

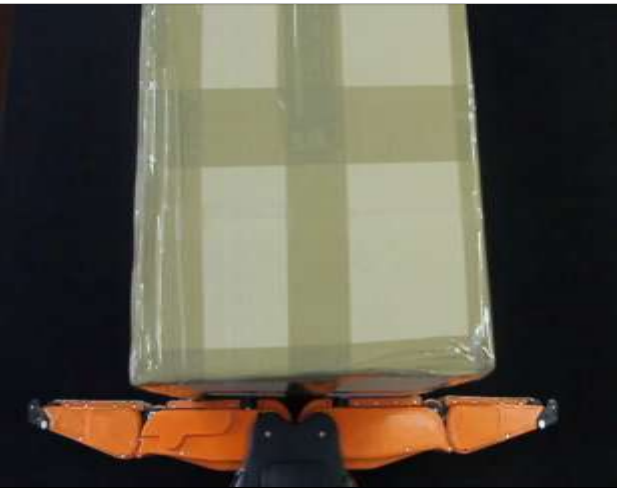


# Cooperating Objects for Industrial Automation

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Centro "E. Piaggio"

# Industrial Automation



# Industrial Automation



# Cooperating objects

Objects?

Mobile and autonomous robots for logistics

Cooperating?





# Cooperating goals



**COORDINATION  
&  
NETWORKING**

# Cooperating requirements

## Safety

- ✧ No collision with humans, environments, robots

## Efficiency

- ✧ Improve productivity with less costs

## Heterogeneity

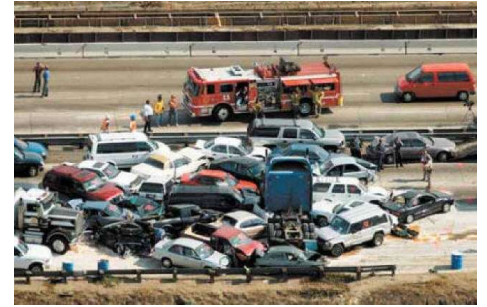
- ✧ Manage different kind of robots/vehicles

## Scalability

- ✧ Manage a possibly large and non-constant number of vehicles

## Security

- ✧ Ensure communication protection from possible attacks and failures





# planet Natural Environments

PLATform for the deployment  
and operation of heterogeneous  
NETworked cooperating objects



## Smart Cities



## Disaster Monitoring and Recovery



## Marine Archaeology



## Marine Surveys



## Industrial Logistics

# Cooperating protocols

Develop new protocols for multi robot coordination ensuring system safety while improving efficiency



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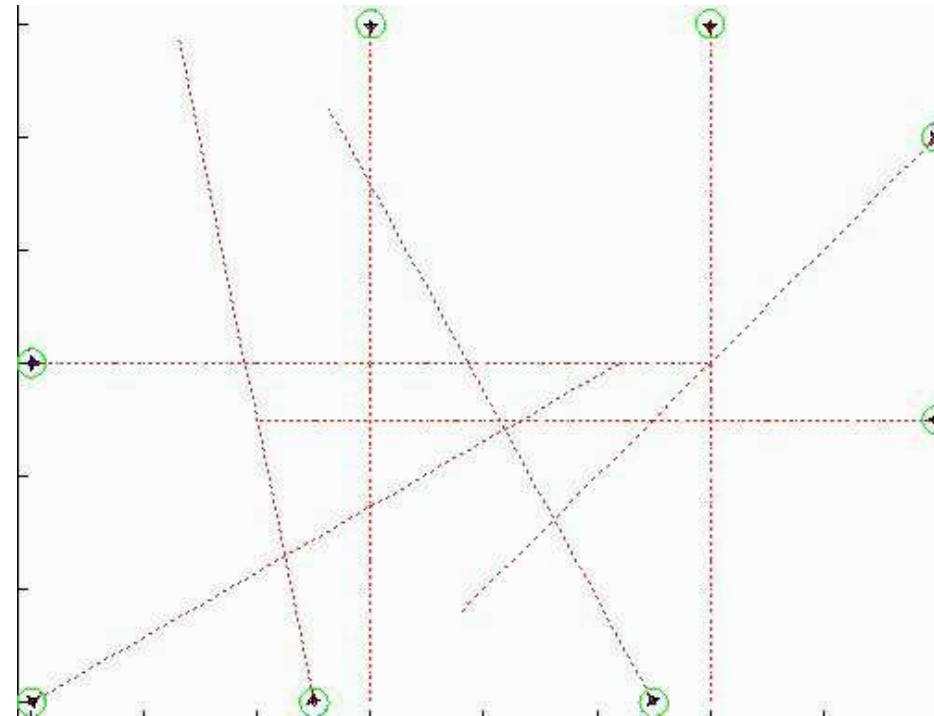
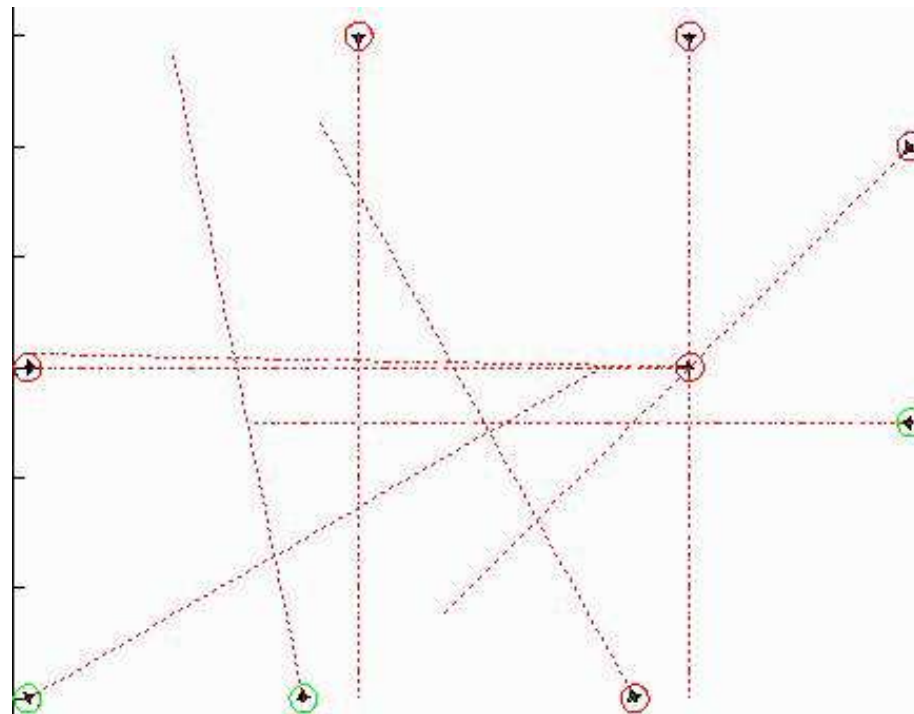
**A Distributed Control Architecture for Fast and Efficient Industrial Mobility**

**University of Pisa - Elettric 80 S.p.A.**

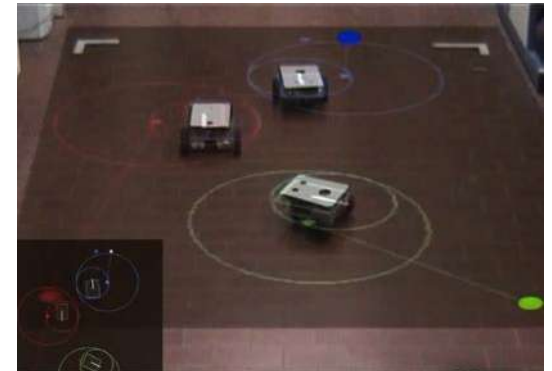
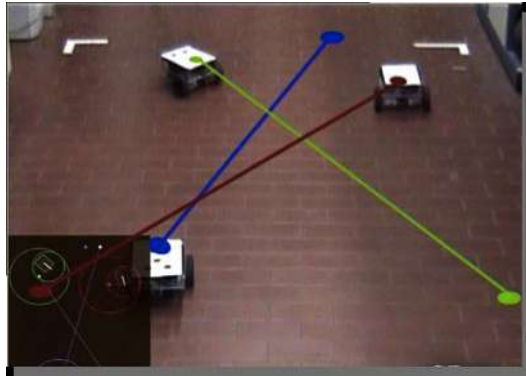




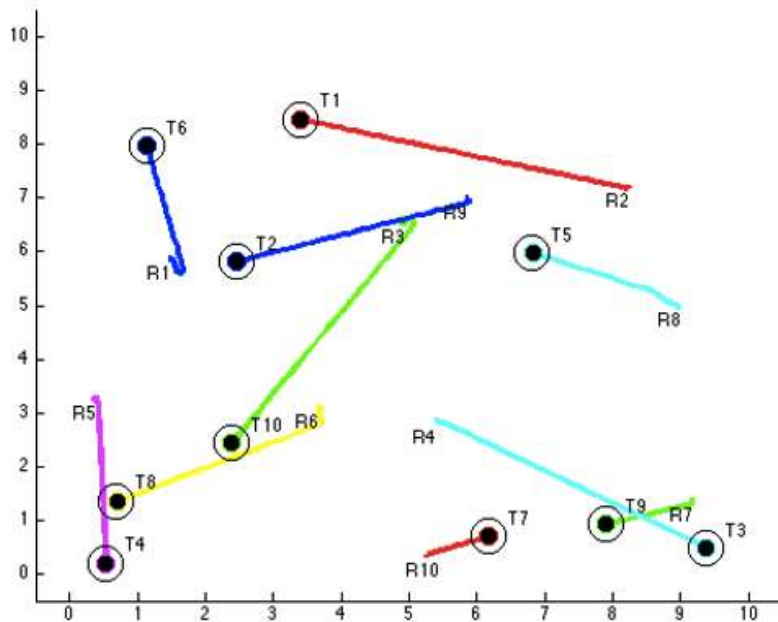
# Optimization-based approaches



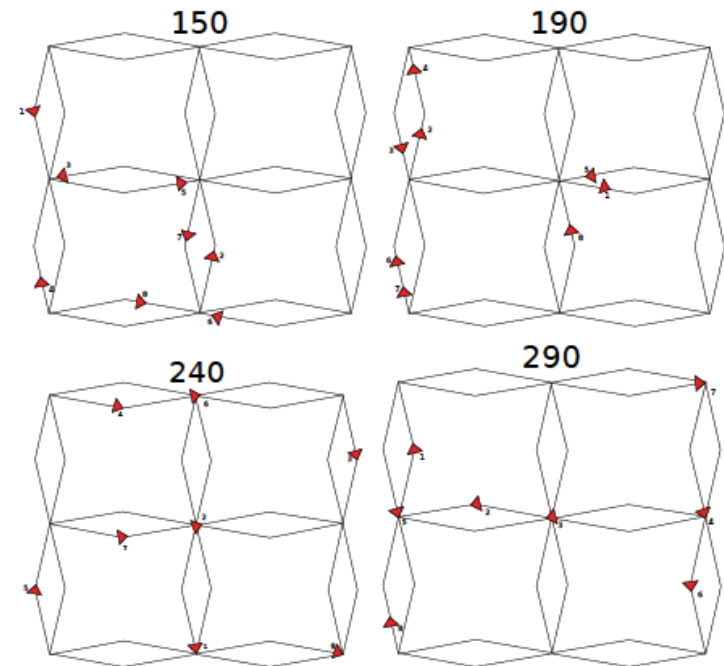
# Rule-based protocols



# Cooperating protocols



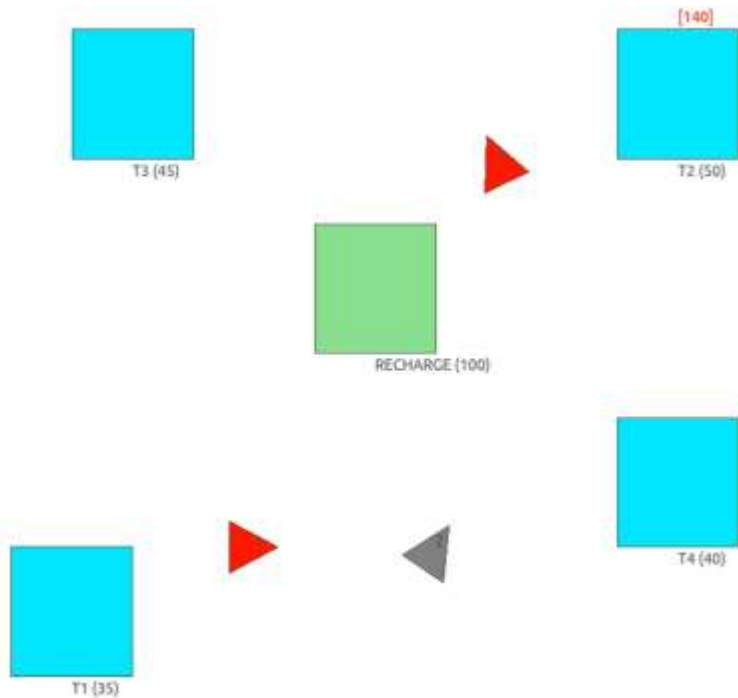
Distributed Task Assignment



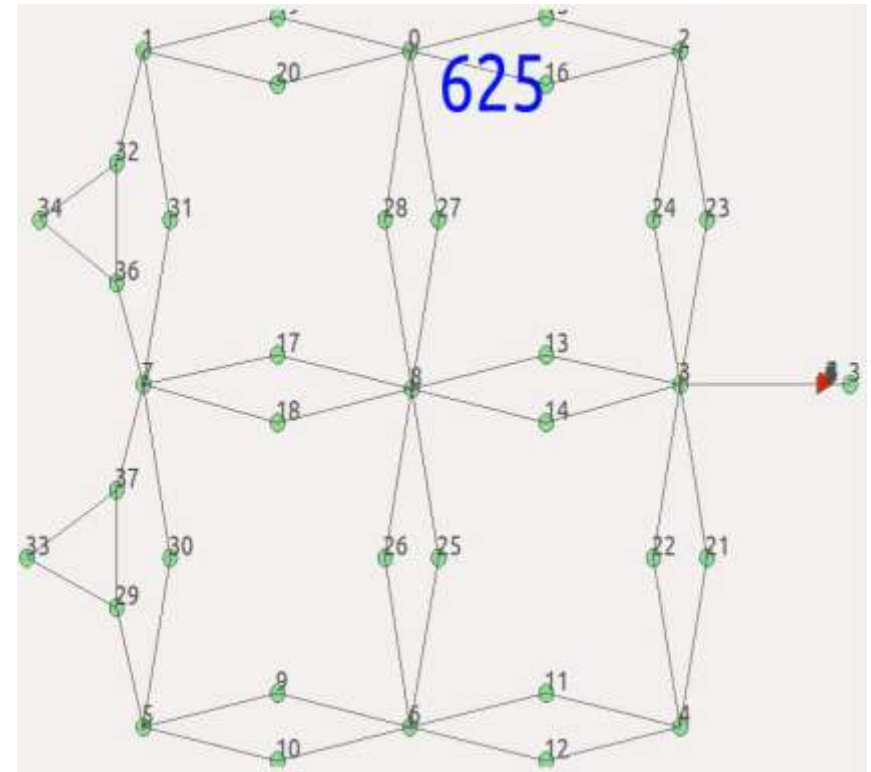
Time-Expanded Networks



# Cooperating protocols



Distributed Task Assignment



Time-Expanded Networks