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Sophia Antipolis

Communication, Mobility and Control for CATS*

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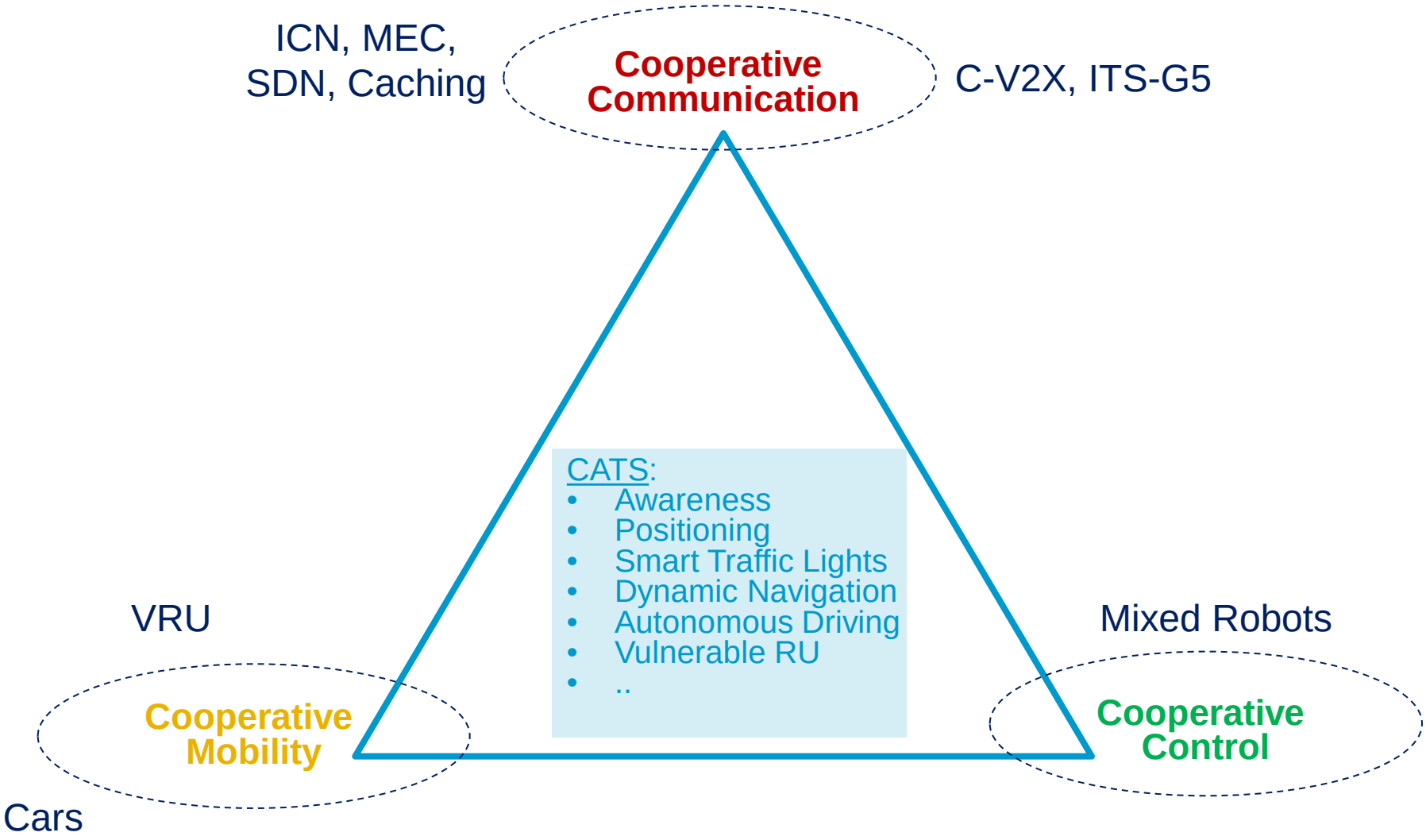
EURECOM

Robot PACA, June 25th 2018

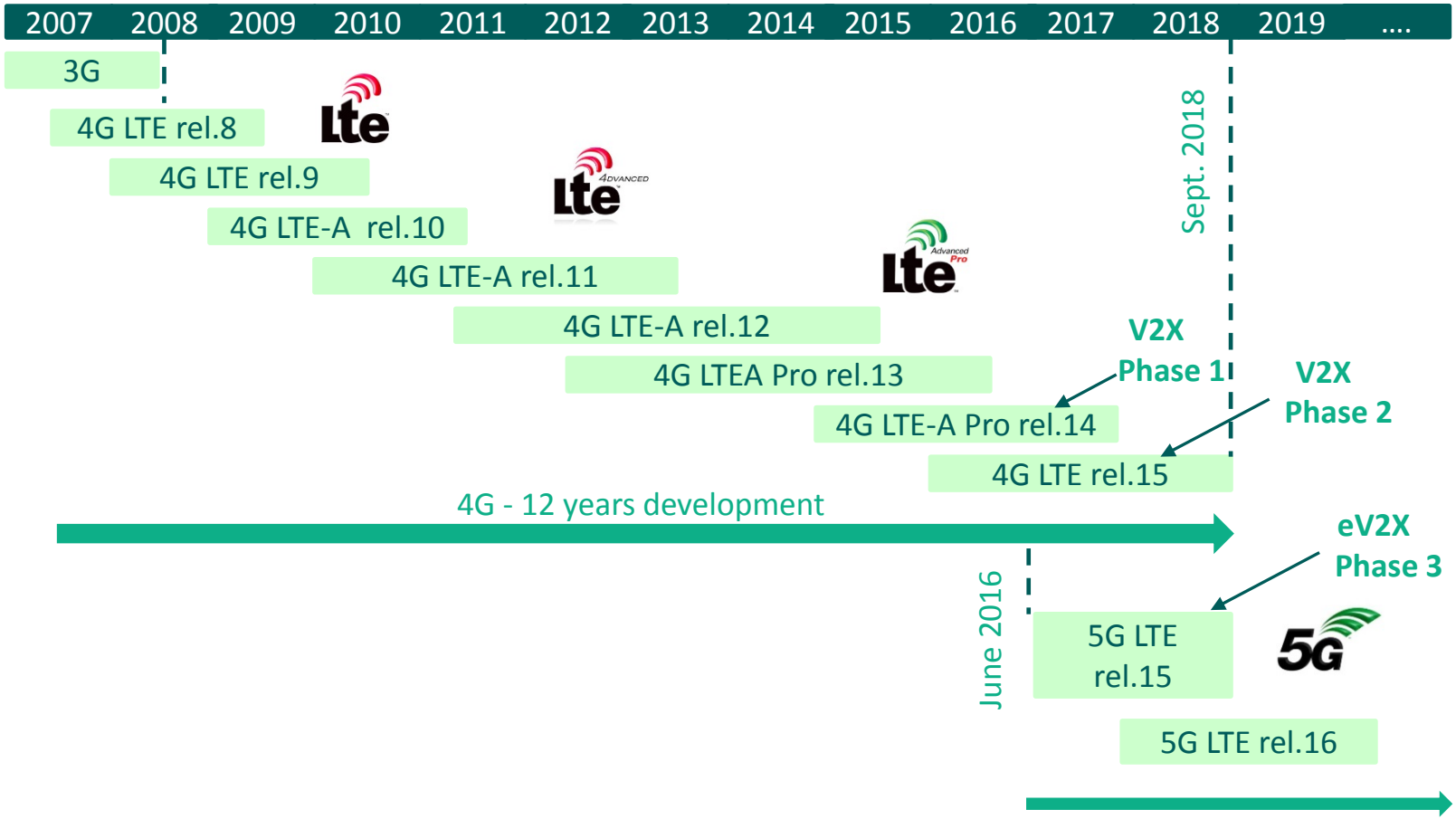
*Cooperative Automated Transport Systems

Cti
Commission des Titres d'Ingénieur

CATS – From Awareness to Autonomy

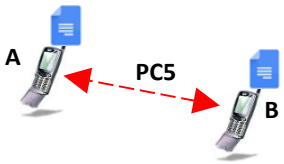


Cooperative Communication – Cellular V2X Roadmap

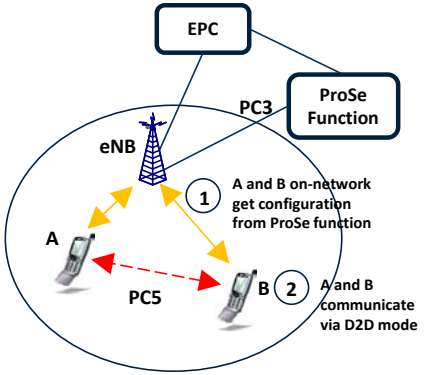


Cooperative Communication – OpenAirInterface – 5G V2X support

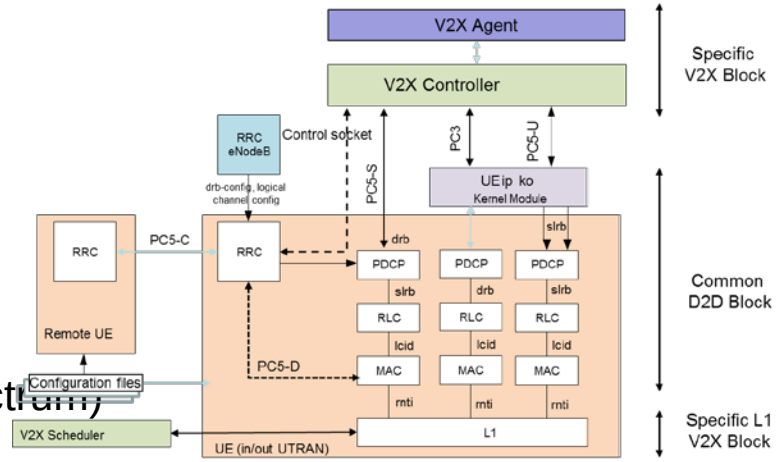
- **Scenario 1: Off-Network V2X-PC5**
  - UEs are off-network but communicate directly via a Sidelink channel



- **Scenario 2: On-Network V2X-PC5**
  - UEs are located closed to their eNodeB but communicate directly via a Sidelink channel



- **V2X Architecture**
  - Common Open-Source D2D Functions
  - Dedicated V2X functions (scheduler)



- **Spectrum**
  - V2V PC5 – 5.9GHz (current implementations)
  - V2I-V2N Uu – 3.4 GHz (require research spectrum)

5G OpenAirInterface - http://www.openairinterface.org

Cooperative Communication – Connecting Automated Vehicles

- **Joint EURECOM, BUPT, CHINA Mobile Demo**
  - Actually: 4G only ☺

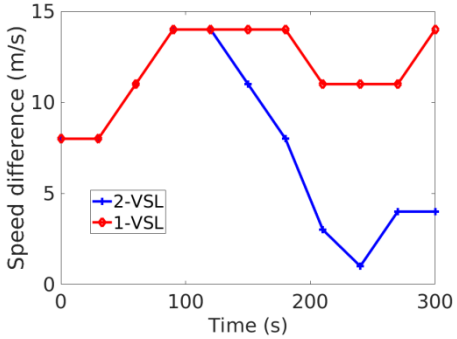
https://youtu.be/7IGewzVH-Ro

https://youtu.be/rdWhQoO0EYo

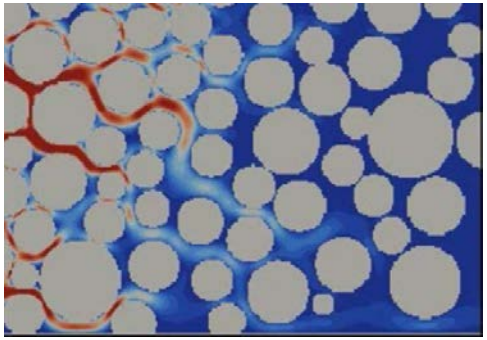
Cooperative Mobility – Modeling Vulnerable Road Users

- **Powered-Two Wheelers (PTW):**
  - Increasing presence in road traffic
  - Lack of knowledge of their influence on traffic flows
  - Critical impact on Smart Cities and Road Automations
  - C-ITS applications are not adapted to PTW
    - New WG at CAR 2 CAR in 2016

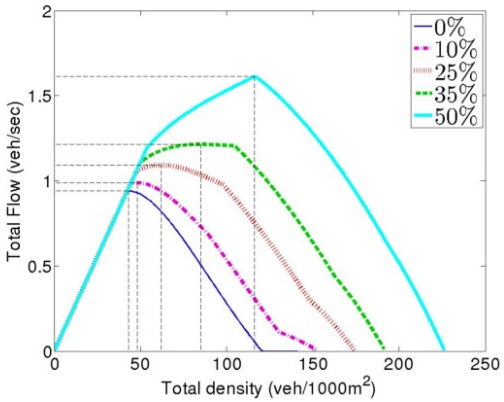
Variable Speed Limits



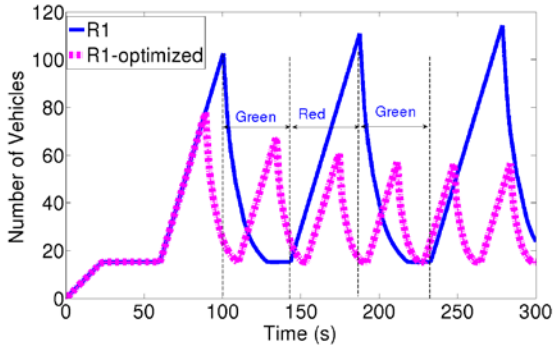
Porous Flow Modeling



Improved Road Capacity



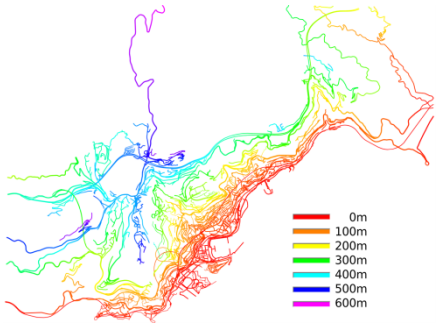
Optimized Traffic Lights



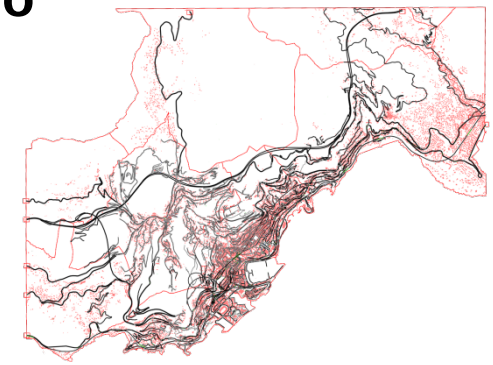
- **Selected Publications:**
  - Sosina Gashaw, Jérôme Härri, Paola Goatin, **"Variable Speed Limit Control for Mixed Powered-Two-Wheelers and Car Traffic**", Submitted to IEEE Intelligent Transport Sytem Conference (ITSC), 2018.
  - Sosina Gashaw, Paola Goatin, Jérôme Härri, **Modeling and Analysis of Mixed Flow of Cars and Powered Two-wheelers**, *Elsevier Transportation Research Part C*, 2018.
  - Sosina Gashaw, Paola Goatin, Jérôme Härri, **Analysis of the effect of Powered two wheelers on adaptive traffic signals operation,** *8th International Conference on Mobility and Transport (Mobil.TUM)*, TU Munich, Germany 2017.

Cooperative Mobility – MoST
A Tool for Large-Scale Multi-Modal Scenarios

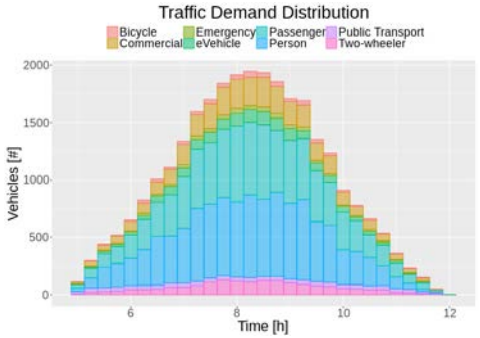
- **Modeling Elevations**



- **Modeling a large Scale Urban Scenario**



- **Modeling Multi-Modal Traffic**

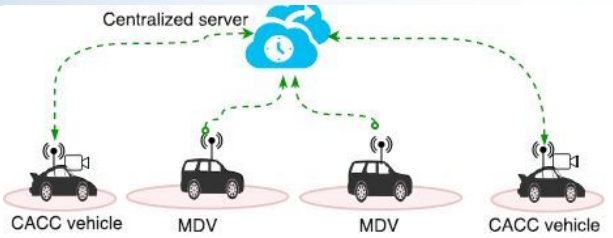


- **Modeling Precise Mobility, including VRU**

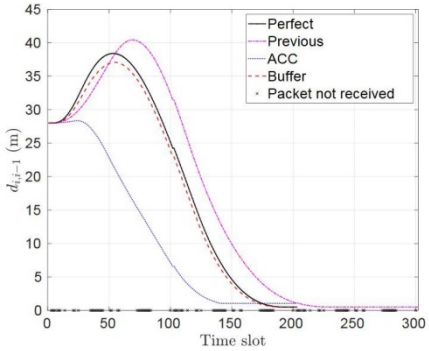
- **Selected Publications:**
  - L. Codeca, J. Härri, "**Towards Multimodal Mobility Simulation of C-ITS: The Monaco SUMO Traffic Scenario**", IEEE VNC'17, Torino, Italy, 2017
  - L. Codeca, J. Härri, ***"A 3D Mobility Scenario for Cooperative ITS"***, *the SUMO Conference, Berlin, May 2018.*
  - L. Codeca, J. Härri, ***"Impact of Powered-Two-Wheelers in a City-Scale Multi-modal Scenario"***, *submitted to IEEE ITSC 2018..*

Cooperative Control – Improving Safety and Efficiency

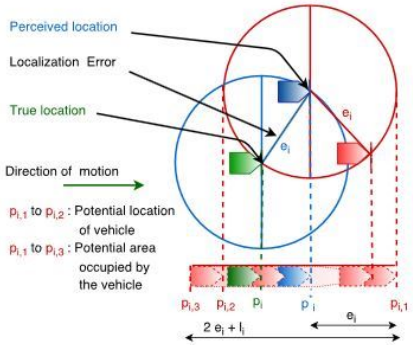
- **Automated Vehicles subject to Various sources of errors**



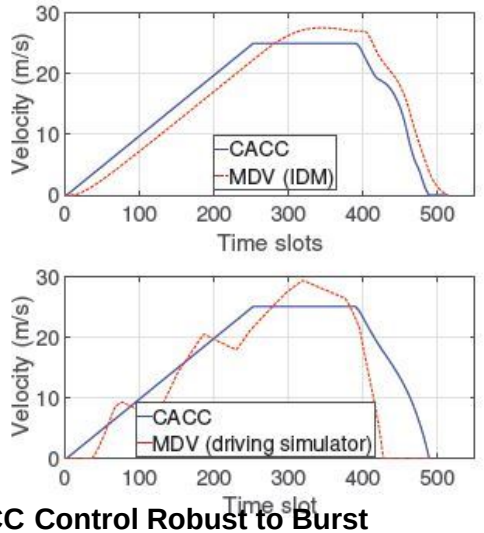
- **V2X Communication Errors**



- **Localization Errors**



- **Perception Errors**



- **Selected Publications:**
  - Raj Haresh Patel, Jérôme Härri, Christian Bonnet, **Centralized Model Predictive CACC Control Robust to Burst Communication Errors,** IEEE VTC-CAVS, Chicaco, 2018.
  - Aramrattana, Maytheewat; Patel, Raj Haresh; Englund, Cristofer; Härri, Jérôme; Jansson, Jonas; Bonnet, Christian, **Evaluating model mismatch impacting CACC controllers in mixed traffic using a driving simulator,** IEEE Intelligent Vehicle Symposium (IV), China, 2018.
  - Raj Haresh Patel, Jérôme Härri, Christian Bonnet, **Impact of localization errors on automated vehicle control strategies,** IEEE Vehicular Networking Confefence (VNC), Torino, Italy, 2017.
  - Raj Haresh Patel, Jérôme Härri, Christian Bonnet, **Braking strategy for an autonomous vehicle in a mixed traffic scenario,** accepted, *3rd IEEE Conference on Vehicle Technology and Intelligent Transport Systems*, 2017, Porto, Portugal.

Vision to CATS for Smart Cities

- **OpenAirInterface as 5G technology enabler for automated and remotely controlled vehicles**
  - 5G V2X Support
  - 5G URLL MEC
- **Model and understand the impact of Vulnerable Road Users (VRU) on Mixed Traffic**
  - Impact on Flows
  - Impact on Infrastructures
- **Provide a tool for modeling large-scale multi-modal urban traffic**
  - https://github.com/lcodeca/MoSTScenario
- **Develop controllers robust to errors and supporting VRU**
  - Robust to localization, communication, perception impairments
  - Integrates mixed traffic and VRU

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