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# Multiagent Coordination In On-demand Transport with Connected Autonomous Vehicles A decentralized resource allocation approach

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# Multiagent Coordination In On-demand Transport with Connected Autonomous Vehicles

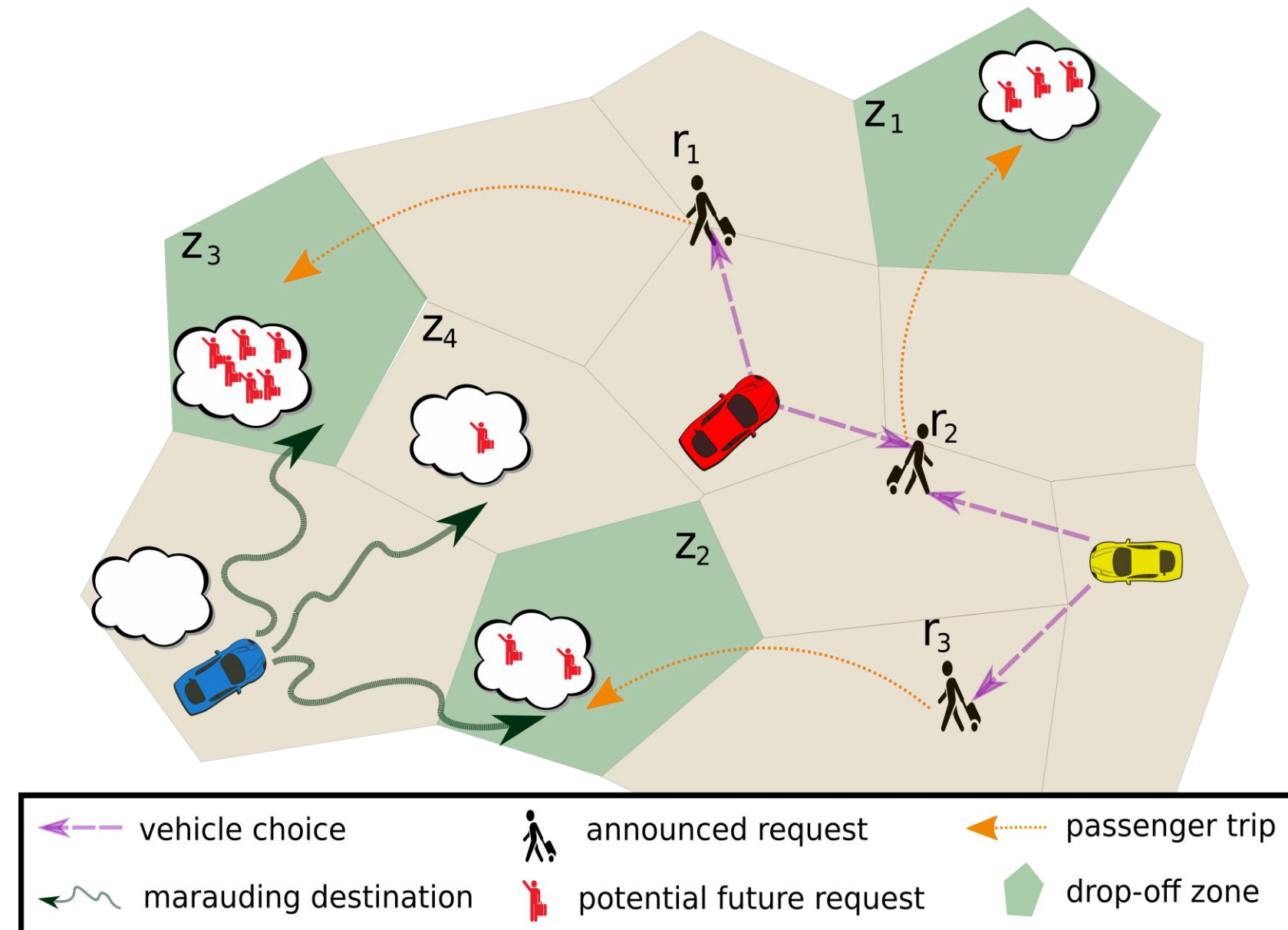
## A decentralized resource allocation approach

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Plateforme Territoire



Application domain : On-demand Transport (ODT)

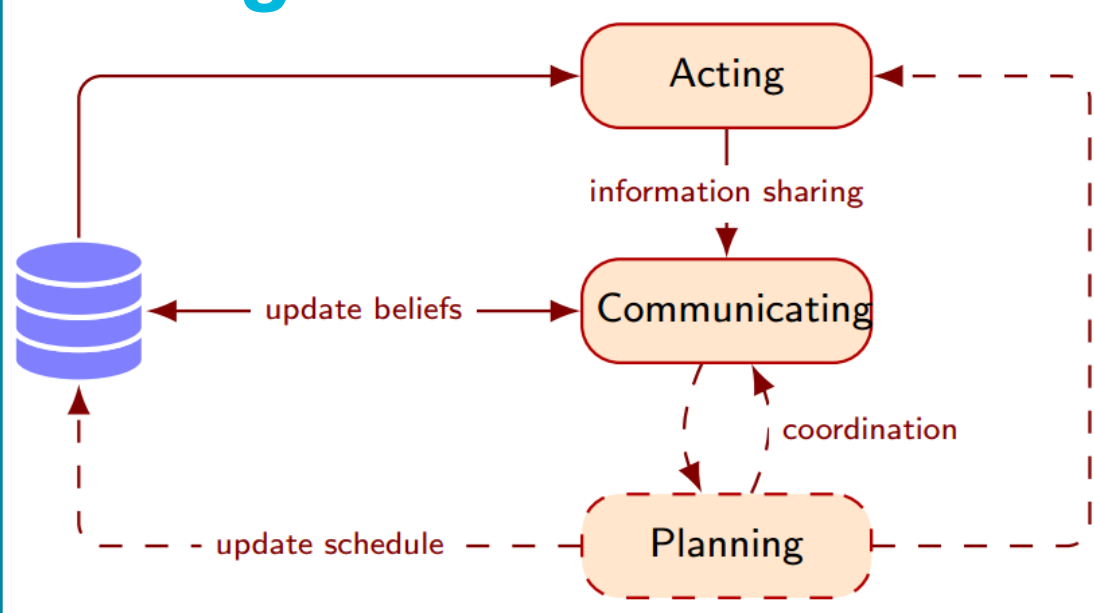
### AV-OLRA

An extension to a more generic model (OLRA) adapted to ODT with AVs and their communication constraints

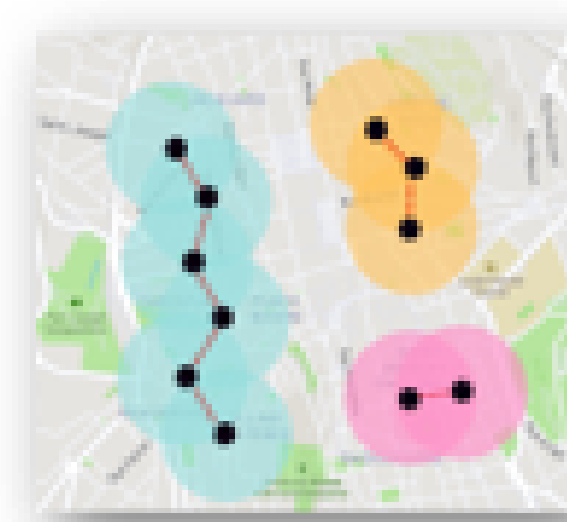
$(R, V, G, T)$

- ▶  $R$  – a dynamic set of requests (ressources)
- ▶  $V$  – a set of connected autonomous vehicles (consumers with communication constraints)
- ▶  $G$  – a graph defining the road network
- ▶  $T$  – the problem's time horizon (discretization of time dimension)

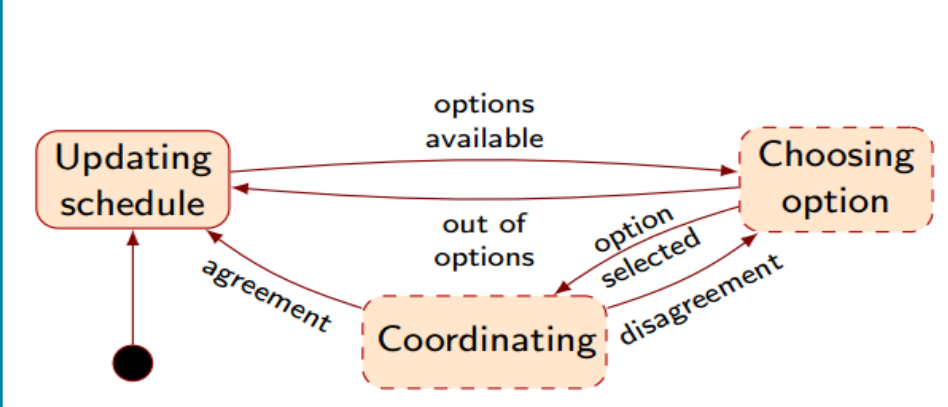
### AV Agent



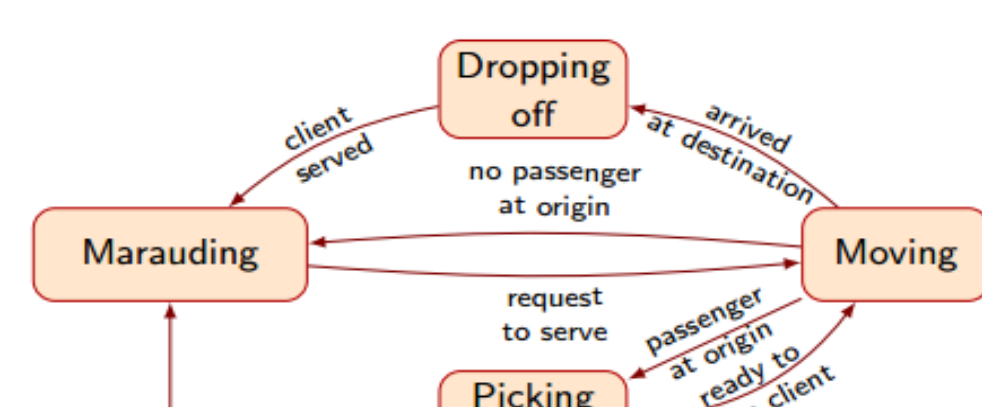
Generic Autonomous Vehicle Behavior



Communication model connected sets (CSs) are formed through vehicles limited communications ranges



Planning sub-behavior  
The coordination mechanism defines the solution method

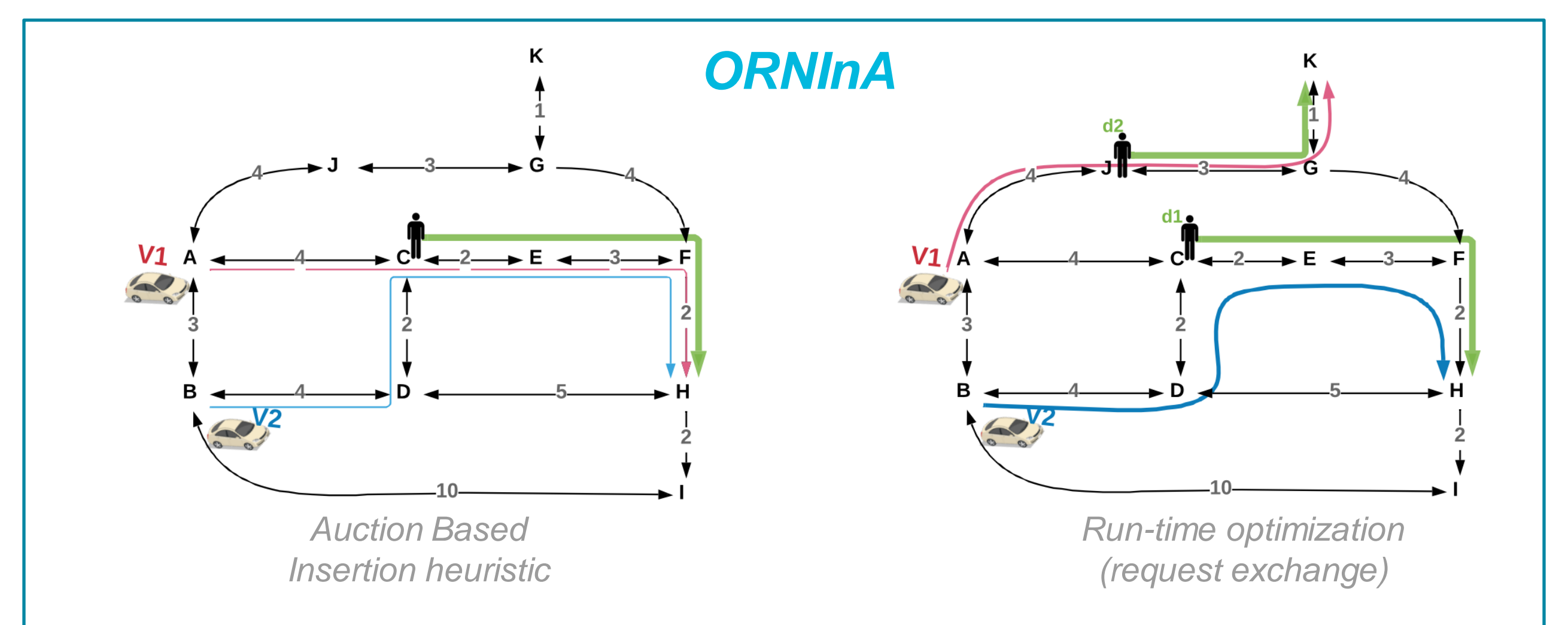


Acting sub-behavior

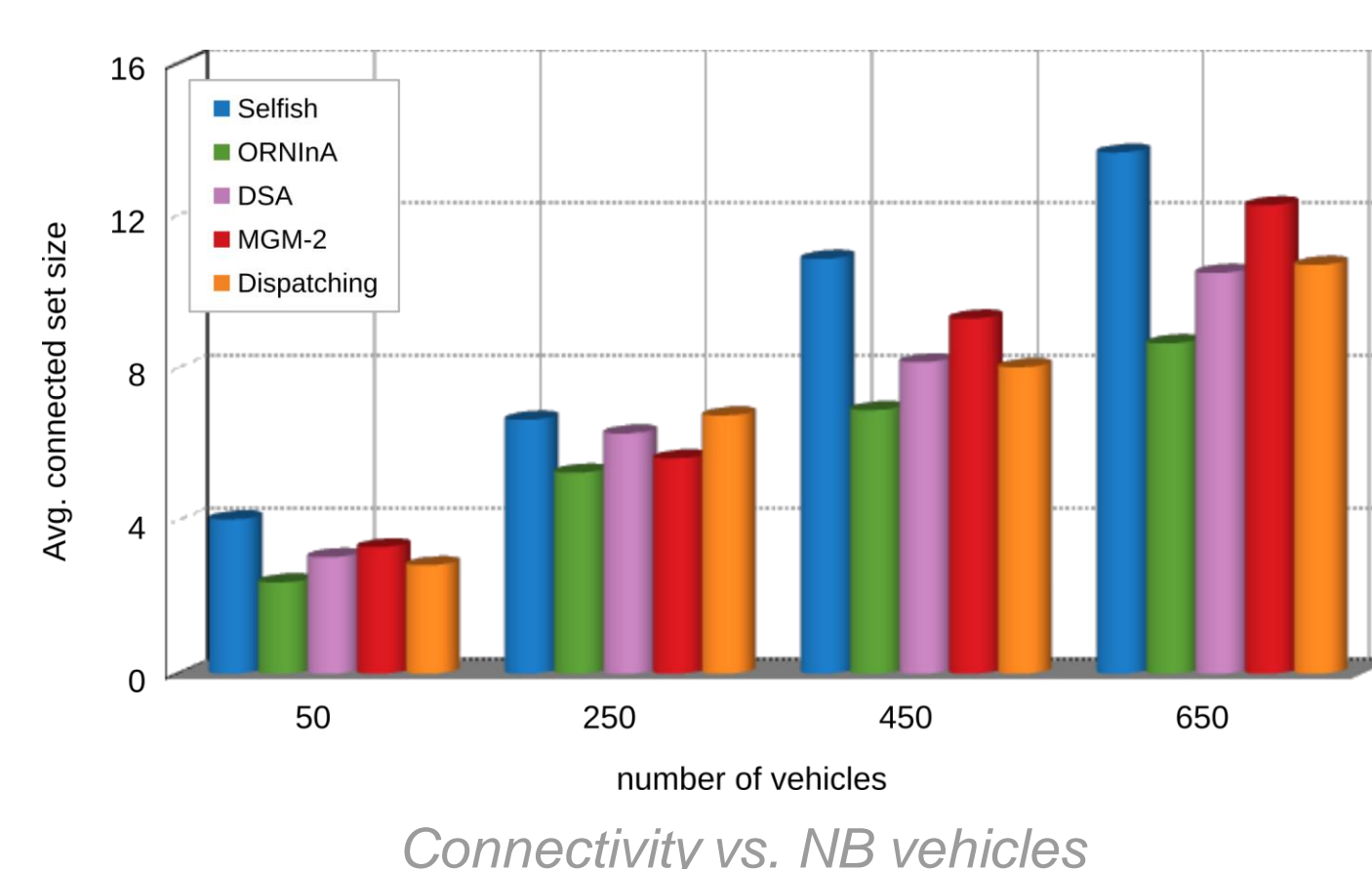
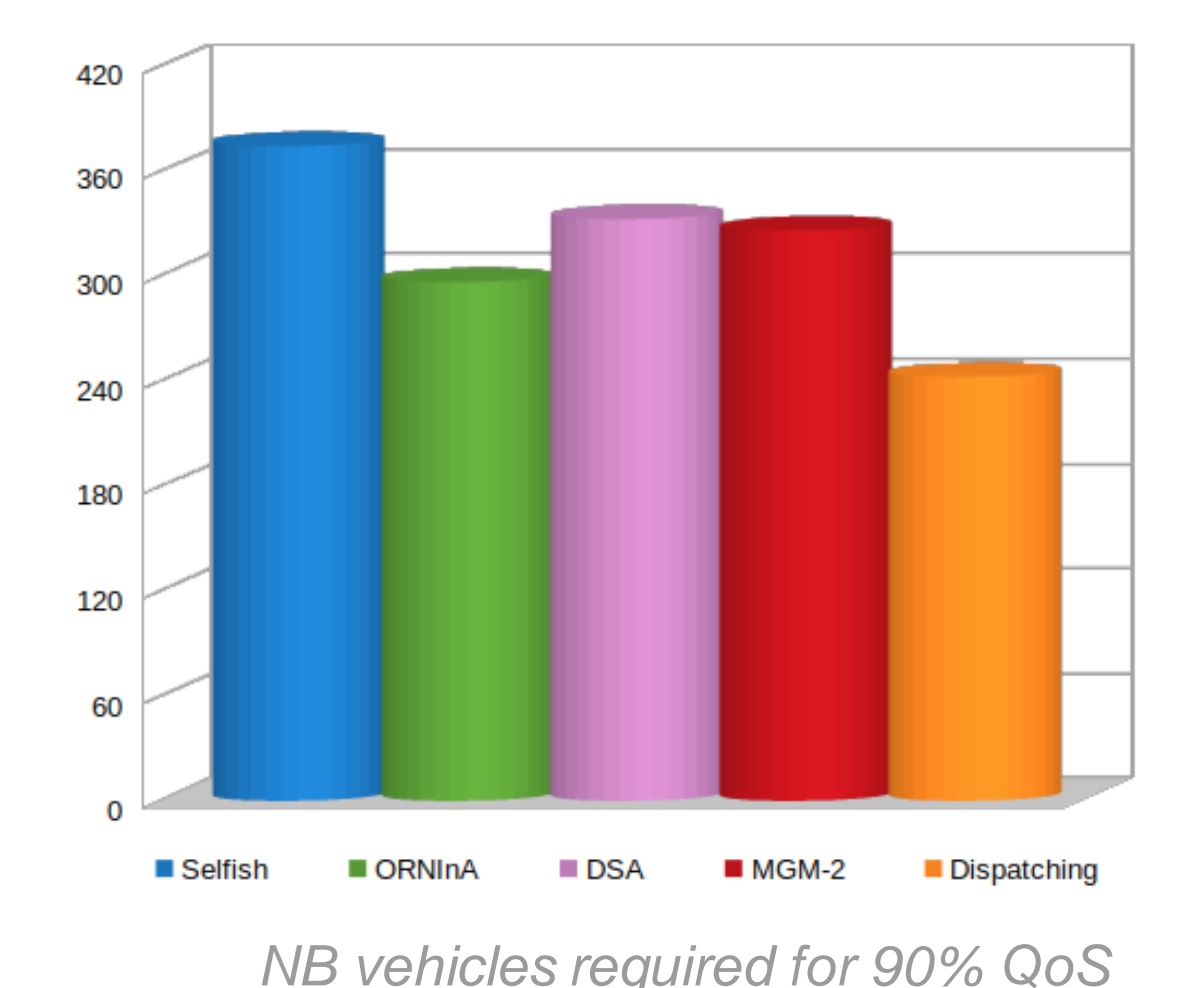
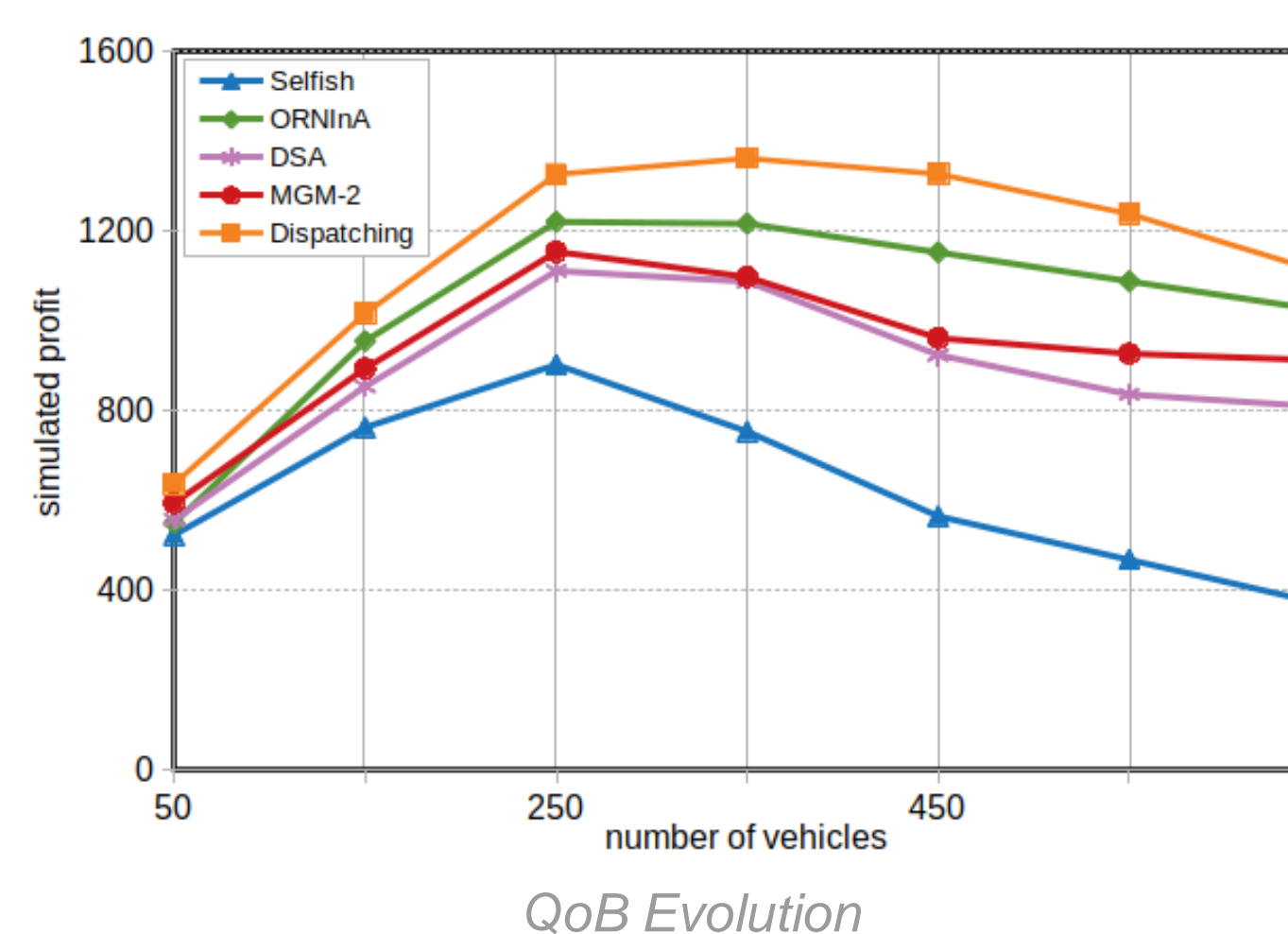
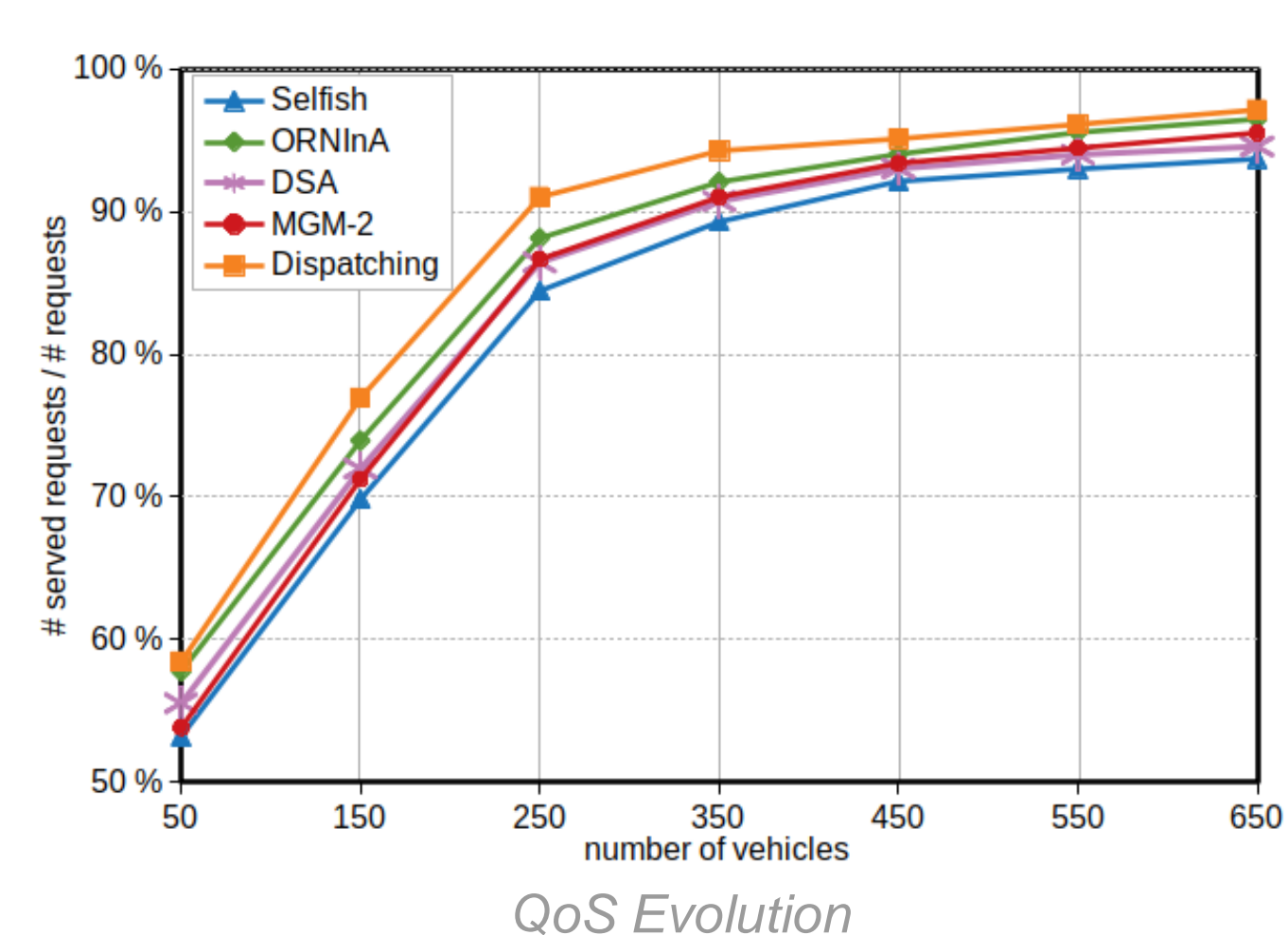
Deploying autonomous vehicle fleets, with limited communication ranges, in order to provide ODT service requires a careful choice and evaluation of solution methods for resource allocation problems.

### Our Multiagent Approach

- ▶ **Generic Modeling (AV-OLRA)** – Autonomous Vehicles Online Localized Resource Allocation: A generic model to ODT's dynamic resource allocation problem in connected autonomous vehicle fleets, taking into account the limited connectivity and communication constraints
- ▶ **Behavior Abstraction (AV Agent)** – Each Autonomous vehicle is an agent whose behavior consists of 3 sub-behaviors: (Acting, Communicating and Planning)
- ▶ **Solution Abstraction (CM)** – A coordination mechanism defines the characteristics of a solution methods and requirements to implement the corresponding planning sub-behavior
- ▶ **Evaluation Testbed (AV-SIM)** – A multiagent simulator based on "Plateforme Territoire" with a set of evaluation criteria (QoB, QoS, Communication load, Connectivity)
- ▶ **A new solution method (ORNInA)** – A Decentralized, Auction-based, coordination approach with run-time optimization



### Experimental evaluation with AV-SIM on real-world data (NYC-TLC trip records)



- ▶ The problem is split into sub-problems (per CS), the global solution is an aggregation of the sub-solutions
- ▶ Consequences of increasing the number of vehicles (enlarging the fleet size) :
  - More requests are served (better QoS) with more operational cost (a decrease in QoB after some threshold) => a trade-off: QoS vs. QoB
  - More connectivity between vehicles (larger connected set sizes) => more coordination messages and communicational cost
- ▶ The centralized (**Dispatching**) is optimal for (fleet size / QoS), the greedy method (**Selfish**) is the worst, while decentralized coordination methods (**MGM-2**, **DSA**, **ORNInA**) are good alternatives in the middle (ORNInA performs slightly better with lower communicational cost)

### References

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