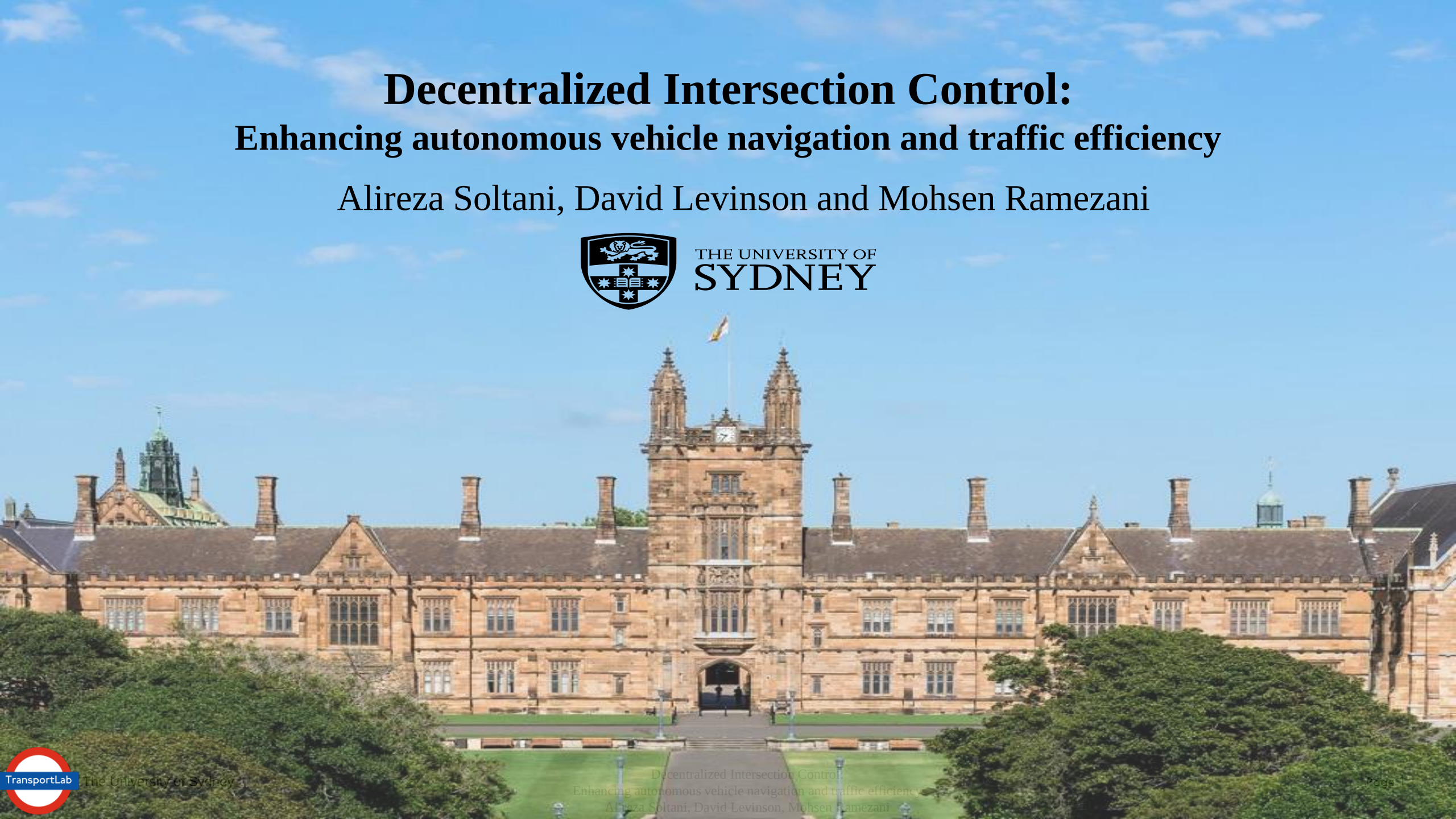
Decentralized Intersection Control:

Enhancing autonomous vehicle navigation and traffic efficiency

Alireza Soltani, David Levinson and Mohsen Ramezani

THE UNIVERSITY OF SYDNEY

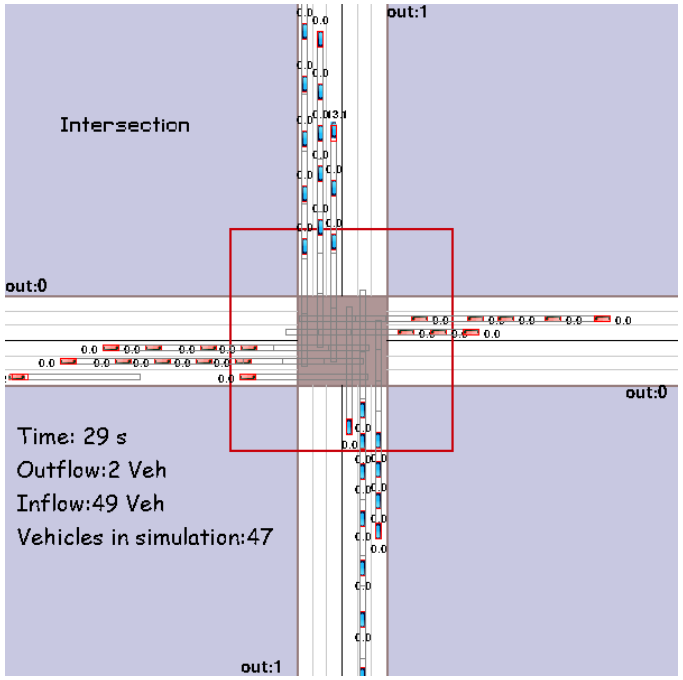


Introduction

- Efficient intersection management is essential for **minimizing** traffic congestion, reducing travel time, and **improving** road safety
- Traditional signalized intersections
- Central controllers

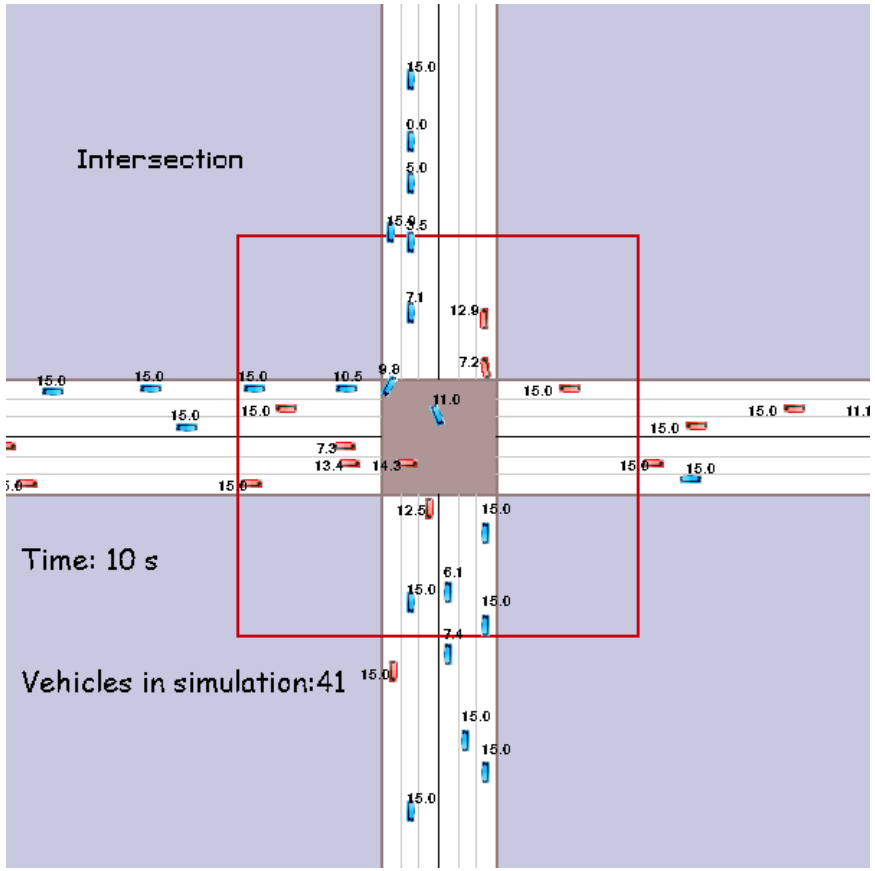
Introduction

- **Deadlocks**



Problem description

- Decentralized intersection control
- **No** central controller
- **No** communication



Assumptions:

- Each lane allocates to a specific movement (right, left, or straight) – No lane changing
- The reaction time of vehicles is zero (minimum headway is 1.33 seconds)
- The conflict point is where two paths cross (i.e. right turns don’t have conflict)
- Genuine behavior of AVs; false actions are not accounted for
- No pedestrians

Method

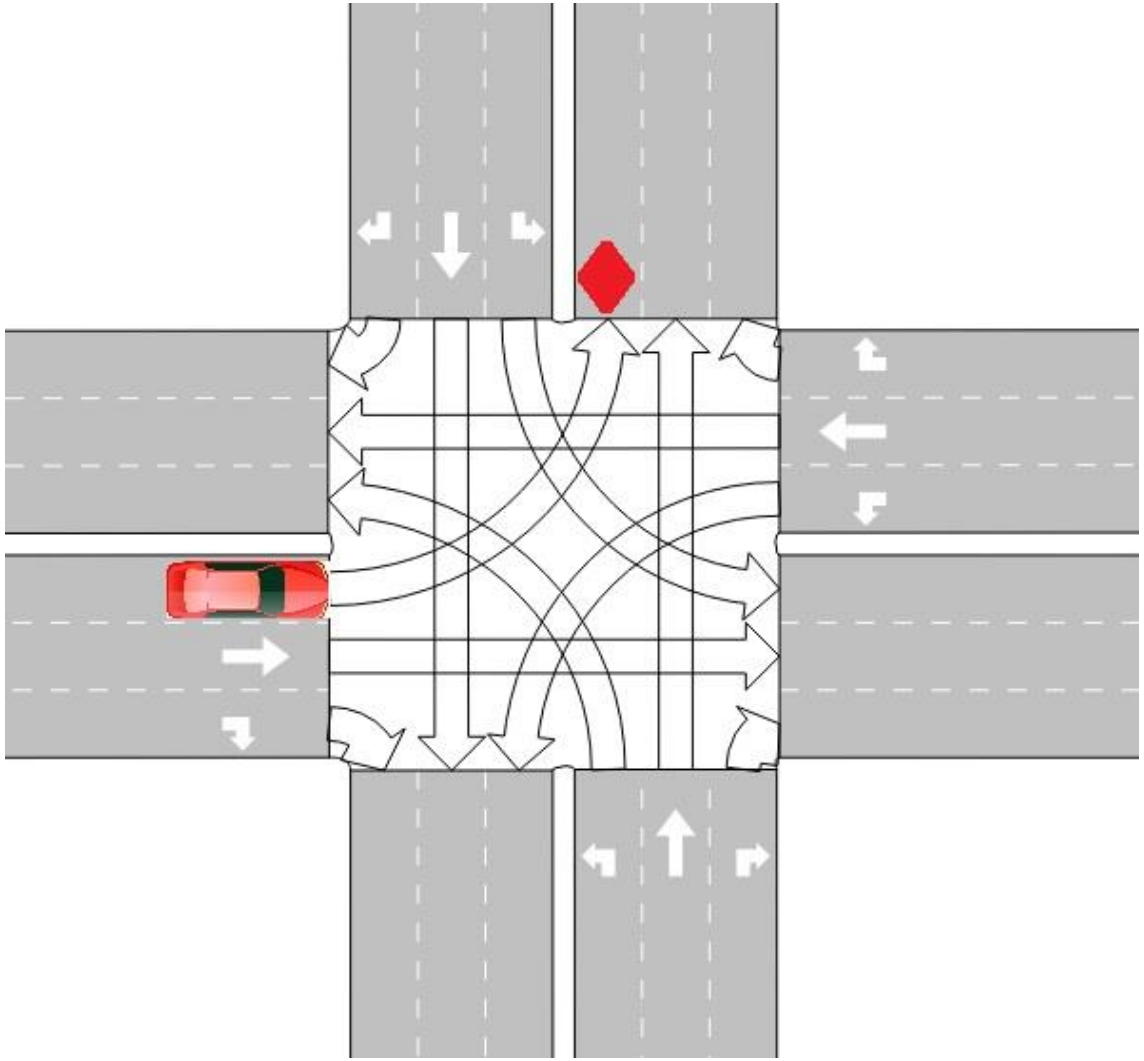
Speed optimum:

- Vehicles **check the front vehicle** to maintain a safe distance
- Vehicles **check conflicting movements**

- Using time to the collision point
- **Risk of collision**, the vehicle that requires more time to cross, **decelerate**

- This process continues at **every time step**

- Other than right turns, always two vehicles can cross



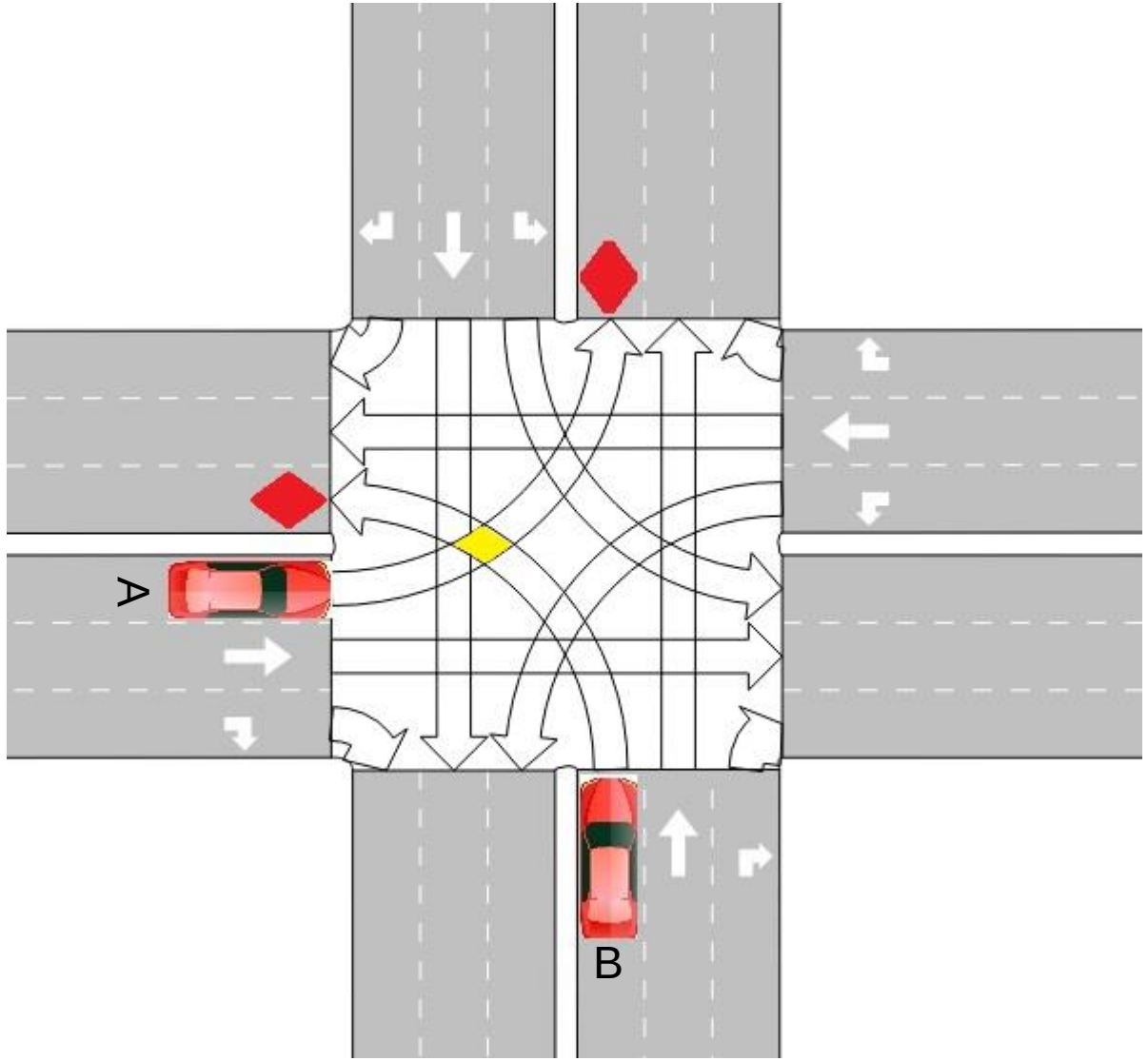
Speed optimum – check collision risk

Compare Times-to-Conflict Point:

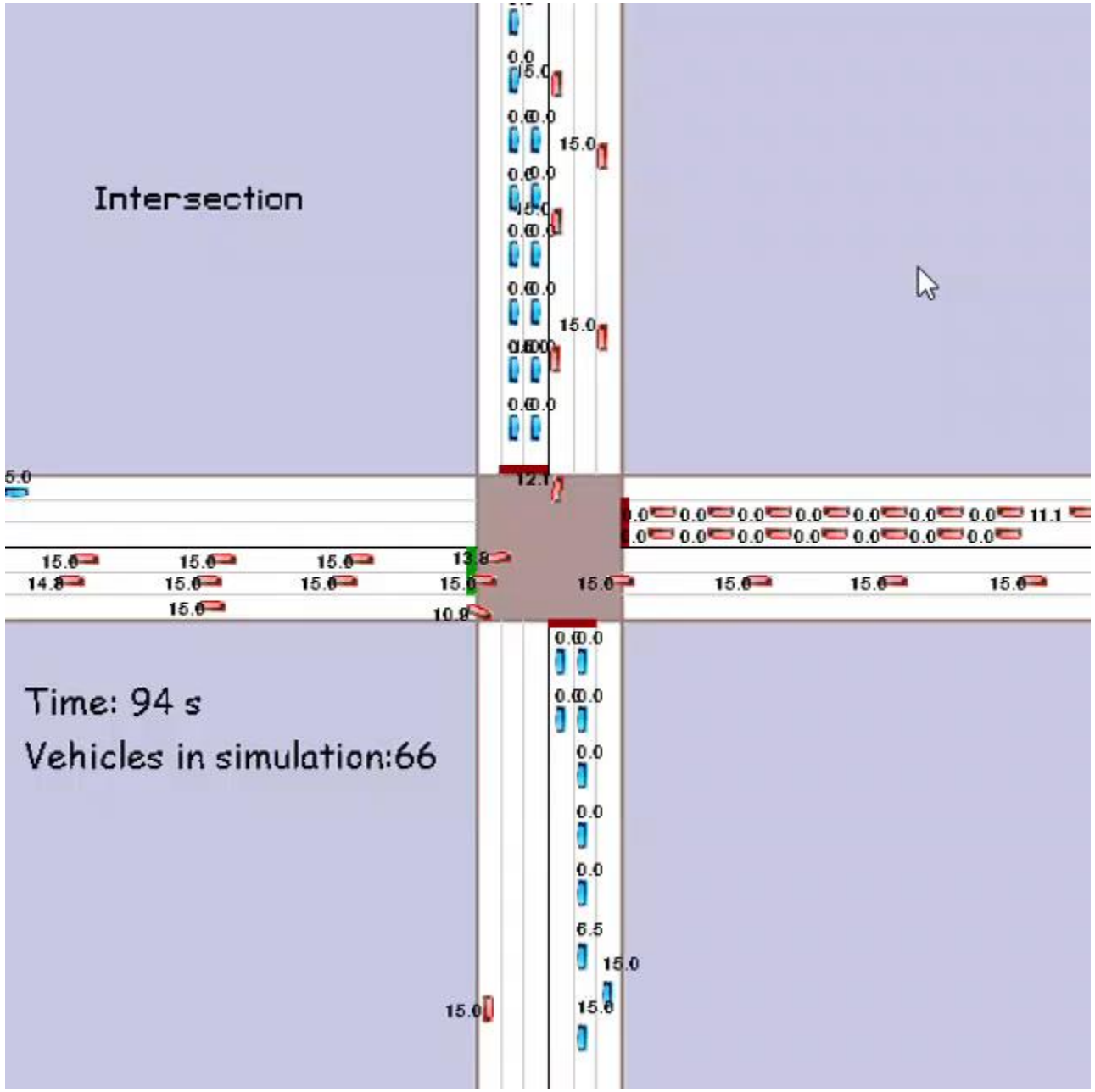
$$\text{interval}_A = [t_A,\ t_A + t_{c,A}]$$
$$\text{interval}_B = [t_B,\ t_B + t_{c,B}]$$

If there is an **overlap,** a collision is possible

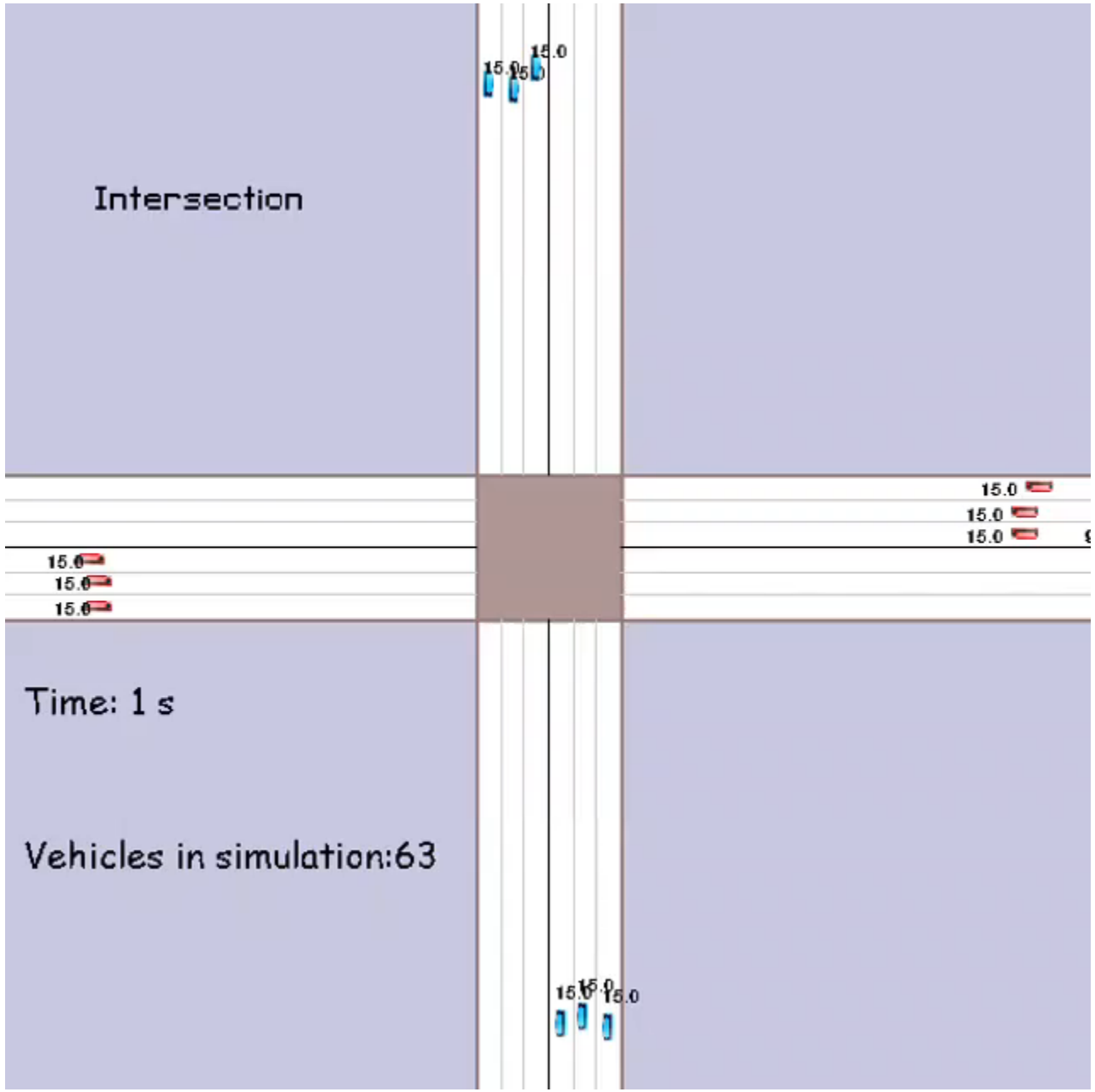
Decelerate to avoid collision.



Signalized

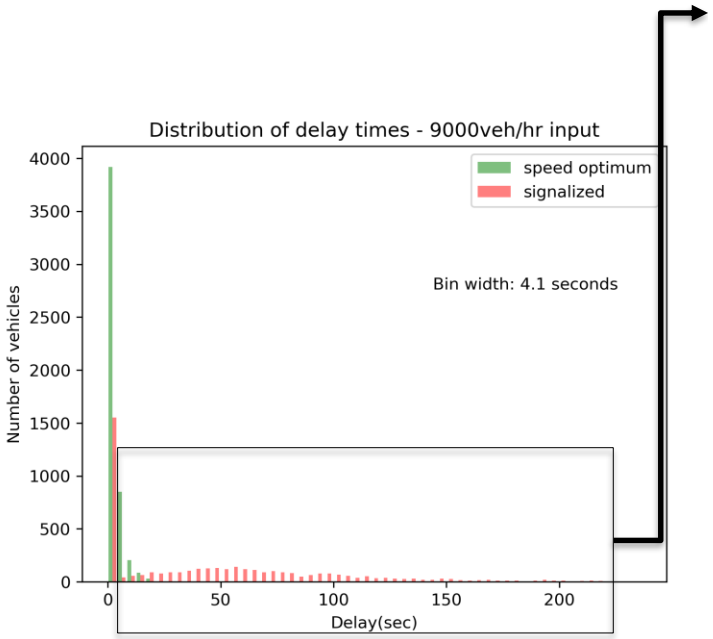


Speed optimum

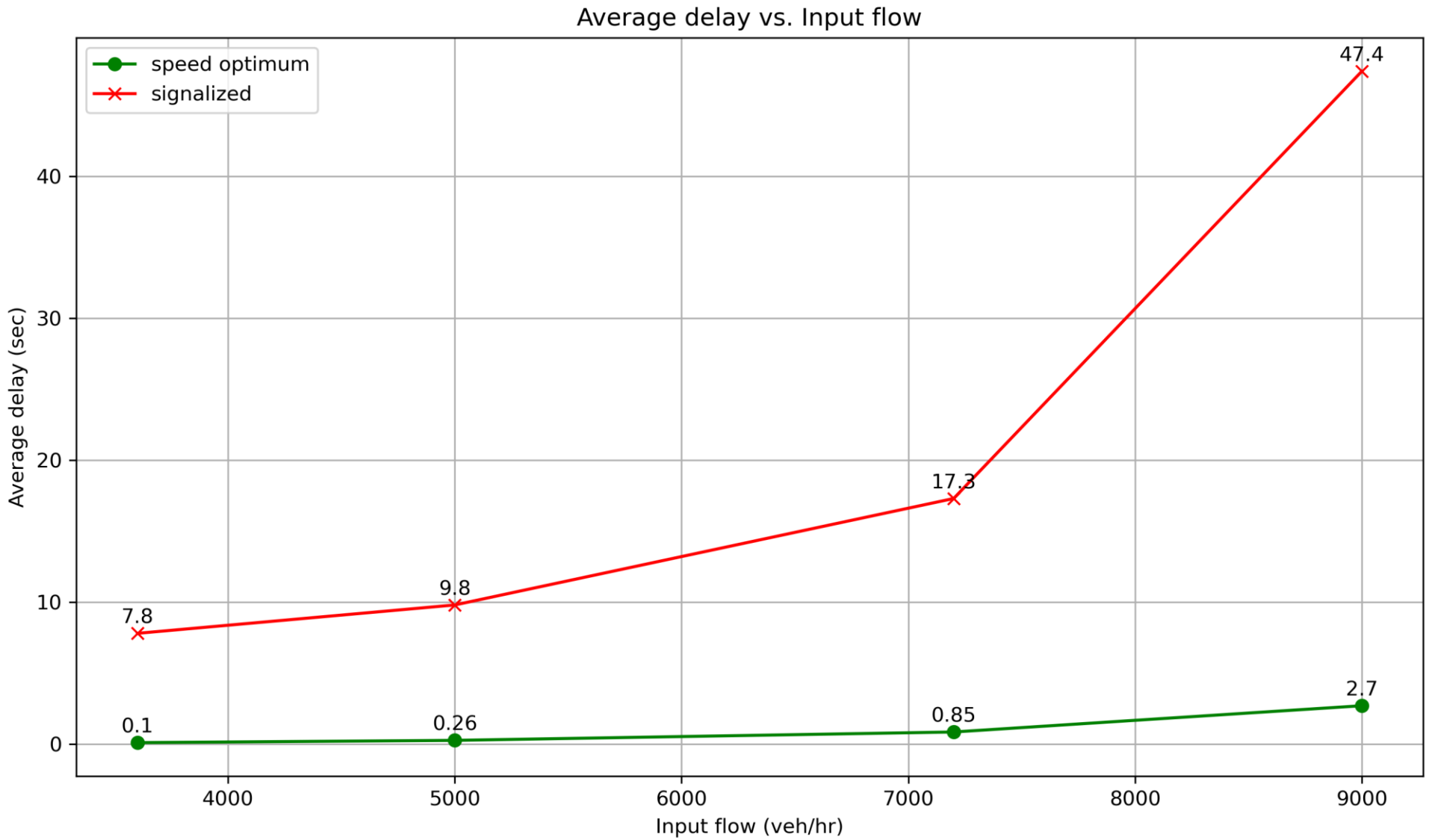


Results

- Higher capacity
- Significantly lower delay
- Shorter queue lengths



Results


Average delay vs. Input flow
speed optimum
signalized
Average delay (sec)
Input flow (veh/hr)
0
10
20
30
40
4000
5000
6000
7000
8000
9000
7.8
9.8
17.3
47.4
0.1
0.26
0.85
2.7

Thank you for your attention!