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/

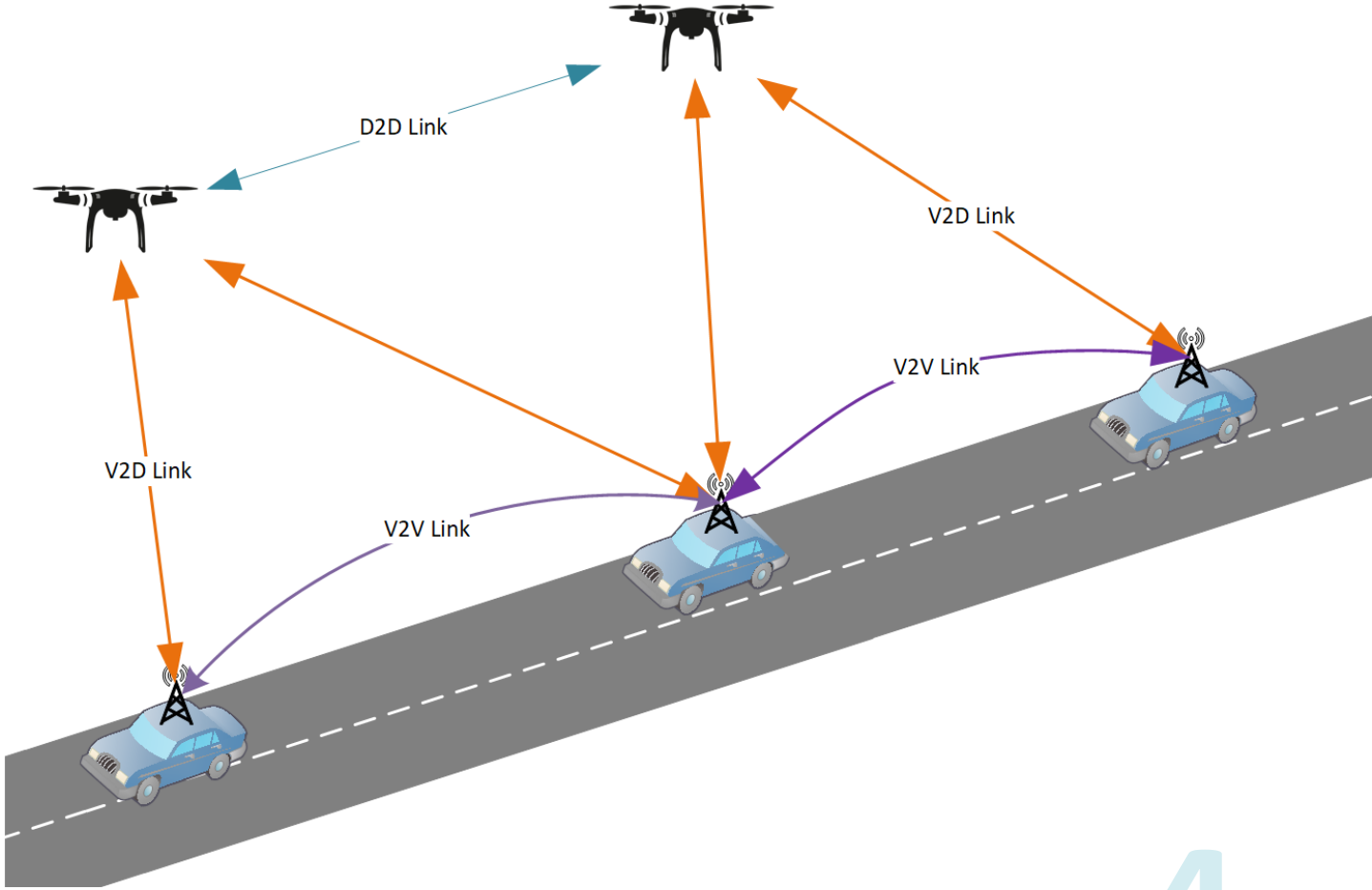
Motivation: related works

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

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

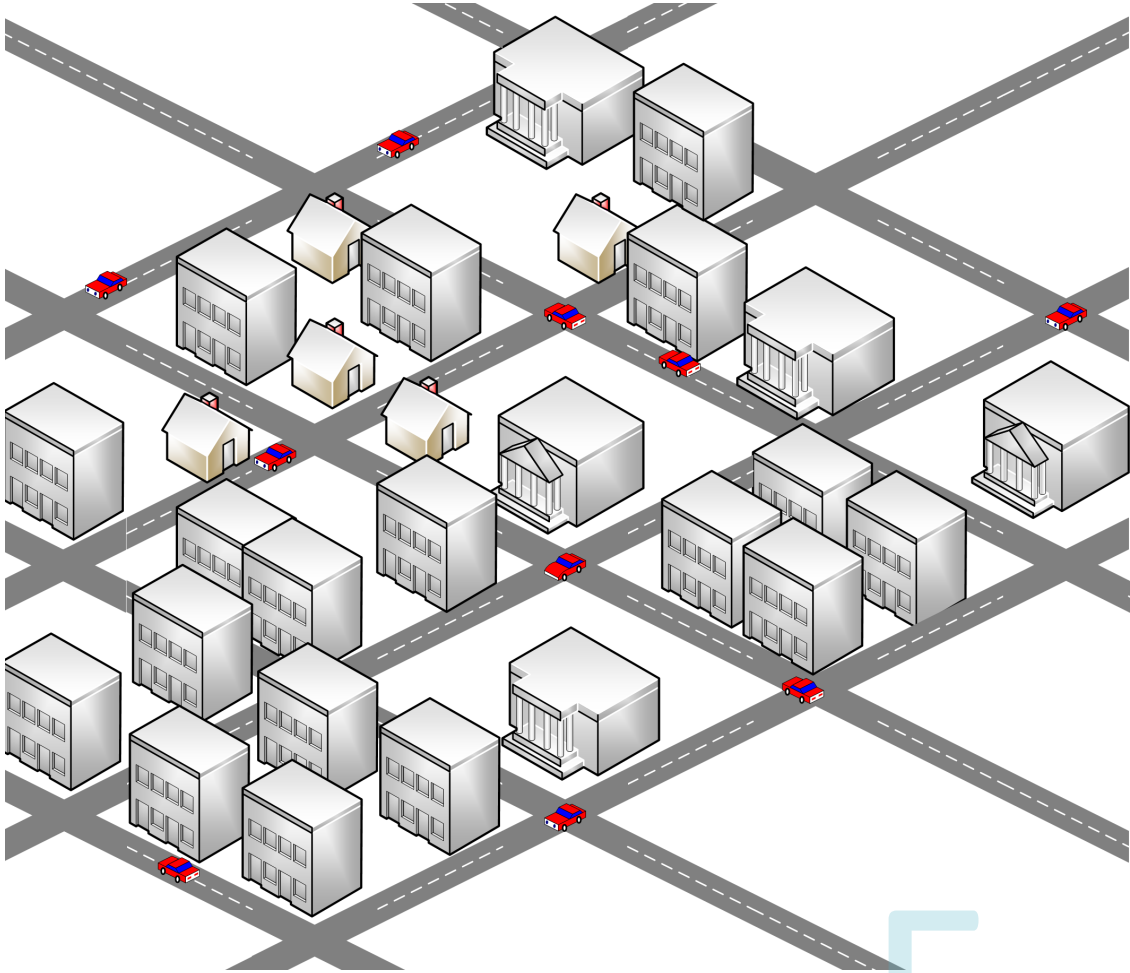
Goals

- 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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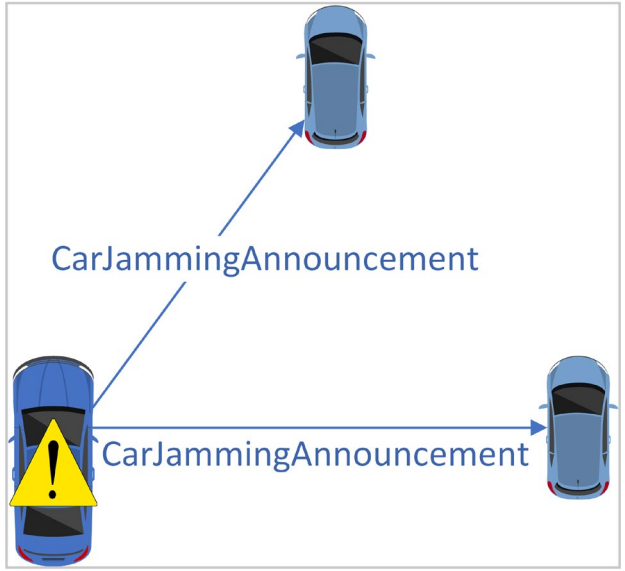

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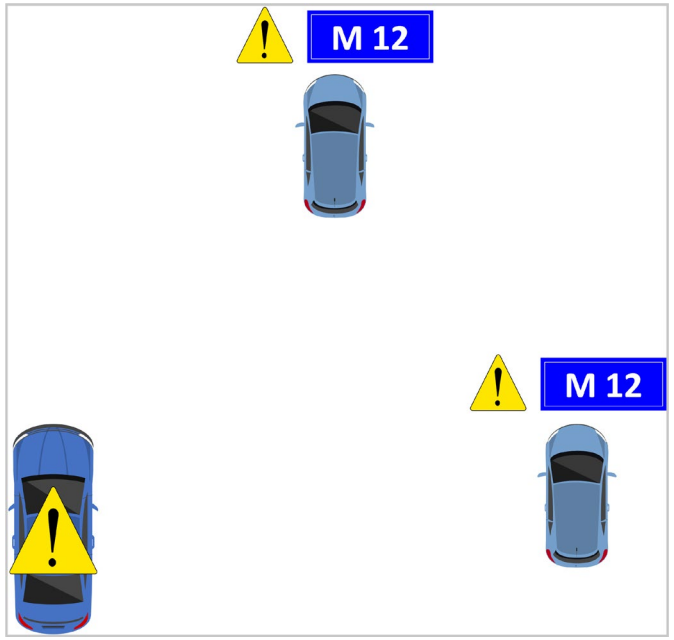

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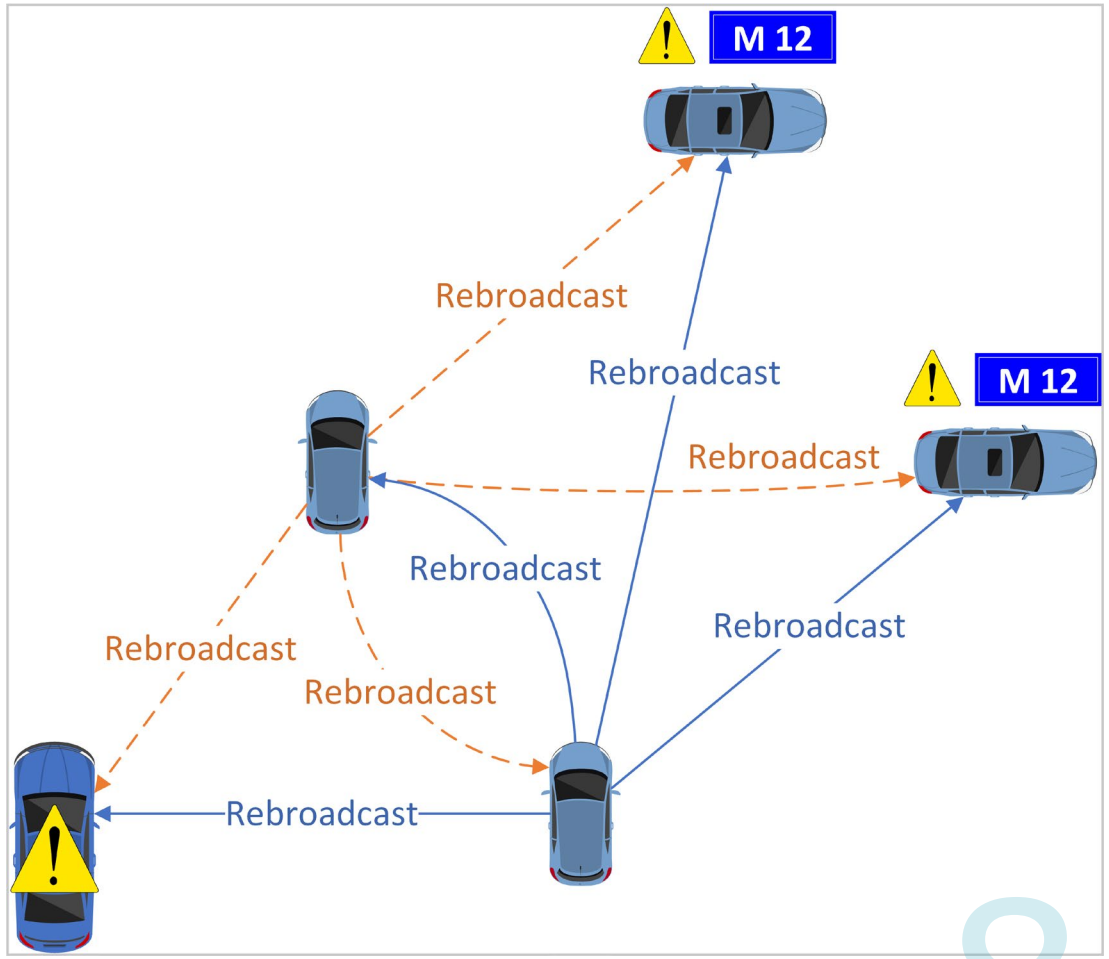
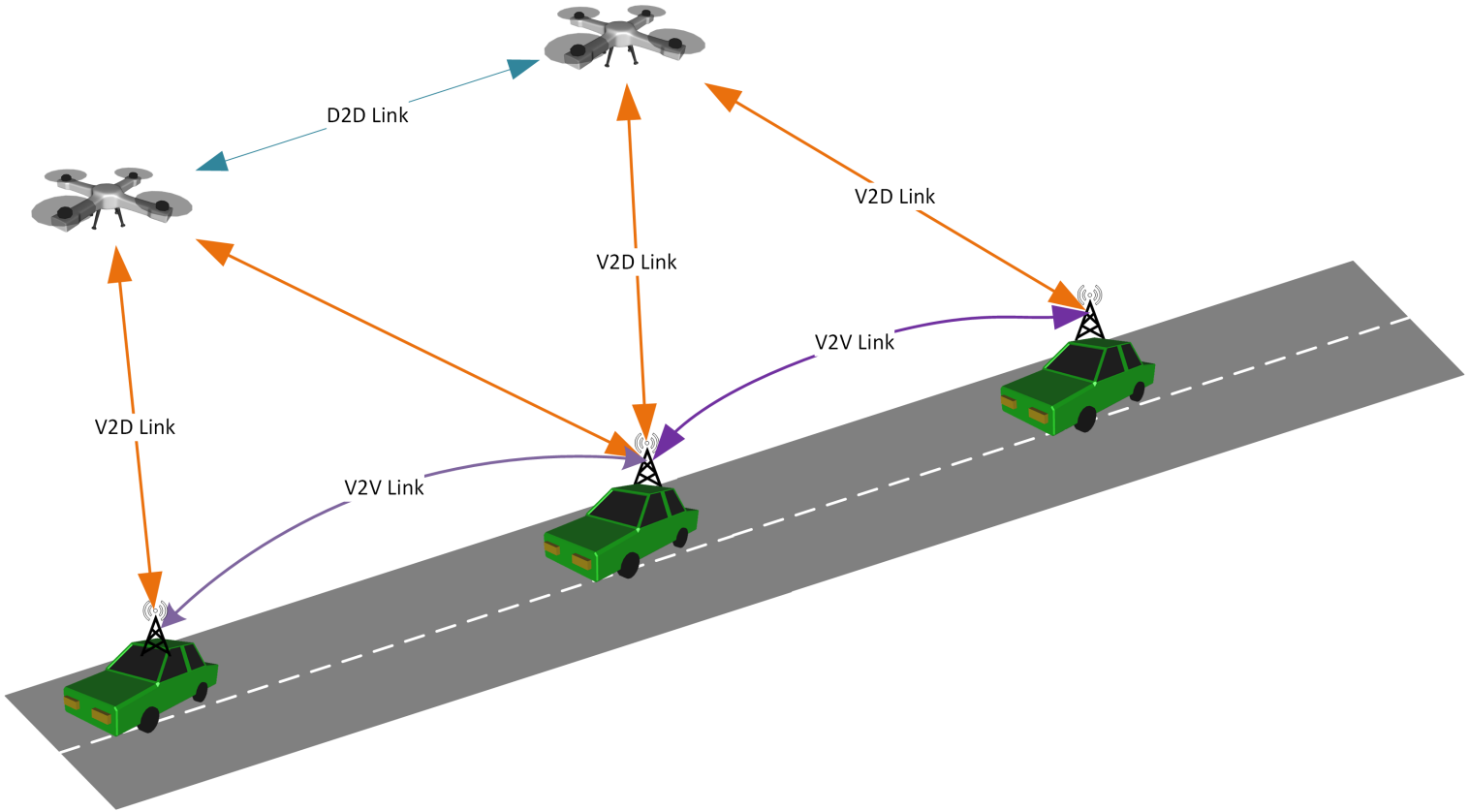


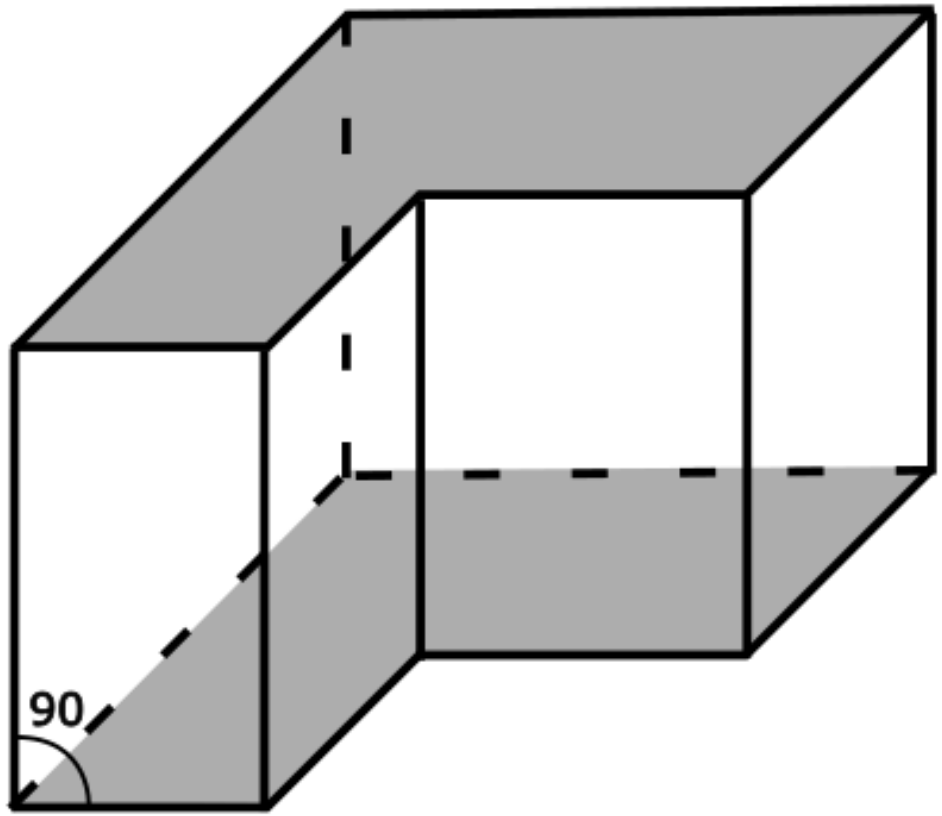
Implementation: drones

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

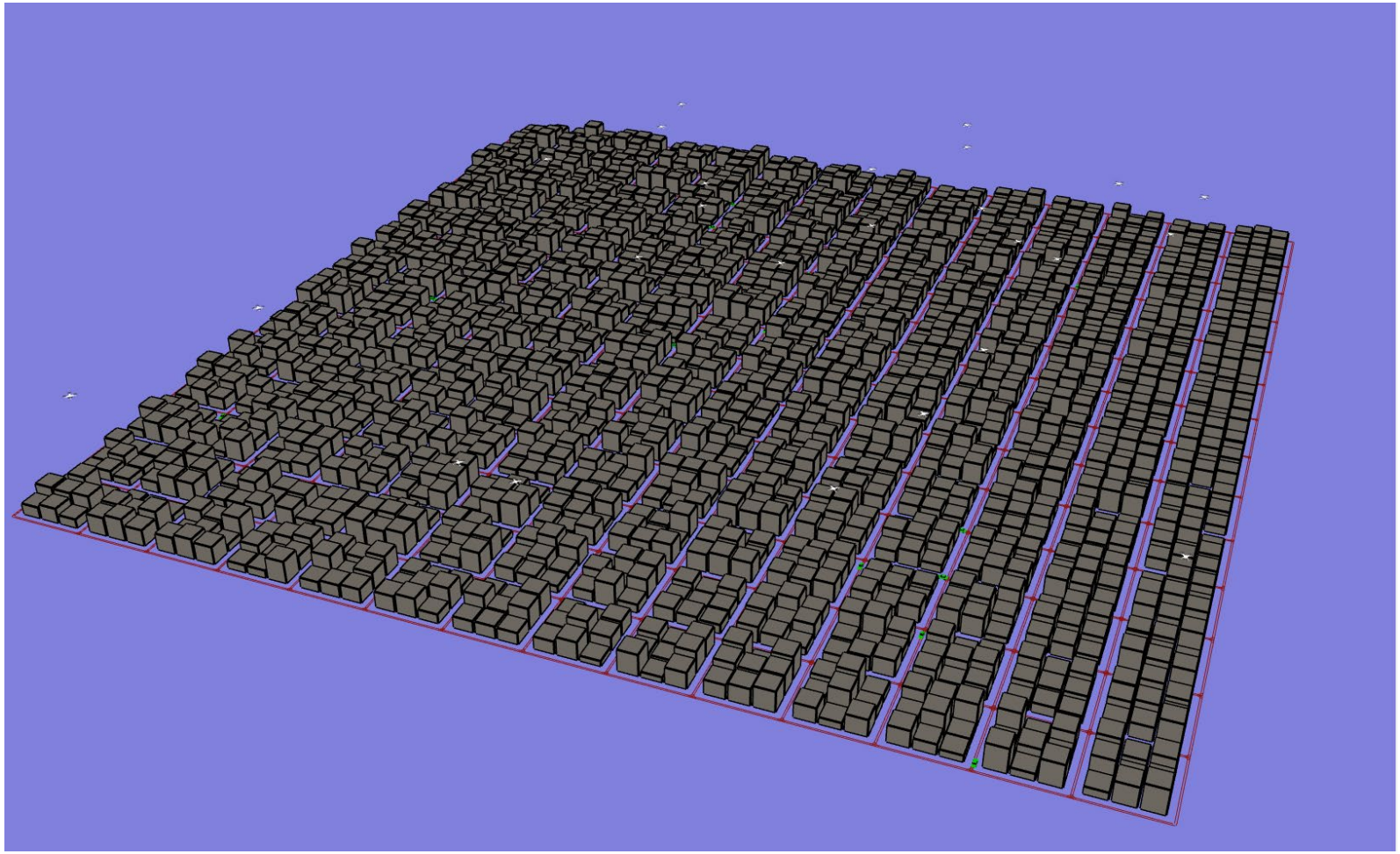


Implementation: 3D Shadowing

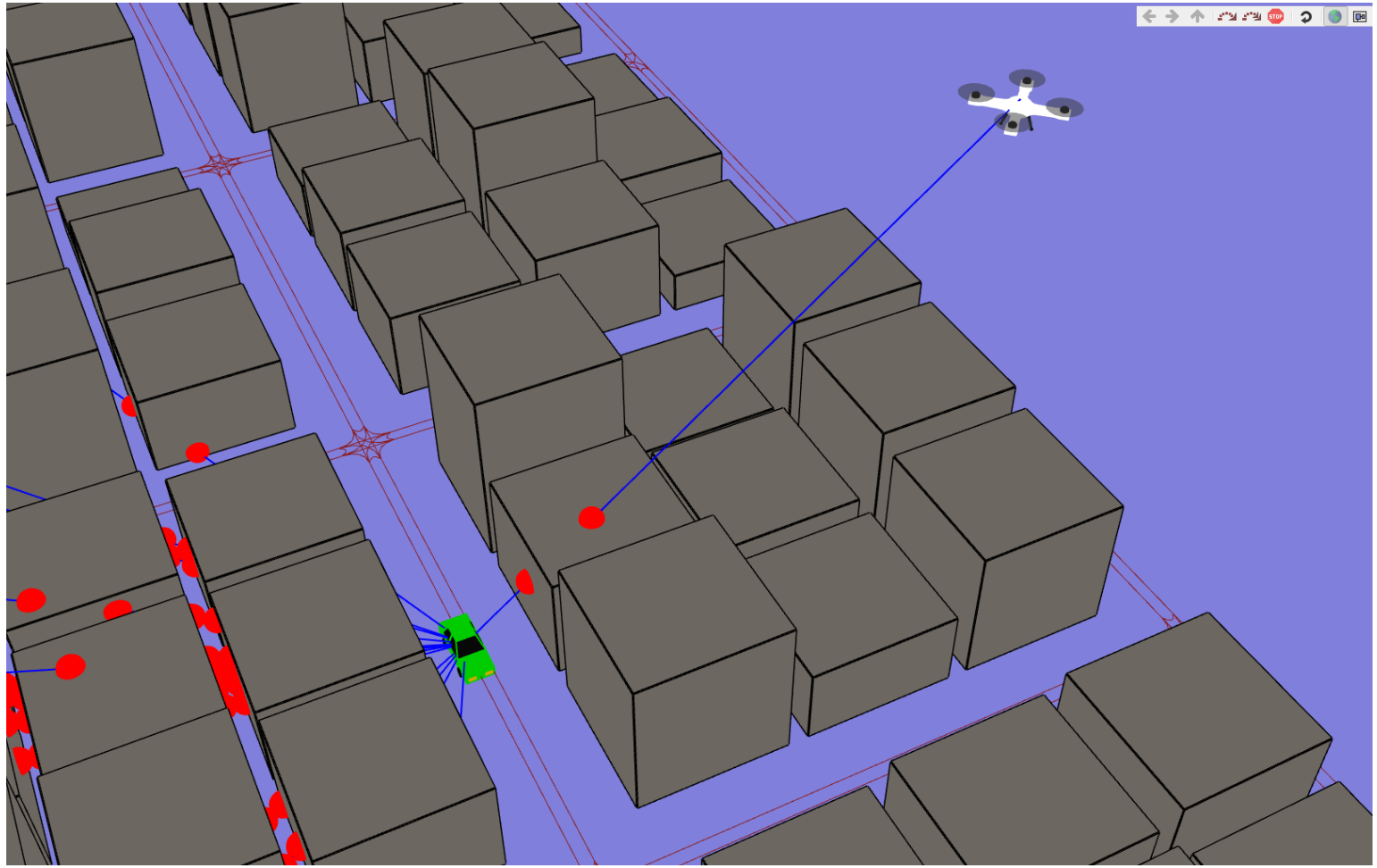
- Buildings are approximated as right prisms
- Calculates line-prism intersection points
- Reuses existing Veins infrastructure



Implementation: visualization

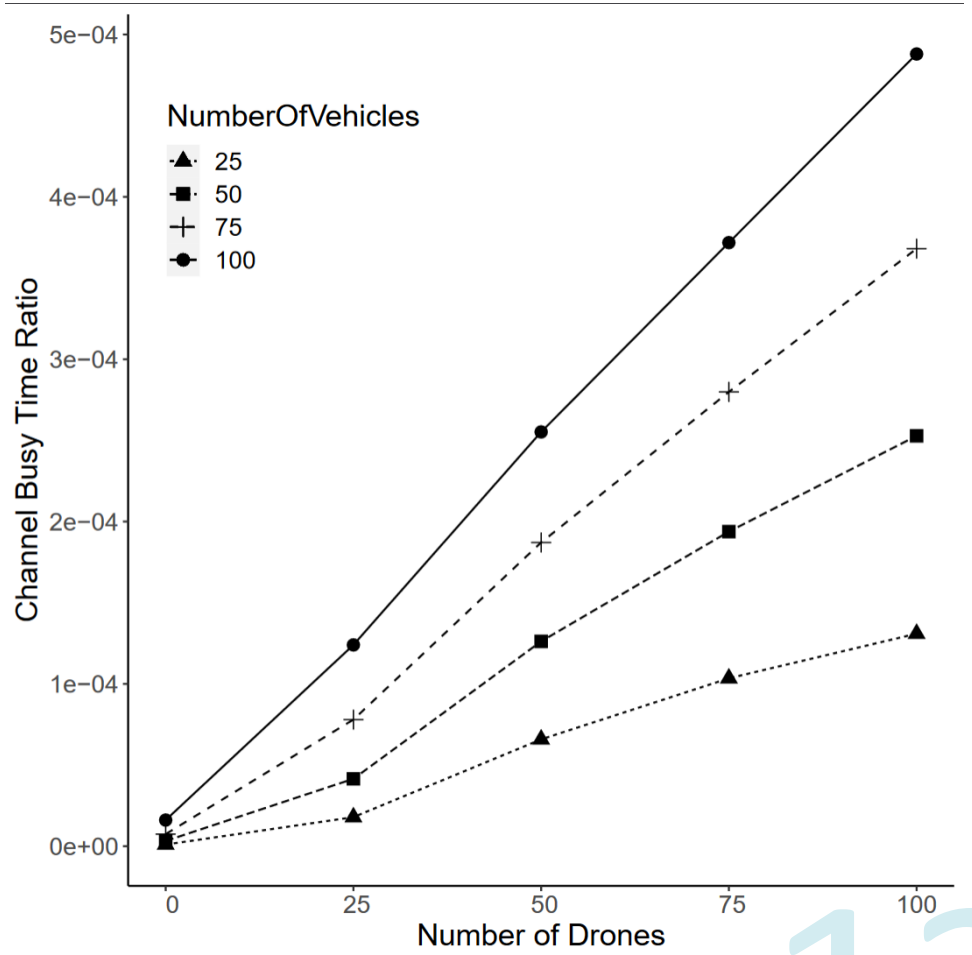


Implementation: verification



Broadcast storm suppression

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



Evaluation: Received Announcements Ratio

1. The Received Announcements Ratio for a single vehicle ($\boldsymbol{Rar_i}$):

Number of unique messages received by this vehicle ($\boldsymbol{R_i}$) divided by total number of unique messages sent by all vehicles (***N***).

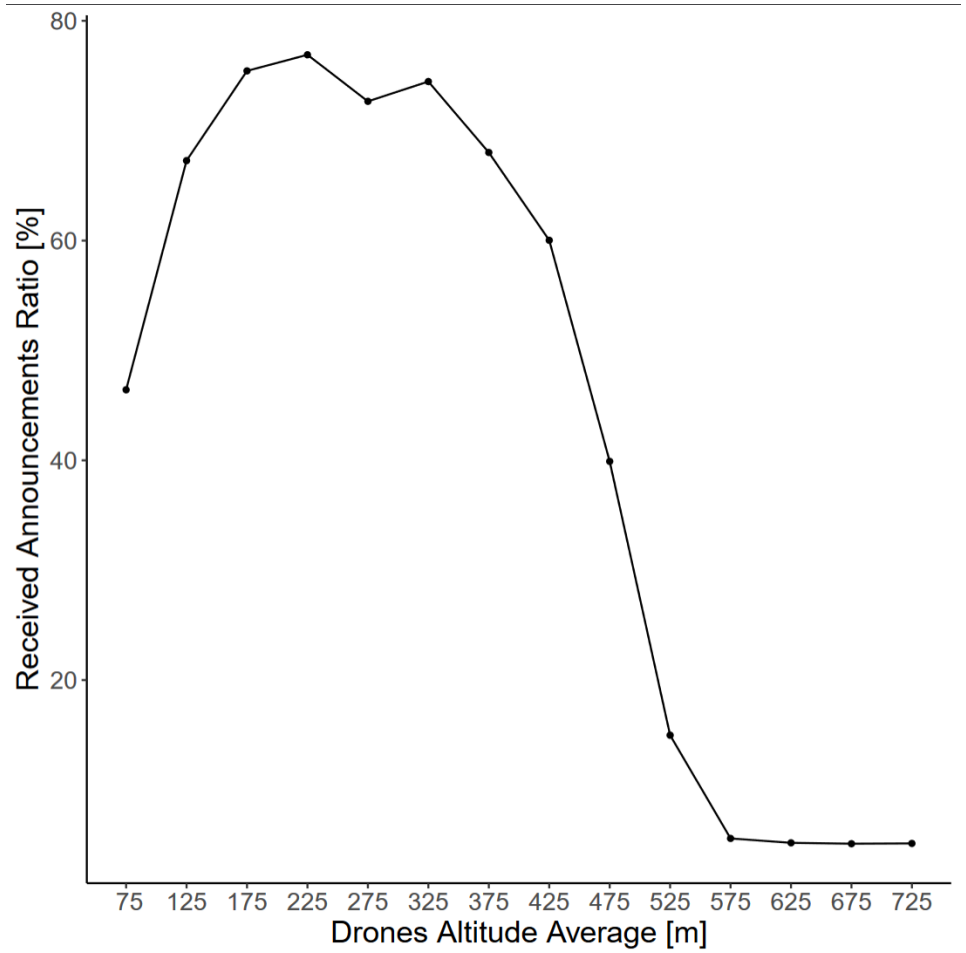
$$Rar_i = \frac{R_i}{N} \quad (1)$$

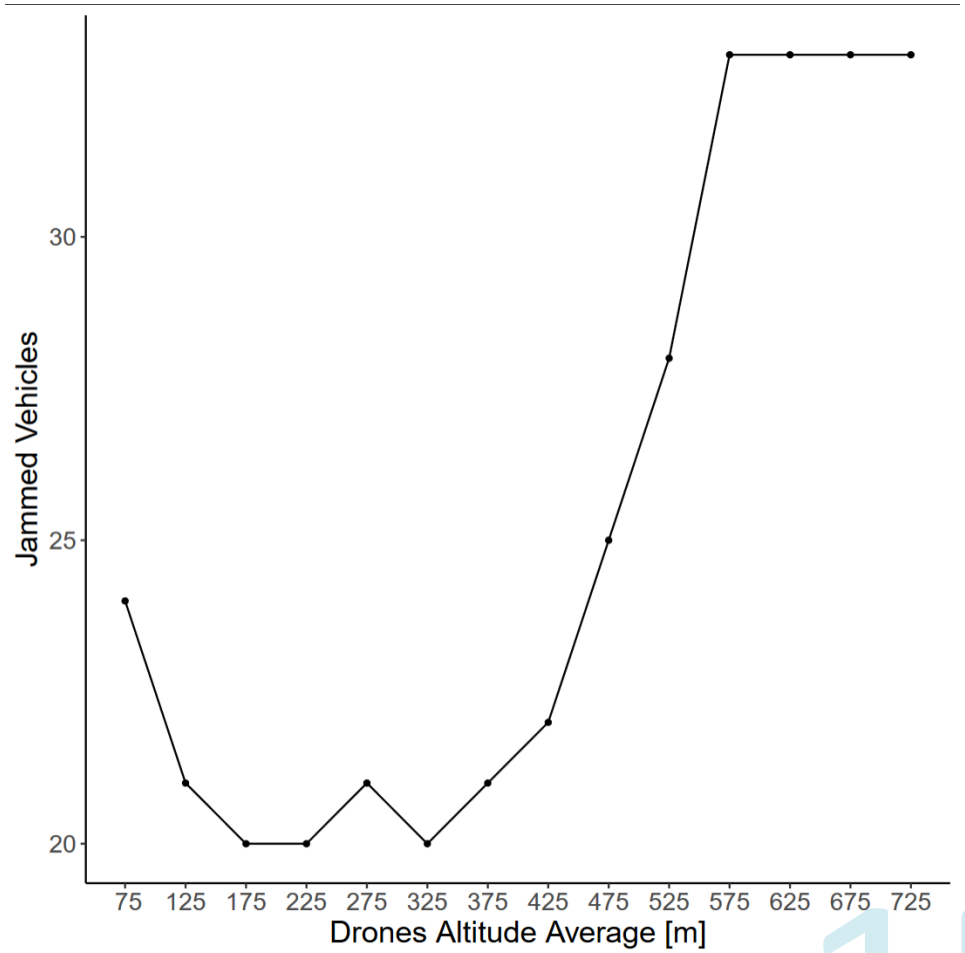
2. The Overall Received Announcements Ratio:

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

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

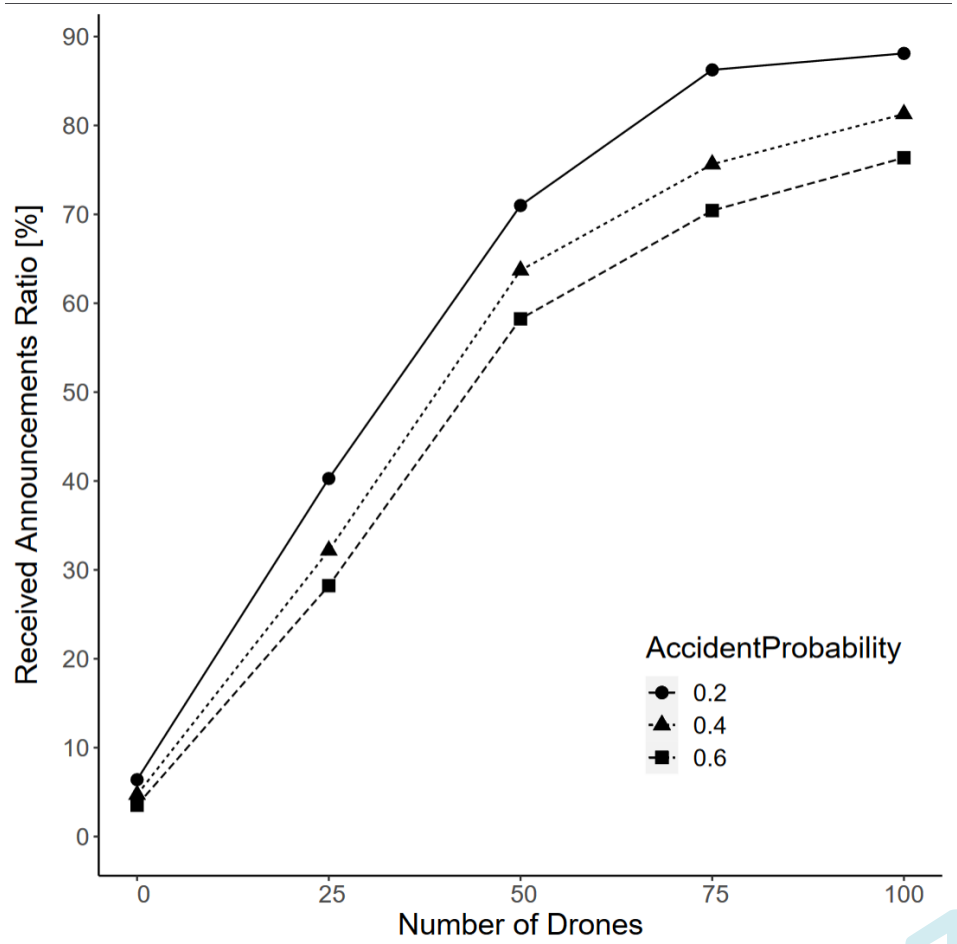
Drone flight altitude



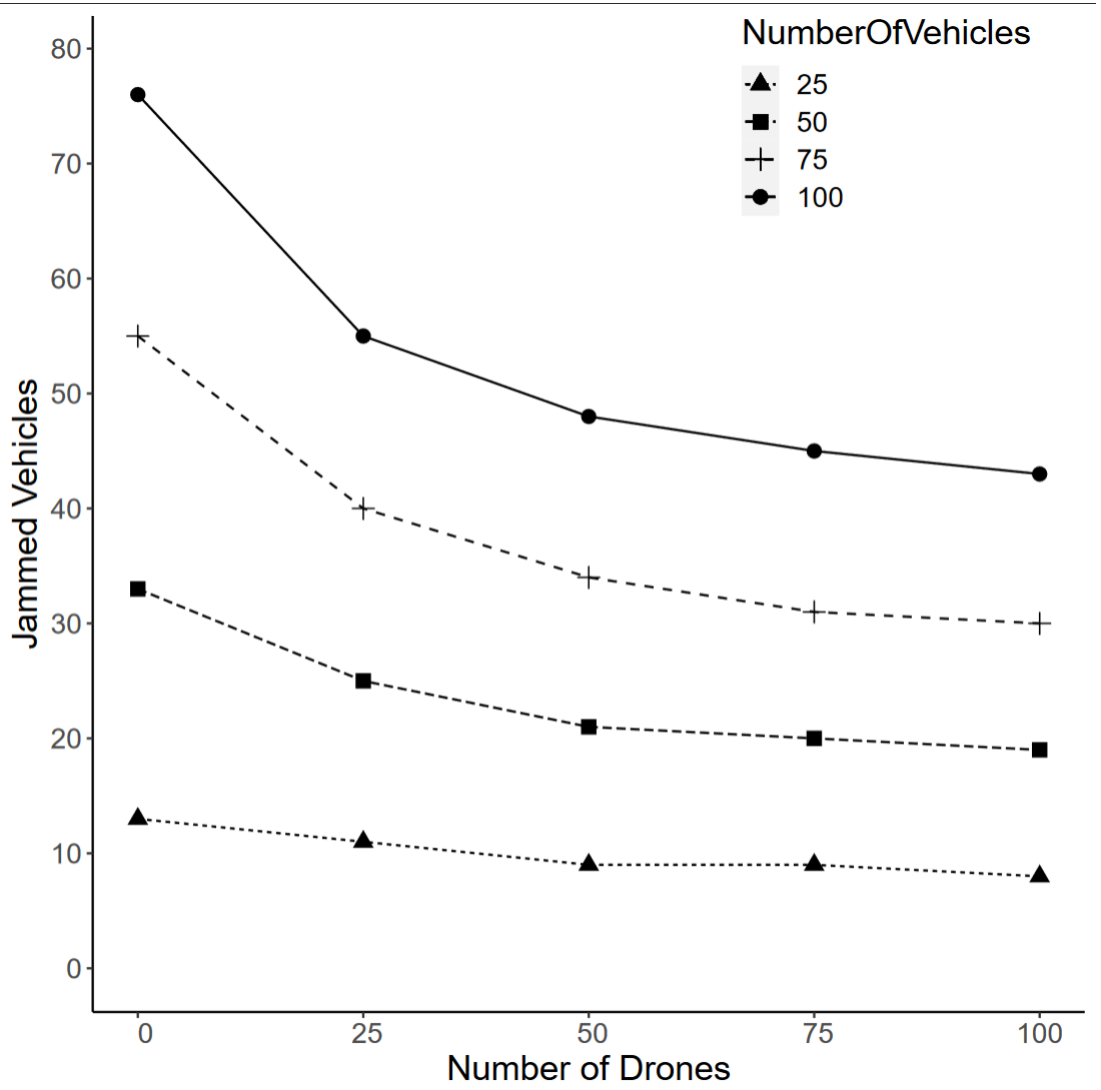


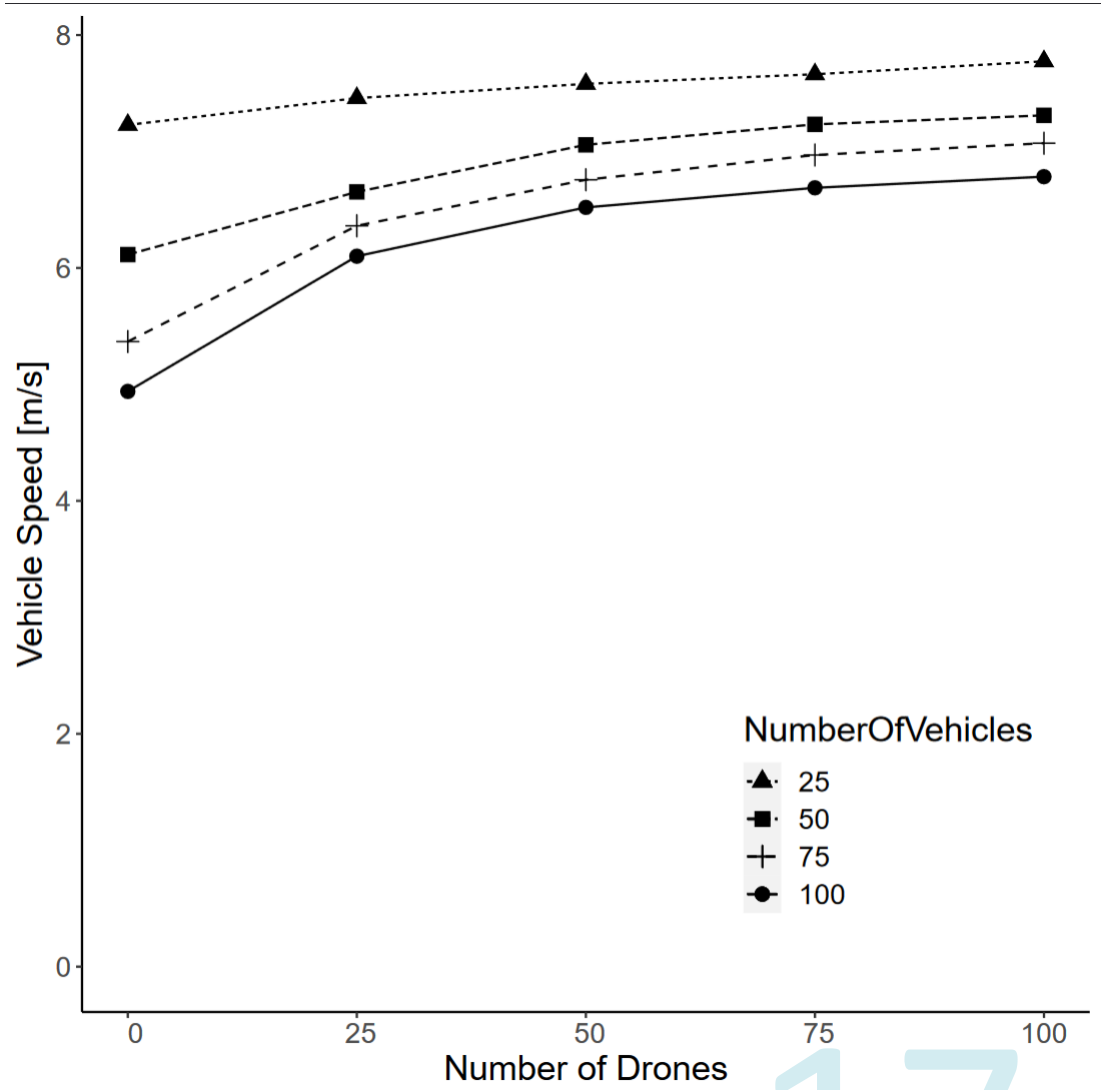
Evaluation: Received Announcements Ratio

- 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: 42% less jammed vehicles in the best case
- Project code can be easily integrated into Veins