La Rochelle Cybercar Demonstration

Fawzi Nashashibi

INRIA – IMARA Team
Outline

- Reminder of La Rochelle I demo
- Results
- Remaining issues
- La Rochelle II at INRIA
- Results
- Conclusion & future work
Showcases sites

- **Cybercars Showcases:**
  - Daventry (Sep. 2007)
  - La Rochelle (Sep. 2008)
  - Vantaa (May 2009)
  - Trondheim (Aug. 2009)

- **Under CityNetMobil:**
  - Clermont-Ferrand (Sep. 2009)
  - Formello (Feb. 2010)
  - Brussels – Ixelles (Sep. 2010)
  - Sophia-Antipolis (Oct. 2011)
  - Reggio Calabria (Nov. 2011)
Automated vehicles showcase - La Rochelle (2008)

- CityMobil Advanced City Cars showcase (automated-manual electric cars)

- Cybercars-2 final demonstrations (cooperative fully automated vehicles)
La Rochelle I Small Demo

May – July 2011
Demonstration Timeline

- 2008: Showcase "GO" for demo
- 2009: Start date
- 2010: CfP
- 2011: CityMobil conference
- 2012: Demo I
- 2012: Demo II
INRIA’s CyberGo
La Rochelle demonstration

- Test site:
  - 800 m
  - 5 stations
  - Partly pedestrian area
  - Partly restricted traffic
  - 4 crossings with “regular” car traffic
  - Traffic priority given to cybertcars (stop signs)
  - On-demand service between 2 “mass transit” points
La Rochelle: site
La Rochelle demonstration

- 2 INRIA’s cybercars
- On-demand transportation service as an “horizontal elevator”
- Speed limited to 10 Km/h
- Operator always on-board
- Demonstration operated between May and July 2011
INRIA’s “Cybus” vehicles

Capacity: 5 pax
Max. speed: 18 Km/h
Mass: 500 Kg
Lead batteries

Front & rear LIDARs:
• Guidance: SLAM
• Obstacle detection
• No infrastructure required

Communication devices
• Communicate with booths and with the depot
Stations

- Accessibility elderly
- Vehicle call interface
- Wi-Fi network relay
- Users information
  - Instructions
  - Usage conditions
Demonstration site constraints
Demonstration site constraints
Demonstration site constraints

Electricity for stations

- Solar energy not feasible
- Direct connection where available
- Batteries recharged overnight from public lightning
Demonstration site constraints

Communications

- 100~200 m between stations
- Interference of trees
- Wifi routers and antennas were installed on 4.5 m poles
- Full Wi-Fi coverage from the depot to the last station (~1 Km)
Cybercars circulation scheme
Demonstration site constraints

Vehicle drives forward & must change lane to drive backwards
Demonstration site constraints

Intersections = priority to cybercars crossing at limited speed
On demand transport system in La Rochelle.

(Movie)
Users acceptance (1/2)

- 6 indicators evaluated:
  - Ease of use ranking (in a rate from 5 to 1): 3.8
  - User willingness to pay: 0.6€
  - Info availability,
  - info comprehensibility,
  - perception of safety,
  - fear of attack measured as percentage of users evaluating them as positive
STATISTICS

899 Passengers (200 interviews)

GENDER

M 51%
F 49%

AGE

< 16 years 9%
16 - 25 years 27%
36 - 45 years 15%
46 - 60 years 10%
> 60 years 31%
26 - 35 years 8%
User acceptance (2/2)

- Information avail.:
- Information compr.:
- Perception of safety:
- Fear of attack:
Transport patterns

- Daily trips: 20
- Daily pax·km travelled: 5.2
- Average vehicle occupancy: 33%
- Average journey time per OD pair: 1’ 15” ÷ 2’ 40”
- Average waiting time: 2’ 30”
- Effective system capacity: 100 pax/h
Environment

- Daily consumption: 1.95 kWh
- Energy efficiency: 0.38 kWh/pax·km
Technological success

- Failure rate of the ‘control’ indicator: 7%
- Mean time between failures: 14 days
Could this transport system be:

Adapted to the city?
- Oui: 94%
- Non: 6%

Generalized?
- Oui: 93%
- Non: 7%
Vandalism
Accident
La Rochelle demonstration extension
Technical architecture: new features
Technical architecture: new features (1/3)

- **Vehicles**:
  - Distributed architecture:
    - Redundancy
    - Fault tolerance
  - Control Electronics: hardware design

- **Guidance**:
  - Laser-based navigation
  - Duplicate sensors:
    - Redundancy
    - “Blindness” Avoidance
Technical architecture: new features (2/3)

- GPS Introduction:
  - Geolocation of the vehicle
  - "Kidnapped" vehicle
    - In case of laser shortage
    - Security of the vehicle

- Communications and Vehicle Management System (VMS)
  - New communication architecture
  - Based on standards (IPv6, 802.11p,...)
  - Development of a VMS for ‘N’ vehicles
Technical architecture: new features (3/3)

• Vehicle interaction:
  – More than one vehicle simultaneously
  – Reservation problem
  – Vehicles overtaking

• Docking function
  – Vision based docking
  – Beacons detection and localization
  – 4cm error (long./lat.)

✔ Tested on an urban vehicle

⚠ Not implemented on the Cybus!
Extension scenarios

Scenario 1

Scenario 2
Extension scenarios

Scenario 3

Scenario 4
Extension scenarios

Scenario 5

Scenario 6

Vehicle Management Server

Mesh network

Collision risk area

Wi-Fi

Vehicle Management Server

Mesh network

Collision risk area

Wi-Fi
Scenario 1

(Movie)
Scenario 2

(Movie)
Scenario 3

(Movie)
Scenario 6

(Movie)
Conclusion & Future work

1. Technical perspectives

- Extended perception
  - Allows complex situations handling
  - Allows more intelligent overtaking
    - Example: overtaking of stopped aligned vehicles
    - Example: barricades, crossing pedestrians...
    - Handles non communicating vehicles
  - Introduction of vision technology
    - Fusion & redundancy
Conclusion & Future work

- Deployment of advanced communications
  - New « communication boxes » under design

- Achieve sensor-based docking:
  - GPS based
  - Vision based (AMARE project)
  - Magnets
Conclusion & Future work

- Test new scenarios with multiple vehicles / multiple platforms
  - Compliance & genericity
- Introduce/study « tricky » situations :
  - moving obstacles
  - Approaching ‘hostile’ obstacle
  - ...
- Introduce platooning
- Autonomy vs. VMS based architecture
2. General perspectives

- At INRIA: Permanent demonstrator / service in 2012 (Rocquencourt)
- In France: Mobilité 2015 / SYSMO 2015
- Europe: CityMobil-2
  - Address technical and legal issues
  - Acceptability and certification
Thank you!

- Special thanks to:
  - Our partners in CityMobil
  - Communauté d’Agglomération & City of La Rochelle
  - Our ‘close’ partners:
    - Armines (LaRA JRU)
    - EIGSI
    - ... and IMARA Team!