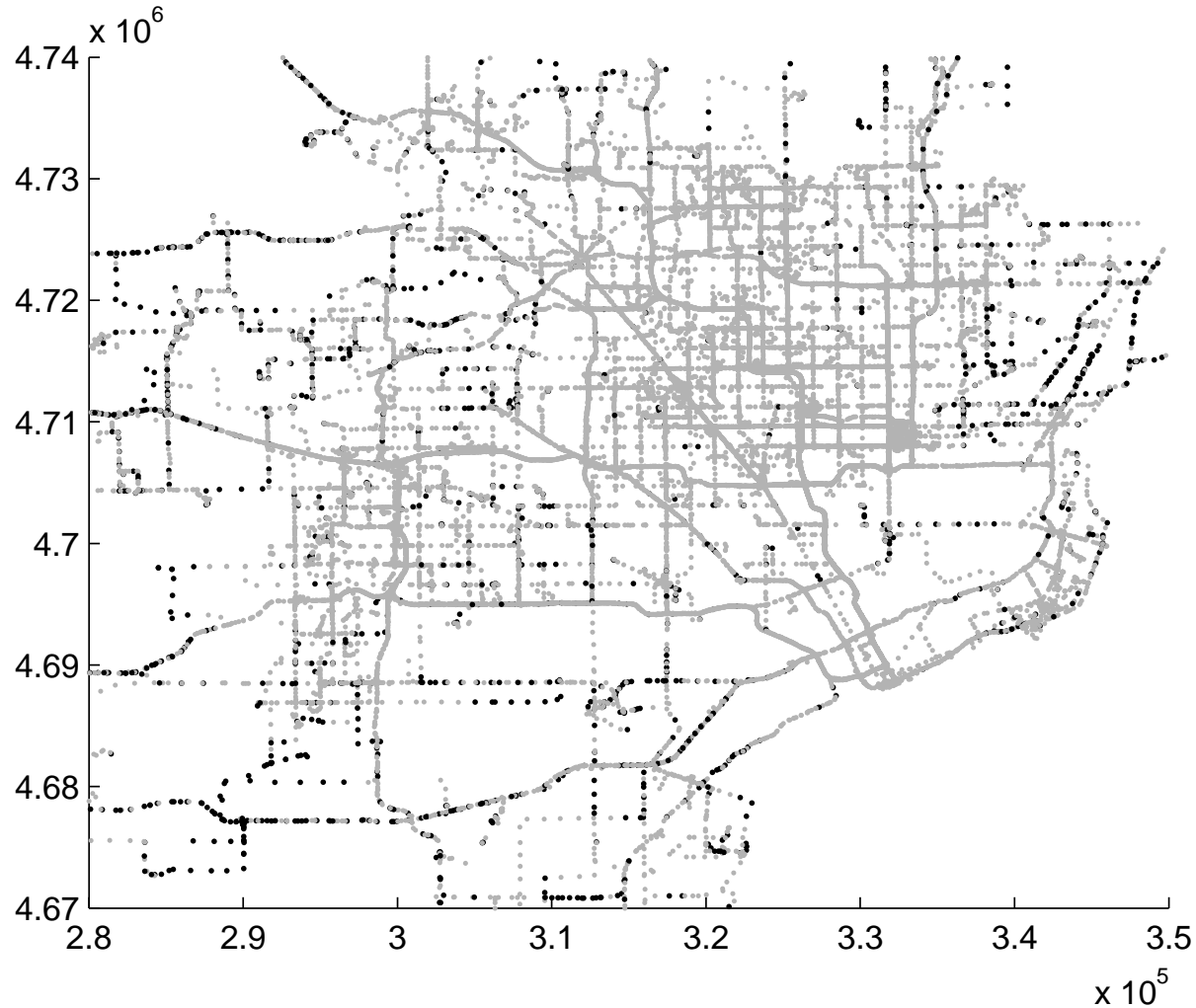
- Data set: 24-hour GPS traces of 2000 probe vehicles on a 70km-by-70km area (built from ~200 actual vehicles)
- Metrics: Tracking time and (relative) road coverage



Evaluation: Protection against Target Tracking



Snapshot of privacy-preserved GPS traces: black dots are removed samples (5min,0.95)





Summary

- *Time-to-confusion*: can be widely used in analyzing a location privacy of location traces database
- *Guaranteeing Bounded Privacy*: Uncertainty-Aware Path Cloaking, effectively suppresses tracking time outliers even in a sparse area
- *High data accuracy*: Uncertainty-Aware Path Cloaking achieves data quality similar to original location traces (without privacy protection)
- Further Work:
 - Map-based tracking model could be used in computing entropy in our proposed algorithm
 - Inference attack with a priori knowledge on a selective individual needs to be analyzed further



Questions?