

TESTING LIDAR UNDER ROAD CONDITIONS

Gilles Le Calvez – VEDECOM Validation and Homologation Devpt Director



AGENDA

1. LIDAR AS A SENSOR, AS A FUNCTION AND AS A SYSTEM
2. LEGACY ACTIVITIES
3. REAL CONDITIONS TESTS
4. CONCLUSION

VEDECOM, Institute for Energy Transition, created in 2014,

Dedicated to **Sustainable Mobility** :

- **Mobility more environmental friendly**
- **Mobility more autonomous**
- **Mobility more shared (inclusive, affordable ...)**

Yearly Budget : 30 Millions Euros

Approx. 200 people dedicated to this mission



**Vehicle
electrification**



**Driving delegation
and connectivity**



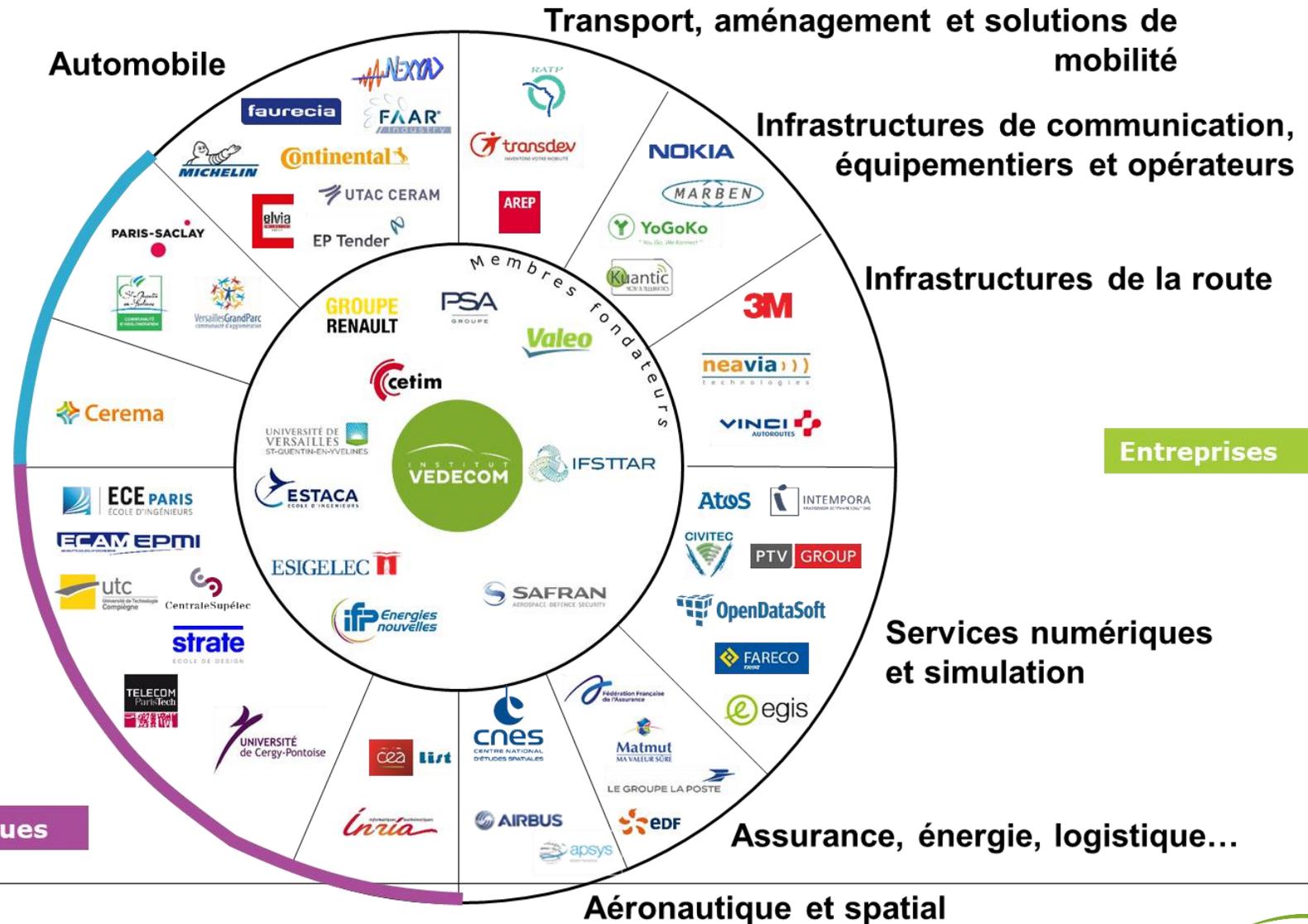
**Shared mobility
and energy**

> 50 MEMBERS AND PARTNERS : PUBLIC AND PRIVATE

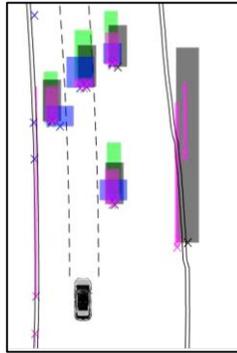
Territoires

Académiques

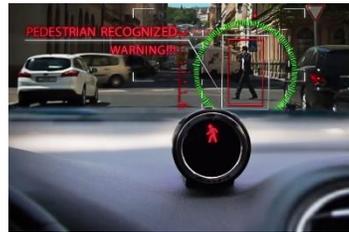
Entreprises



VARIOUS TECHNOLOGICAL SOLUTIONS



**Detection Performance
Dependability / confidence index**



Classification : AI



Collaborative Perception

**Heterogeneity for Dependability : Data Fusion
Machine Learning for Classification : What is enough ?**

V2V – V2I

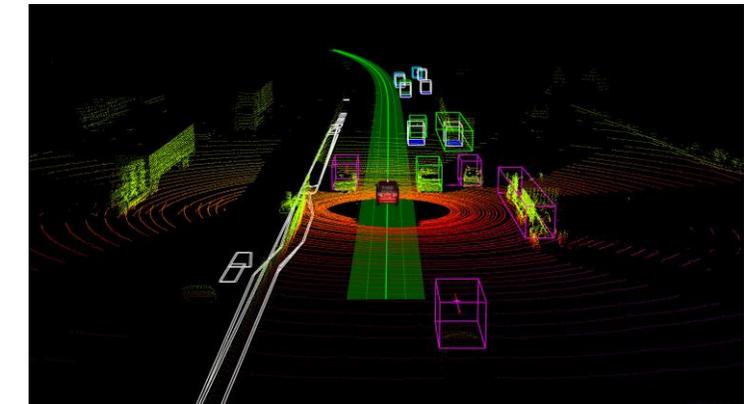
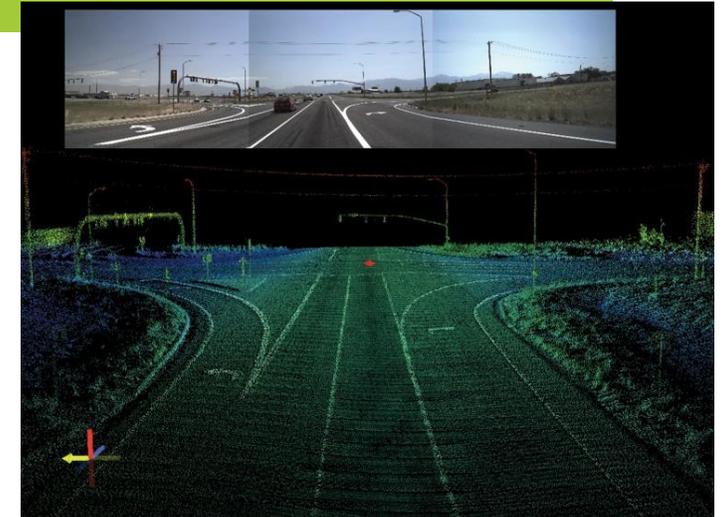
Main Current Function: Building a 3D representation of the surrounding Environment

→ Detecting Obstacles and Characteristics :

- Mobile objects
- Static objects
- Buildings (invariant static objects)
- Road Markings

→ BUT ...

- Movement and Optical leads to **masking**
- Same appearance** may hide differences
- Physical Properties** vary (eg paintings)
- Contrast / Size** matters ...
- Environmental** conditions perturbate



LIDAR : CONSIDERED STANDALONE AND IMPLANTED IN THE VEHICLE SYSTEM

HARDWARE SENSOR

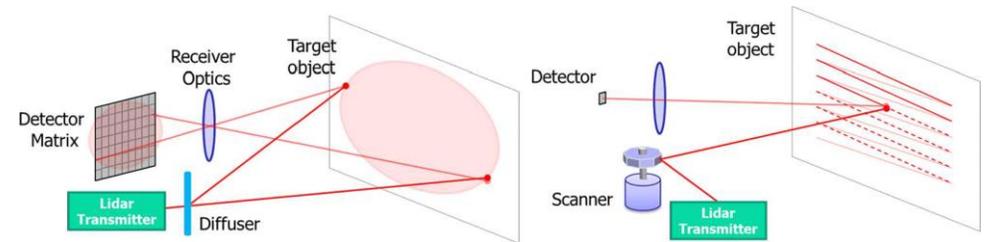
Emitter / Receiver → Hw (Lens / CMOS)

Field of View and Resolution

Speed

Vertical Distribution ...

Depends on the technologies



RAW DATA Processing : Cloud of Points

DETECT & IDENTIFY : **What ?**

→ Artificial Intelligence → Datasets

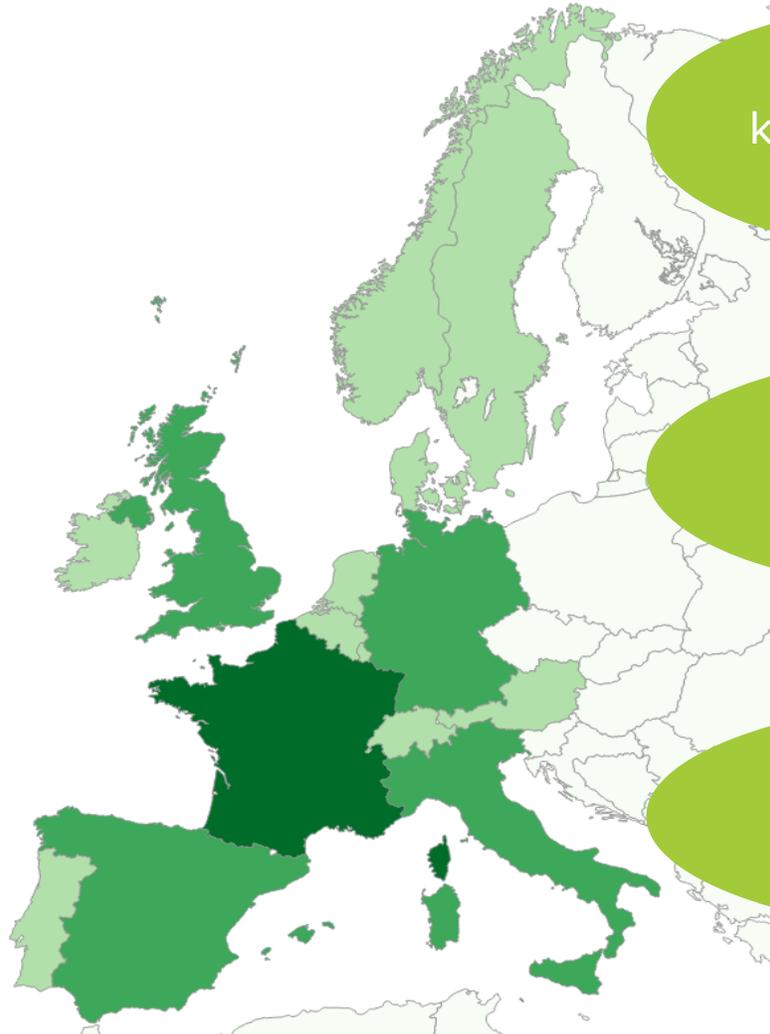
Real World Driving Sequences to collect Data

Data Processing / Tagging

OUR APPROACH : TEST THE PERCEPTION IN ITS ENVIRONMENT



COLLECTING REAL WORLD DATA FOR SAFETY



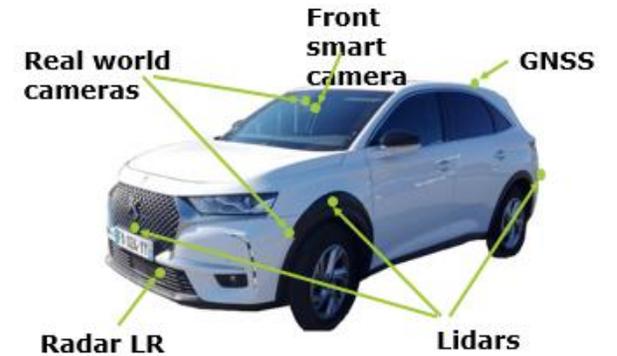
1 million kms, 16 000h of data...

... in 17 European countries

All motorway, night & day, traffic, tunnels, bridges, and weather conditions...



360° perception sensors



Big data collection



Pre-processing
Neutral Format



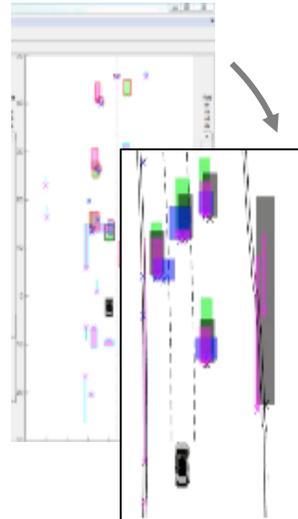
Perception algorithms



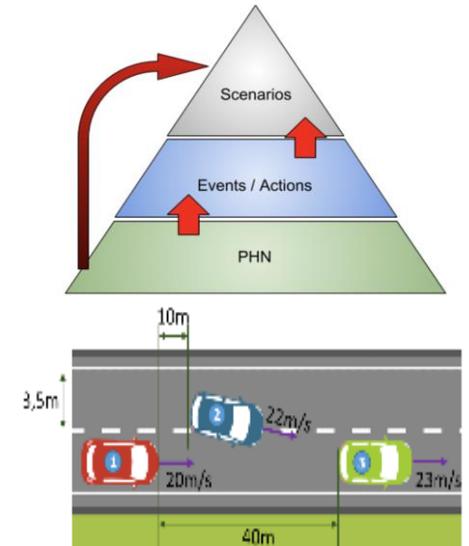
Computation of High Level Parameters



Scenario exploration
Safety events

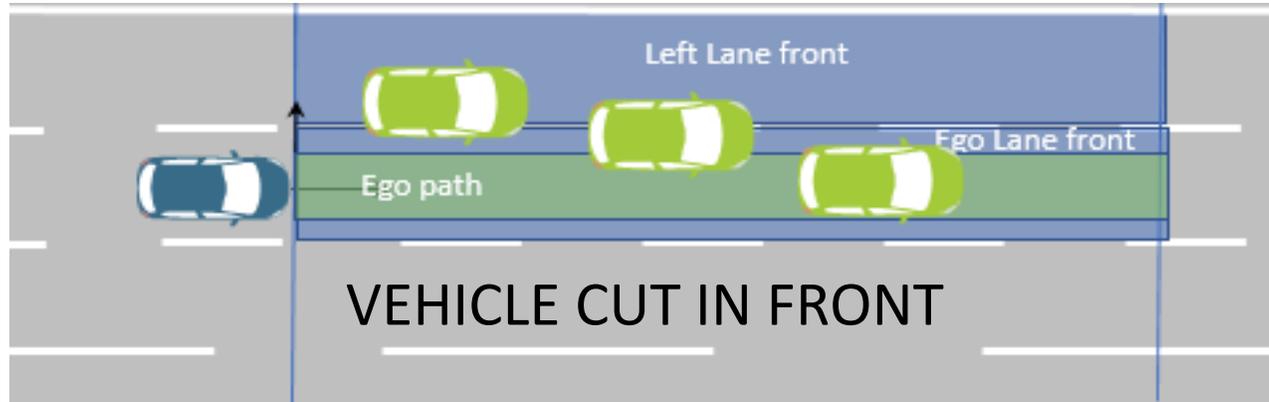


- Road Infrastructure
- Ego
- Obstacles
- Climatic



ANNOTATE SCENARIOS BY AN EXPERT SYSTEM 10

Scenarios, with their events, were detected in BDD by an Expert System based on logical rules. This Expert System annotate automatically each time series of records in our DataBase.



Time	Event List
E1 (t_1)	<code>Event_EnterOverlapFront(TargetOstacleID(t_3))</code> == TRUE
E2 (t_2)	<code>Event_EnterEgoLaneFront(TargetOstacleID(t_3))</code> == TRUE
E3 (t_3)	<code>Event_enterEgoPathFront(TargetOstacleID(t_3))</code> == TRUE

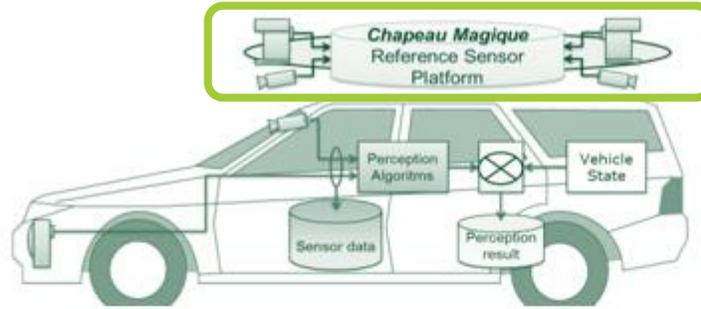


*More than
170 rules /
algorithms*

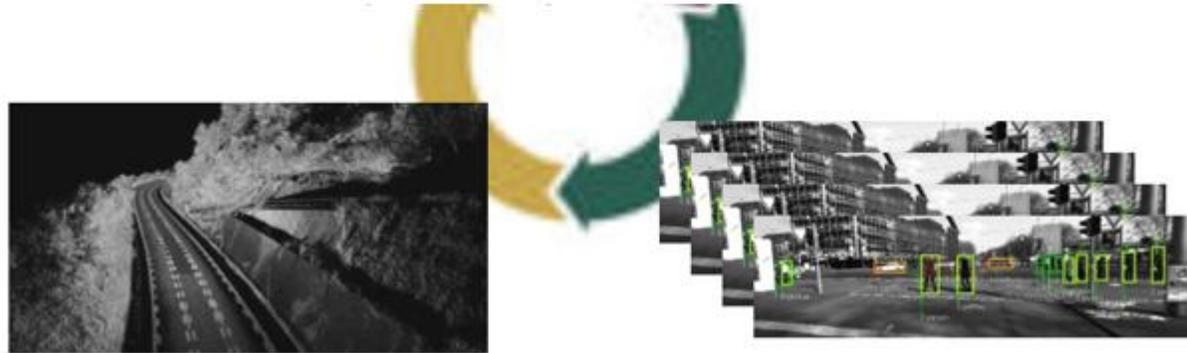
Main objective : Feed Test Scenario Database → Enrichment through Simulation

LET'S NOW FOCUS ON THE « TESTS IN THE REAL WORLD » ...

THE CONCEPT :



OffLine positioning
Fusion GPS / INE
Odométrie



Mobile Mapping

Reconstructing environment
Characterization through
reflectance

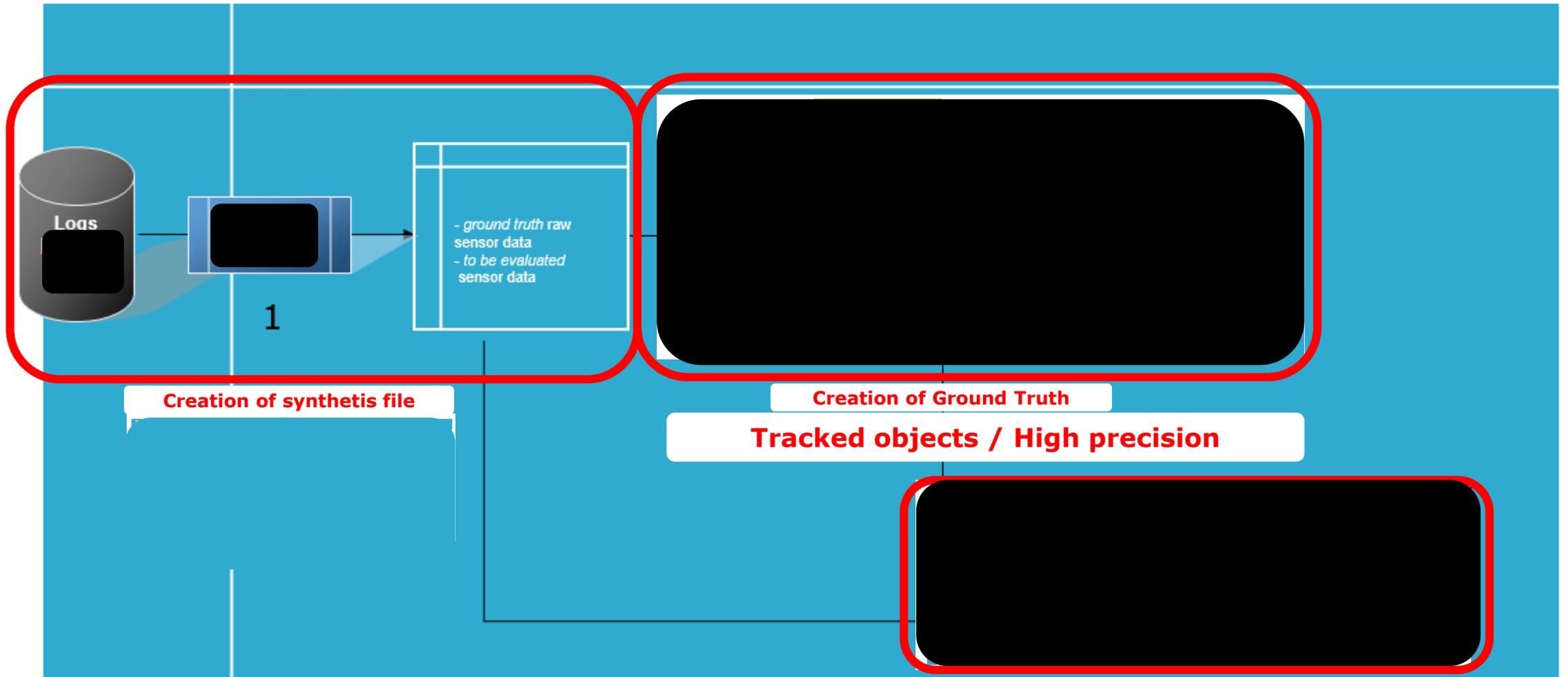
Performance
Comparison and
Evaluation

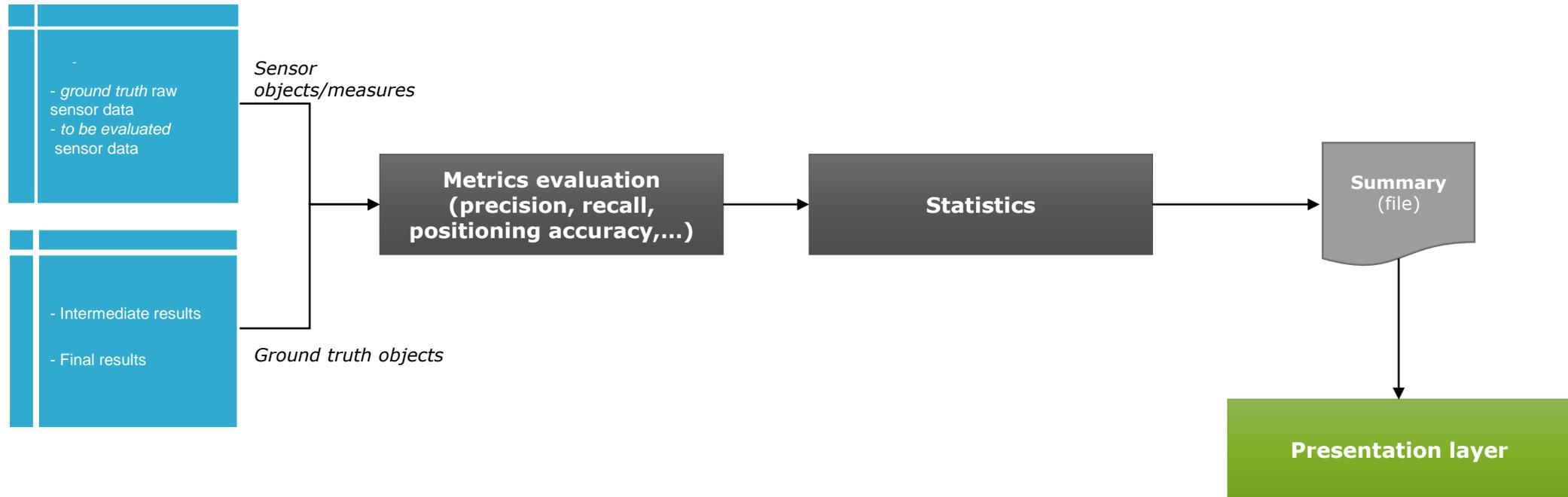
Object Detection

Detection and Tracking
Dynamic Propagation of information

Ground Truth
for Simulation

Labelled Database
for Research





CURRENT STATUS:

Stage of « **Sensor under test** » **Data**

NEXT STEPS:

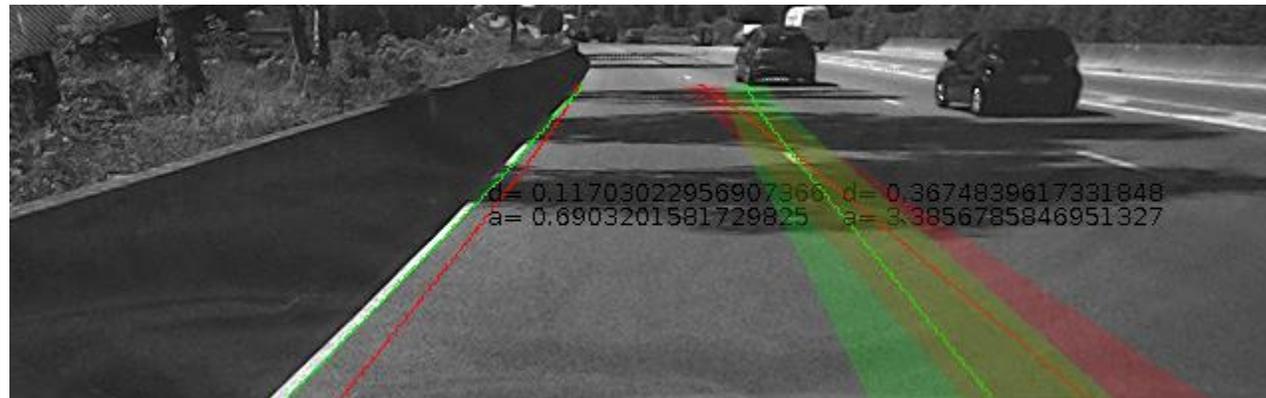
Comparison of Various Sensors / Algorithms / Sensor Locations

Quantification Standard of Performance / Test Plans

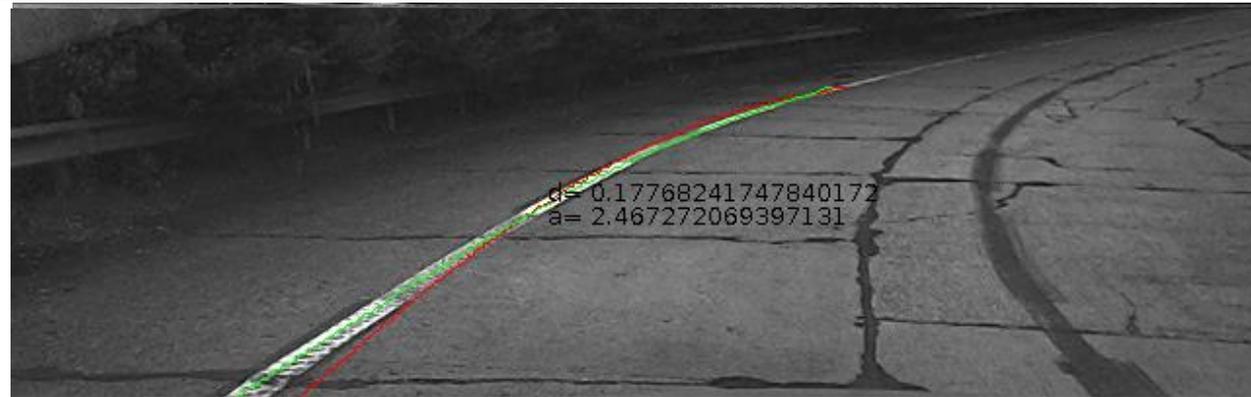
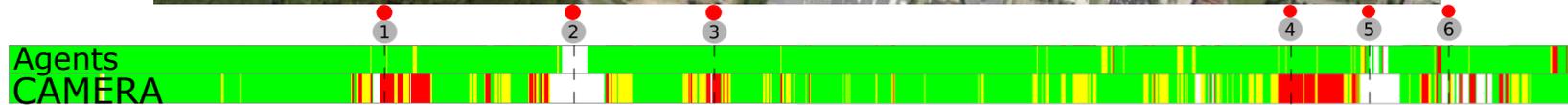
EVOLUTIVE SYSTEM: Reference Sensor(s) / Additional Processing / Flexibility

RESULTS ON HIGHWAYS/EXPRESSWAYS

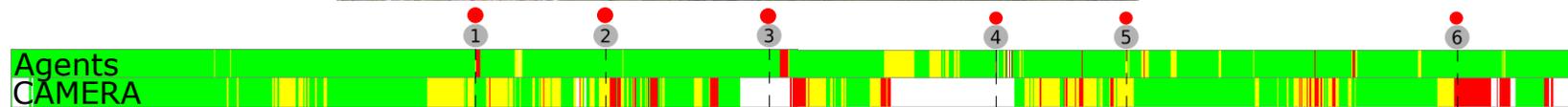
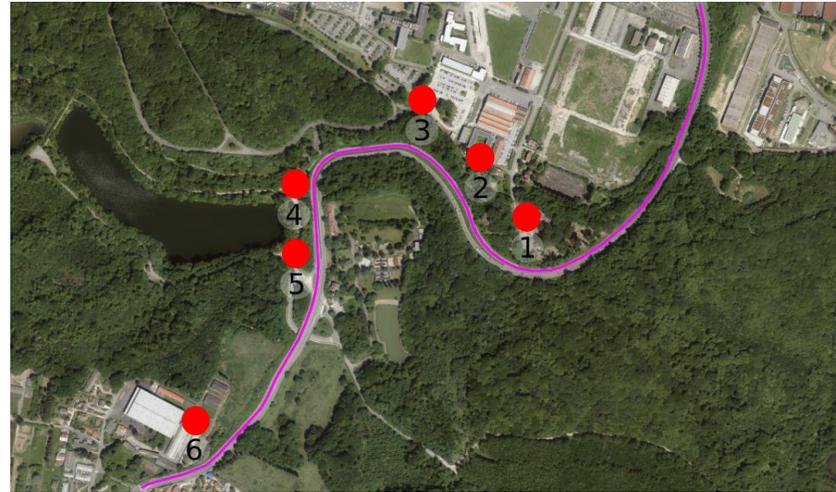
- 3 scenarios: Satory track, highways, expressways
- Contains: LIDAR, Camera, CAN vehicle, GPS data
- Comparison with A CAMERA system detection
- Validation protocol based on consensus



RESULTS ON SATORY TRACK



RESULTS ON HIGHWAYS

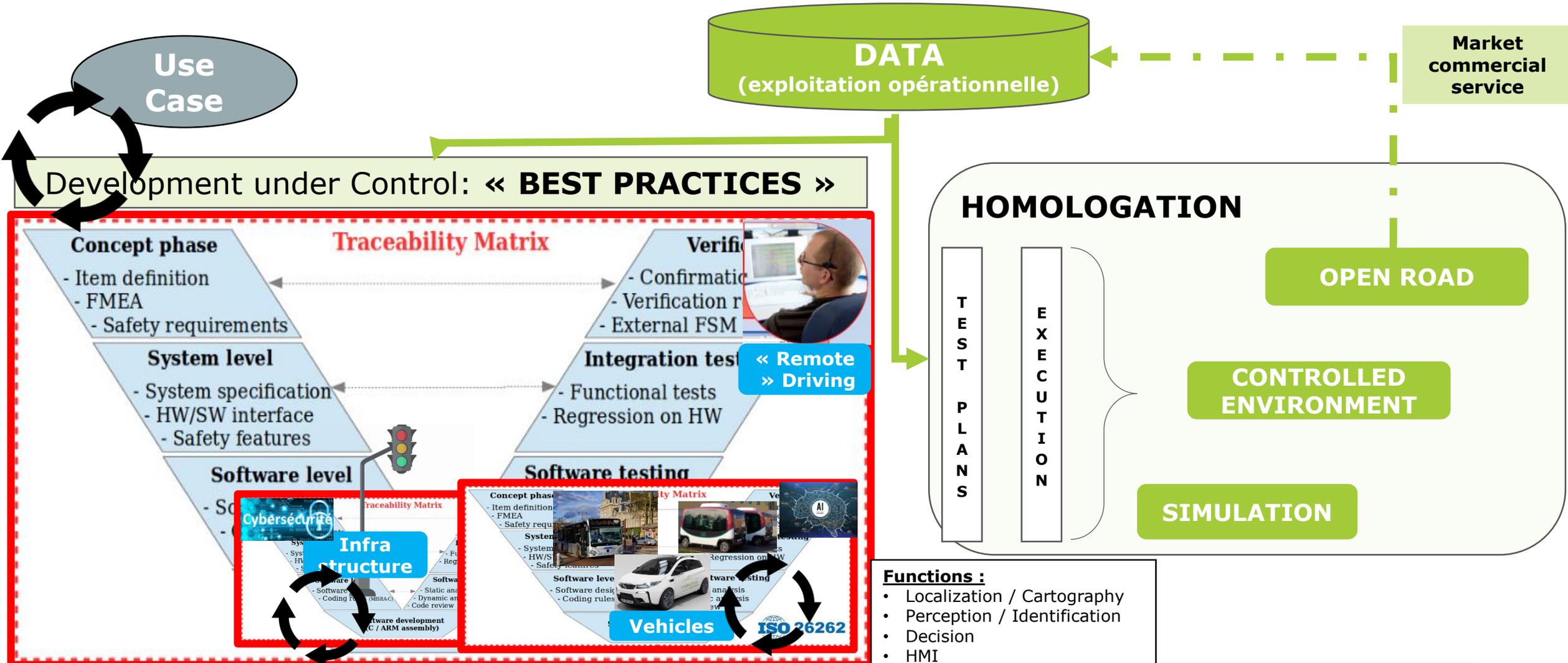


RESULTS ON EXPRESSWAYS



Scenario	Algorithm	TPR	FPR	AR	FNR
Complete	CAMERA	93,79%	0,70%	3,62%	1,90%
	Multi-agent	96,66%	0,22%	3,68%	1,12%
Without special areas	CAMERA	96,29%	0,17%	2,79%	0,75%
	Multi-agent	99,01%	0,11%	0,43%	0,38%

CONCLUSION : SET OF SUCCESSIVE STEPS TO BE DEFINED AND PERFORMED





Thank you for your attention

Together to accelerate the mobility of tomorrow!

