

Improving Urban Traffic Flow with Drone Supported Vehicular Networks

final Talk by Dmitriy Monakhov

Motivation: why DAVNs?

- Drones can improve communication in VANETs
- Drones maintain line-of-sight easier
- Drones avoid radio obstacles



Source: <https://www.unmannedairspace.info/uncategorized/39-cities-pioneering-urban-drone-operations/>

Motivation: related works

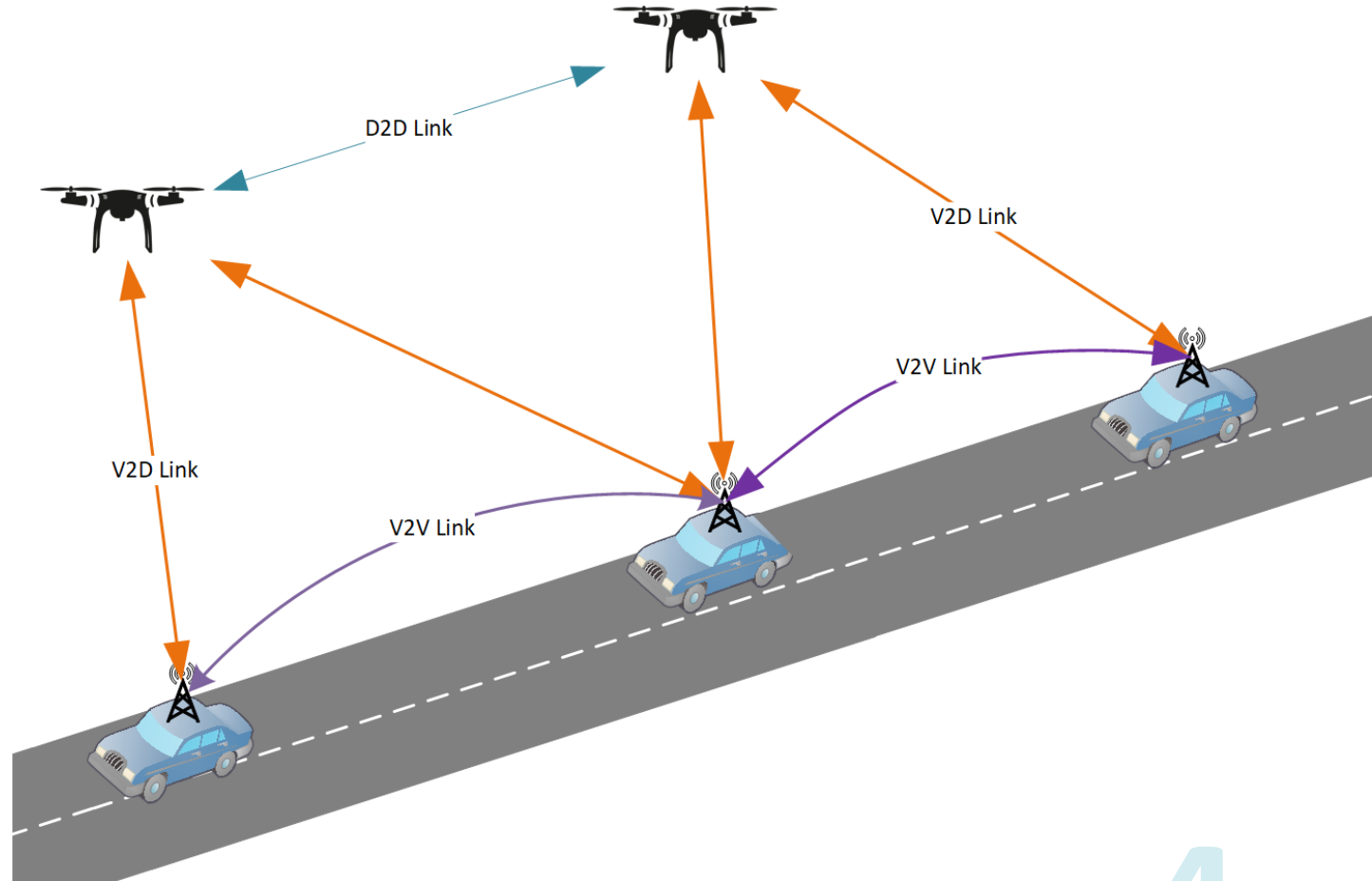
- Most recent works focus on different aspects
- Very few works discuss urban environments



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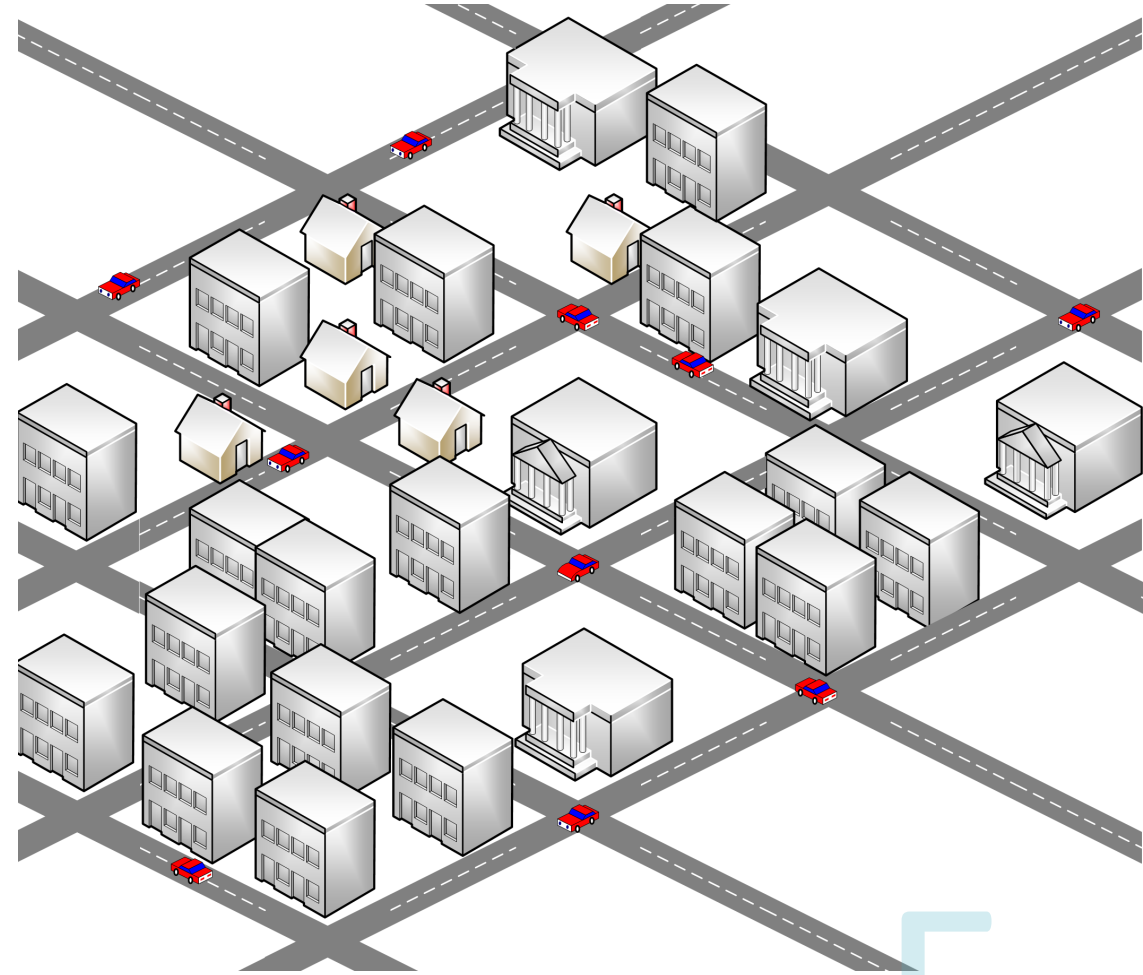
Goals

- Simulate DAVN in a dense city region
- Simulate traffic jams
- Measure traffic flow with and without drones
- Assess drone effects



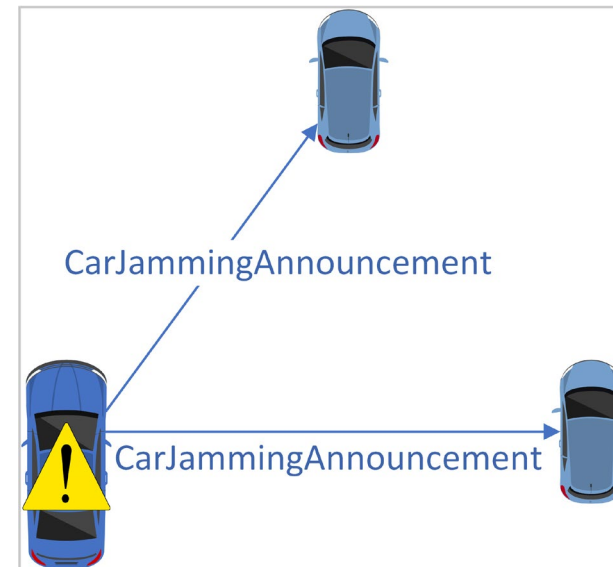
Implementation: setup

- **Manhattan Grid**
- **Vehicles follow random routes**
- Some vehicles break down and block the road
- Broken vehicles send broadcasts
- Other vehicles change route and rebroadcast



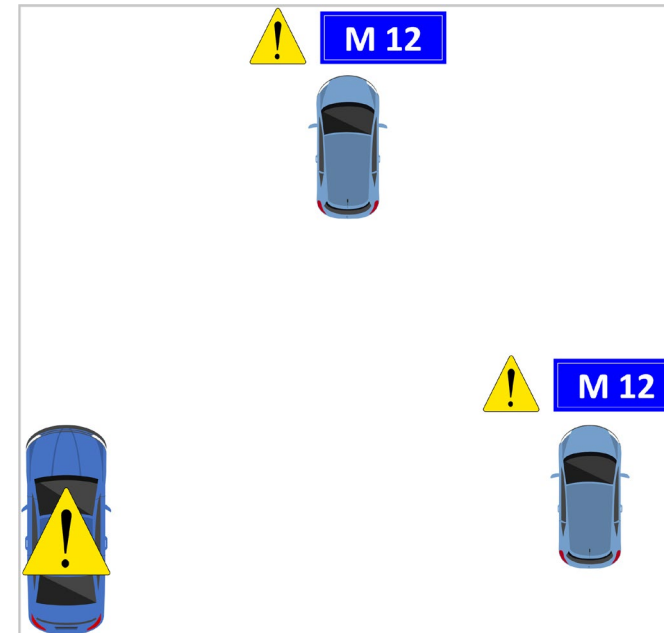
Implementation: protocol

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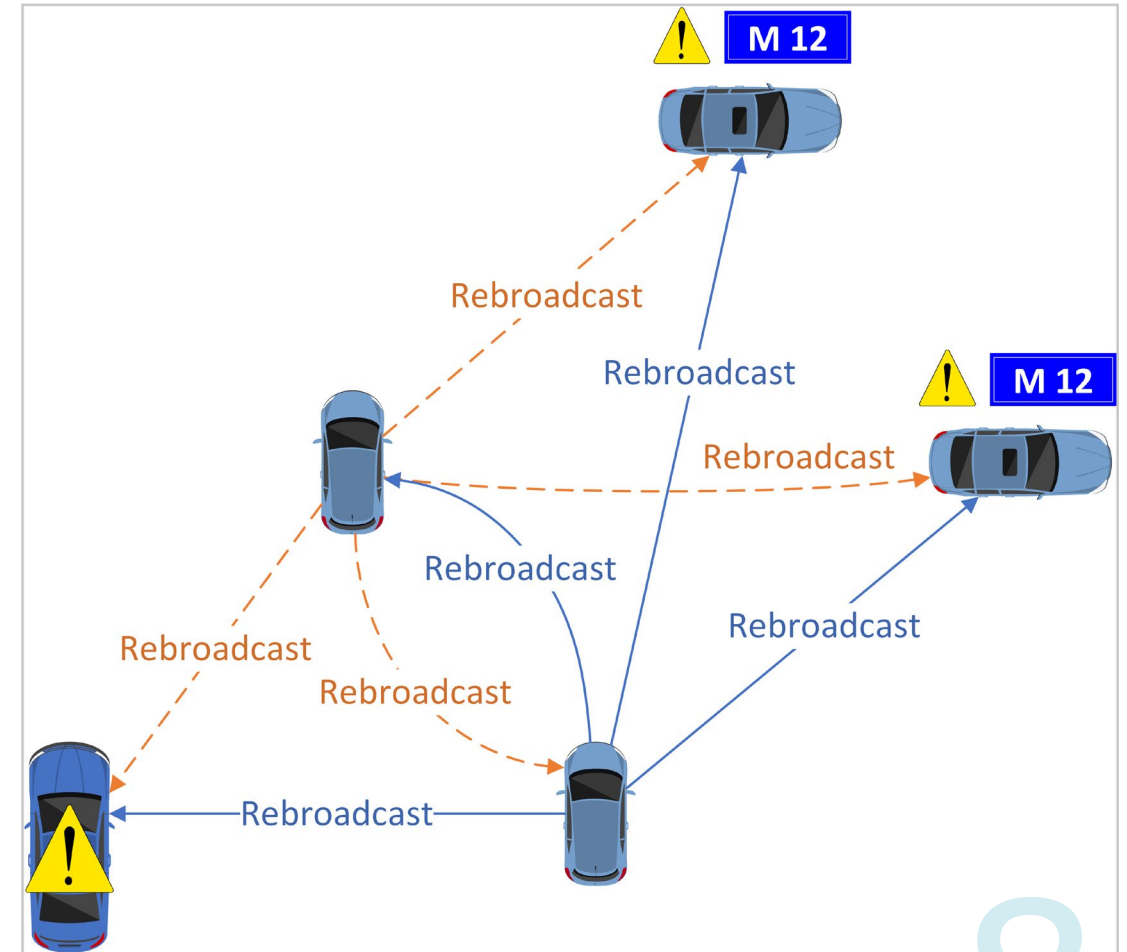
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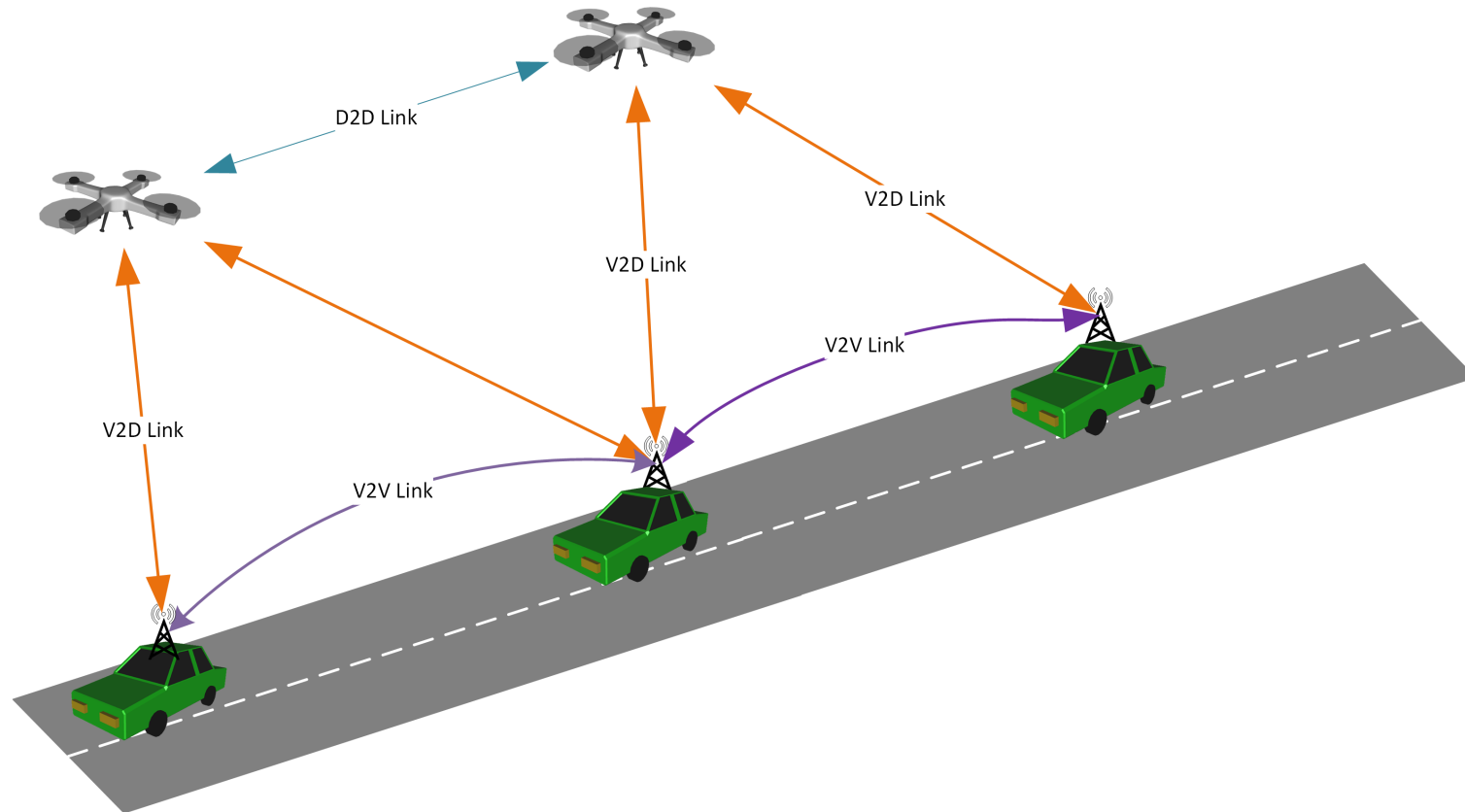
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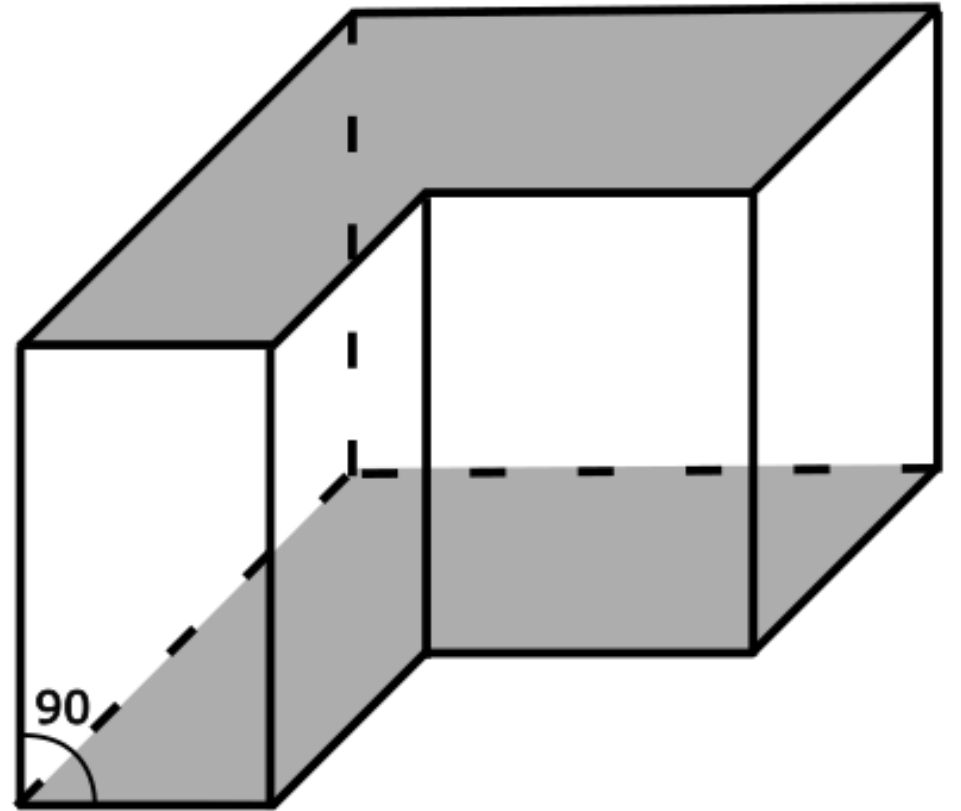
Implementation: drones

- Drones reuse vehicles' protocol
- Drones fly opportunistically above buildings (average altitude: 175 m)
- Drones rebroadcast messages from vehicles and other drones

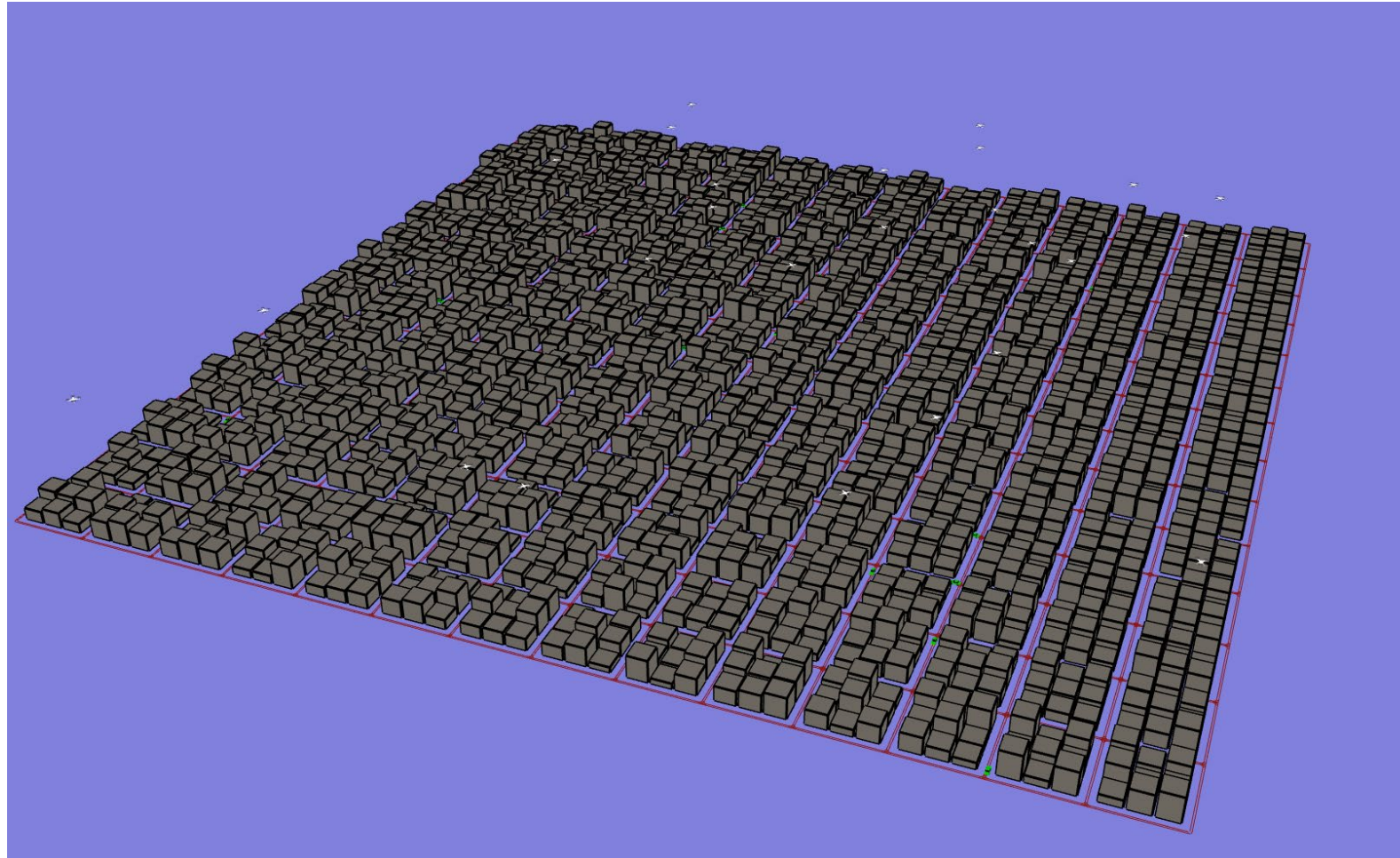


Implementation: 3D Shadowing

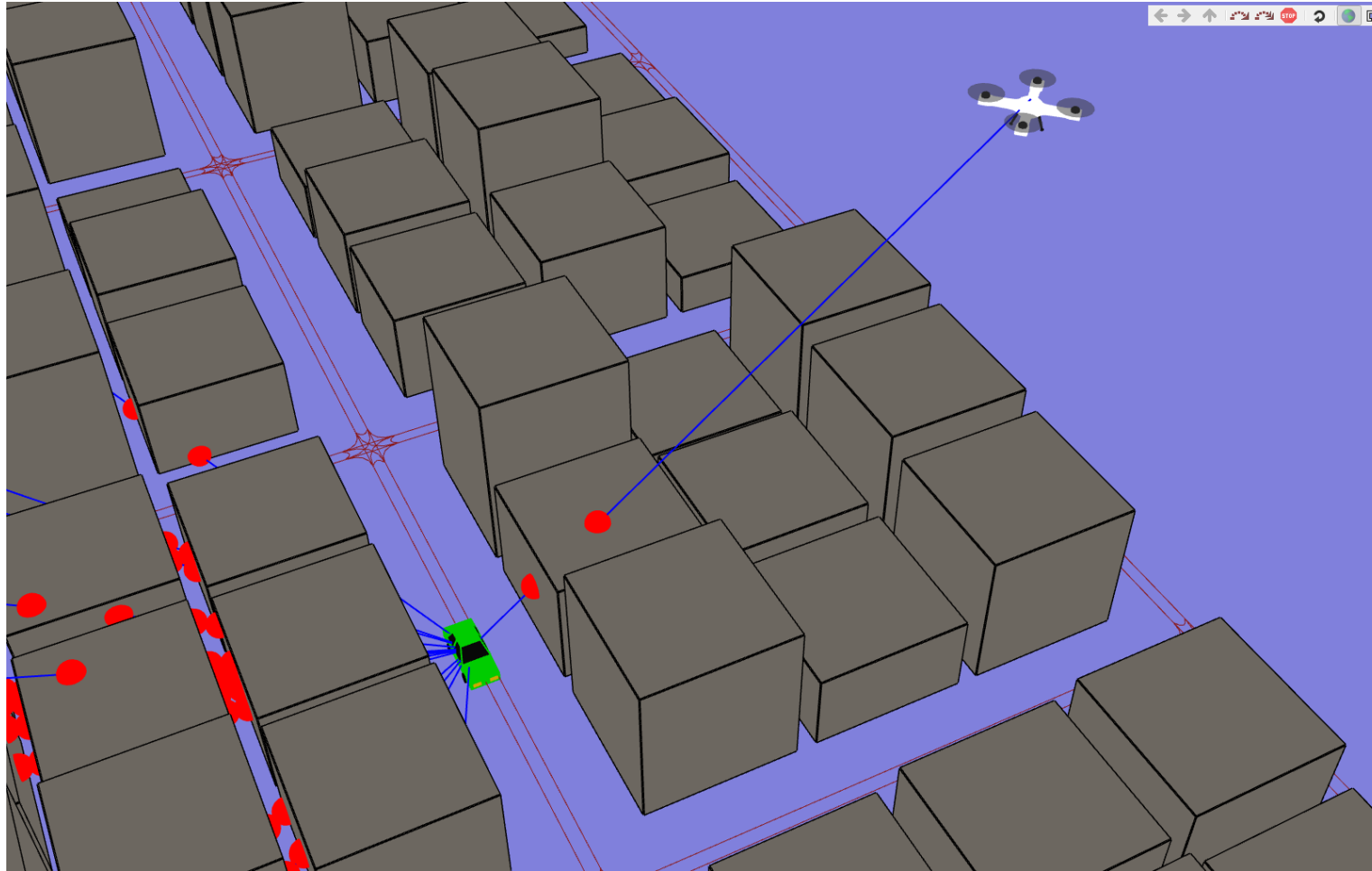
- Buildings are approximated as right prisms
- Calculates line-prism intersection points
- Reuses existing Veins infrastructure



Implementation: visualization

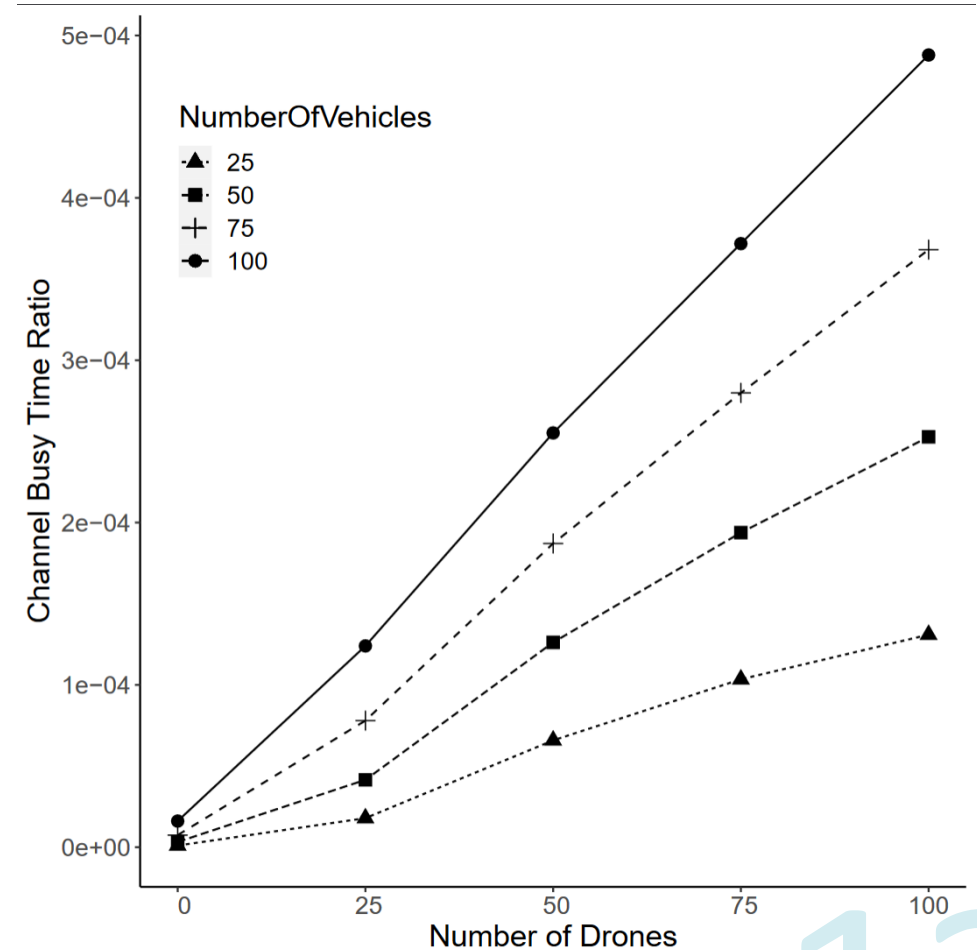


Implementation: verification

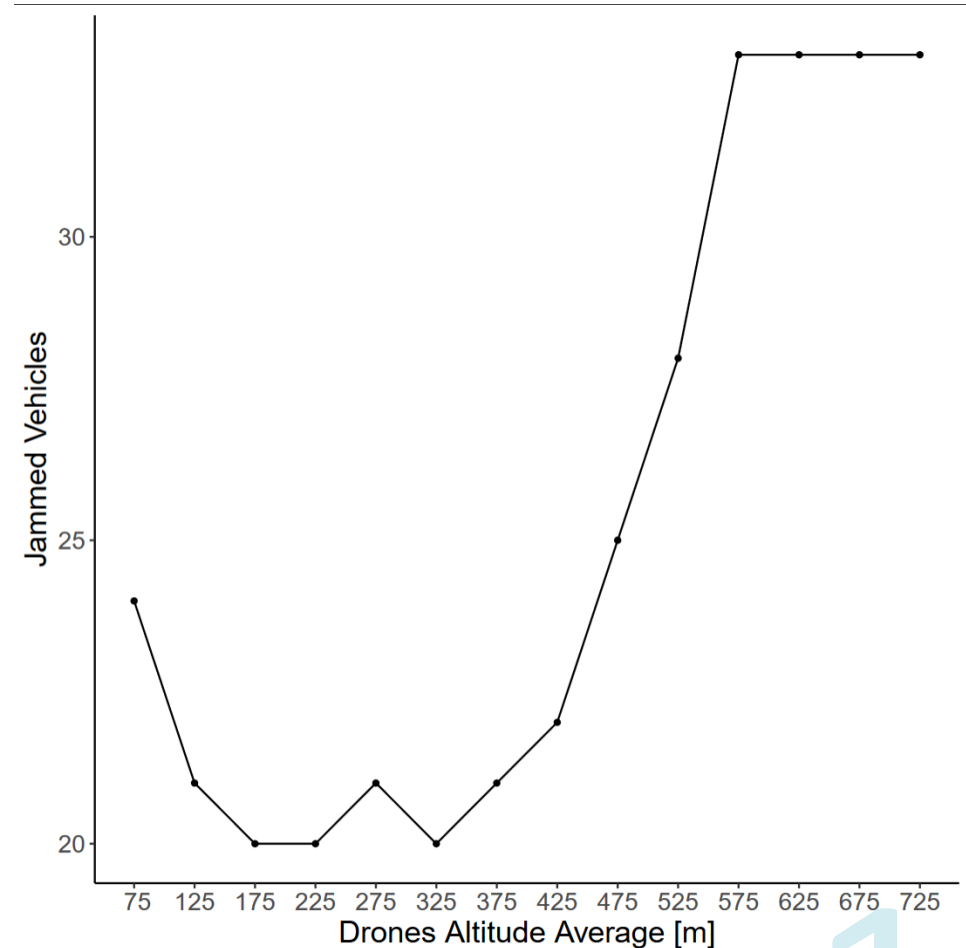
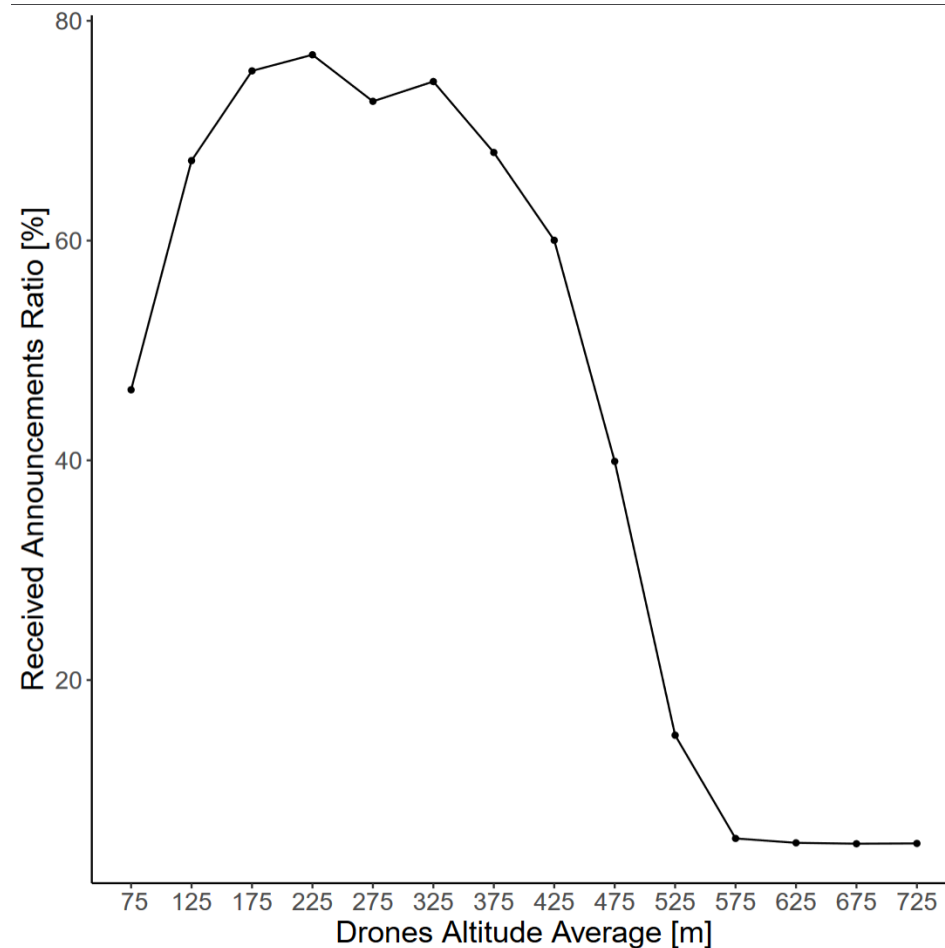


Broadcast storm suppression

- Weighted p-persistence algorithm
- Different parameters for drones and vehicles
- **Channel busy-time ratio low in all cases**



Drone flight altitude



Evaluation: Received Announcements Ratio

1. The Received Announcements Ratio for a single vehicle (Rar_i):

Number of unique messages received by this vehicle (R_i) divided by total number of unique messages sent by all vehicles (N).

$$Rar_i = \frac{R_i}{N} \quad (1)$$

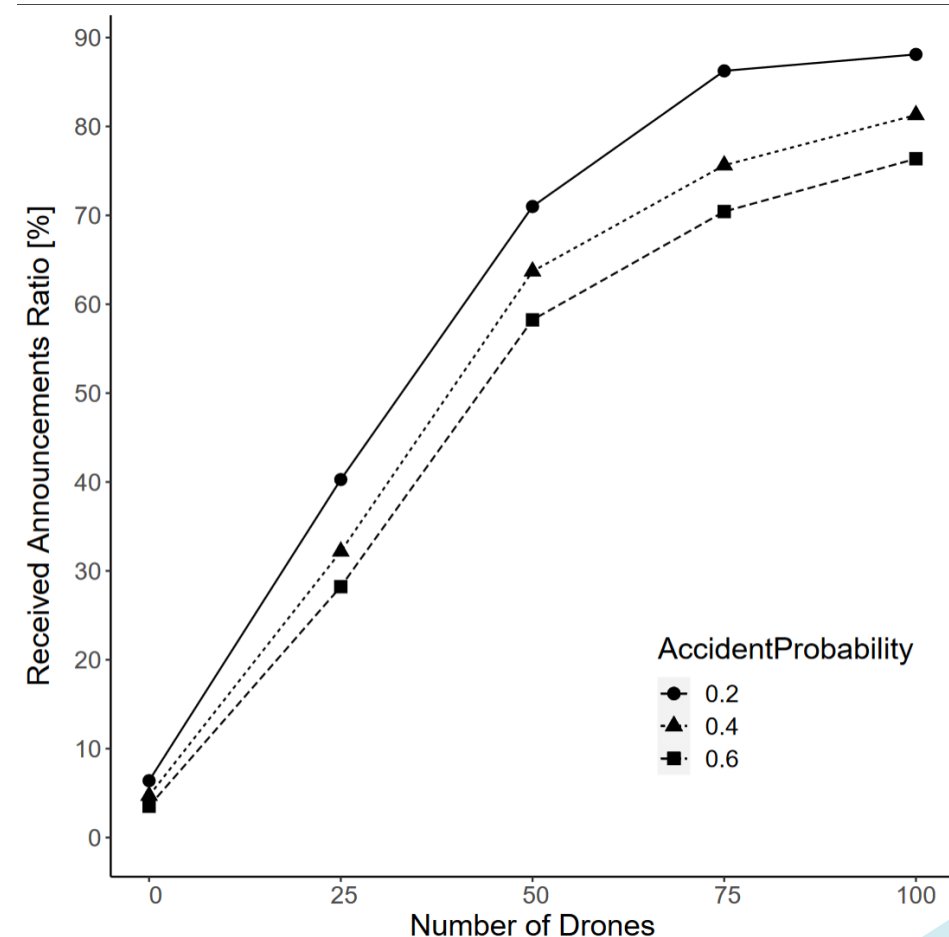
2. The Overall Received Announcements Ratio:

The average Received Announcements Ratio of all vehicles. V – total number of vehicles.

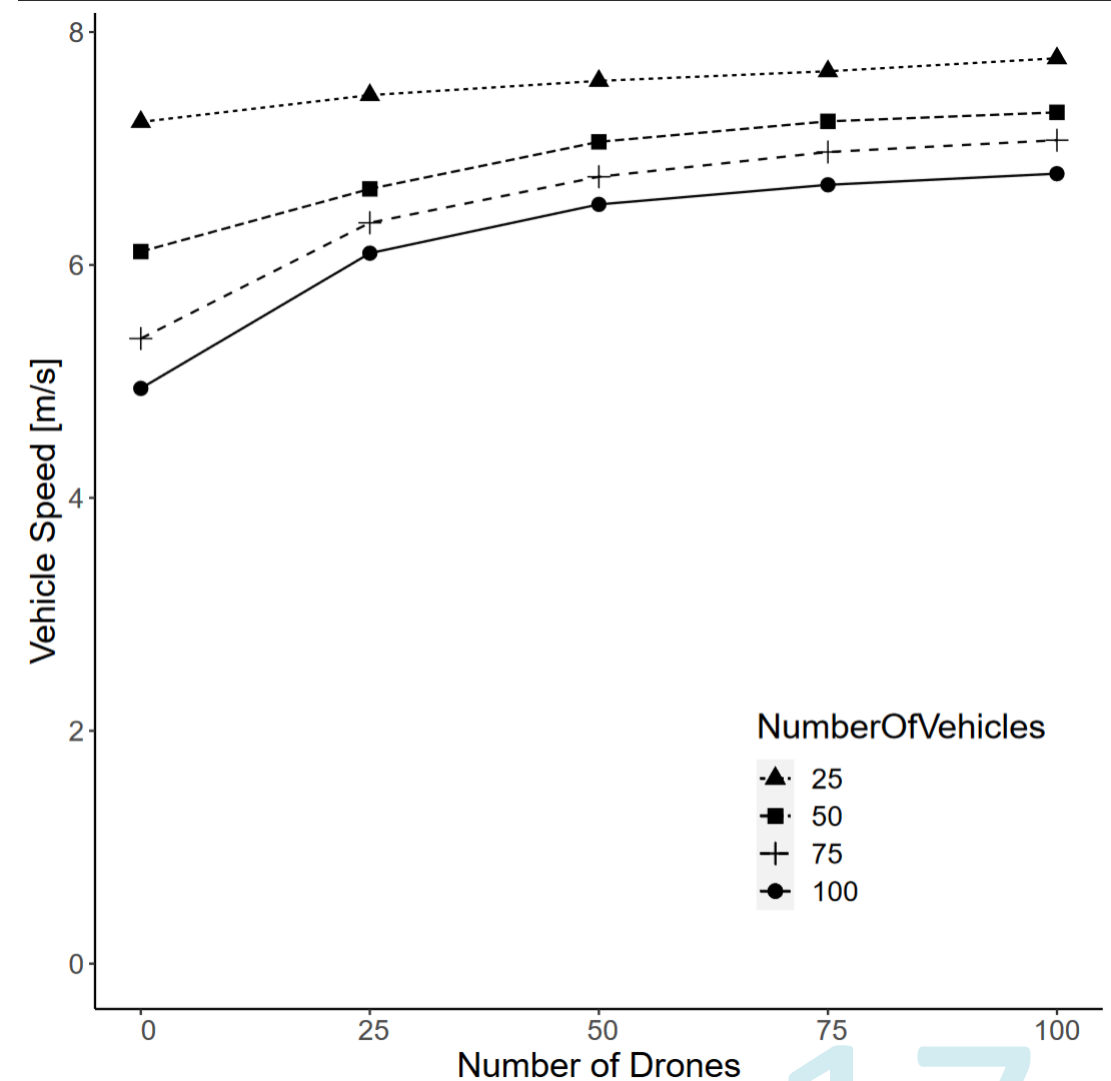
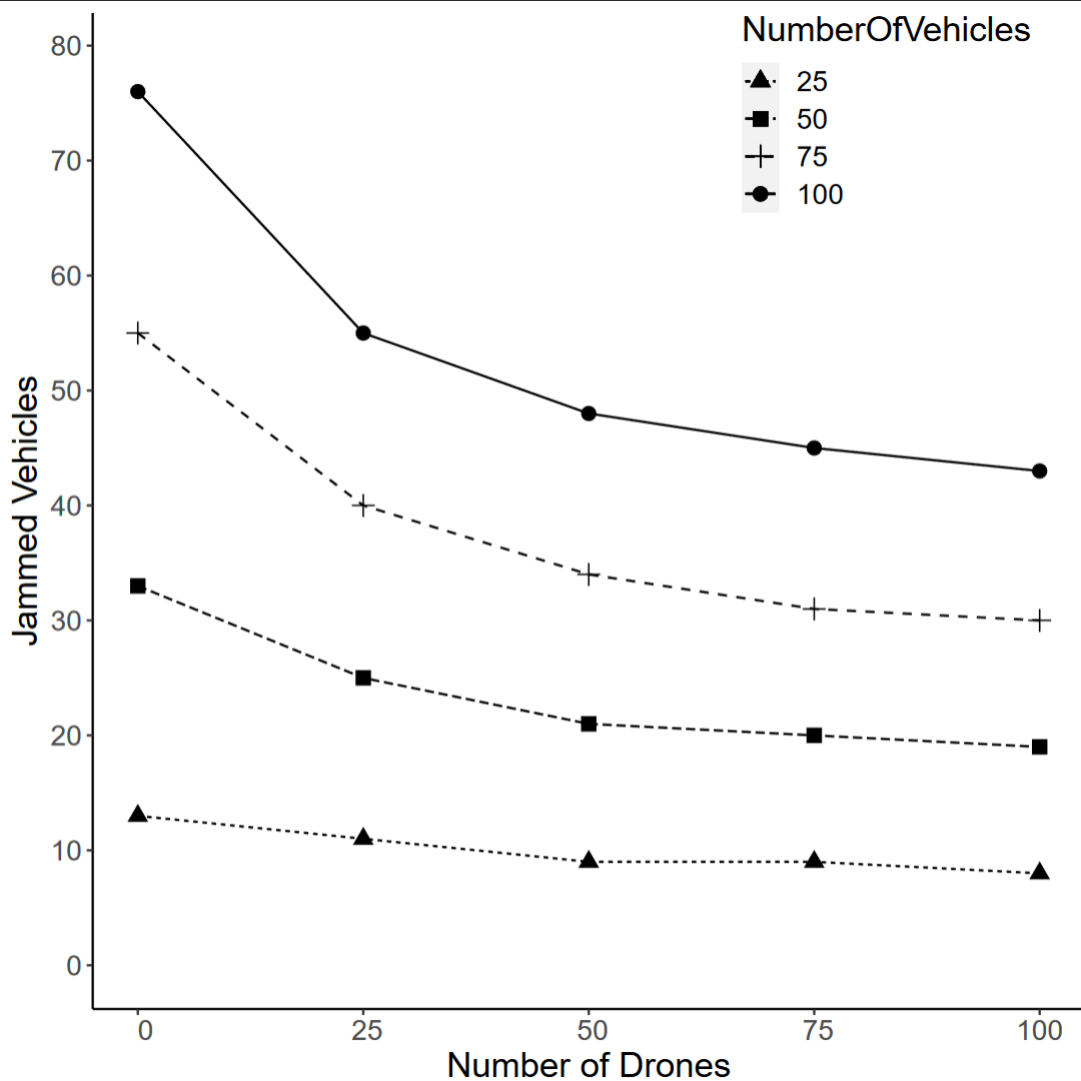
$$Rar = \frac{1}{V} \sum_{i=1}^V Rar_i \quad (2)$$

Evaluation: Received Announcements Ratio

- Can be used as connectivity metric
- Connectivity increases when number of drones is rising
- Accident probability has negative impact



Evaluation: traffic flow improvement



Conclusion

- Drones help to spread vehicles' messages over the buildings
- Drones improve VANET's connectivity
- Improved connectivity leads to better traffic message dissemination
- Urban traffic improvement can be achieved!

Conclusion

- Software simulation was implemented
- Simulation results showed significant improvement in traffic flow (42% less jammed vehicles in the best case)
- Project code can be easily integrated into Veins