

# Platoons and Traffic Management

*Date: 4 112014*

*Inria*



# People involved

- ▶ **Alexis Scheuer Assistant professor**
- ▶ **Olivier Buffet CR Inria**
- ▶ **Olivier Simonin Professor (now at Insa de Lyon)**
- ▶ **François Charpillet DR Inria**
  
- ▶ **Jano Yazbeck PhD student**
- ▶ **Tlig Mohamed PhD Student**



# Actions in InTraDE

1. Action 5 : Platooning of Intelligent Automated Vehicles  
François Charpillet, Alexis Scheuer, Jano Yazbeck

2. Action 7 : Distributed Optimization of Traffic in  
Transport Networks for Autonomous Vehicles  
Olivier Buffet, Olivier Simonin, Mohamed Tlig

# Platooning of Intelligent Automated Vehicles

Francois Charpillet, Alexis Scheuer, Jano Yazbeck

## Platooning:

move containers efficiently = train guided by a human operator.

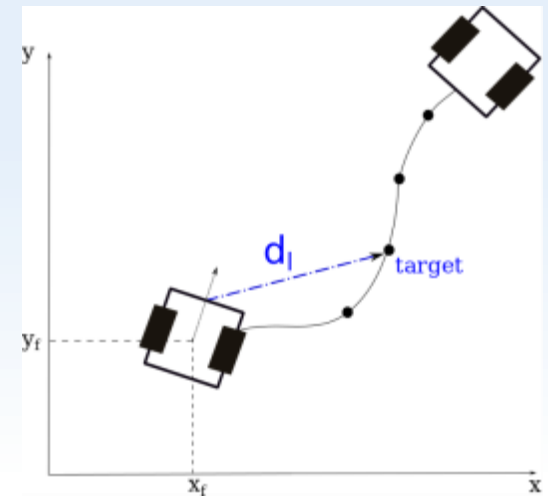
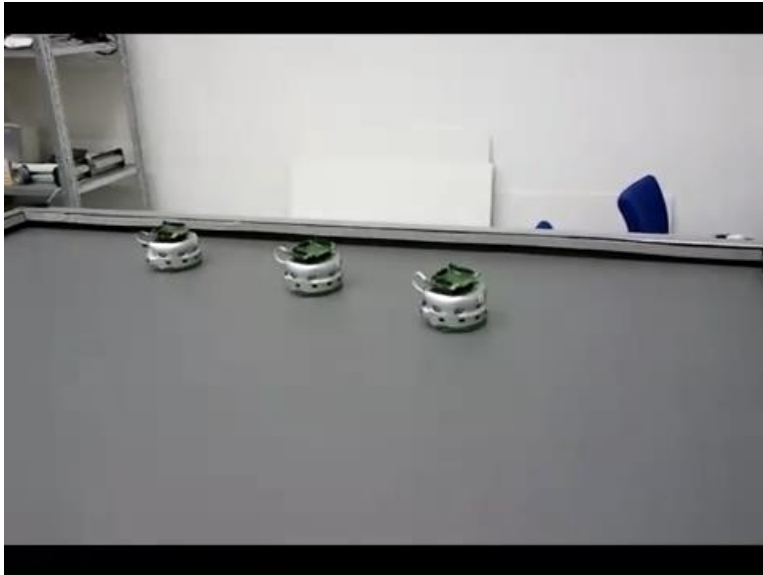
**Contribution:** decentralized local controller without communication.

**Proposed Algorithm:** at each time step,

- Acquire and memorize the new position of the previous vehicle
- Compute the longitudinal command according to this position
- *Compute the lateral command* according to the memorized positions
- Apply the commands on the vehicle

# Platooning: First Approach (Memo-LAT)

- Select from memorized positions the one at a fixed look-ahead distance  $d_l$
- Compute the lateral command to reach this position



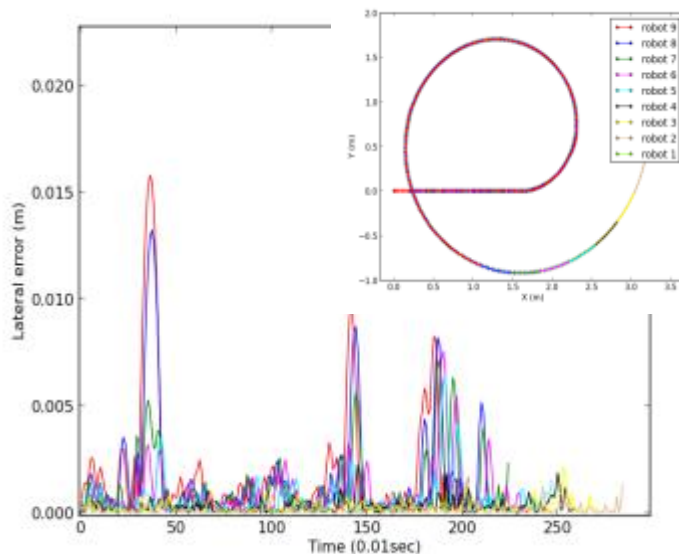
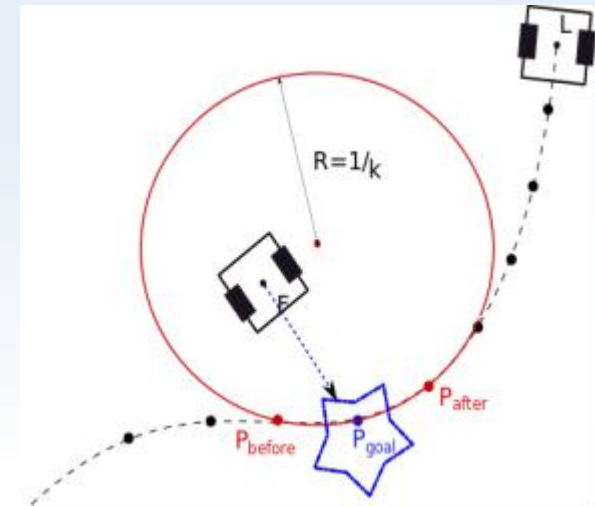
- Simulations (Python, Scanner Studio)
- Implementation (Khepera III)

## Drawbacks:

- Important lateral error
- Oscillations at straight turns (unstable)

# Platooning: Better Approach (NOC = Geometry / Heuristic)

- Memorized positions  $\rightarrow$  path
- Approximate curvature at close range
- Compute the lateral command to reach the path without oscillation



Simulations (???)

## Advantages:

- No oscillation around the leader's path
- Very small lateral error

# Platooning: Conclusion

## On-line and robust platoon control:

- Communication-free algorithm
- Very small lateral deviation from the leader's path
- Proof of stability

# Distributed Optimization of Traffic in Transport Networks for Autonomous Vehicles

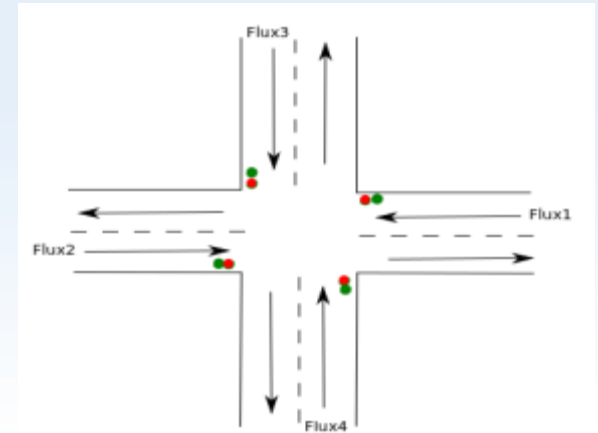
## Concerns Workpackage

PhD Thesis of Mohamed Tlig

Supervised by O. Simonin and O. Buffet

### Objectives:

- ◆ Optimization of IAV traffic at road intersections,
- ◆ Minimization of delays and energy consumption

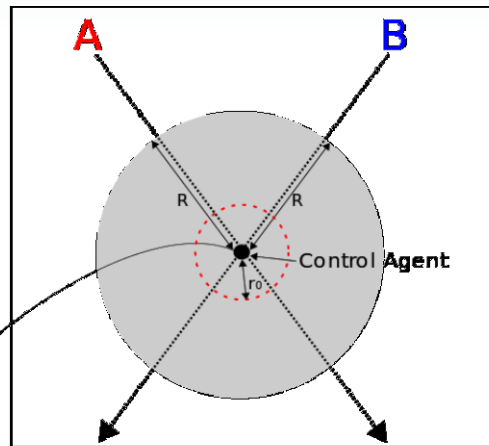




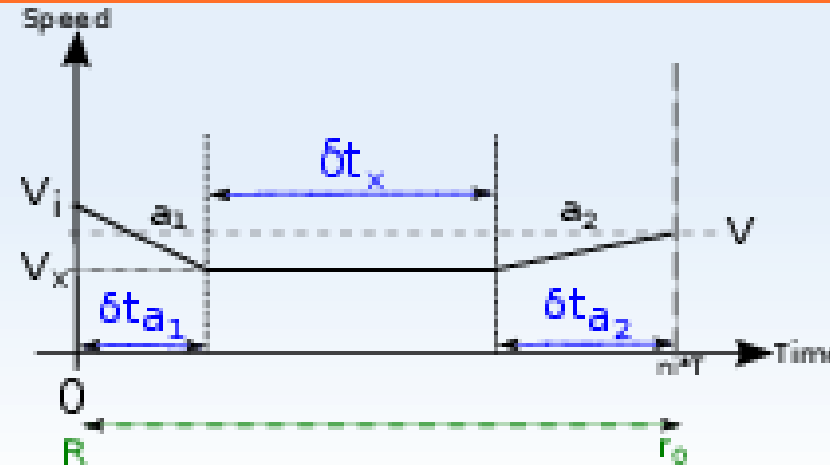
# Alternating Approach (Alt) [Tlig et al., 2014]

## Principle

- ◆ Do not stop vehicles
- ◆ Pass the vehicles from each flow alternately
- ◆ Keep a sufficient inter-distance in order to prevent collisions



Alternate the passage of vehicles



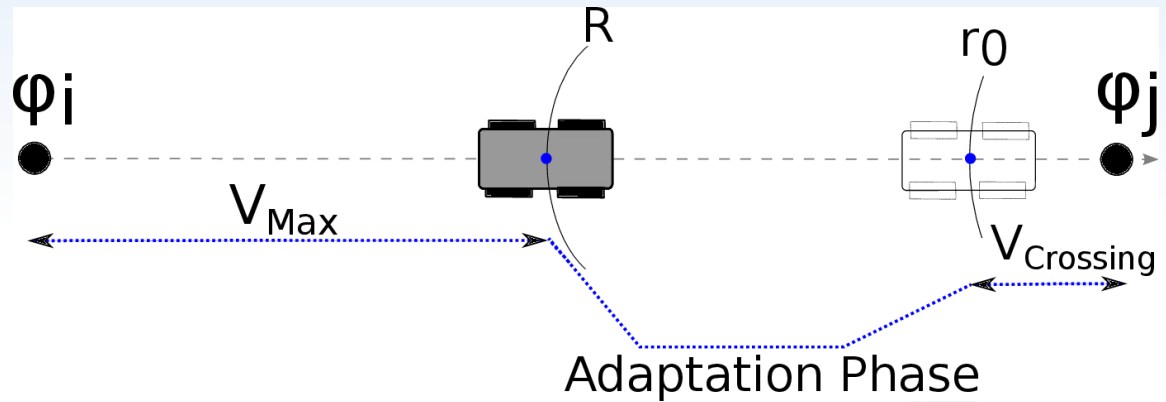
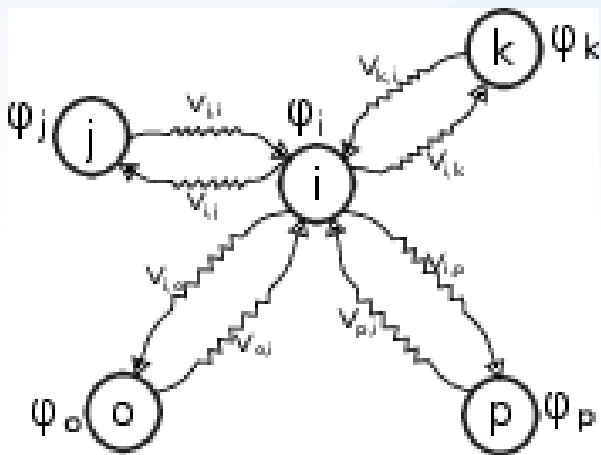
## Flow management by the Control Agent

- ◆ For each vehicle  $i$  entering the control zone:
  - ◆ Perceive  $r(i)$ ,  $V(i)$
  - ◆ Determine the crossing period  $T_{min}$
  - ◆ Compute and Send Speed profile to vehicle  $i$

# Green Waves (Synchronizing Intersections)

## Objective

Synchronize the intersections in order to smooth out the traffic



## Principle

- ◆ Constrain all intersections to share the same period
- ◆ Control the **phase** (offset)  $\varphi_i$  of each intersection  $i$
- ◆ All Control Agents perform simultaneous Hill-Climbing searches, each knowing its neighbors' phases



# International Publications

- J. Yazbeck, A. Scheuer, O. Simonin, F. Charpillet, *Improving near-to-near lateral control of platoons without communication*, in International conference on Intelligent Robots and Systems 2011 (IROS 2011).
- J. Yazbeck, A. Scheuer, F. Charpillet, *Decentralized Near-to-Near Approach for Vehicle Platooning based on Memorization and Heuristic Search*, in International Conference on Robotics and Automation ICRA 2014 .
- Mohamed Tlig, Olivier Buffet, Olivier Simonin, “Cooperative Behaviors for the Self-Regulation of Autonomous Vehicles in Space Sharing Conflicts”. *In the Proceedings of the Twenty-Fourth International Conference on Tools with Artificial Intelligence (ICTAI' 12)*, Athens, Greece, 2012.
- Mohamed Tlig, Olivier Buffet, Olivier Simonin, “Reactive coordination rules for traffic optimization in road sharing problems”. *In the Proceedings of the 11th Conference on Practical Applications of Agents and Multi-Agent Systems (PAAMS' 13)*, Salamanca, Spain, 2013
- Mohamed Tlig, Olivier Buffet, Olivier Simonin, “Decentralized Traffic Management: A Synchronization-Based Intersection Control”. *In the Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems (ICALT-ITS' 14)*, Hamamet, Tunisie, 2014.