

PLATOONING TRAJECTORY OPTIMIZATION FOR CONNECTED AUTOMATED VEHICLES IN COORDINATED-ARTERIALS

Agustin Guerra, Lily Elefteriadou PhD

Objective

To develop a heuristic framework to optimize Connected-Automated-Vehicles (CAVs) trajectories.

Motivation

- In the U.S current signal control strategies account for 295 million vehicle-hours of delay on major roadways alone [1].
- Simulation results suggest that it is possible to reduce delays by exploiting CAVs capabilities [2]
- Most of the existing optimization frameworks are limited by the complexity of their formulation making their implementation challenging [2]

Methodology

A heuristic framework was developed to adjust CAVs trajectories using the kinematics equations (variable acceleration case).

$$x(t)_{l,n} = x(t_0) + \int_{t_0}^t v(t) dt$$

$$v(t)_{l,n} = v(t_0) + \int_{t_0}^t \alpha(t) dt$$

$$\alpha(t)_{l,n} = y - zt$$

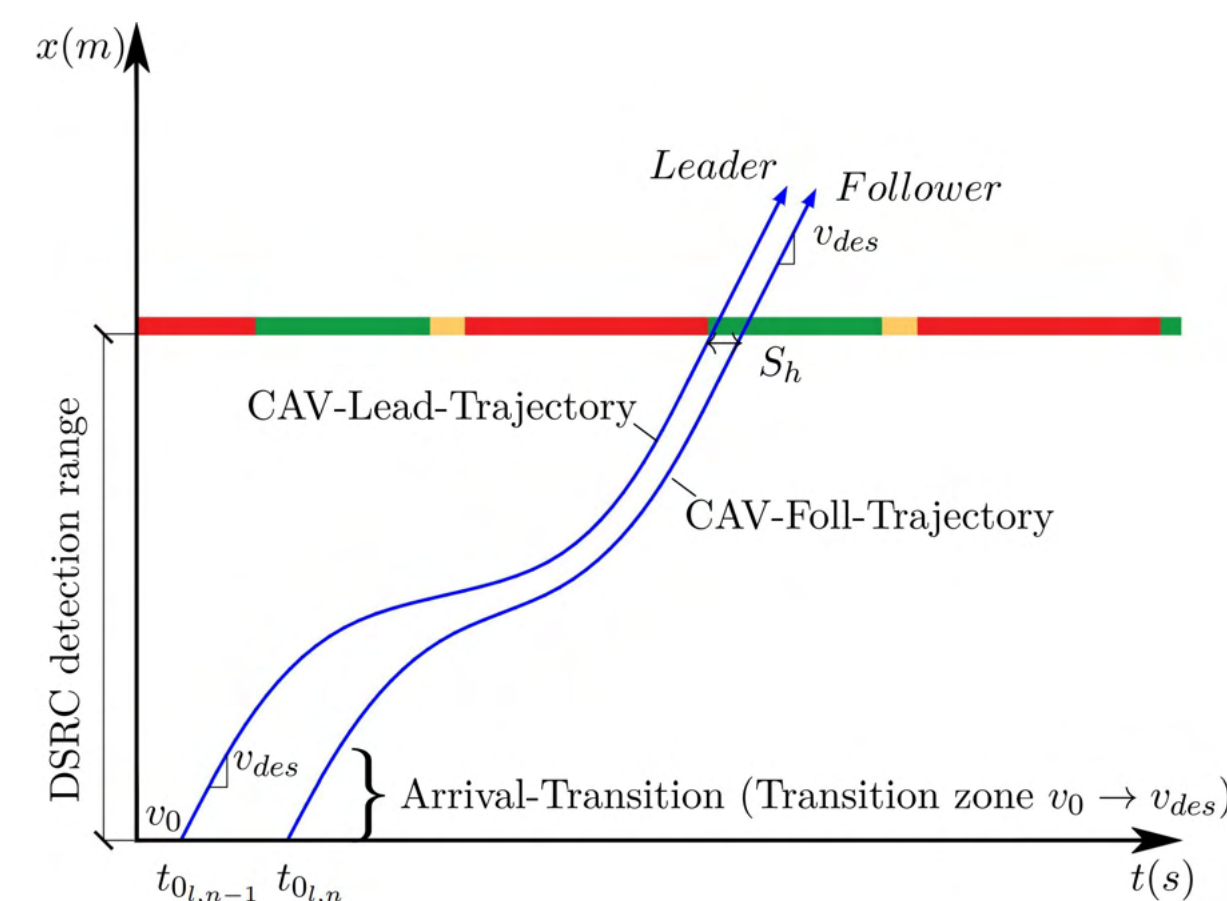


Fig. 1: Concept of trajectory optimization algorithms.

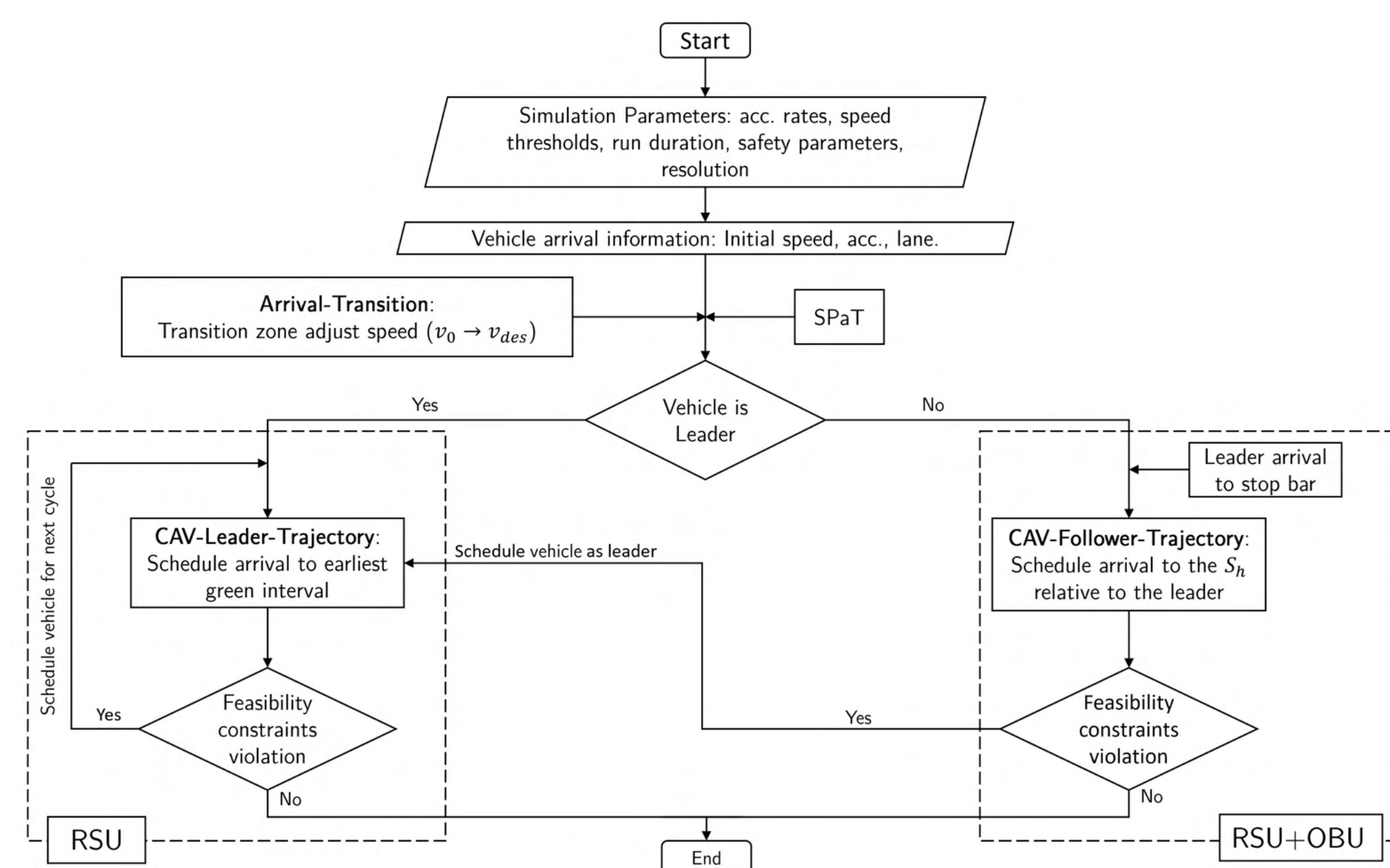


Fig. 2: Algorithms integration.

Simulation Experiments

An arterial with two intersections was used to evaluate the efficiency of the proposed heuristic. Demand from Eastbound (EB), and Southbound for both intersections were considered (SB-1), (SB-2).

Demand (vph)	Scenarios						
	I	II	III	IV	V	VI	VII
Eastbound (EB)	150	250	350	475	600	725	750
Southbound Intersection 1, (SB-1)	130	190	280	350	470	580	625
Southbound Intersection 2, (SB-2)	120	210	270	380	450	550	625
Network (EB + SB-1 + SB-2)	400	650	900	1205	1520	1855	2000

Fig. 3: Demand Scenarios.

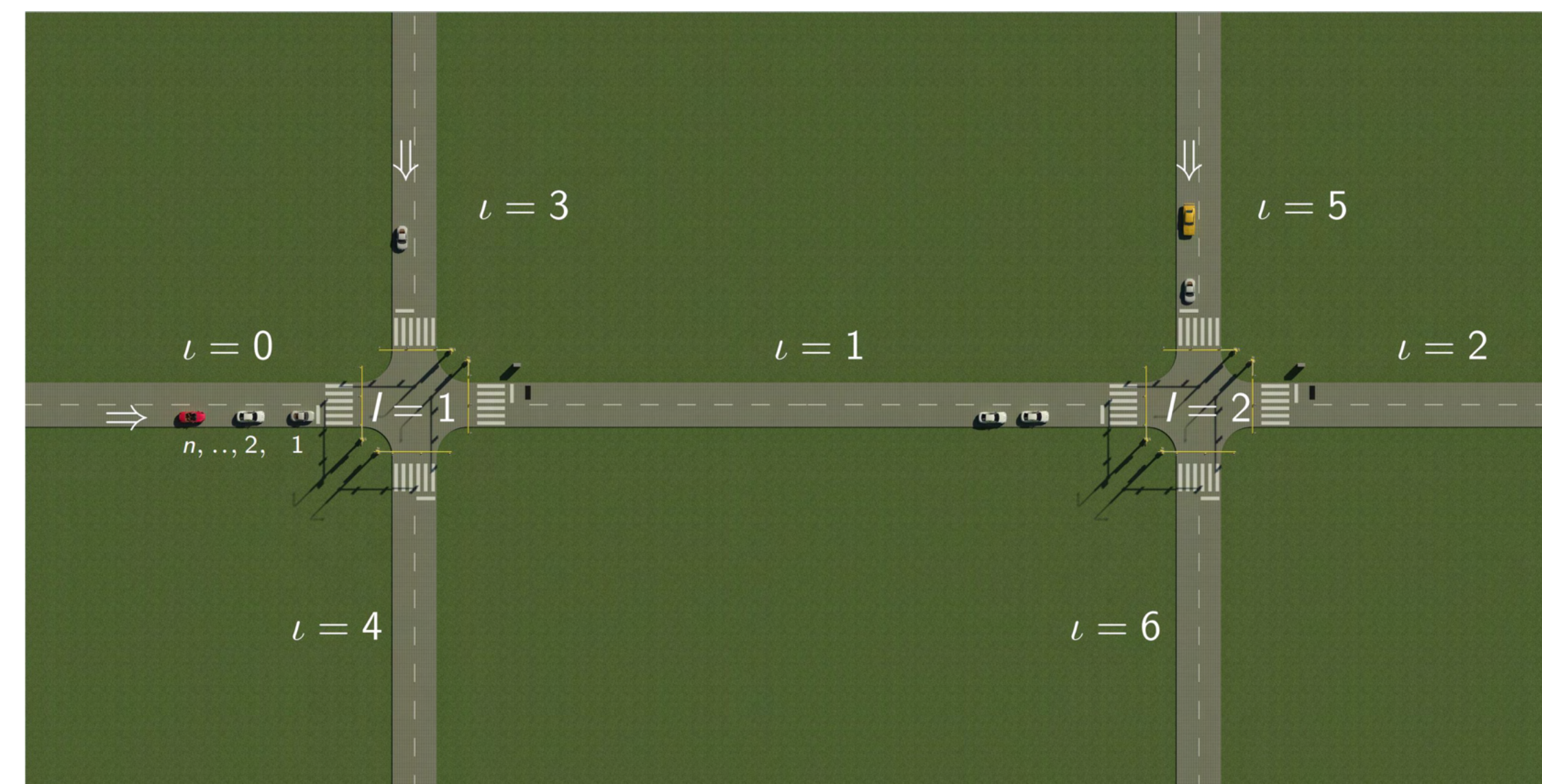


Fig. 4: Study arterial for simulation experiments.

I. Results

Simulation results showed that the trajectory optimization framework successfully form collision-free platoons at the saturation headway.

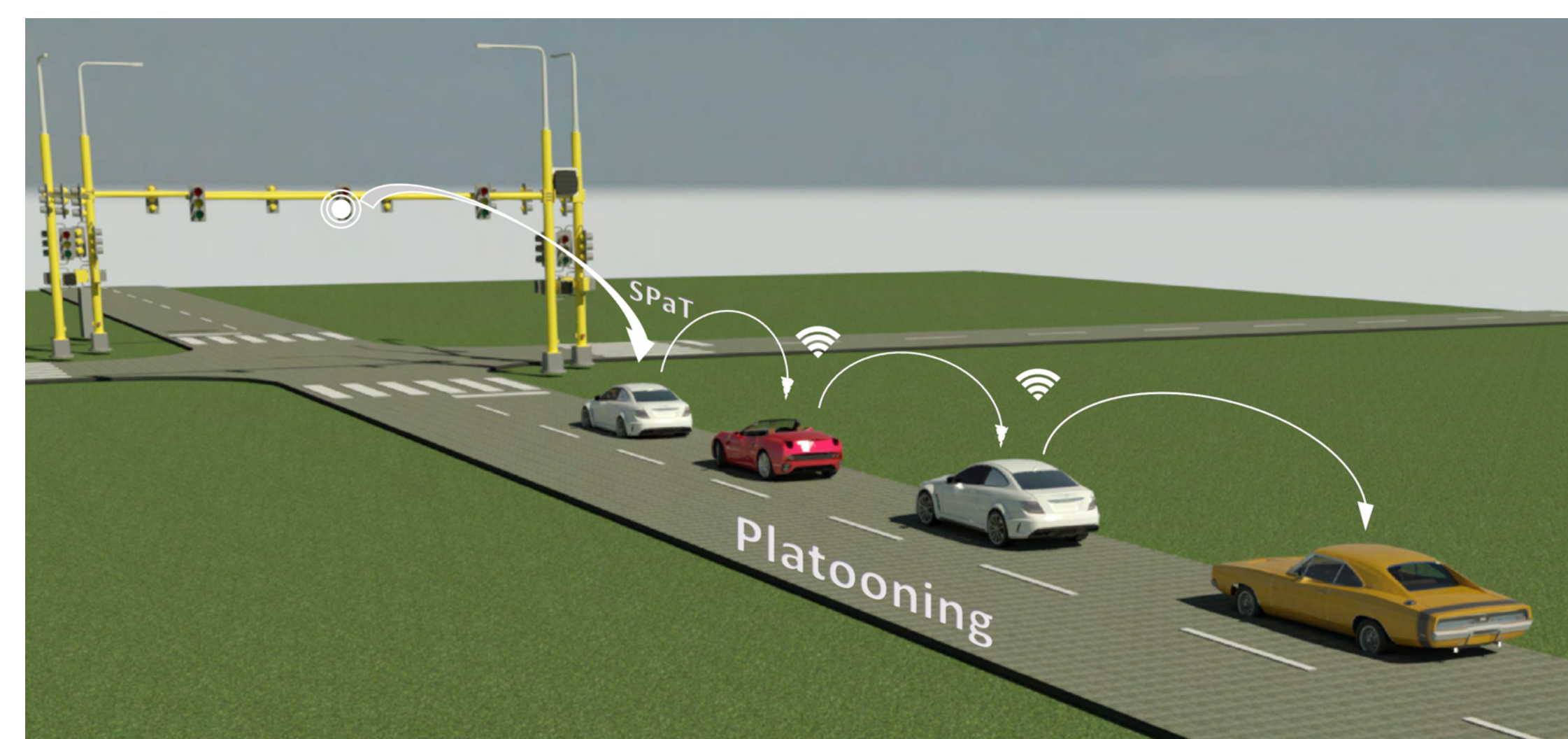


Fig. 5: Conceptual of Platooning.



II. Results

The results showed that travel time and delay are reduced by (8-22%) and (11-23%), respectively.

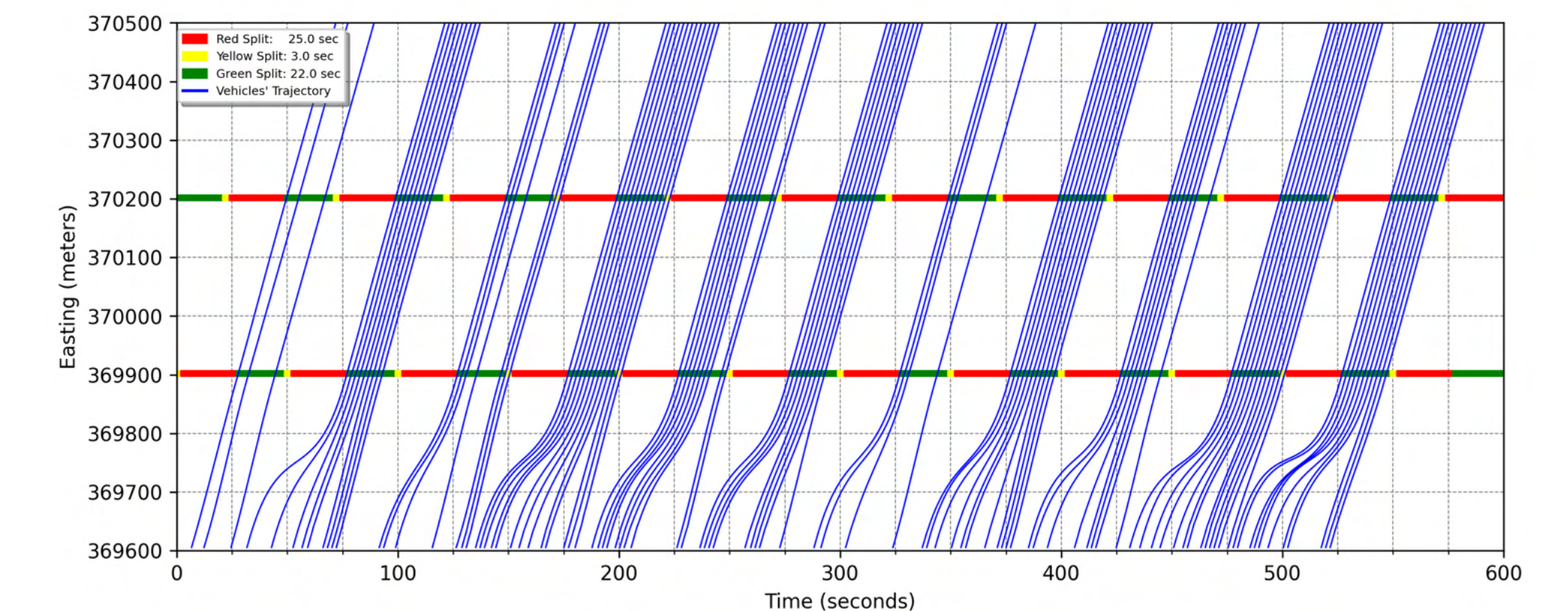


Fig. 6: Time-Space Diagram.

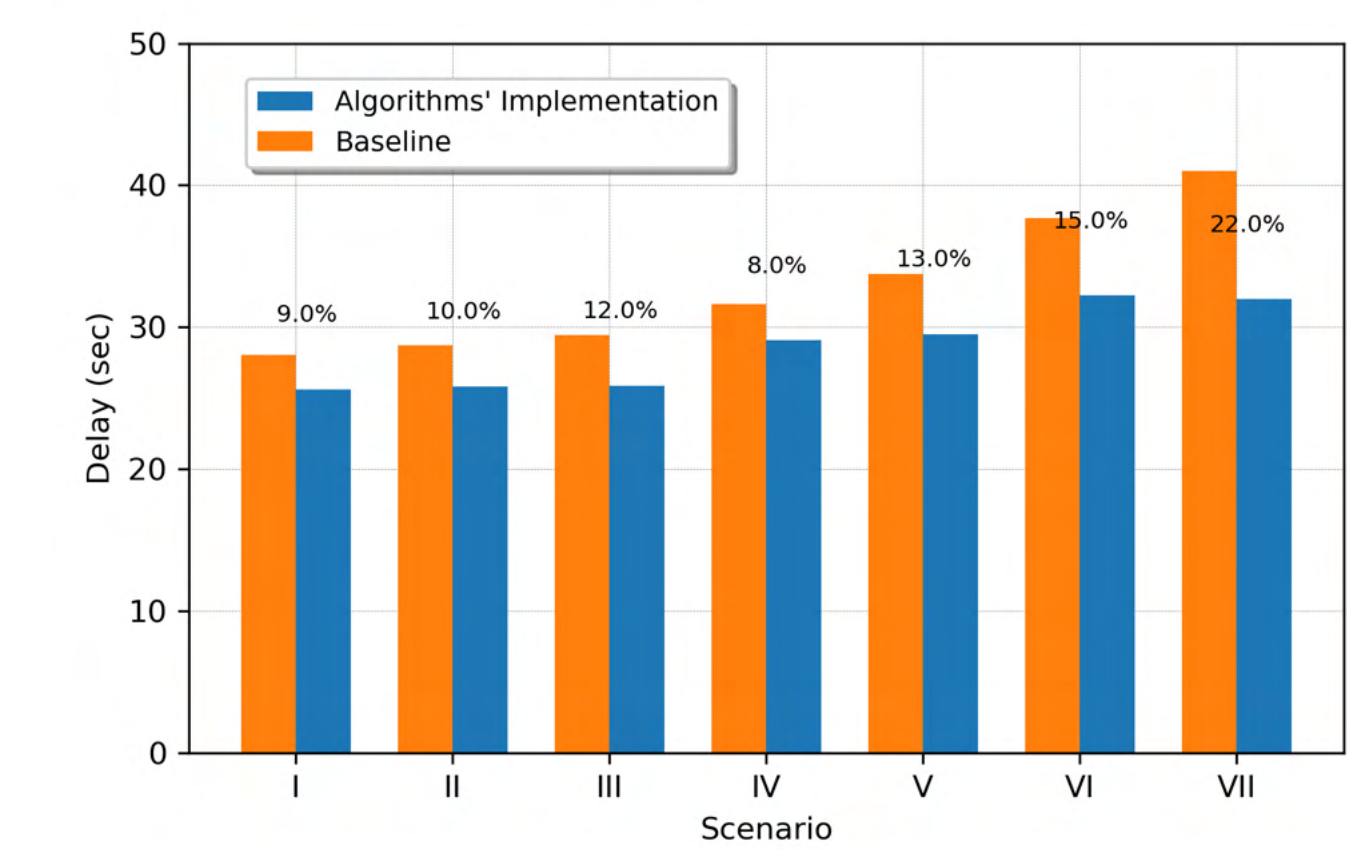


Fig. 7: Average Network Travel Time Improvements.

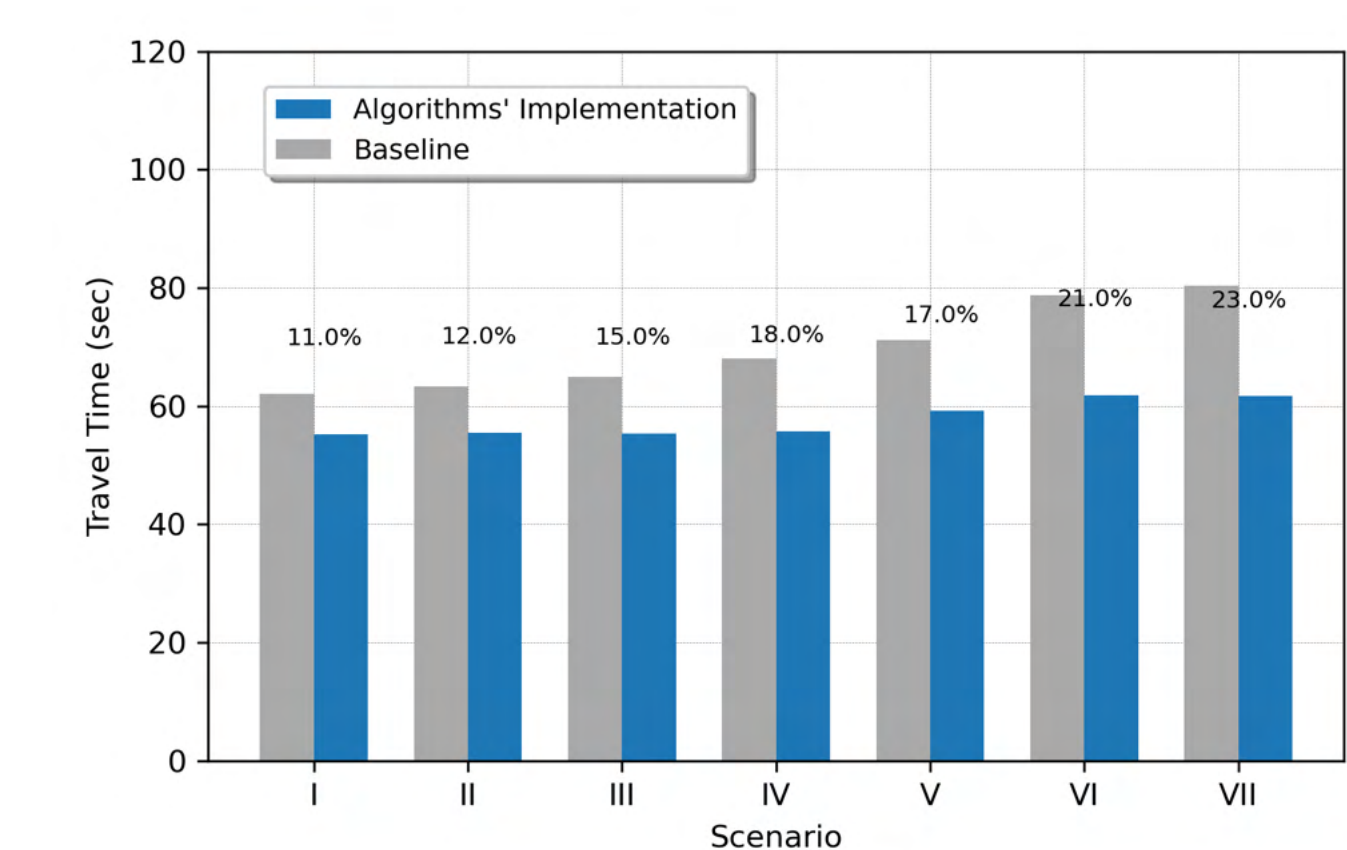


Fig. 8: Average Network Delay Improvements.

Remarks

This work is an extension of previous studies for an isolated intersection that has been tested in a real intersection. The time complexity of the algorithms is quadratic $O(n^2)$. However, empirical results showed $O(n)$, we believe this framework is suitable for real-world implementation. Although we only considered CAVs, this methodology can be extended to Connected-Vehicles (CVs).

References

- Zhuofei. Li et al. In: (2014). DOI: <https://doi.org/10.1016/j.trc.2014.10.001>.
- Aschkan Omidvar et al. In: (2018). DOI: 10.1177/0361198118782798.