

Collaborative Research: SaTC: CORE: Small: Privately Collecting and Analyzing V2X Data for Urban Traffic Modeling

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URL: <http://cs.iit.edu/~yhong/projects/pptm.html>

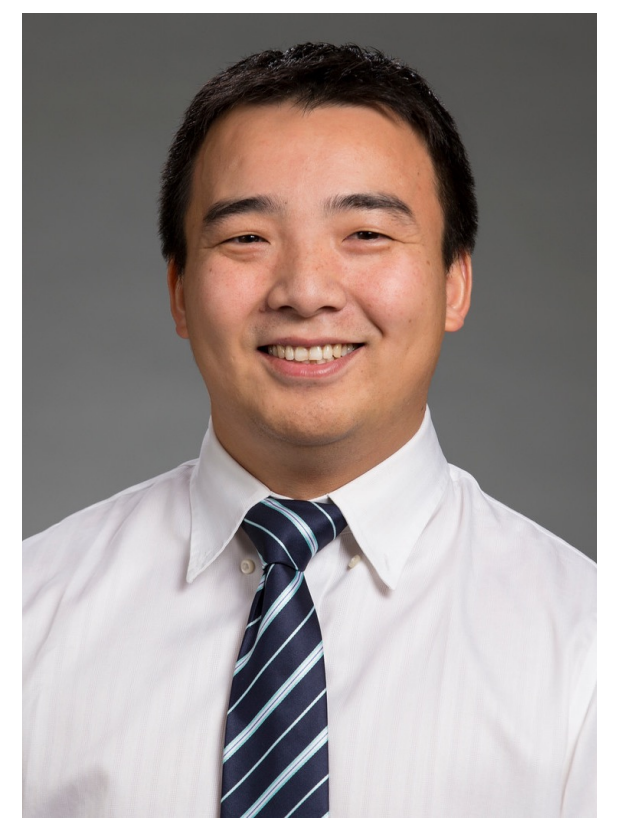
Video: <http://cs.iit.edu/~yhong/projects/pptm/satc22.mp4>

Project Duration: 10/2021-9/2024

This project develops a series of privacy preserving vehicle-to-everything (V2X) data collection and analysis techniques with provable privacy guarantees

(I) **Local Differential Privacy (LDP)** based data aggregation for large-scale urban traffic modeling

(II) **Secure Multiparty Computation (MPC)** based real-time data for small-scale urban traffic modeling



<https://tomorrow.city/a/smart-mobility-definition-solutions-and-all-you-need-to-know>

Improving Traffic Mobility

- Origin-destination analysis
- Queue length estimation
- Delay pattern estimation
- Traffic signal timing learning
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<https://echalliance.com/the-road-to-the-autonomous-age-will-be-paved-by-smart-cities/>

Improving Vehicle Safety

- Road safety index learning
- V2V safety enhancing
- V2I safety computing
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Technical Research Challenges

- Heterogeneous V2X data protection
- Highly-dimensional and correlated data release with LDP
- Randomization mechanism design for complex data analysis, e.g., deep learning
- MPC protocol and system design for complex V2X data analysis
- Real-time system design and implementation

Scientific Impacts

- Novel LDP schemes for data collection
- Novel MPC systems for secure computation
- Advancing privacy preserving data collection and analysis in CPS
- Provable privacy guarantees
- Designing and implementing real systems for private V2X data collection and analysis

Solution and Key Innovations

- New V2X data (e.g., locations) encoding schemes for improving data utility
- New randomization mechanism for sampling the V2X data with differential privacy (TDSC'21)
- Machine learning for interpolating private V2X data (as post-processing)

- Optimizing the efficiency for MPC protocols with new garbled circuits for verifying the constraints
- Extending the SF3 experimental platform with parallel simulation and distributed emulation capability, to conduct high-fidelity and scalable evaluations with the parameters/data and traffic scenarios collected from real connected vehicles (CV) testbeds in Madison, WI

Broader Impacts (I)

- V2X data (e.g., collected from the infrastructure) privacy and confidentiality impact the national security
- Private urban traffic modeling improves the traffic mobility and vehicle safety
- The designed protocols and systems can be extended to mitigate privacy risks for other CPS/IoT systems

Broader Impacts (II)

- Updating two new courses "Cryptography" (CS549) and "Data Privacy and Security" (CS528) in the computer science department of Illinois Tech
- Updating "Transportation Networks and Optimization" at University of Washington
- Jointly develop "Privacy Protection in Transportation"

Broader Impacts (III)

- Dissemination to transportation agencies, the academic community, and the industry
- BPC through programs such as IIT's K-12 outreach activities, IIT STEM Expo, IIT Computer Discovery Camp for Girls, and UW's Discovery Day

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