



PhD student: Aniello Mungello

**Cooperative, Connected and Automated
Mobility: methodologies and
applications**

Tutor: Stefania Santini

Cycle: XXXVIII

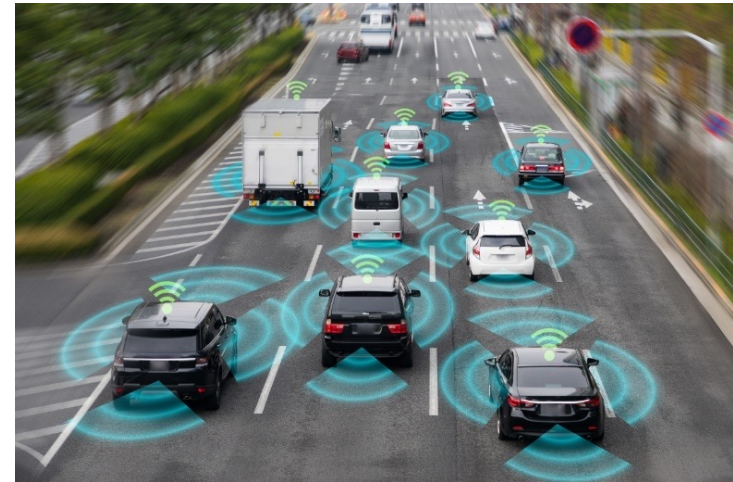
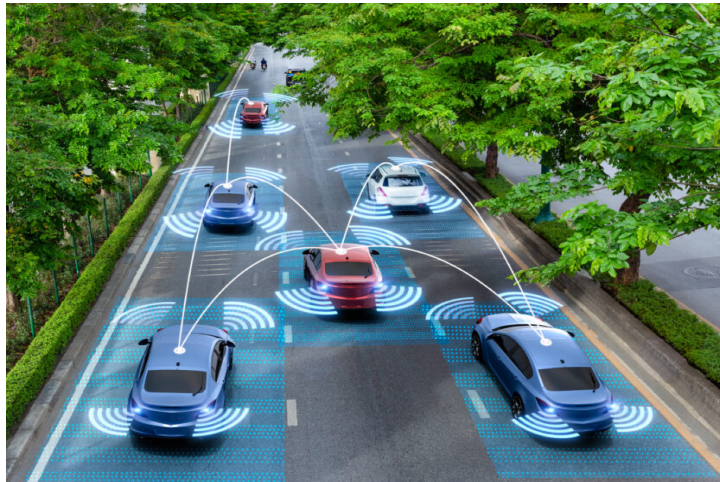
Year: Second

My background

- **Master Degree** in Autonomous Vehicle Engineering obtained from University of Naples – Federico II
- **Master Thesis:** Autonomous Driving Control System of a Race Car: Design and Experimental Validation (In collaboration with UniNa corse)
- **Research Group:** DAiSY Lab (Prof. Stefania Santini)
- **PhD start date:** January 2023
- **Scholarship type:** PNRR Centro Nazionale di Ricerca per la Mobilità Sostenibile (MOST) Spoke: CCAM e Smart Infra

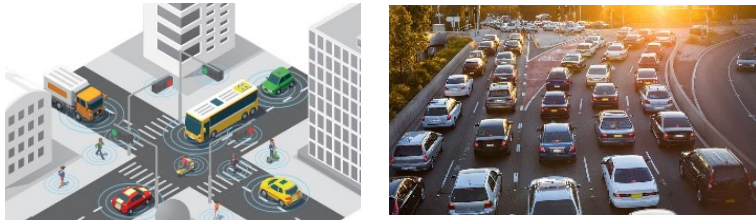
Research Field 1/2

Control Methods for Cooperative, Connected and Automated Mobility (CCAM).

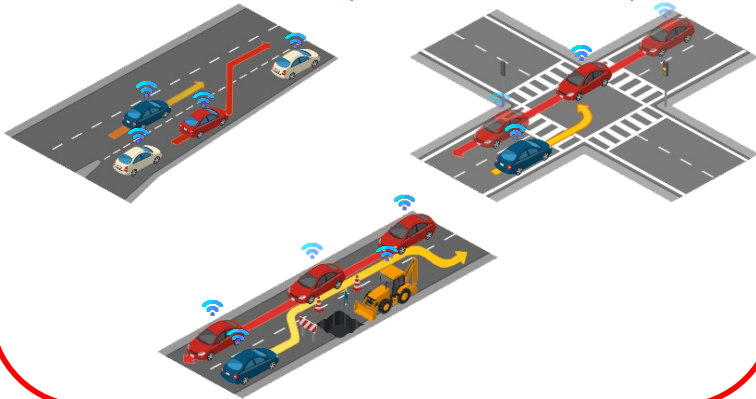


Research Field 2/2

Traffic Layer



Cooperative Driving Scenarios Via V2X (V2V, I2V ...)



Virtual Testing with Testbed Vehicle



My Second Year: Study & Training activities

In this my second year I went deeper in acquisition of some concepts related to my research topic. Specifically, I investigated the approach to the design of a self-driving vehicles in the paradigm CCAM moving through the sustainable and safety mobility.

In doing so, I attended to various seminars and courses, the most relevant of which are listed below:

- **PhD School:** *“AS3 – Automotive Software Summer School ” - Nardò Technical Center – Porsche Engineering*
- **Course:** *Automotive Cyber Security Academy*
- **Seminar:** *From ACE Technologies to Sustainable, Accessible and Equitable Urban Mobility: An Optimization Journey*

I also attended to:

- ❑ **Conference:** *IEEE European Control Conference (ECC) Stockholm 25-28/06/2024*

Research Activity

- **Problem**
 - The brand new CCAM paradigm

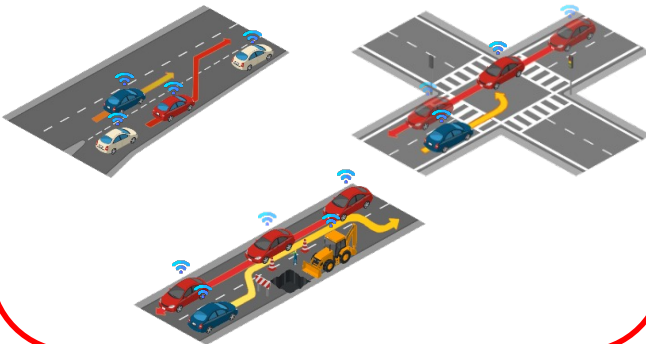
Traffic Layer



Virtual Testing with Testbed Vehicle

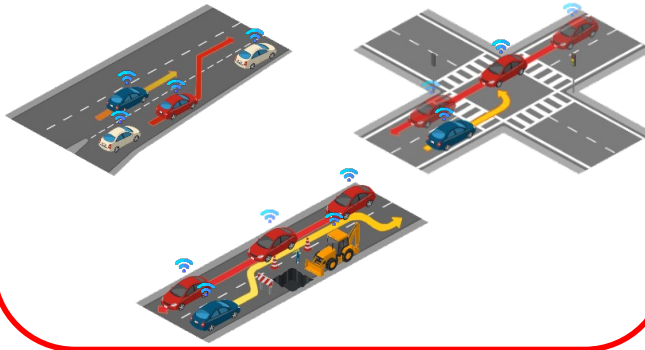


Cooperative Driving Scenarios Via V2X (V2V, I2V ...)

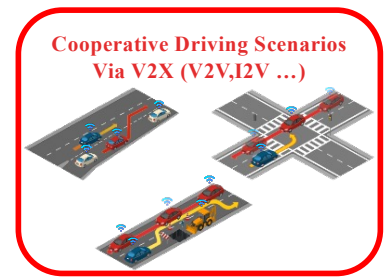


Research Activity 1/3: Platoon Formation

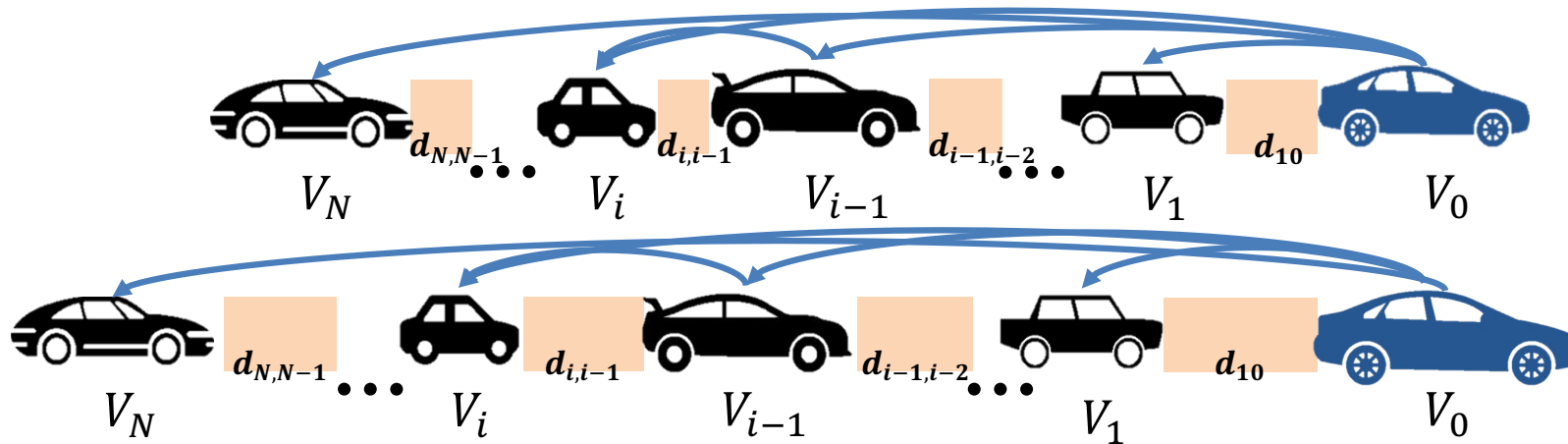
Cooperative Driving Scenarios
Via V2X (V2V, I2V ...)



Research Activity 1/3: Platoon Formation



- **Problem:** Formation platooning of autonomous nonlinear vehicles connected using a variable spacing policy under nonlinear time-delay communication.



- **Methodology:** Distributed Formation Control.
- **Main contribution:** Full Speed range variable spacing policy

$$d_{ij}(t) = (i - j) \left\{ d_{st} + v_i(t)h + M \left[1 - e^{\frac{-v_i(t)}{\gamma}} \right] \right\}$$

Where:

- $d_{st}[m]$ is the standstill distance;
- $v_i(t)[m/s]$ is the speed of vehicle i ;
- $h [s]$ is the constant time-gap distance;
- M and γ are parameters to be properly tuned via the optimization procedure

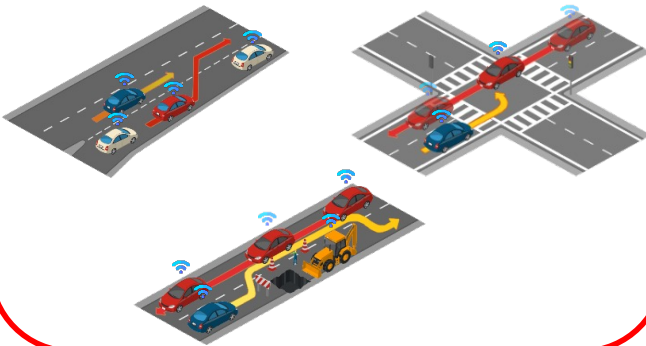
Research Activity

- **Problem**
 - The brand new CCAM paradigm

Traffic Layer



Cooperative Driving Scenarios Via V2X (V2V, I2V ...)



Virtual Testing with Testbed Vehicle



Research Activity 2/3: Traffic Penetration Rate Analysis

Traffic Layer



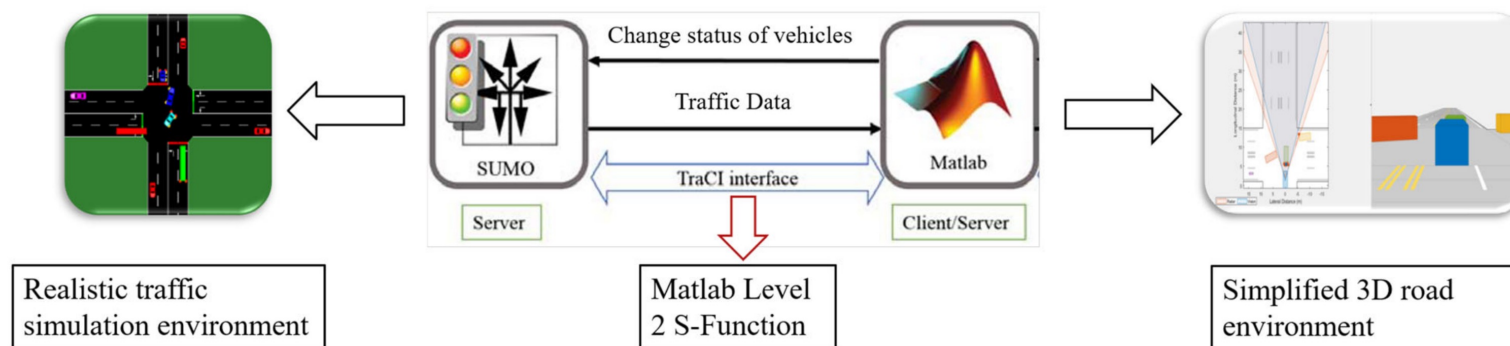
Research Activity 2/3: Traffic Penetration Rate Analysis



- **Problem:** Analyze the throughput and emissions in a mixed traffic flows.



- **Methodology:** Performance assessment via virtual testing for different Operational Design Domain (ODD).



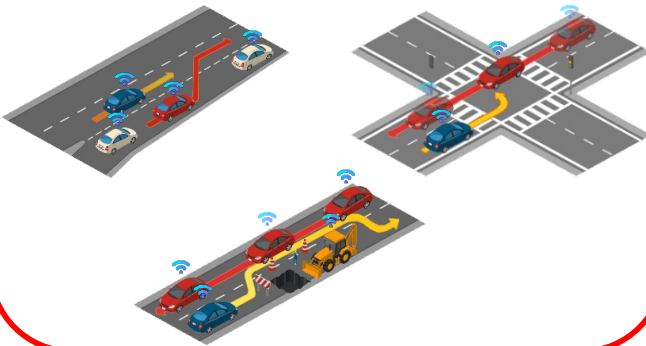
Research Activity

- **Problem**
 - The brand new CCAM paradigm

Traffic Layer



Cooperative Driving Scenarios Via V2X (V2V, I2V ...)



Virtual Testing with Testbed Vehicle



Research Activity 3/3: ViL Simulation Platform

Virtual Testing with Testbed
Vehicle

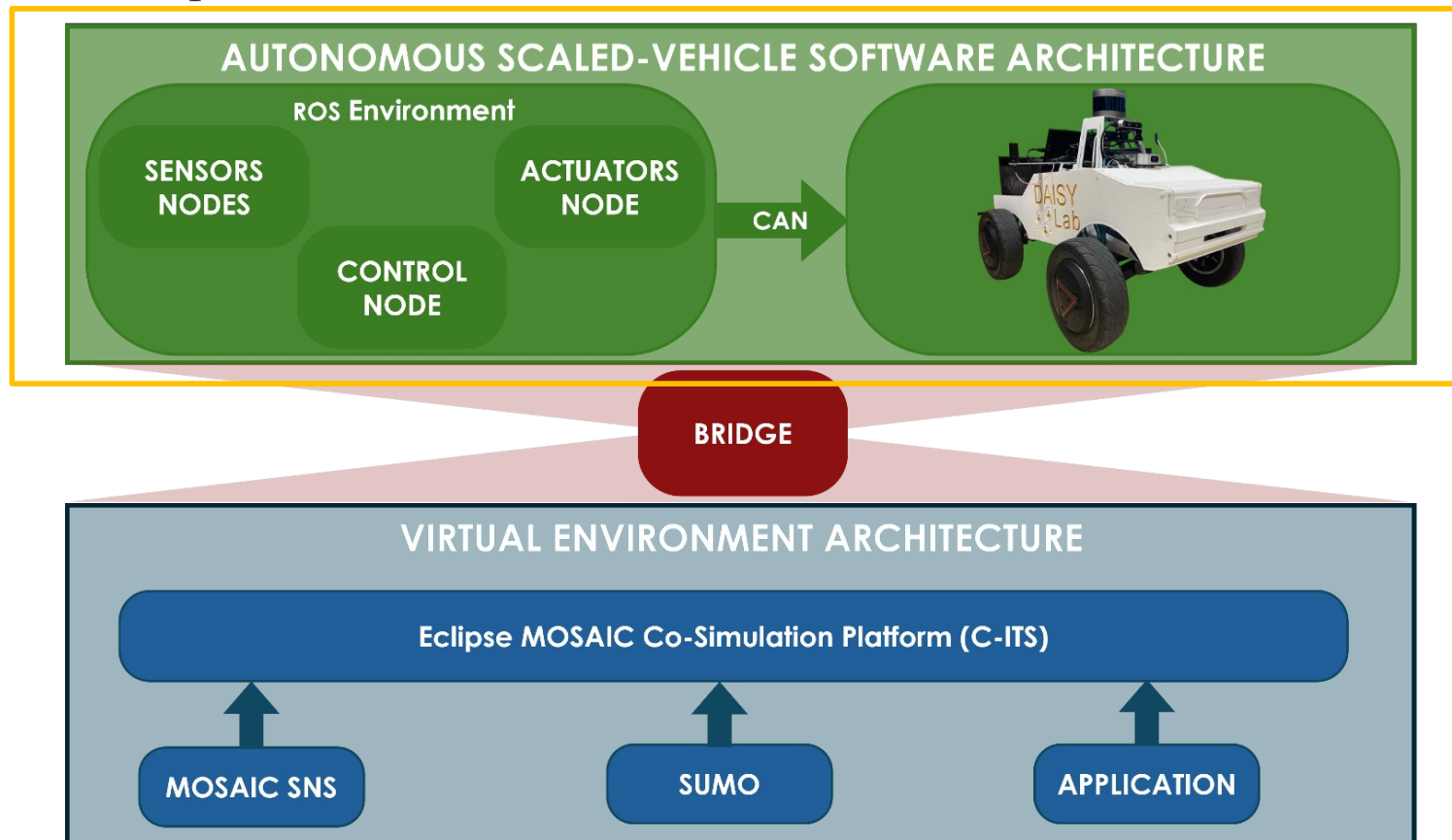


Research Activity 3/3: ViL Simulation Platform

Virtual Testing with
Testbed Vehicle



- **Problem:** Validation of Autonomous Software Architecture compliant with CCAM requirements.
- **Methodology:** Virtual testing via properly develop Vehicle in the Loop (ViL) simulation platform.

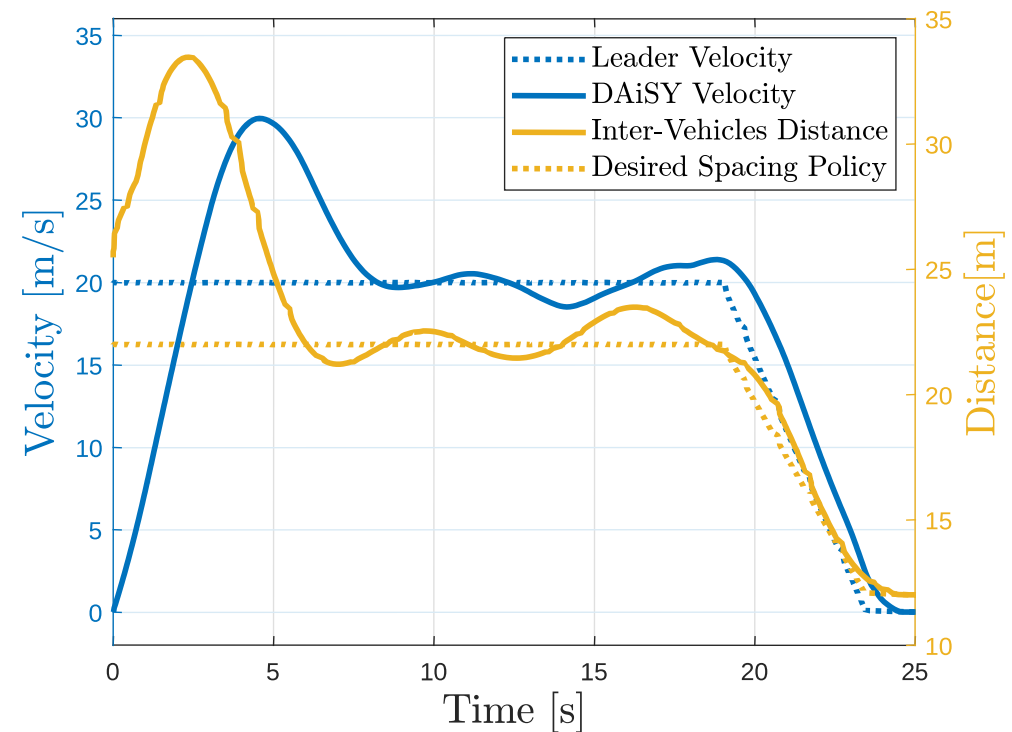
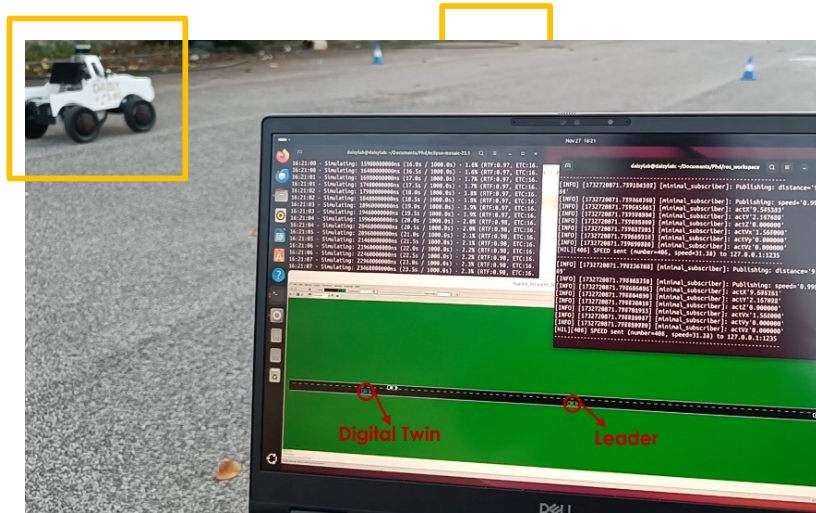


Research Activity 3/3: ViL Simulation Platform

Virtual Testing with
Testbed Vehicle



- **Contribution:** Implementation of a Vehicle in the Loop (ViL) platform that is compliant with CCAM requirements.
- **Result:** The case study of the virtual testing for an AdaptiveCruise Control (ACC) system in the CCAM environment.



Study and Training Activities – Credits earned

	Courses	Seminars	Research	Tutorship	Total
Bimonth 1	0	0	10	0	10
Bimonth 2	0	0	10	0	10
Bimonth 3	3	4.4	2.6	0	10
Bimonth 4	3.2	0	6.8	0	10
Bimonth 5	8	0.4	1.6	0	10
Bimonth 6	0	0	10	1.2	11.2
Total	14.2	4.8	41	1.2	61.2
Expected	10 - 20	5 - 10	30 - 45	0 – 1.6	

Products

[C1]	Bifulco, G. N., Coppola, A., Mungiello, A., Petrillo, A., & Santini, S. (2024, June). CAVs platoons under nonlinear spacing policy and heterogeneous communication delays as a formation control problem. In 2024 European Control Conference (ECC) (pp. 1393-1398). IEEE.
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Tutorship

[ING-INF/04]	Control Architectures for Autonomous Driving Module: Control Systems for Autonomous Ground Vehicles Hours: 30 Credits: 1.2
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Next Year

- Period Abroad at Technical University of Munich (TUM) (Jan - July)
- Keeping on working on the actual virtual world by also considering urban contexts, traffic lights and intersections;
- Keeping on working on the current physical world by also integrating other scaled vehicles in order to create a cooperative ecosystem, hence paving the way toward the virtual testing of cooperative driving of autonomous connected vehicle platoons.
- Study about the impact and the benefits of CCAM control strategy for different traffic flow condition and different driving scenario, along with the definition of novel KPI.

**Thanks
for Your
Attention**