



HAL
open science

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

Alaa Daoud, Flavien Balbo, Paolo Gianessi, Gauthier Picard

► **To cite this version:**

Alaa Daoud, Flavien Balbo, Paolo Gianessi, Gauthier Picard. Multiagent Coordination In On-demand Transport with Connected Autonomous Vehicles A decentralized resource allocation approach. Colloque IMT “ Les sciences de l’information au service des nouvelles mobilités ”, Oct 2022, Palaiseau, France. emse-03812946

HAL Id: emse-03812946

<https://hal-emse.ccsd.cnrs.fr/emse-03812946v1>

Submitted on 13 Oct 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Multiagent Coordination In On-demand Transport with Connected Autonomous Vehicles

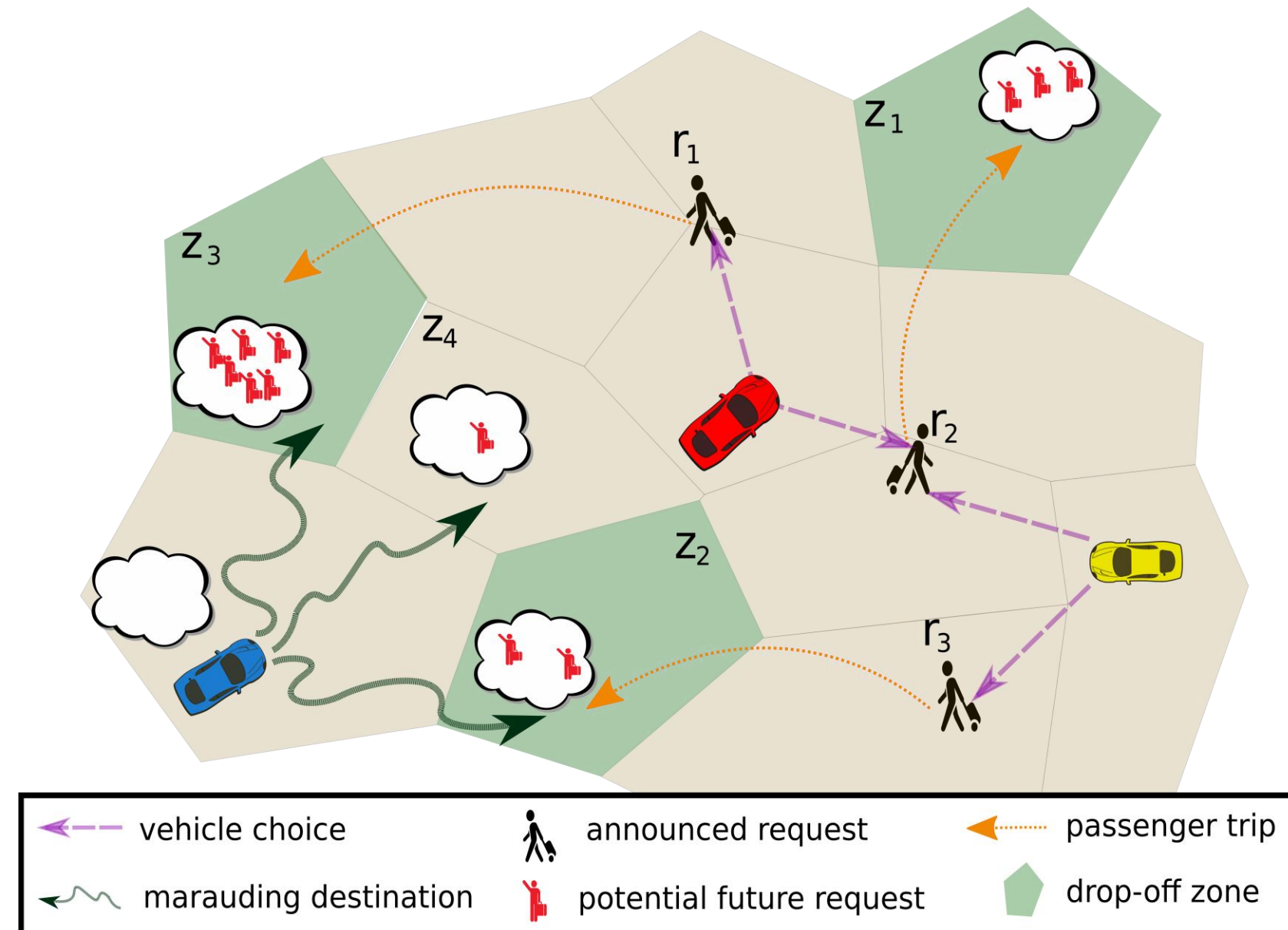
A decentralized resource allocation approach

Authors

Alaa DAOUD
Flavien Balbo
Paolo Gianessi
Gauthier Picard



Plateforme Territoire



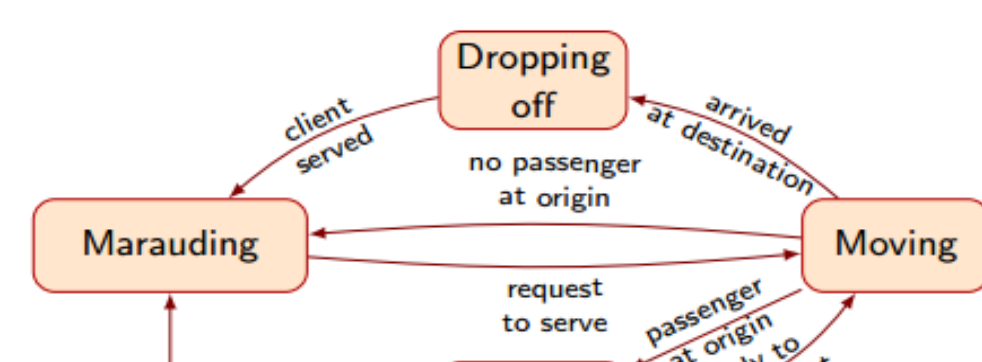
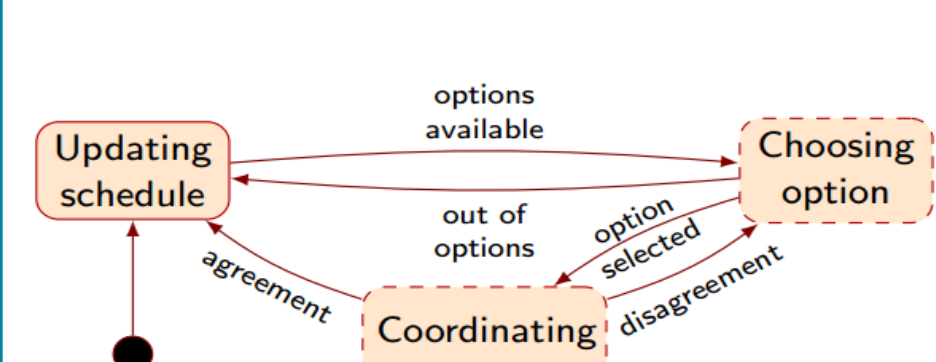
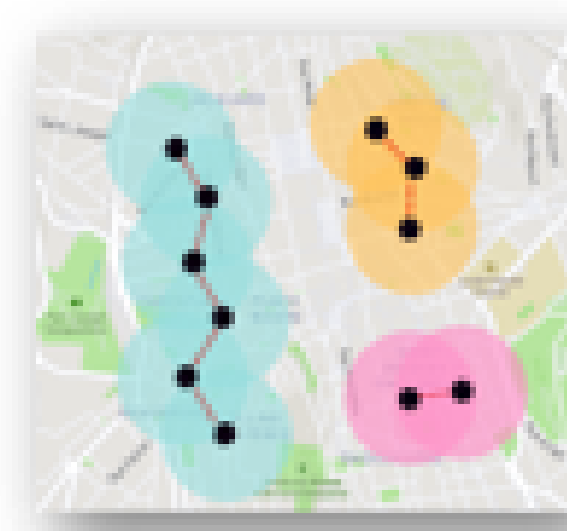
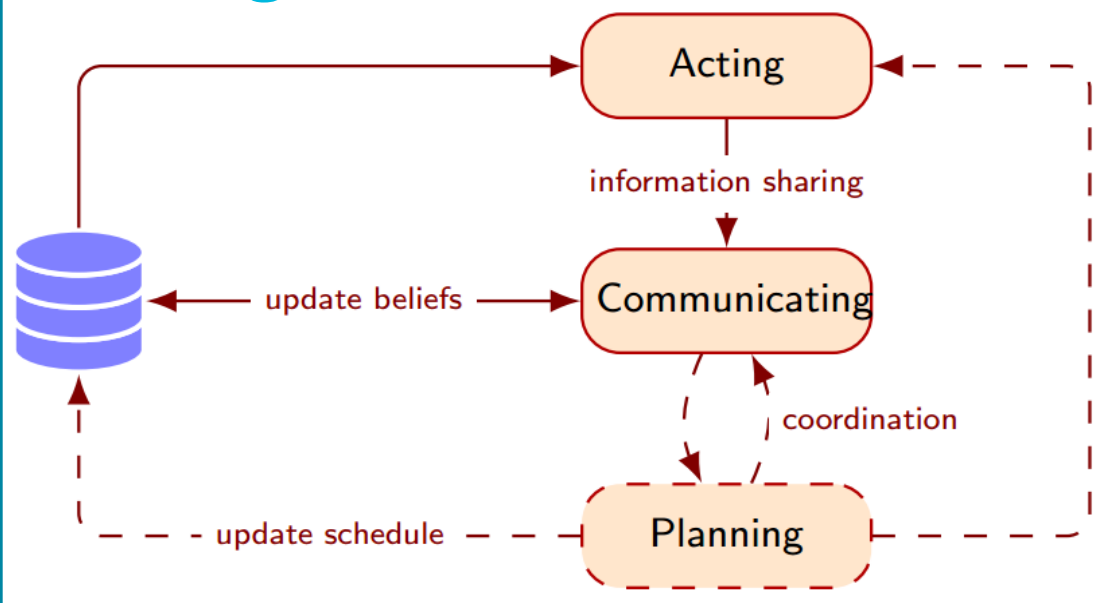
AV-OLRA

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)

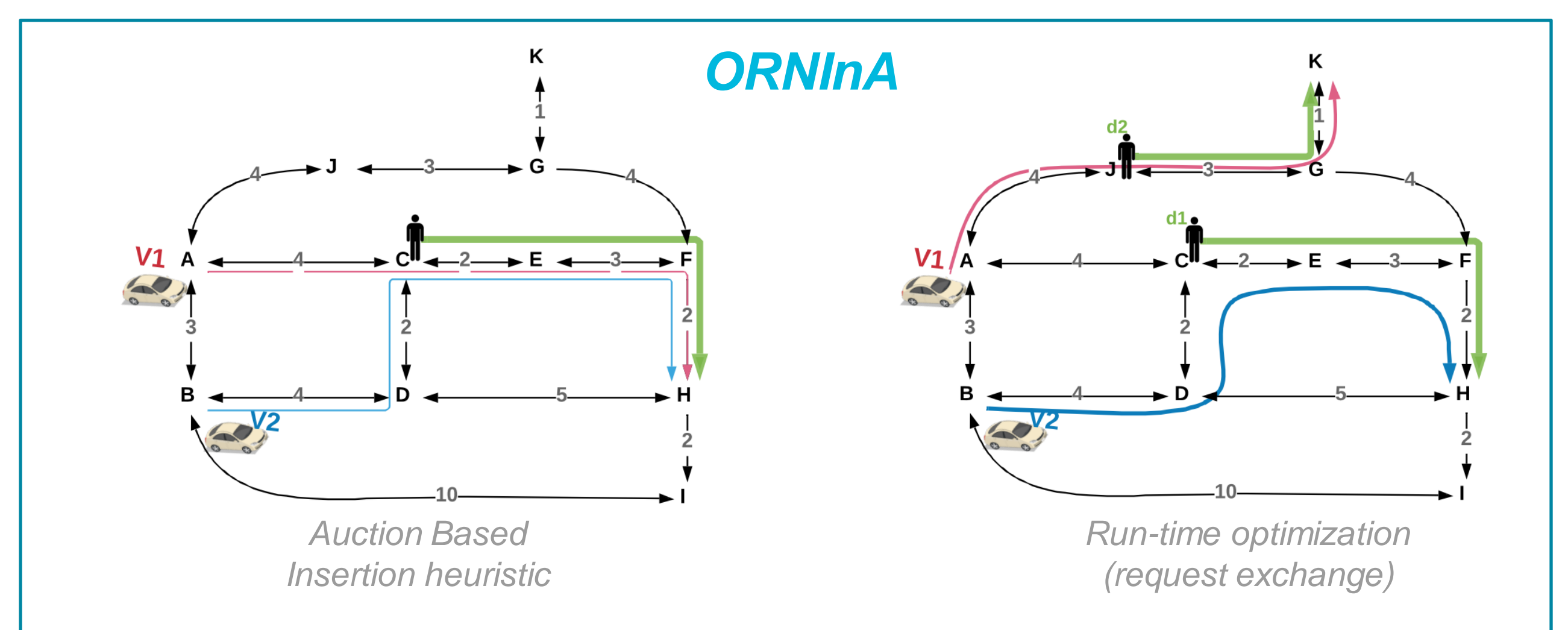
AV Agent



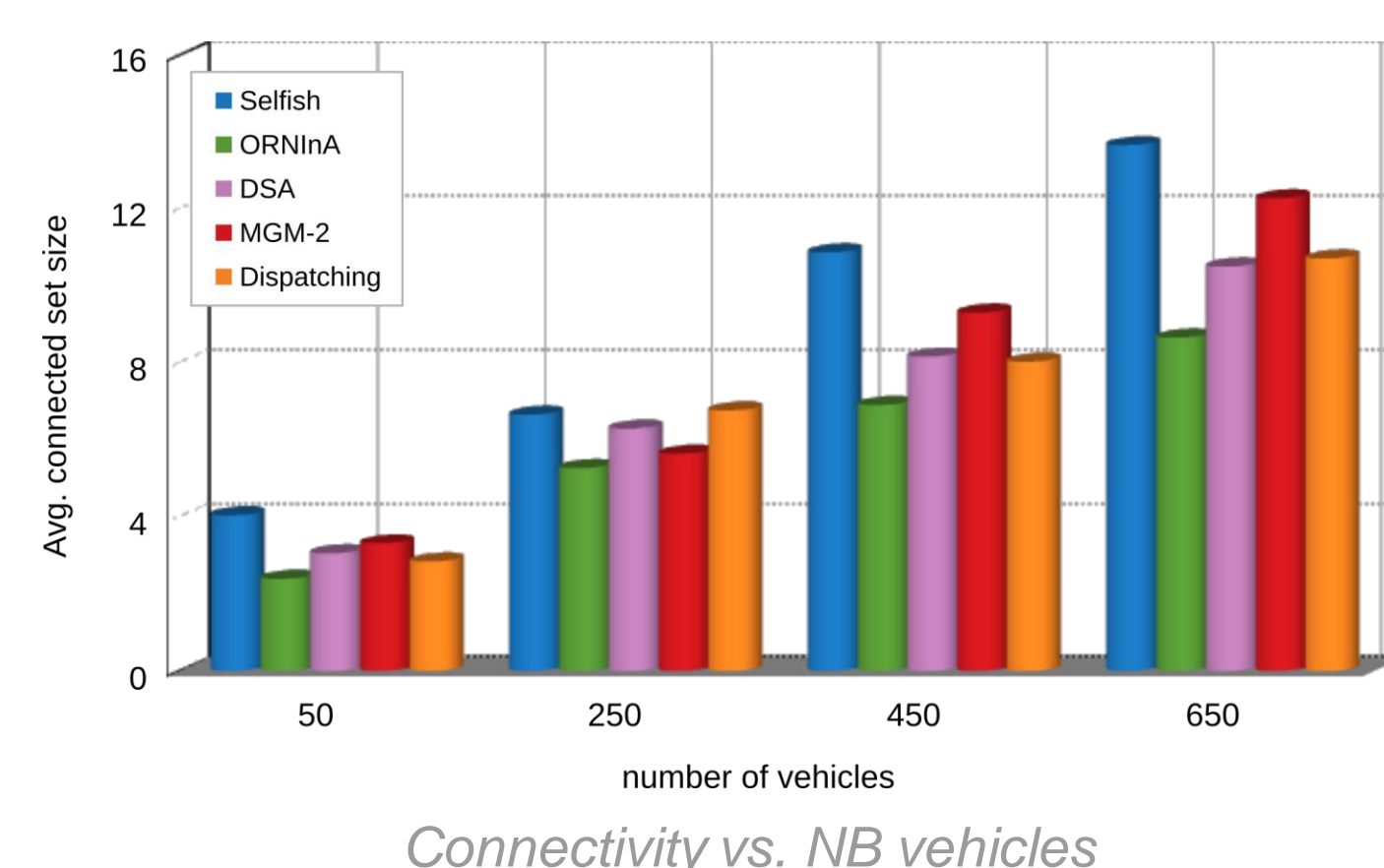
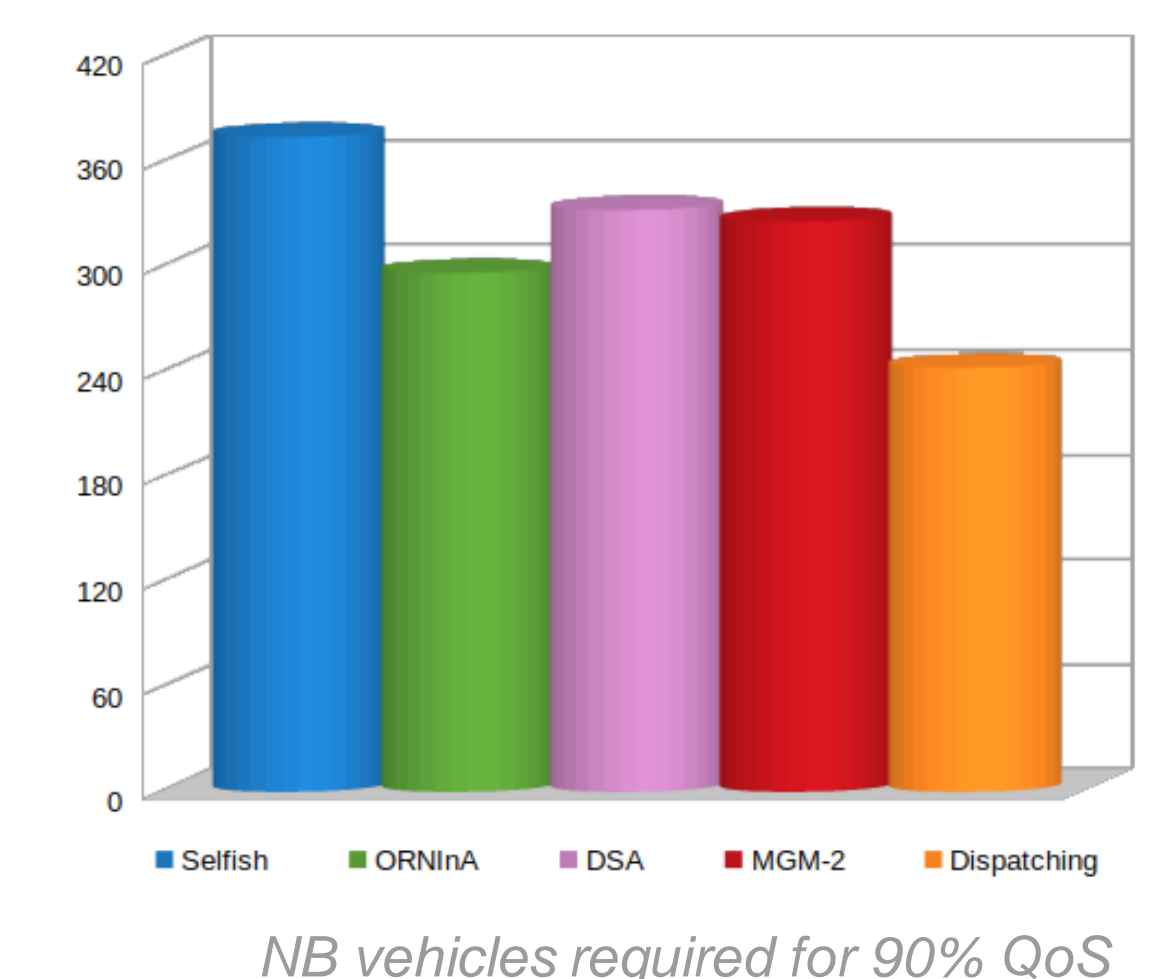
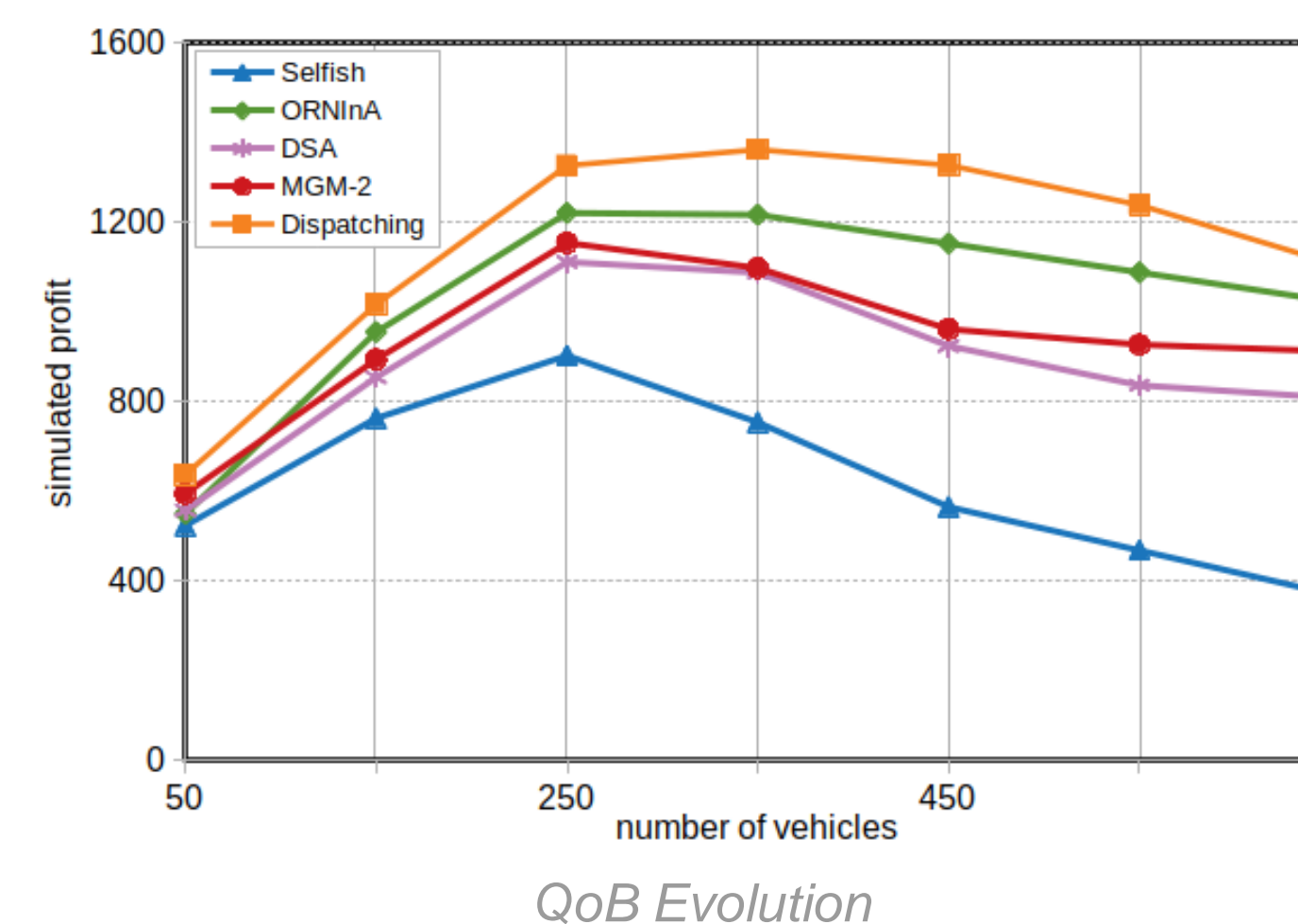
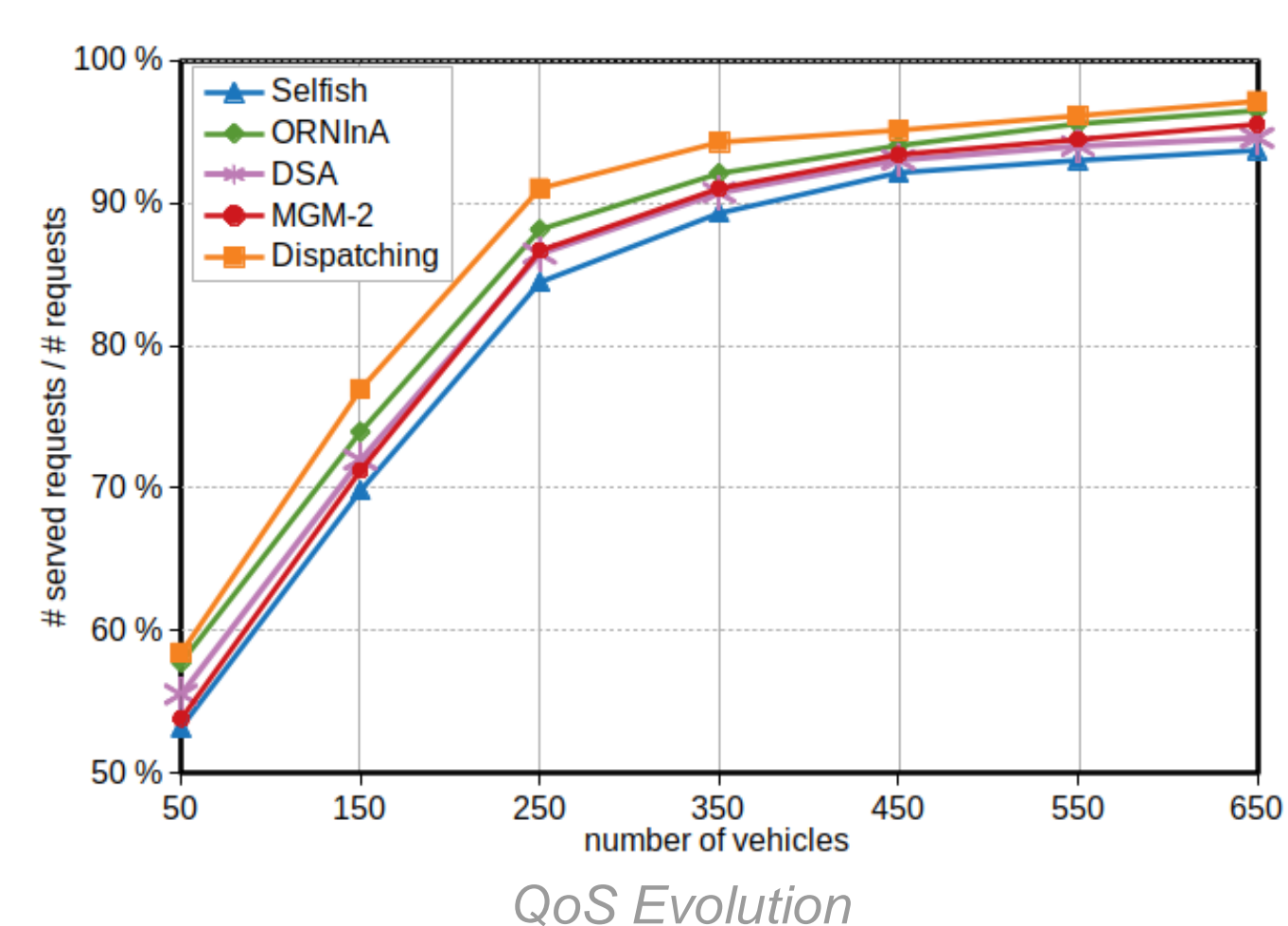
Deploying autonomous vehicle fleets, with limited communication ranges, in order to provide ODT service requires a careful choice and evaluation of solution methods for resource allocation problems.

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

- Alaa DAOUD. (2022). Coordination in Connected Autonomous Vehicle fleets: A Multiagent Resource Allocation Approach to Online On-Demand Transport. (Ph.D. Thesis)
- Alaa Daoud et al. "A Generic Multi-Agent Model for Resource Allocation Strategies in Online On-Demand Transport with Autonomous Vehicles". In: AAMAS-21. 2021, p. 3.
- Alaa Daoud et al. "ORNInA: A decentralized, auction-based multi-agent coordination in ODT systems". In: AI Communications 34.1 (15 February 2021), pp. 37–53.
- M. Zargayouna, et al. « Generic model for resource allocation in transportation. Application to urban parking management », Transportation Research Part C 71 (2016), p. 538 - 554.
- Plateforme Territoire : <https://territoire.emse.fr/>

Contact : alaa.daoud@emse.fr , flavien.balbo@emse.fr , paolo.gianessi@emse.fr , gauthier.picard@onera.fr