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Mobility Strategies for Swarms of Autonomous UAVs

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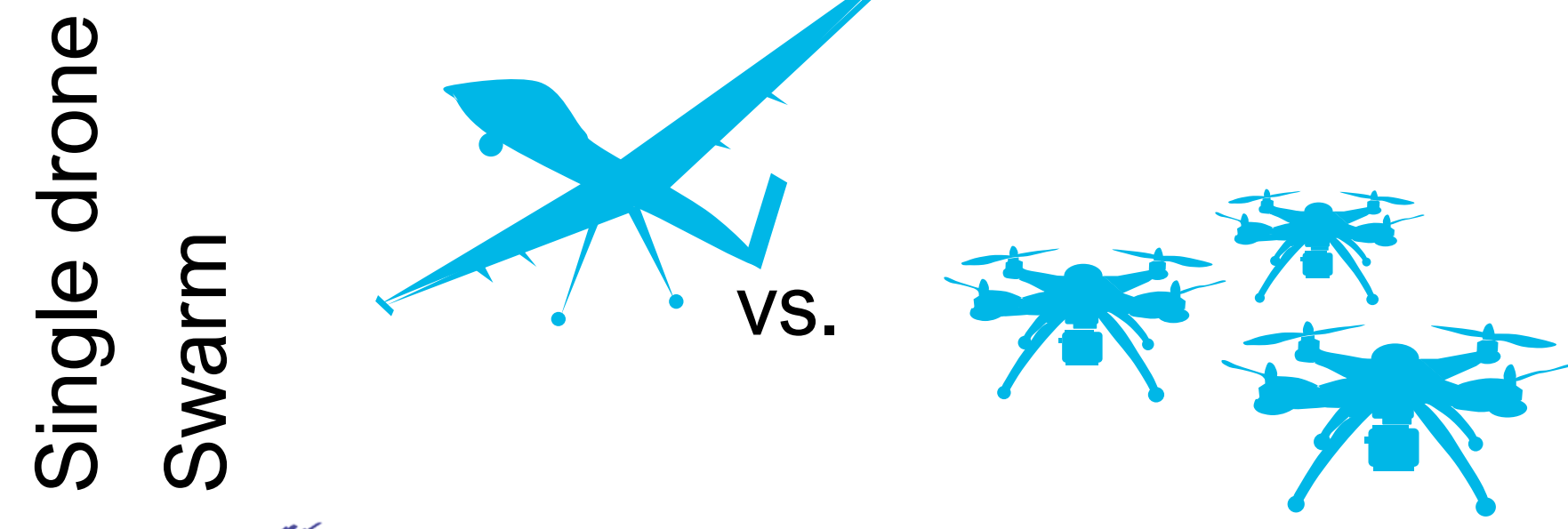
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Context

Mission: detect suspicious events

- ▶ Without human intervention
- ▶ In unknown area
- ▶ Quickly



- Resilient
- Considered as a unique entity
- Quick intervention
- Precision due to low altitude

Objectives

Whole project

Allow Autonomous Unmanned Aerial Vehicles (UAVs) to perform **collaborative** tasks, such as wide area surveillance. The UAVs communicate between them and have similar characteristics: they form a **swarm**. They are considered as a **unique entity** as seen by an operator.

PhD

- ▶ Develop a distributed mobility model for a swarm of autonomous UAVs
- ▶ Allow compact flights
- ▶ Update the UAVs behaviour in real time, in function of the mission objective and the airborne sensors performances

Related Work

Some uses of swarms of UAVs

- ▶ Firemen Assistance
- ▶ Pesticides Spraying
- ▶ Park Cleaning
- ▶ Area Surveillance
- ▶ Search And Rescue

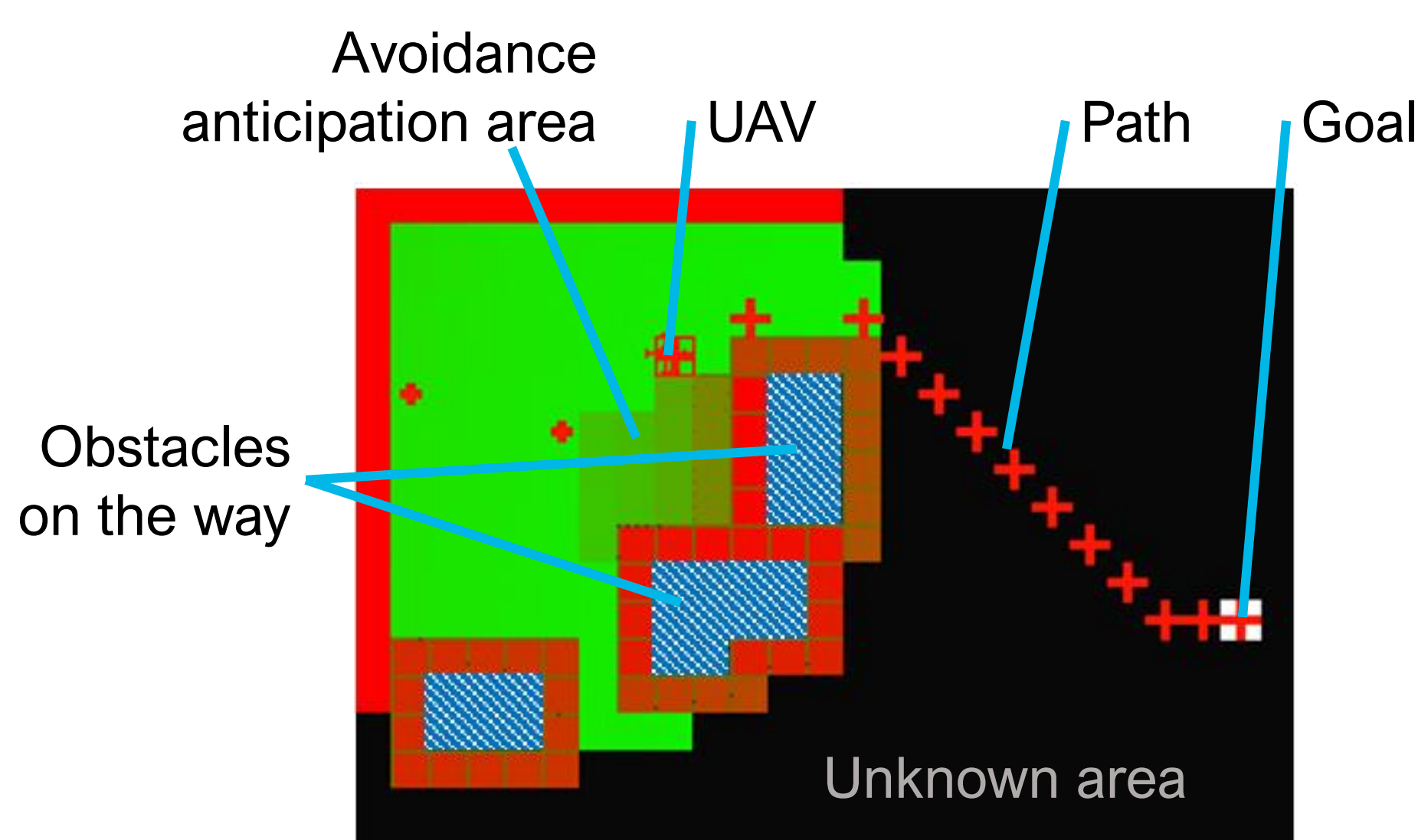
Some path planning methods

- ▶ **Artificial Potential Fields**
- ▶ Virtual Forces
- ▶ Genetic Algorithms
- ▶ Chaotic Processes
- ▶ Particle Swarm Optimization
- ▶ Dijkstra's algorithm, A* & derivatives

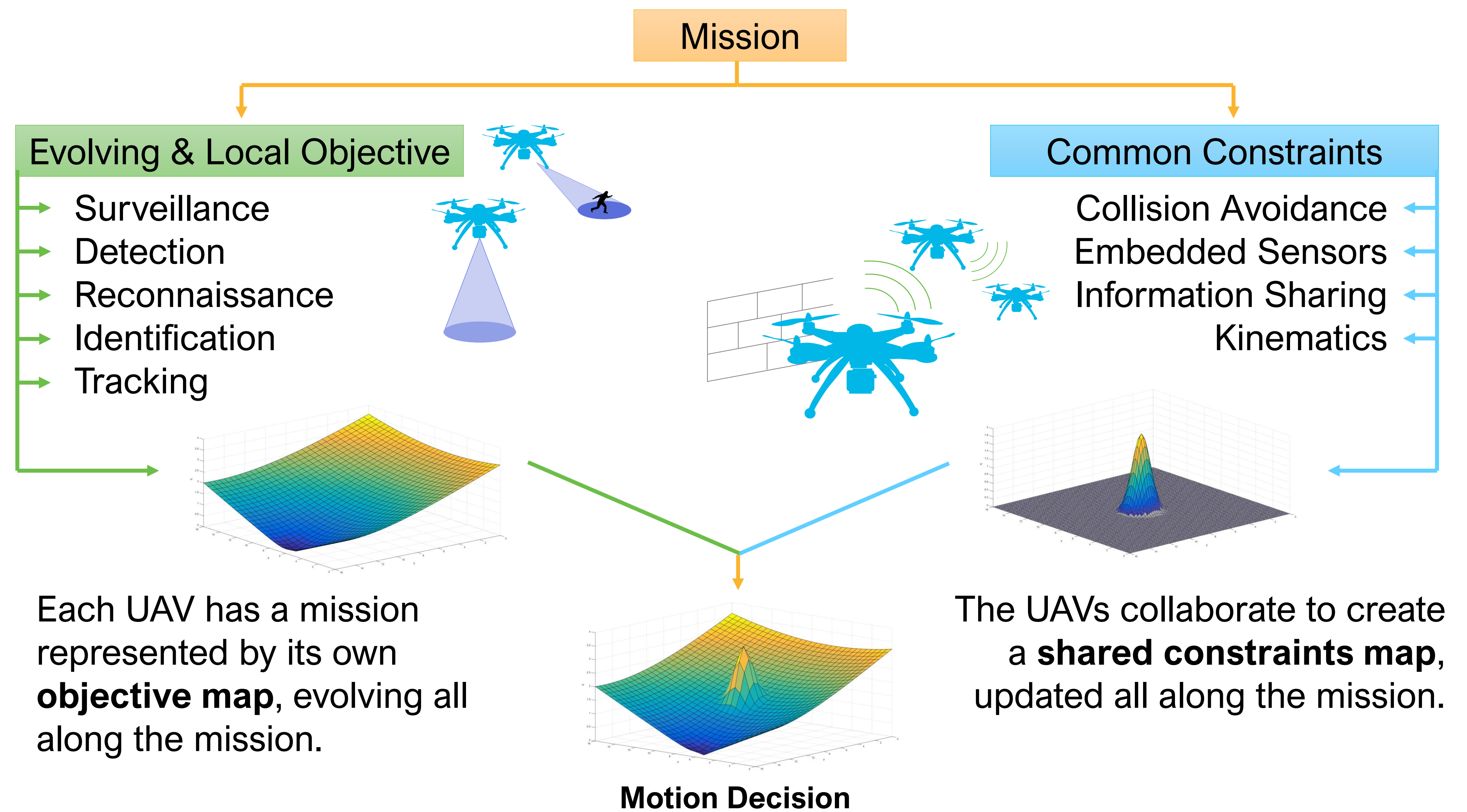
Obstacle Avoidance Anticipation

Our Approach:

- ▶ Environment discretized into square cells
- ▶ Mobility model based on Artificial Potential Field Principle (APF)
- ▶ Creation of an innovative field for obstacle avoidance anticipation



Principle of Our Mobility Strategy



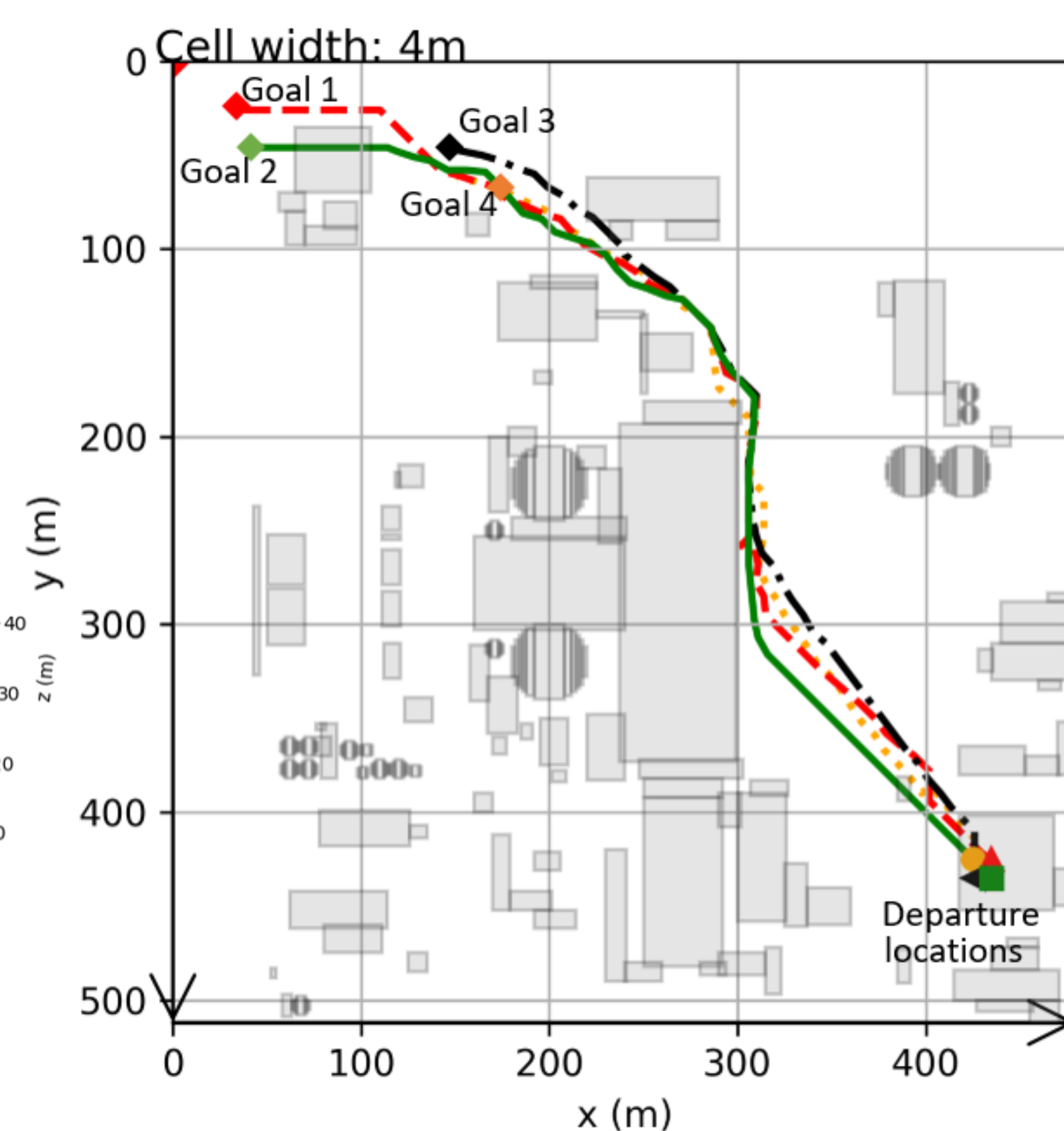
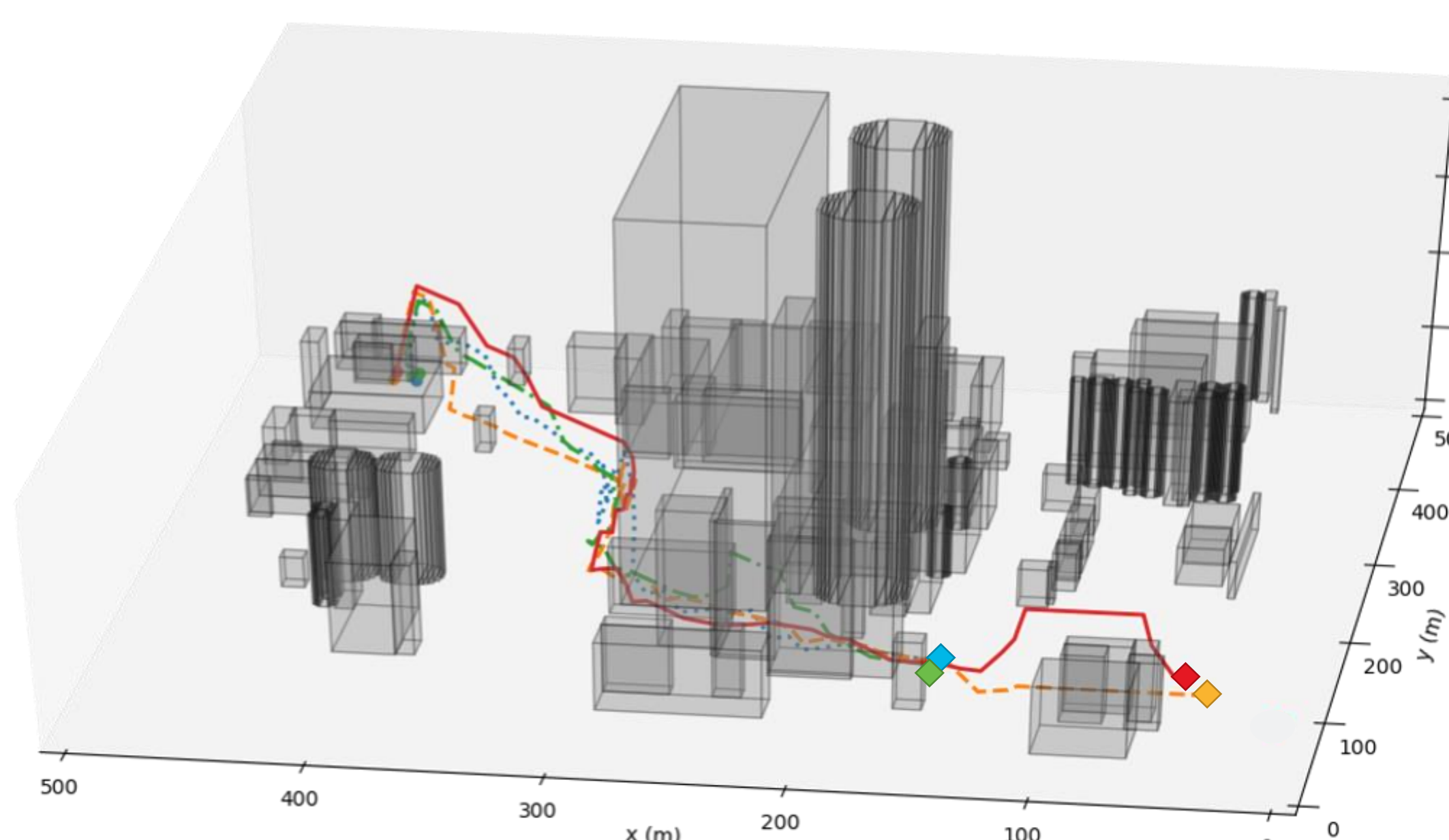
Some Illustrative Results

Mobility Model

- ▶ Distributed
- ▶ Dynamic
- ▶ Robust to UAV loss

Simulation of:

- ▶ Real environment
- ▶ Sensor capabilities
- ▶ Information sharing



Trajectories followed by a 4-UAV swarm in a 3D unknown environment

International Publications & Patent

E. Falomir, S. Chaumette and G. Guerrini. Mobility Strategies based on Virtual Forces for Swarms of Autonomous UAVs in Constrained Environments. ICINCO 2017.

E. Falomir, S. Chaumette and G. Guerrini. A Mobility Model Based on Improved Artificial Potential Fields for Swarms of UAVs. IROS 2018

E. Falomir, G. Guerrini, P. Garrec, Essaim constitué d'une pluralité de drones volants légers.