

Data Backup for Mobile Nodes : a Cooperative Middleware and an Experimentation Platform

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Work presented here

- Middleware
 - Architecture developed for the HIDENETS project
 - Car-to-car middleware
 - Building blocks
 - Application: a Distributed Black Box
- Experimental Platform for Mobile Systems
 - How to experiment with mobile systems?
 - How to develop reproducible experiments?
- Demonstration

Architecture

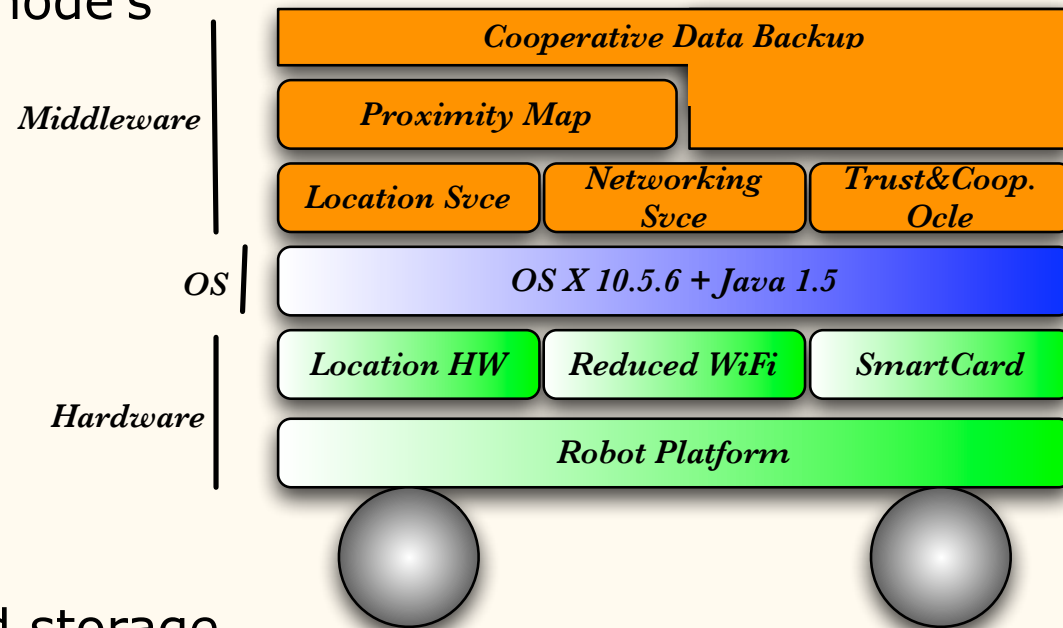
Distributed Black Box Test-Bed

- Cooperative avionics-like « black box » for cars
- Collectively backup on the C2CC system: Neighbors' positions, speed, gear, etc.
- Despite Accidental failures & Malicious attacks
 - Permanent and transient faults (e.g. car crash)
 - Lack of cooperation, DoS, selfish nodes, ...
- Preserving Important Properties
 - Data availability
 - Data integrity
 - Data confidentiality



HIDENETS middleware services and architecture

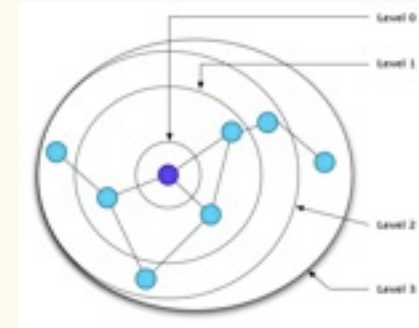
- Proximity map service
 - Building a map of the knowledge of each node's proximity
- Trust & Cooperation Oracle
- Cooperative data backup service
 - Data replication and storage
 - Ad-hoc and infrastructure domains



Proximity Map

- Knowledge of each node's proximity :
 - Nearby nodes
 - Available services/resources
- Beaconsing -> Fisheye-like
 - The nearest, the freshest
- Merges network and localization information

- Can be implemented using any localization technology
 - Outdoor: GPS
 - Indoor: crickets, cortex.



Trust and Cooperation Oracle

- Oracle
 - Is a given node j going to cooperate in the future?
 - Is node j trustworthy, e.g. will it respect my privacy
- Different approaches were considered
 - Remuneration: users give “money” to providers
 - Reputation: good behavior is rewarded
 - Trusted hardware: enforce cooperation policies
 - White/Black-lists



Cooperative Data Backup Service Overview

- Cooperation à la P2P to leverage
 - Available storage resources
 - Mobility of nodes -> data dissemination
- Participants are both:
 - Data owners (clients of backup service)
 - Contributors (providers of backup service)
- Adhoc mode
 - Data owners send data chunks to contributors
- Infrastructure mode
 - Data chunks are sent to a secure storage

Cooperative Data Backup Service Overview

- Data owners
 - Discover nearby contributors (proximity map)
 - Evaluate contributors trustworthiness (trust and cooperation oracle)
 - Produce data chunks
 - using fountain code like technique
 - Disseminate according to backup policy
- Contributors
 - Accept storage/restoration requests from trusted sources
 - Upload data chunks on secure storage when infrastructure is available

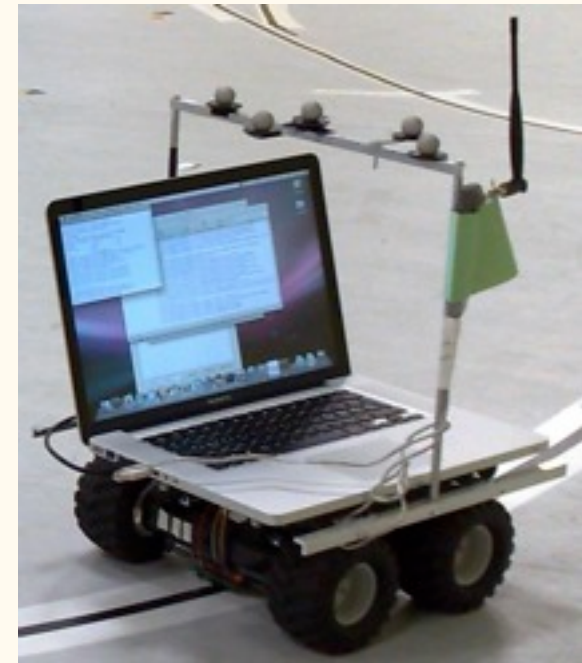
Experimental platform

Why an experimental platform ?

- Dependability implies testing
 - mobile systems: usually on simulators
 - accuracy of tests ?
- **LAAS-ARUM platform**
 - Towards a generic platform for testing mobile systems (car-to-car, pedestrians)
 - Scale ability
 - Is it possible to reproduce accurately a mobile system in a laboratory
 - Aim
 - Have reproducible experiments (impossible in a real system)
 - Realistic experiments

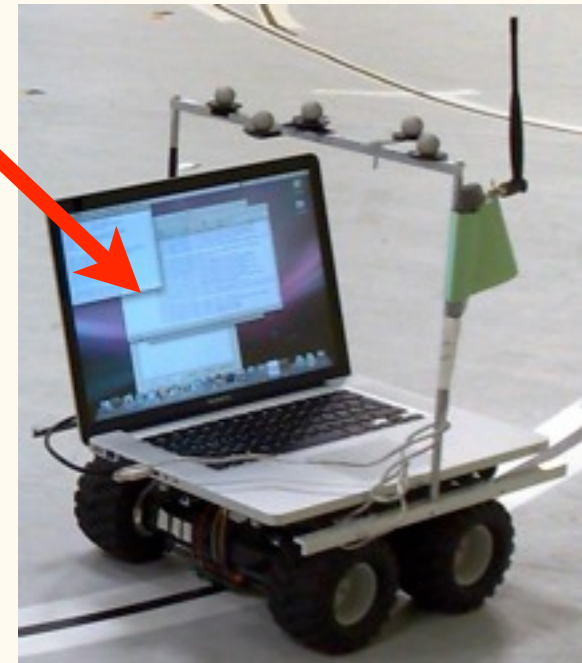
Evaluation Platform at scale

- Computing
 - Macbooks (OSX, Java 1.5)
- Communication
 - Application adhoc network =
Reduced-range WiFi 802.11b (2-3 m)
 - Supervision network = 802.11n
- Localization
 - Evert motion-capture (mm-scale)
- Mobility
 - Lynx Motion 4WD1 Rovers
 - Following a tape-track (next *autonomic* version due soon)



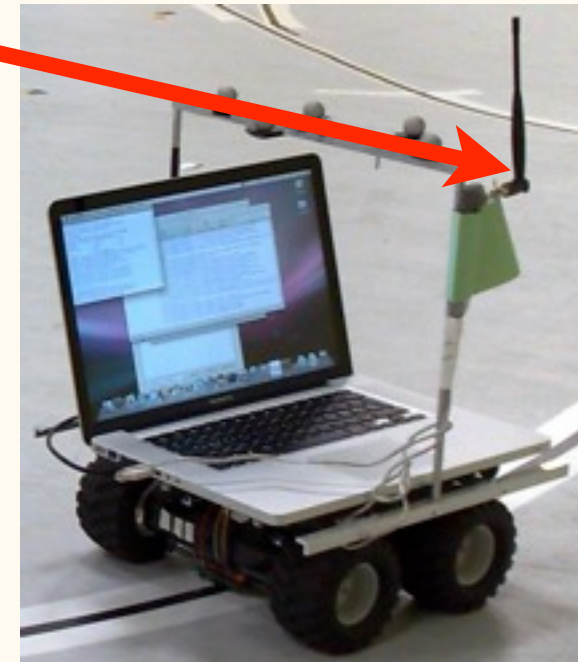
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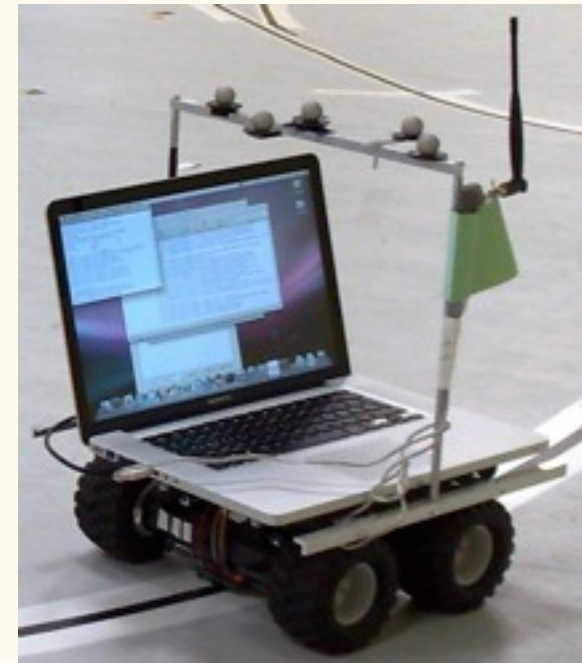
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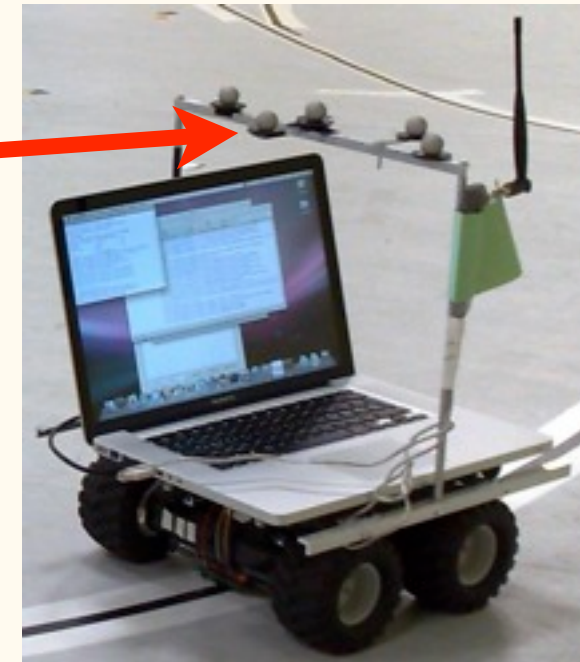
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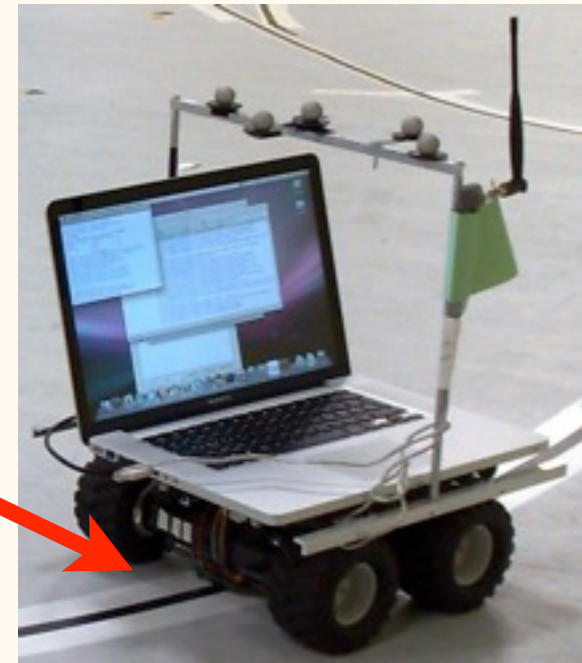
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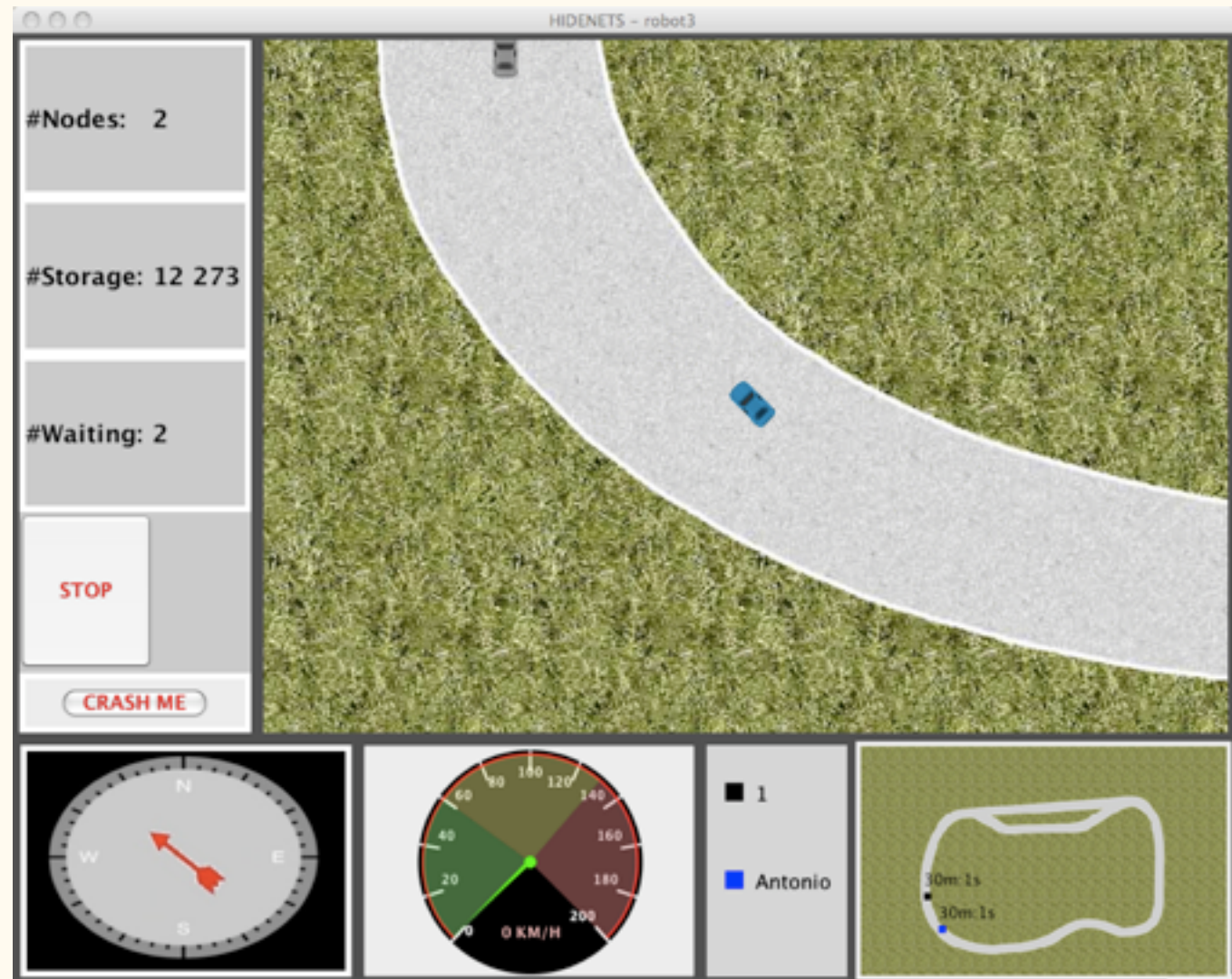
Live experiment

video available at:

<http://theresumeexperience.blogspot.com/>

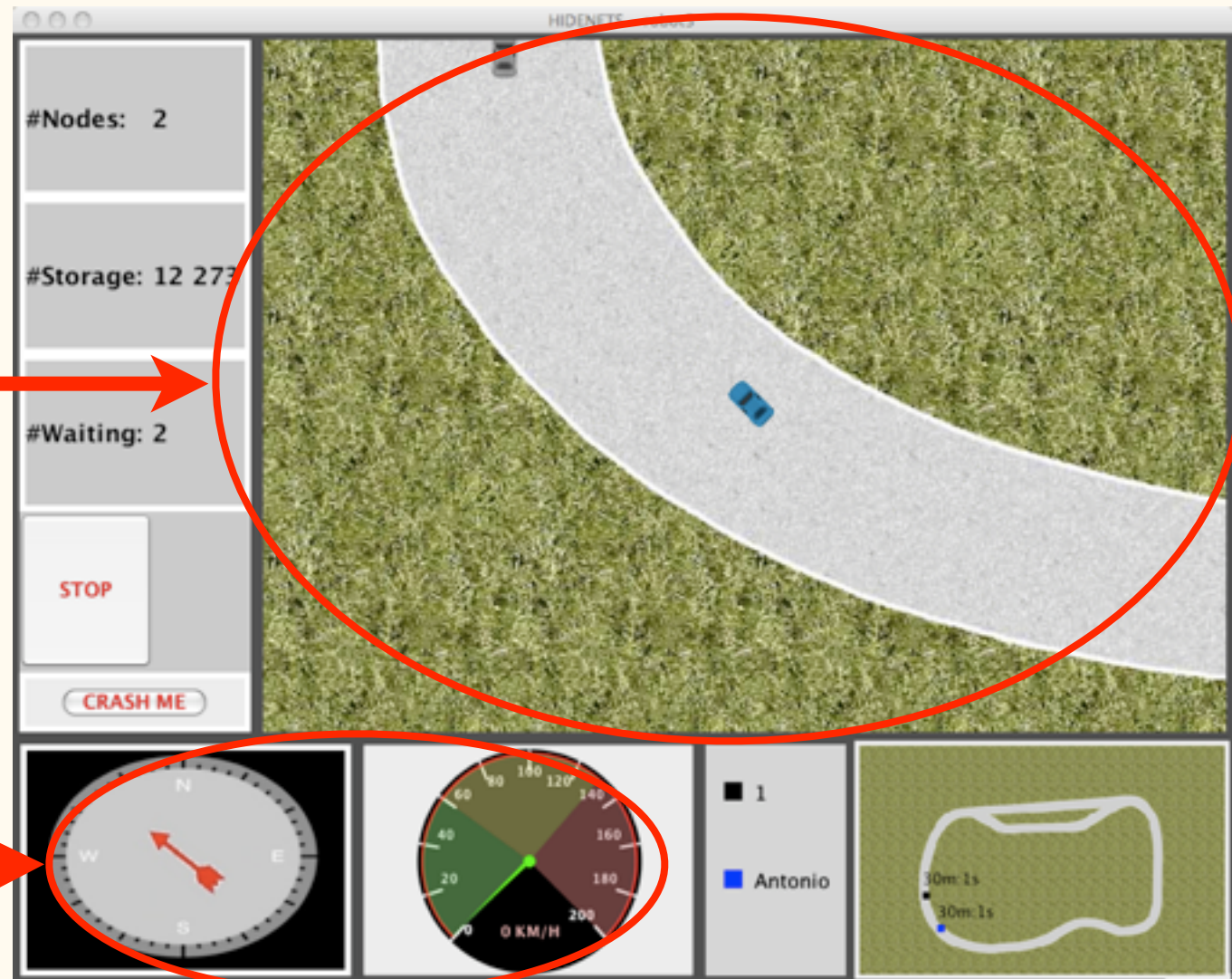


Application Interface



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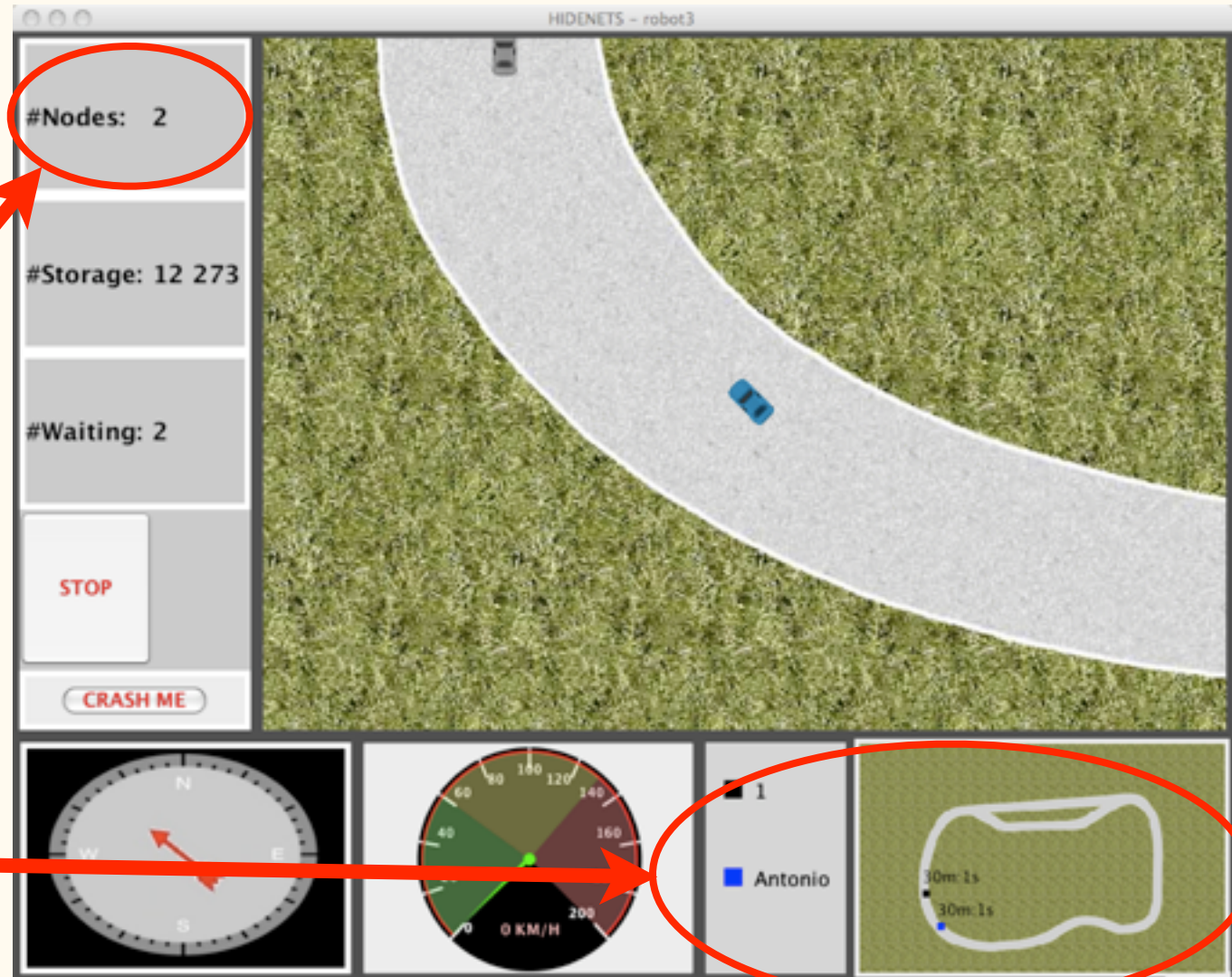
Local view



Navigation info



Application Interface



Number of nodes in the PMAP

View of the PMAP

Application Interface

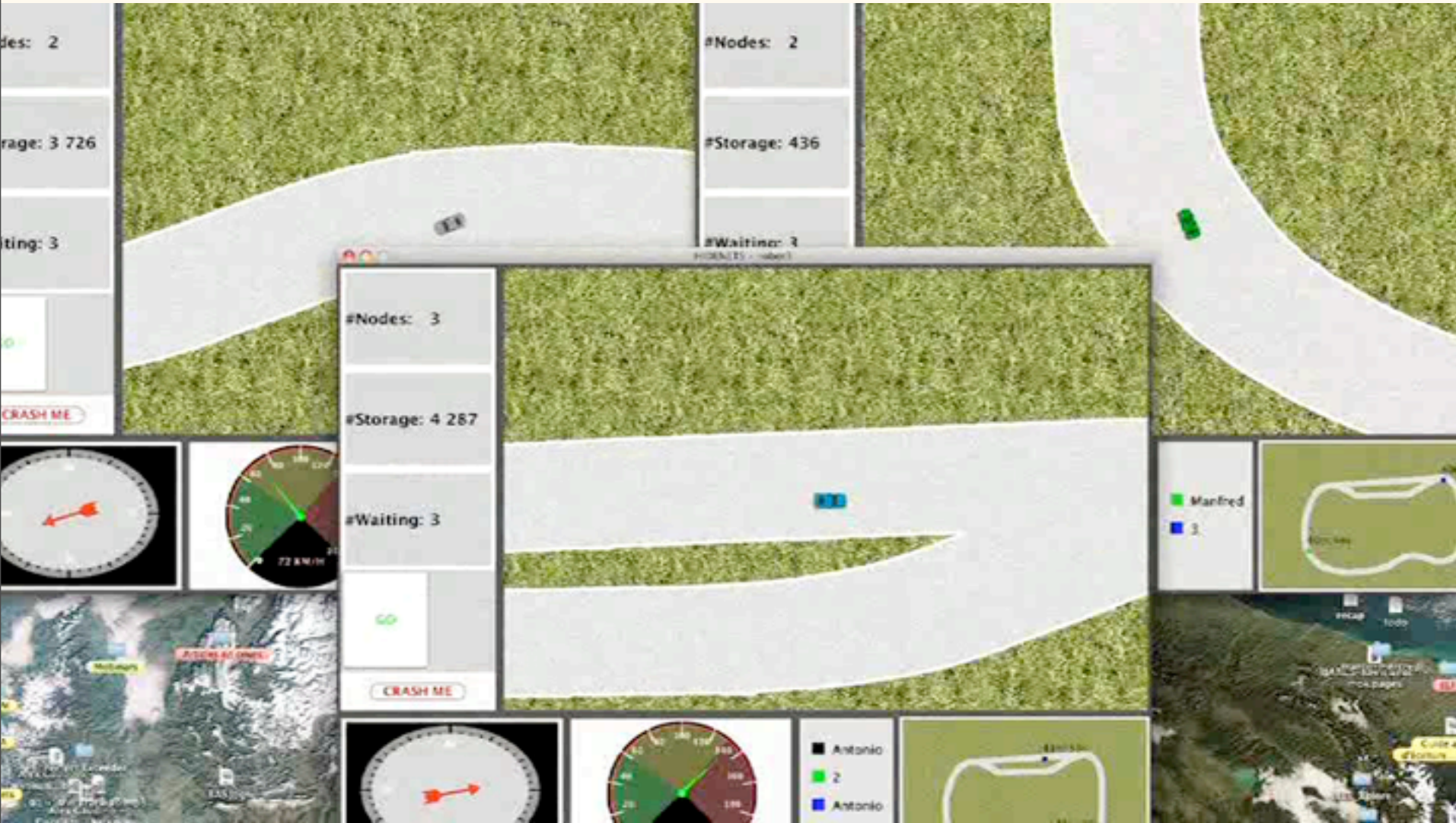
Control of the robot



Fault-injection

The screenshot shows a window titled 'HIDENETS - robot3'. On the left is a vertical sidebar with four grey panels: '#Nodes: 2', '#Storage: 12 273', '#Waiting: 2', and a control area containing the 'STOP' and 'CRASH ME' buttons. The main area is a top-down view of a green field with a grey asphalt road curving through it. A blue car icon is on the road. At the bottom, there are four panels: a compass, a speedometer showing 0 KM/H, a legend with a black square for '1' and a blue square for 'Antonio', and a track map with two '30m: 1s' markers.

Backup





Restoration

video available at:

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Conclusion

- Results
 - Architecture for resilient mobile applications
 - Application: distributed Black Box

- An experimental platform for experimentation
 - preliminary results
 - simulators are not accurate
 - scale reduction seems accurate
 - real experimentations takes time...

- Experimental platform LAAS-ARUM
 - open for other uses
 - someone willing to test mobile algorithms ?