Vehicle automation in urban scenario
Partners

FCA
FIAT CHRYSLER AUTOMOBILES

BMW GROUP

VOLVO

DELPHI

CHALMERS

UNIVERSITY OF TRENTO - Italy
Challenges

Traffic conditions’ variety

Human failures

Demanding and repetitive tasks
// Perception and Action: scenario variables

**RESILIENT PERCEPTION & ACTION**

- **CONDITIONS RAPIDLY VARYING** within one automatic maneuver ... traffic density
- **CONDITIONS SLOWLY VARYING** between two automated maneuvers ... visibility, road conditions
- **INVARIABLE TRANSITIONS** geo-referenced area characteristic... a crossing, a roundabout
- **HUMAN INTERACTIONS** ... driving behaviours, drivers’ inattention
- **ROAD USERS** ... cars, motorbikes, trucks, pedestrians, cyclists

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// Technology: co-driver agent

**SUBSUMPTIVE APPROACH** “mirroring” human motion control and decision making

SAE level #3 “City Chauffeur” … lane change, lane following, speed adaptation, vehicle following:

- when any “subsumed function” is missing perception the function drops to SAE level #2

**CO-DRIVING AGENT** designed in “CarMaker simulator” and tested in demo vehicle

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Technology: trajectory planning and control

**TRAJECTORY GENERATION AND CONTROL** for real-time execution in mixed traffic and complex maneuvers: ... overtaking, lane change, merging, crossings

**Model Predictive Control** for safe & comfortable driving

- **Vehicle dynamic** flexible to different vehicles
- **Near future trajectories** real-time updated

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## Functions: vehicle automated driving

<table>
<thead>
<tr>
<th>SAE Level</th>
<th>Function</th>
<th>Description</th>
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| -                       | SAFE STOP            | DRIVER is not responding  
SYSTEM slows down the vehicle and stops                                      |
| 3 - Conditional Automation | CITY CHAUFFEUR     | DRIVER performs fallback manoeuvres  
SYSTEM monitors driving environment & supports overtaking, crossings, roundabouts, traffic lights |
| 2 - Partial Automation  | SUPERVISED CITY CONTROL | DRIVER monitors driving environment  
SYSTEM takes longitudinal and lateral controls                                    |
| 1 - Assisted            | CITY CRUISE          | DRIVER monitors driving environment & takes lateral control  
SYSTEM takes longitudinal control                                                  |
Vehicle demonstrators: sensor setup

Front Radar & Camera
Electronic Horizon
Rear blind-spot radar
Side Ultrasound
V2X via G5
GNSS

Front Radar & Camera
Corner Radars
Front, side & rear Ultrasounds
Front Lidar
V2X via 3-4G
GNSS

Laser Scanner
Long Range Radar
Short Range Radar
Camera
GNSS
Vehicle demonstrators: fields of view
// Functions

1. **Driver not responding**
   - Safe Stop (before leaving supported area)
   - High Automation

2. **Road infrastructure\n   Rear/side obstacles**
   - City Chauffeur (system takes full control)
   - Conditional Automation

3. **ADAS maps\n   Lane geometry**
   - Supervised City Control (system takes lateral and longitudinal control)
   - Partial Automation

4. **Standard maps\n   Front obstacles**
   - City Cruise (system takes longitudinal control, driver takes lateral control)
   - Assisted

5. **Vehicle sensors\n   Driver commands**
   - Direct Driver Commands (driver has full control)
   - Manual Vehicle Control

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Vehicle automation in urban scenario: now & next

**AWARENESS** and selection of «operational design domains» with:

- **RESILIENCY** in perception & action
- **REDUNDANCIES** multi-sensor technologies

- **SENSING TECH** for all traffic participants including also connectivity
- **POSITIONING** vs urban canyoning effect
- **ADDRESS** long terms effects in urban mobility
Thank you.

Luisa Andreone
FCA-CRF
Vehicle Innovation Collaboration & Public Funding
“Safe & Integrated Mobility”

Tel. +39 335 77 55 243
e-mail luisa.andreone@crf.it