

Research Title:

Scalable Distributed Learning-based Approach for Joint Navigation in Local Environments

Primary Investigator:

Name: **Dr. Gilad Katz**

Faculty: **Department of Software and Information Systems Engineering**

Academic Institute: **Ben-Gurion University of the Negev**

This research introduces a scalable, learning-based approach for coordinating autonomous vehicles at unsignalized intersections. Existing multi-agent methods rely on fixed command sets or peer-to-peer messaging, and most must be retrained when the number of vehicles changes. Our approach uses a hierarchical architecture instead. A Master module, designed to run on roadside infrastructure, observes only vehicle positions and velocities. It broadcasts a compact, fixed-size “proto-plan” embedding that encodes a coordination strategy for all vehicles. Each vehicle combines this shared plan with its own state to choose its actions. Communication cost is therefore constant for any number of vehicles, and vehicles never need to share routes or intentions.

The project produced two systems, each reported in a research paper. The first, MAPS, establishes the proto-plan mechanism for a single Master. Across 234 traffic configurations in three road layouts, MAPS outperformed seven baseline methods on every safety and efficiency metric. It reached a 99% success rate at a single intersection and transferred from three to five vehicles without retraining. The second, HD-MAPS, extends the approach to large fleets. Its proto-plan has the same size as a single vehicle’s state, so one Master network can coordinate vehicles, other Masters, or both. Hierarchies of Masters are assembled automatically at run time and reorganized as vehicles enter and leave. Trained on at most six vehicles, the same network coordinated 48 vehicles across 16 intersections with an 85.5% arrival rate, against 76.6% for the strongest baseline. Crash rates stayed at 2–7% while the hierarchy changed continuously, and compute grew only linearly with fleet size. Together, these results show that hierarchical proto-plan coordination scales to large, changing fleets without retraining, a key step toward safe and efficient large-scale traffic management.