INSTITUT VEDECOM
DU VÉHICULE DÉCARBONÉ ET COMMUNICANT ET DE SA MOBILITÉ

Dependability and Driving Delegation

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VEDECOM,
A unique French Research Hub

Partnering Foundation from Université de Versailles Saint-Quentin-en-Yvelines (UVSQ)

Granted **Institut pour la Transition Energétique** in 2014 French National Research Agency(ANR)

Set up in the frame of the **Programme d'Investissements d'Avenir**

VEDECOM is a major contributor to « Plan Véhicule Autonome » of**Nouvelle France Industrielle** (NFI)

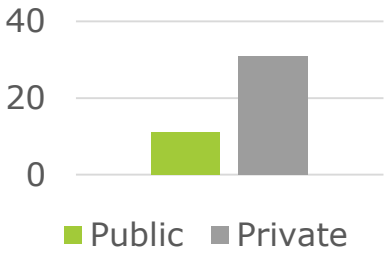
KEY FIGURES FOR VEDECOM

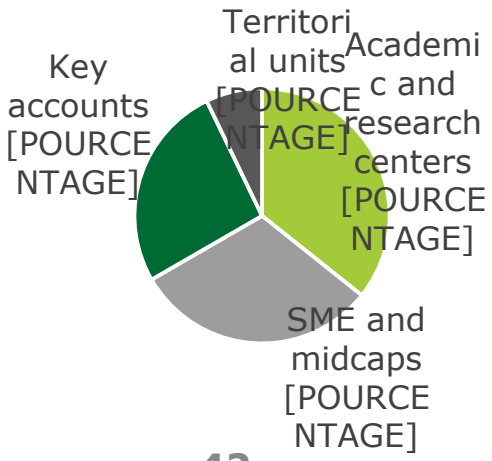
Number of employees: 175 (more than 110 researchers including 45 PhD students)

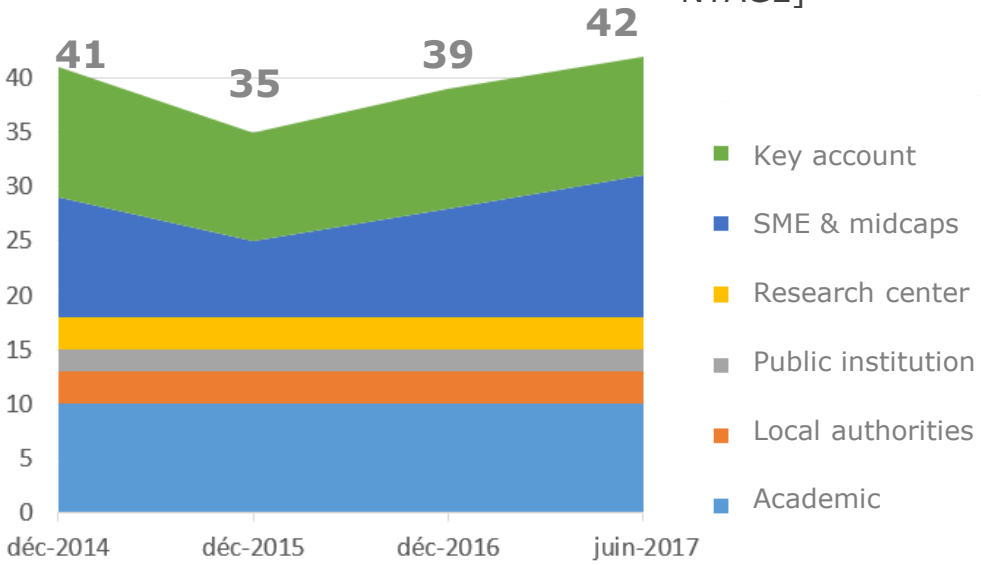
2017 Budget: k€ 31,150 (subsidies: k€ 15,800 ANR+CD78)

Capital assets: k€ 9,100 (end 2016/material and immaterial)

Large and diversified ecosystem







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MAIN ACHIEVEMENTS

Current assets

2014: 1 M€ 2015: 7,2 M€ 2016: 5,1 M€

Workshops	• Electric motor prototyping • Power electronics reliability testing • Power electronics (1st stage)
Infrastructure	• Road equipped with connectivity features (G5 – LTE 5G) • Smart grid configuration (Mako, H2 station, 10 bikes) • Dynamic and inductive charging track (FABRIC)
Rolling platforms	• Platforms devoted to perception and data collection • Self-driving and connected platforms • « Wizard of Oz » vehicle to analyze user interface and self-driving vehicle use • Dedicated vehicles to induction charging system and two-way charging
IT Platforms	• Automated driving simulator • Mobility simulator






VEHICLE ELECTRIFICATION

Improve urban air quality by a dramatic greenhouse gas emissions reduction



Innovative electric motor prototyping
and reliability testing



Fast and/or dynamic charging
Smart grid

Breakthrough

- Total cost of ownership
  - Powertrain cost
  - Energy storage cost
- No limit range
  - Fast charging
  - Dynamic charging
- Shared network connection

SELF-DRIVING AND CONNECTIVITY

Boost the emergence of the levels 4 and 5 applications to propose safer and more efficient mobility solutions (increase free time) : Level 4 for passenger cars – Level 5 for "robot-taxis"

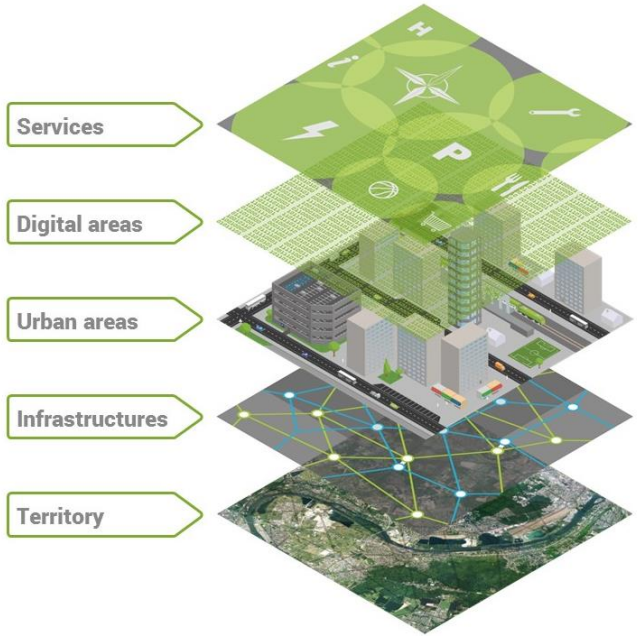
Perceptions, Communication, Control, Human factors and regulation

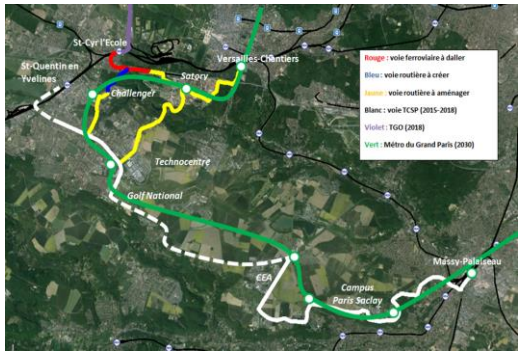
Breakthrough

- Technologies (sensors-IA-ECU, etc…)
  - Operational safety => SOTIF
  - Human factors compatibility
  - Connectivity : 5G and/or G5
  - Infrastructure
- Societal acceptance
  - Responsibility / Liability
  - Law and regulation
  - Insurance
  - Ethics

SHARED MOBILITY AND ENERGY

Optimize future mobility services systems based on carbon-free, connected and self-driving vehicles





Breakthrough

- Shared energy
  - New sustainable use
- Shared mobility
  - Multimodal trips
  - "Car-sharing"
  - "Carpooling"
- Cooperation with local authorities according to the "smart cities" project for mobility

Societal trends & Mobility local assessment

DEPENDABILITY AND DRIVING DELEGATION

Let’s see what we are talking about …

- **JUNE 2017**
- **ITS Strasbourg**

From Strasbourg (F) …

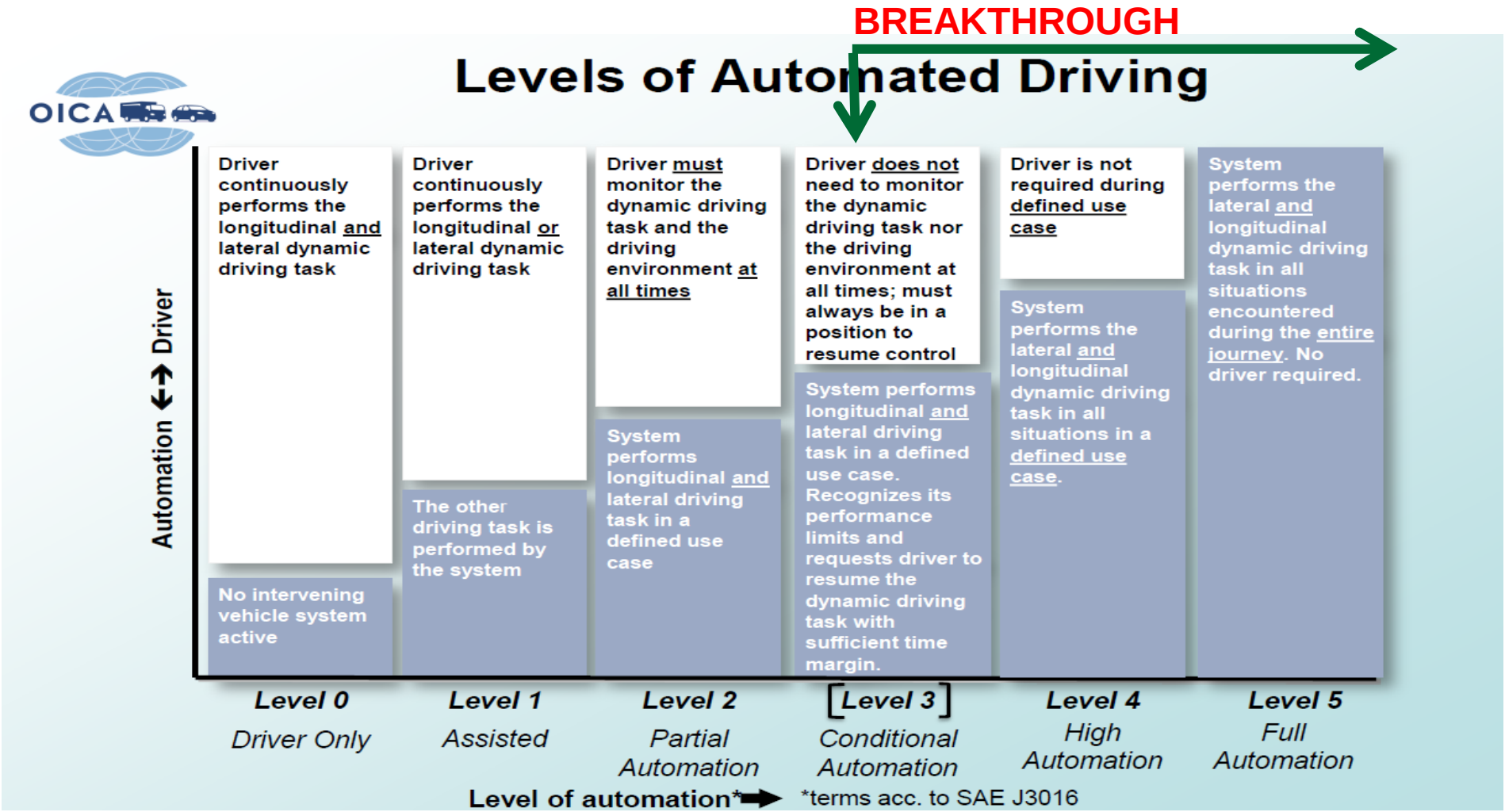
To Kehl (G) …

And Back !

Cross-border

Autonomous Mobility Service

DIFFERENT LEVELS OF DRIVING DELEGATION



AUTONOMOUS VEHICLE

An Autonomous Vehicle is …A VEHICLE !

Standards from Automotive apply to Autonomous Vehicle

- **Hardware based requirements (Electronic and Mechanical Components)**
  - **FMEA / Reliability Testing …**
- **Software based requirements (Functional / Safety)**
  - **ISO 26262 with ASIL definition (Automotive Safety Integrity Levels)**
- **Back-up modes (Limp Home / degraded modes …)**

Is this enough ? …

AUTONOMOUS VEHICLE

An Autonomous Vehicle is …AUTONOMOUS !

- METRO

- AERONAUTICS

Let’s not reinvent everything …

TECHNICAL ANALYSIS FROM OTHER DOMAINS

Safety principles	Principles	Technical Domain	Positive Point for AV
ALARP	Apply every safety measure that reduce risk, in a reasonable financial scope	Nuclear	-
AFAP	Reduce all risks whatever their importance	Medical	Benefit/risk
MEM	Calculation of the acceptable risk level based on an independant safety objective	(Transportation)	Mortality rate
GAME	**The new system must demonstrate a similar or lower risk than its predecessor**	**Railway** **Aeronautics**	**Method for setting up objectives** **X Factor**

A QUALITIATIVE APPROACH

THE DRIVING DELEGATION relies on multiple factors :

- PERCEPTION / LOCALIZATION

NO SINGLE POINT OF FAILURE

→ REDUNDANCY IS MANDATORY

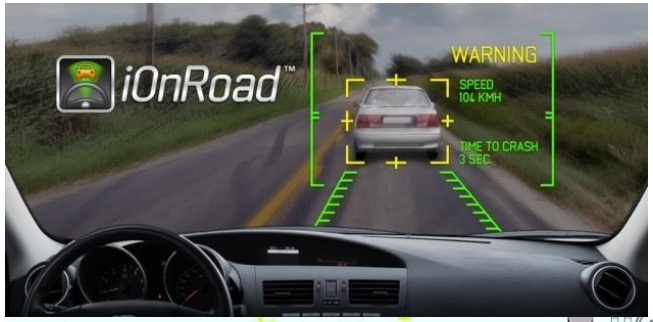
(CAMERA / LIDAR / RADAR … GPS / INERTIAL UNIT … CONNECTIVITY)

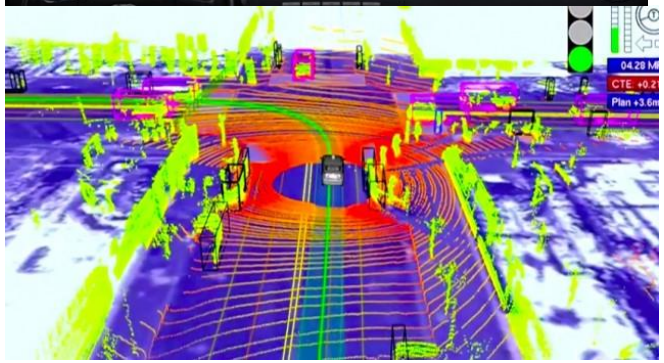
A QUALITIATIVE APPROACH

THE DRIVING DELEGATION relies on multiple factors :

- PERCEPTION / LOCALIZATION

- DECISION





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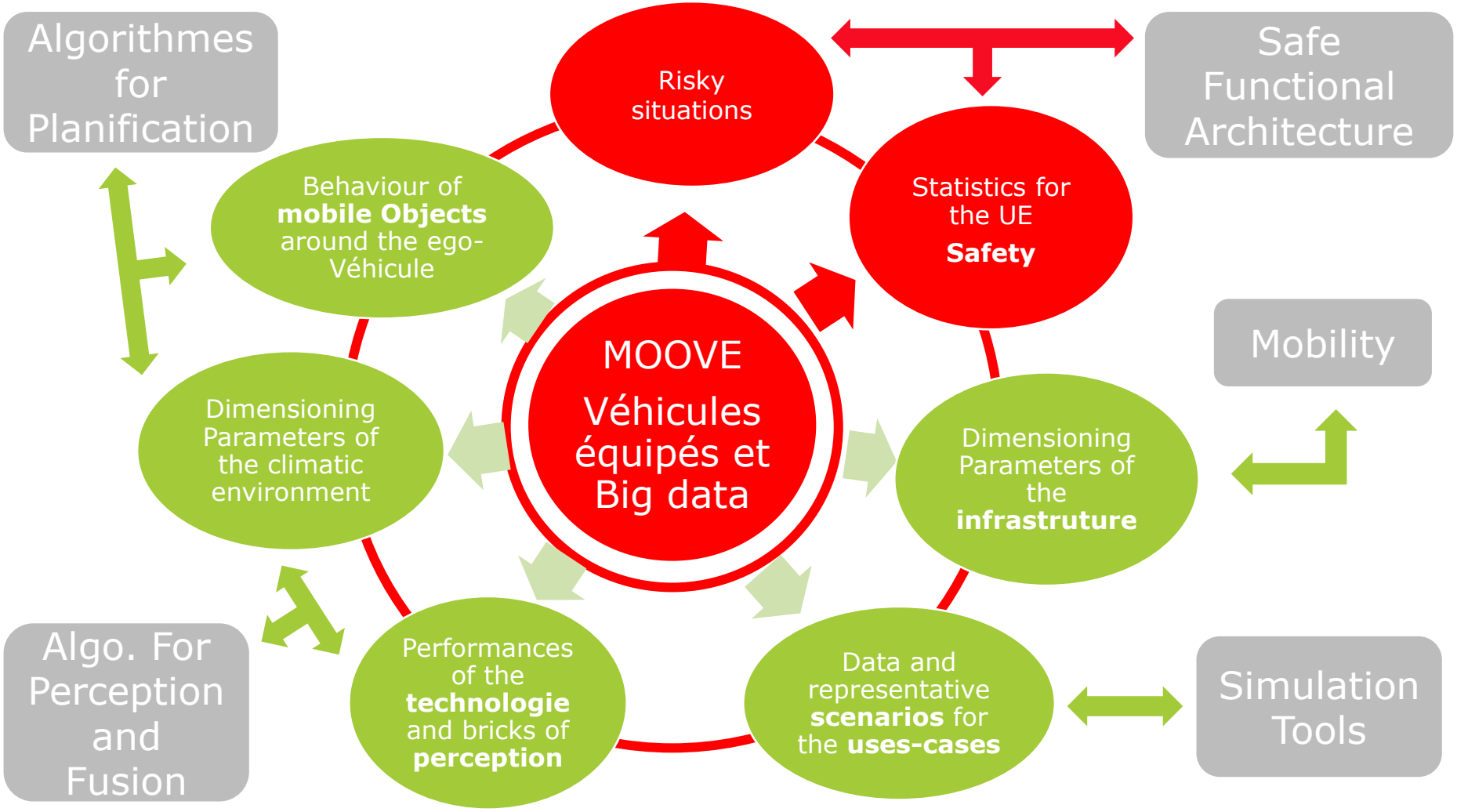
DEPENDABILITY AND SAFE BEHAVIOUR



A QUALITATIVE APPROACH

SETTING UP FUNCTIONAL RULES : (under definition)

- Consider a set of **critical situations from a safety point of view**
  (library of scenarios and identified situations)
- **« Refuge locations »** must always be identified, in case driver does not take over

- **Standard Criteria** for assertion :
  - Manual control take-over time
  - Driver Monitoring
  - Alerts
  - Activation / De-Activation / Take-over

- **Continuous Analysis process** for Incidents and Failures in action

A QUANTITATIVE APPROACH

THE REFERENCE IS SET UP :

- **Database of Accidentology**

Probabilities	France « LAB » « VCS » VL	France « Highway » VL	Germany « PEGASUS » « Highway »	« Average »
S3 Fatalities	**3,04. 10^{-8}/h**	10^{-7}/h	**1,5. 10^{-7} /h**	**1.10^{-7} /h**
S2 Wounded	**1,52. 10^{-7}/h**	3. 10^{-7} /h	**1,88. 10^{-6} /h**	**7,8. 10^{-7} /h**
S1 Lightly Wounded	**3,42. 10^{-7}/h**	2,5. 10^{-6} /h	**8. 10^{-6} /h**	**3,6.10^{-6} /h**

- **Improvement Factor is defined : 10 (btw : 90% of accidents are caused by Human Factor)**

- **Allocate the SAFETY Goals per Sub-system / Organ (Objectives of Failures)**

Consider Both ISO 26262 (known) and SOTIF (Objective Proven In Use)

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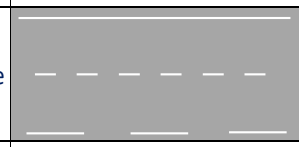
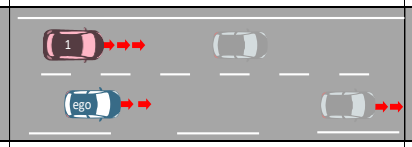
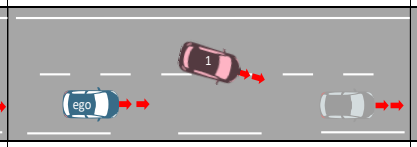
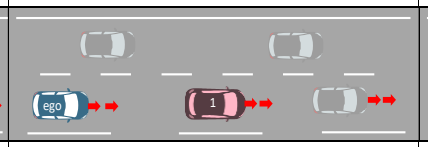
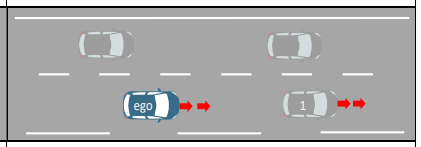
PUTTING THIS IN ACTION …

Cut-In	scenography_Parameters	scene (initial)	event	action	scene (final)
Cut in in front of ego vehicle					
target (if existing) velocity, target distance, target distance constraint, target deceleration	lanes separated by median strip	Ego vehicle is on its lane	Vh1 inserts in ego lane in front of the ego	Vh1 is the new target of the ego	the ego vehicle follows its target

SCENARIO LIBRARY

2

Cas de vie avec les caractéristiques suivantes :

Moment de la journée : Jour
Précipitations : Pas de pluie
Type de route : Voies rapides
Vitesse limite : Moyenne
Densité du traffic : Fluide
Changement de route : Jamais
Possibilité de changement de file : Possible
Tunnels : Pas de tunnel

Glissières : Glissière des deux cotés
Mur : Pas de mur
Courbes : Ligne droite
Dos d'âne : Pas de dos d'âne
Barrière : Pas de barrière
Feux : Pas de feux
Signalisation verticale : Présence de signalisation verticale

Signalisation horizontale : Présence de signalisation horizontale
Largeur des voies : Voie normale
Etat des marquages : Visibles
Zones spécifiques : Jonction
Zone accidentogène : Pas de zone accidentogène
Objets mobiles : Haute densité de Voiture

REAL-LIFE MEASURE

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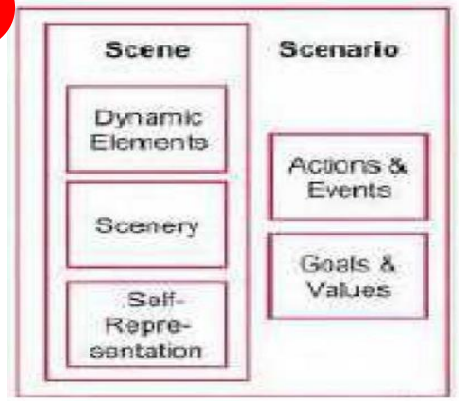

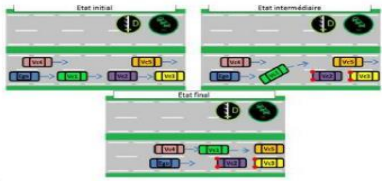

MODELING

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SIMULATION

5

TESTING / HOMOLOGATION

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WRAP-UP AND CONCLUSION

DEPENDABILITY OF THE AUTONOMOUS VEHICLE RELIES ON :

- <u>STANDARD PROCESS</u> FROM AUTOMOTIVE + EXPERIMENTS

- <u>BASICS</u> FROM OTHER TECHNICAL DOMAINS

- LEADS TO ADDRESS ALSO SECURITY

(Connectivity → Cyber-security)

- <u>NEW FIELDS</u> (TAKE-OVER / CHANGING ENVIRONMENT / MIXITY …)

A CONTINUOUS PROCESS THAT IS ONLY BEGINNING …

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Thank you for your attention

Together to accelerate the mobility of tomorrow !