5G-MOBIX FR TS

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Technical Challenges

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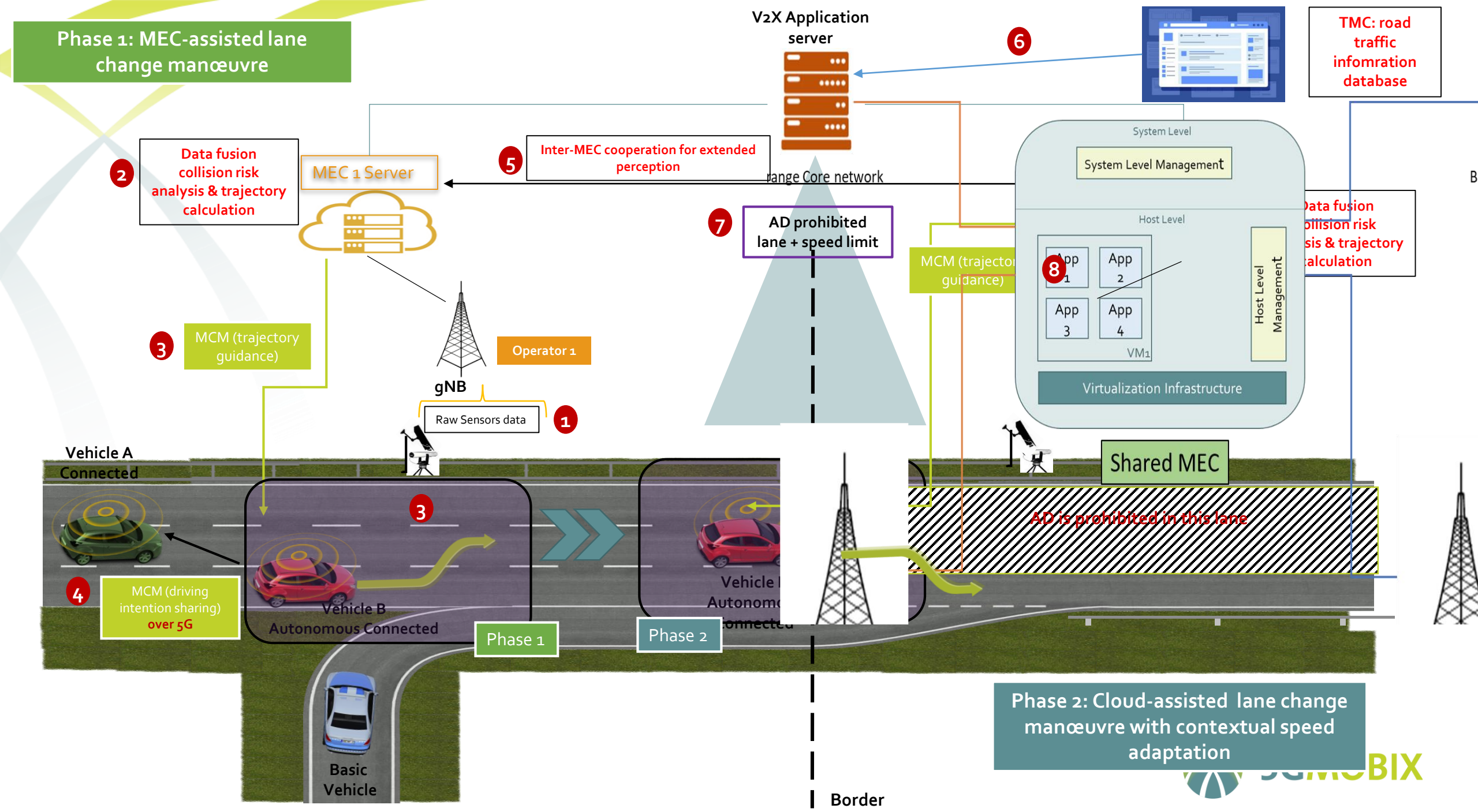
Phase 1: MEC-assisted lane change manœuvre
V2X Application server
6
TMC: road traffic infomration database
System Level
System Level Management
Host Level
App 1
App 2
App 3
App 4
VM1
Host Level Management
Virtualization Infrastructure
8
2
Data fusion collision risk analysis & trajectory calculation
MEC 1 Server
5
Inter-MEC cooperation for extended perception
Core network
7
AD prohibited lane + speed limit
MCM (trajectory guidance)
3
MCM (trajectory guidance)
Operator 1
gNB
Raw Sensors data
1
Vehicle A Connected
Shared MEC
AD is prohibited in this lane
4
MCM (driving intention sharing) over 5G
Vehicle B Autonomous Connected
Phase 1
Phase 2
Basic Vehicle
Border
Phase 2: Cloud-assisted lane change manœuvre with contextual speed adaptation

FR Site : Cross Border Issues(XBI) and Considered Solutions (CS)

24 Test Cases performed on FR Site addressing 6 XBI and 9 CS

XBI	Title
XBI_1	NSA Roaming interruption – 1 TC
XBI_2	SA Roaming interruption
XBI_3	Inter-PLMN interconnection latency
XBI_4	Low coverage Areas – 3 TC
XBI_5	Session & Service Continuity – 10 TC
XBI_6	Data routing
XBI_7	Insufficient Accuracy of GPS Positioning
XBI_8	Dynamic QoS Continuity – 2 TC
XBI_9	Geo-Constrained Information Dissemination – 1 TC
XBI_10	mmWave applicability – 7 TC
XBI_11	Network slicing applicability

CS	Definition
CS_1	S1 handover with S10 interface using an NSA network – 1 TC
CS_2	Release and redirect using an NSA network
CS_3	Release and redirect with S10 interface using an NSA network
CS_4	Multi-modem / multi-SIM connectivity - Passive Mode – 3 TC
CS_5	Multi-modem / multi-SIM connectivity - Link Aggregation – 4 TC
CS_6	Release and redirect using an SA network
CS_7	Internet-based Interconnection
CS_8	Direct Interconnection.
CS_9	Satellite connectivity – 3 TC
CS_10	MEC service discovery and migration using enhanced DNS support
CS_11	Imminent HO detection & Proactive IP change alert
CS_12	Inter-PLMN HO, AF make-before-break, SA
CS_13	Double MQTT client

CS	Definition
CS_14	Inter-MEC exchange of data – 2 TC
CS_15	Inter-server exchange of data – 1 TC
CS_16	LBO NSA
CS_17	HR NSA
CS_18	LBO SA
CS_19	HR SA
CS_20	Compressed sensing positioning
CS_21	Adaptive Video Streaming.
CS_22	Predictive QoS – 2 TC
CS_23	Uu geobroadcast
CS_24	PC5 geobroacast – 1 TC
CS_25	mmWave 5G. – 7 TC
CS_26	Network slicing

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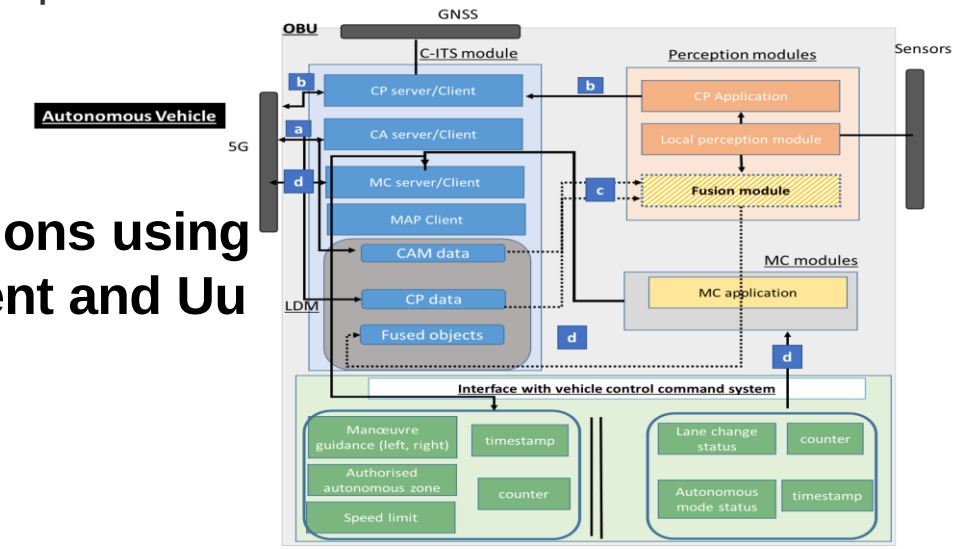
Technical challenges addressed

Development of a 5G OBU

- Hardware : Compact Unit with several radios – availability of 5G chipsets (5Gmm, PC5)
- Software : V2X Application Client – MAP, CAM, CPM, MCM



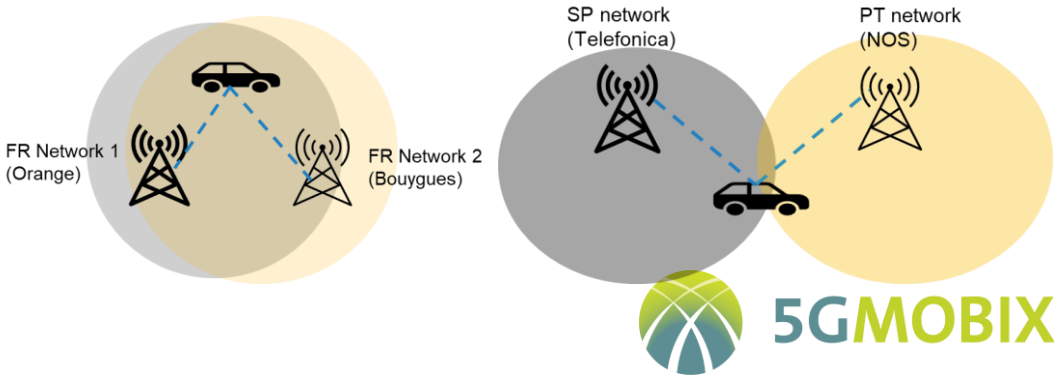
Development of V2X applications in MEC and communications using preliminary architecture of V2X Application Server and Client and Uu interface

Early experimentation of 5Gmm

- Experimental Network deployed in Satory
- UE Evaluation Kit

Service Continuity with MultiSim and Satcom

- 5Gcm-5Gcm, 5Gcm-5Gmm, 5Gcm-Satcom
- Without Link Aggregation and with Link Aggregation



QoS Prediction

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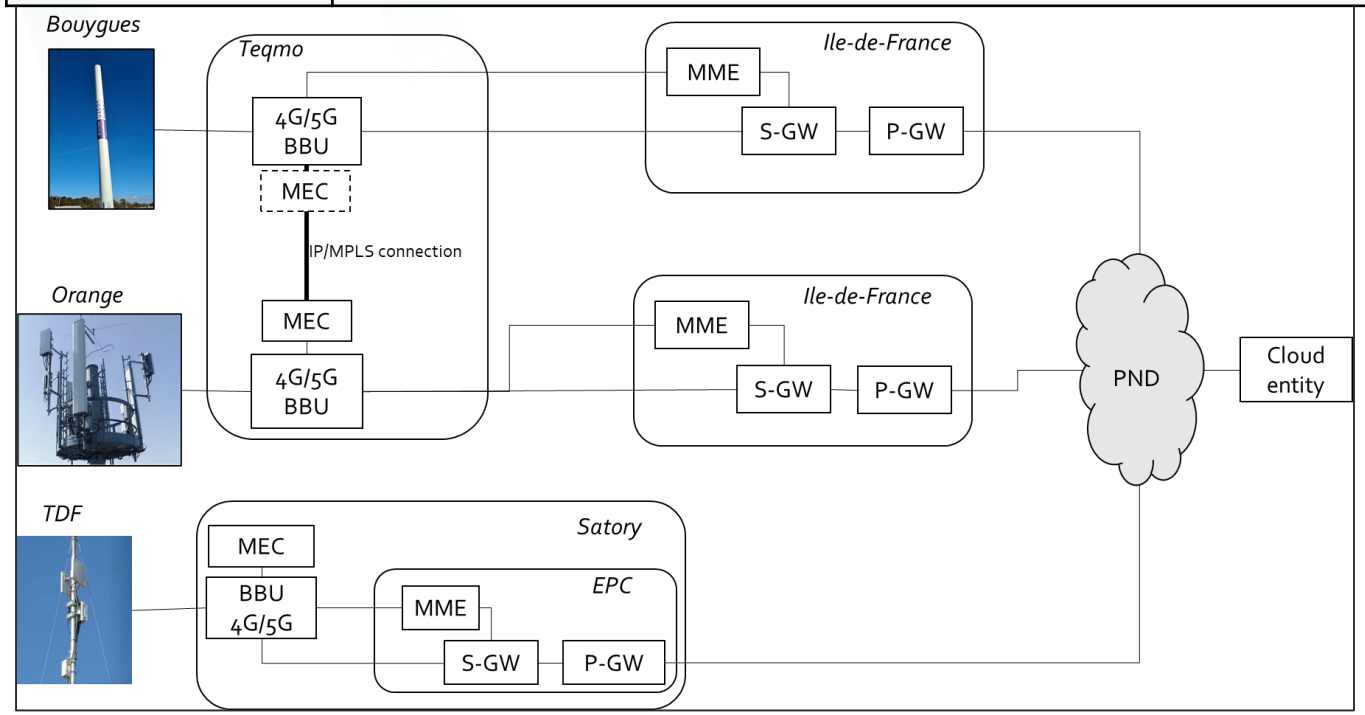
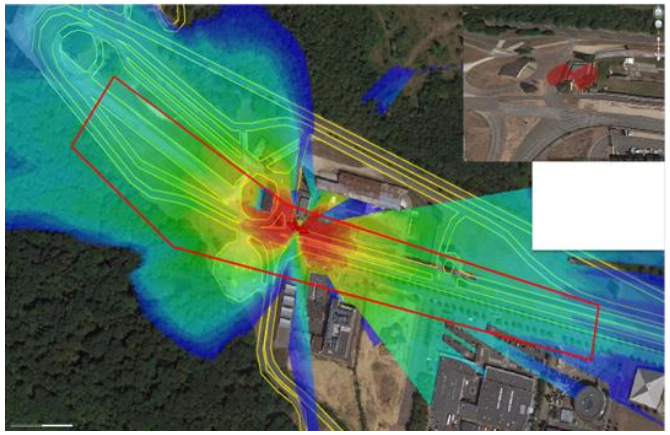
Solutions in place – 5G Networks

Three (3) 5G Networks

TDF	NSA, experimental private NW, 1gNB (Satory), 26 GHz (5Gmm)
Bouygues	NSA, commercial public NW, 2 gNB (Satory, Teqmo) 3,5GHz
Orange	NSA, experimental NW, 1gNB, 3,5GHz (Teqmo)





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Solutions in place – Infrastructure

- **MEC**
  - 2 Cloud Servers (VEDECOM, CATAPULT)
  - 2 MECs (TDF, AKKA)
- **Roadside sensors (VEDECOM)**
  - 3 RGB cameras
  - 1 lidar
- **Applications (VEDECOM)**
  - V2X Application Server (CAM, CPM, MCM, MAP)
  - Perception data fusion modules for Infra and AV sensors
  - Risk Analysis and trajectory guidance module
  - QoS prediction module
  - KPI Manager

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Solutions in place – 5G Devices

Vehicles

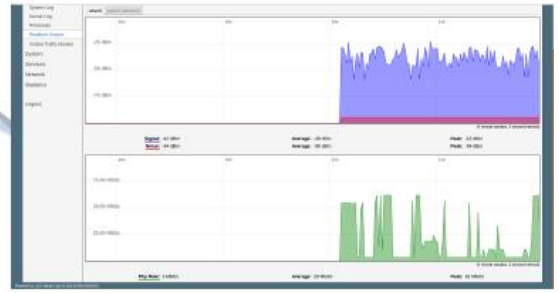
- 1 Automated Vehicle (L4) with 5G OBU and Satellite modem
- 2 Connected Vehicles with 5G OBU

Embedded Devices

- Three 5G OBU developed by VEDECOM (5G on sub-6G et mmWave bands)
  - SIMCOM 5G Chipsets
- Three 5G OBU from VALEO (5G on sub-6G band)
- 1 Satellite terminal and intelligent router (CATAPULT)

Software (VEDECOM original)

- Protocol stacks IP and non-IP for V2X messages (CAM, CPM, MCM, MAP)
- V2X Client
- QoS prediction Client
- KPI management Client



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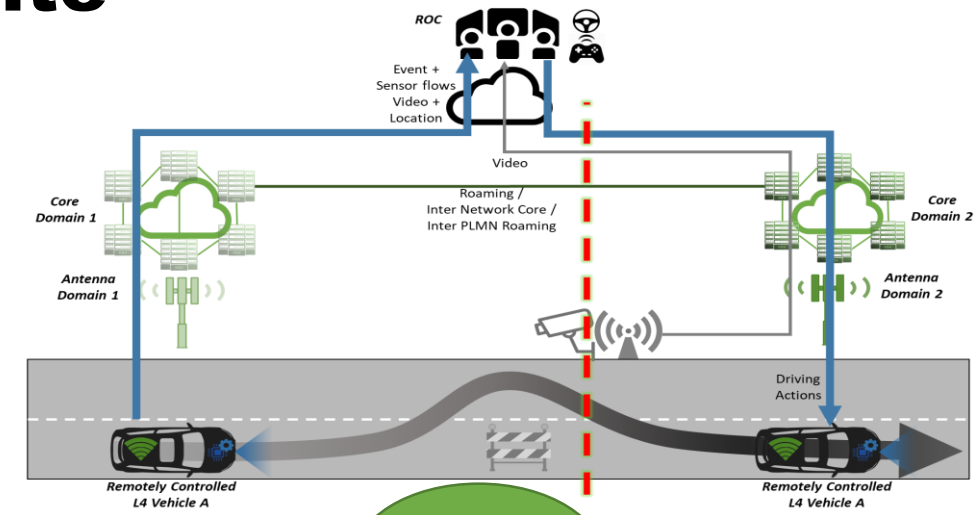
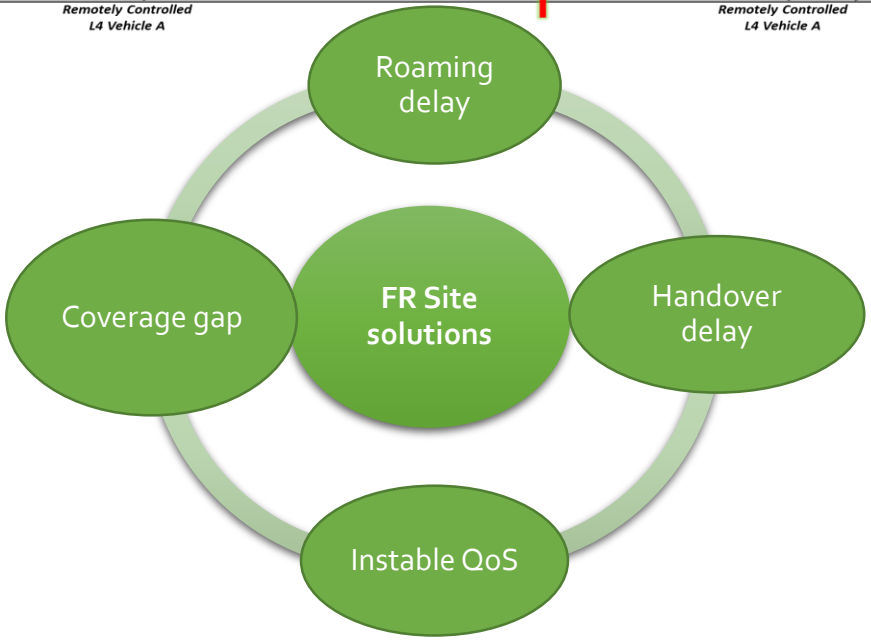
Main challenges adressed in FR Site

- **Service continuity and Service quality are key requirements for CAM applications**

Challenges	Solutions from FR Trial Site
Delay in roaming/handover	Seamless handover thanks to multi-SIM solution
Low radio coverage	Usage of Satellite technology
Sudden change in communication quality	QoS Prediction





As per FR Site contribution, study on 5Gmm applicability has been addressed

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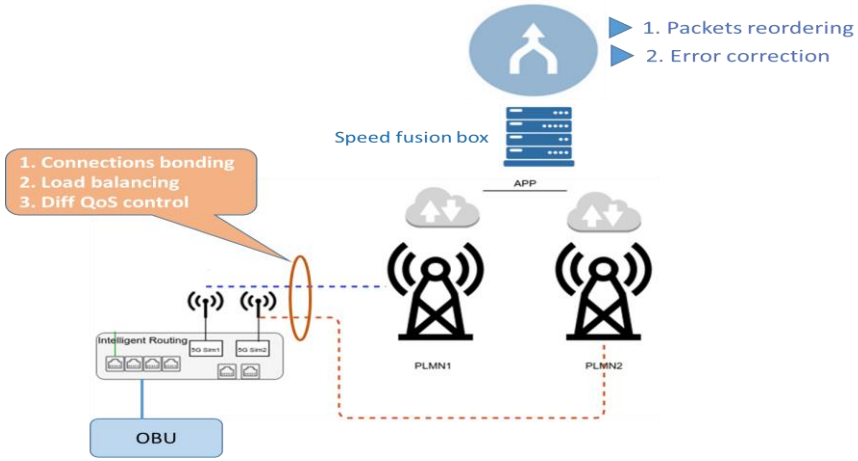
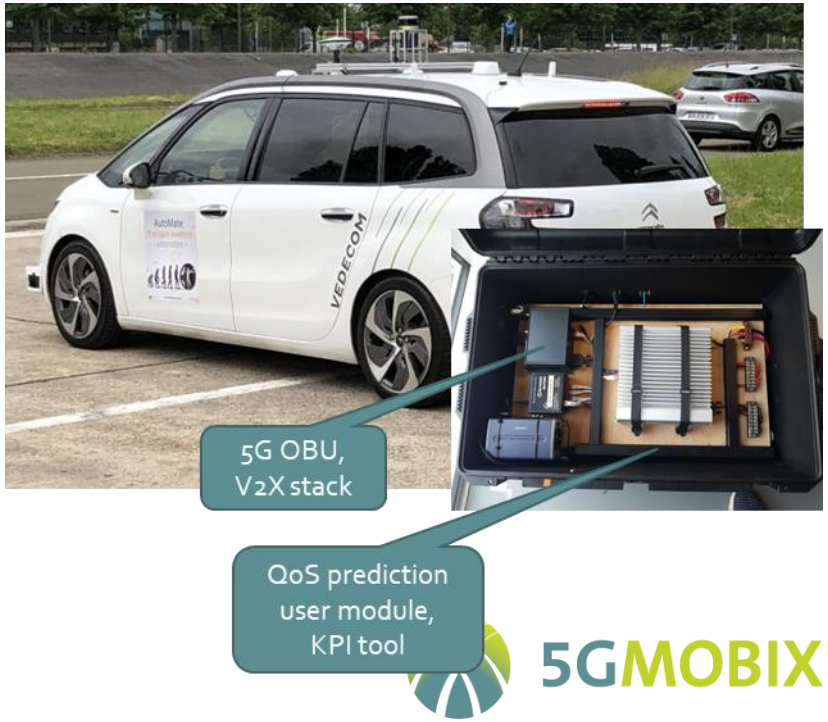
Contribution on Cross Border ES-PT

- Contribution to ES-PT use cases with a connected vehicle from FR Site
  - **FR connected vehicle** equiped with **dual stack OBU** and a **security mechanism** developed in FR Trial Site
  - Interoperability tests on 5G communications and on security performed in March 2022 on ES-PT border.
- Multi-SIM solution tested
  - Tests and demonstration of CAM service continuity in Cross Borders scenarios





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THANK YOU

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