



RENAULT NISSAN MITSUBISHI

DSC 2019 EUROPE VR
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From Assistance to Autonomous Driving: New safety Validation Challenges

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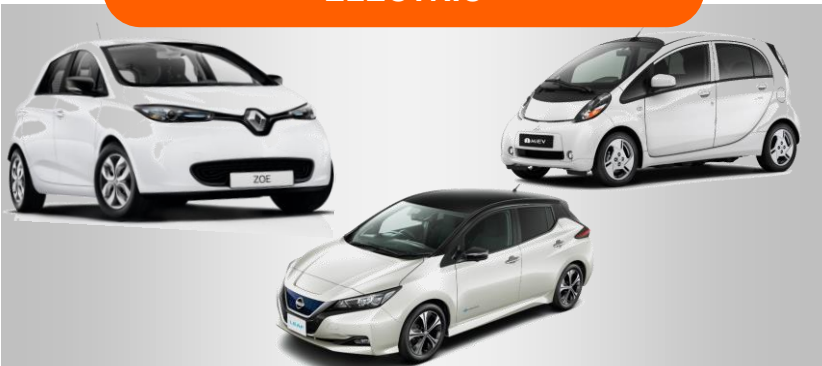
Autonomous cars is an ALLIANCE 2022 priority

CONNECTED



90% CONNECTIVITY IN 2022

ELECTRIC



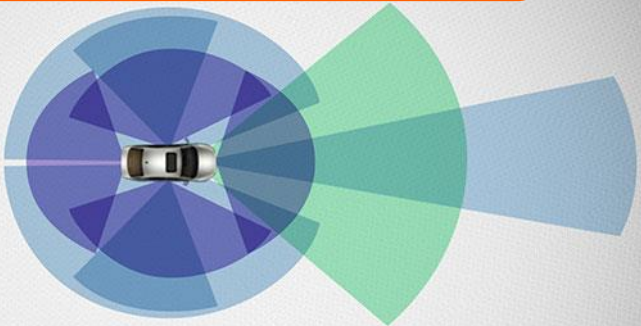
12 NEW EVS BY 2022

MOBILE

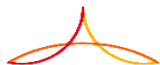


BECOME AN OPERATOR
OF ROBO-VEHICLE RIDE-HAILING SERVICES

AUTONOMOUS



OVER 40 MODELS BY 2022
WITH AUTONOMOUS DRIVE TECHNOLOGY



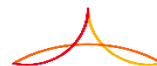
AD – Intelligent Connected Vehicle is an old story...

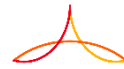


**Renault 1986
PrometheUS Project**



**Test Vehicle Renault 4L with
anti collision prototype radar**





It took 62 years for Auto to be adopted by 50 millions users...

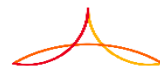
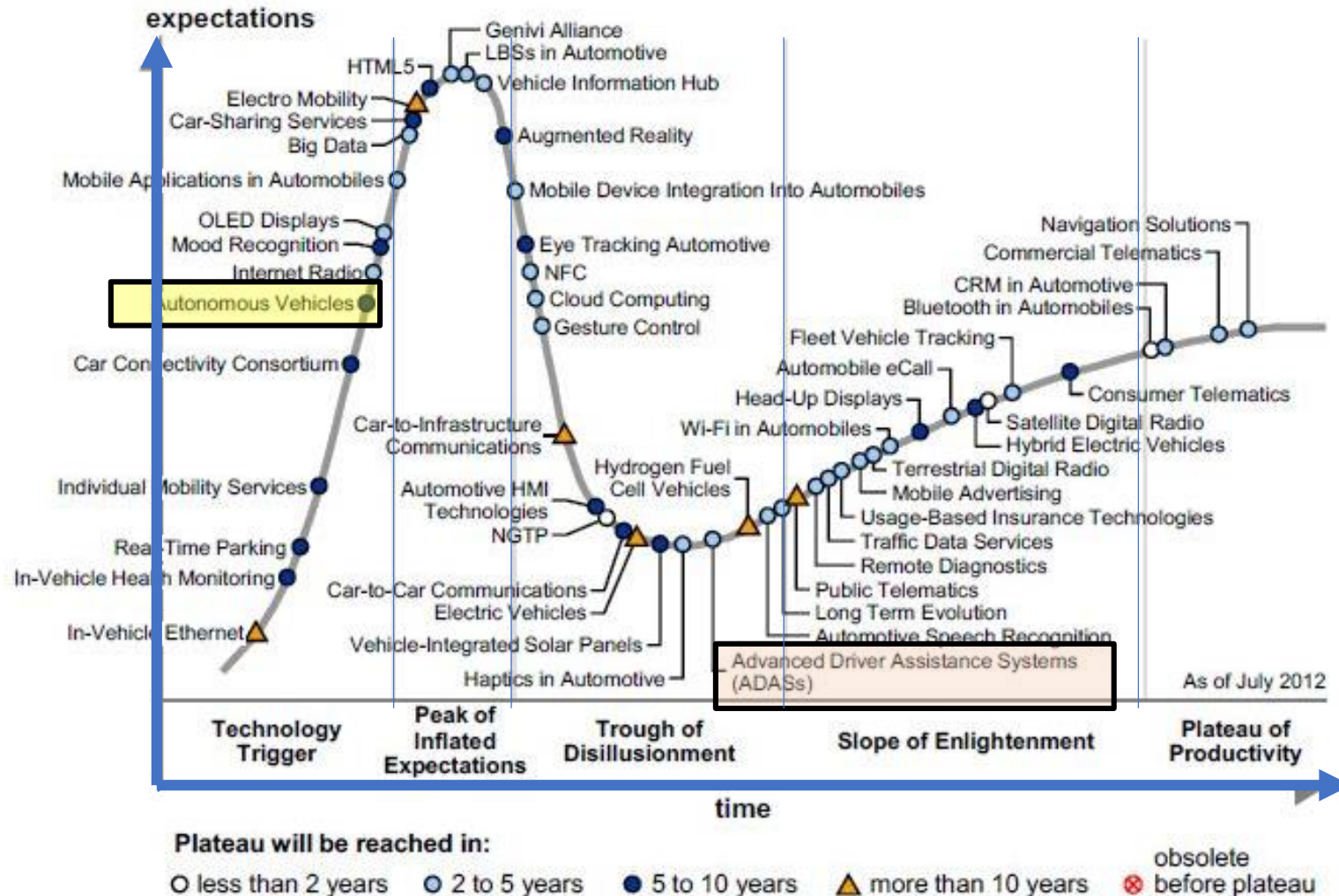
Atoms Versus Bytes

(Time to scale)

Product / Technology	Time it Took to Hit 50 Million Users
Airlines	64 years
Automobiles	62 years
Facebook	4 years
Electricity	46 years
WeChat	
Credit Cards	28 years
Television	22 years
Computers	14 years
Mobile Phones	12 years
Internet	7 years
Pokemon Go	

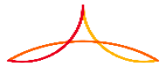
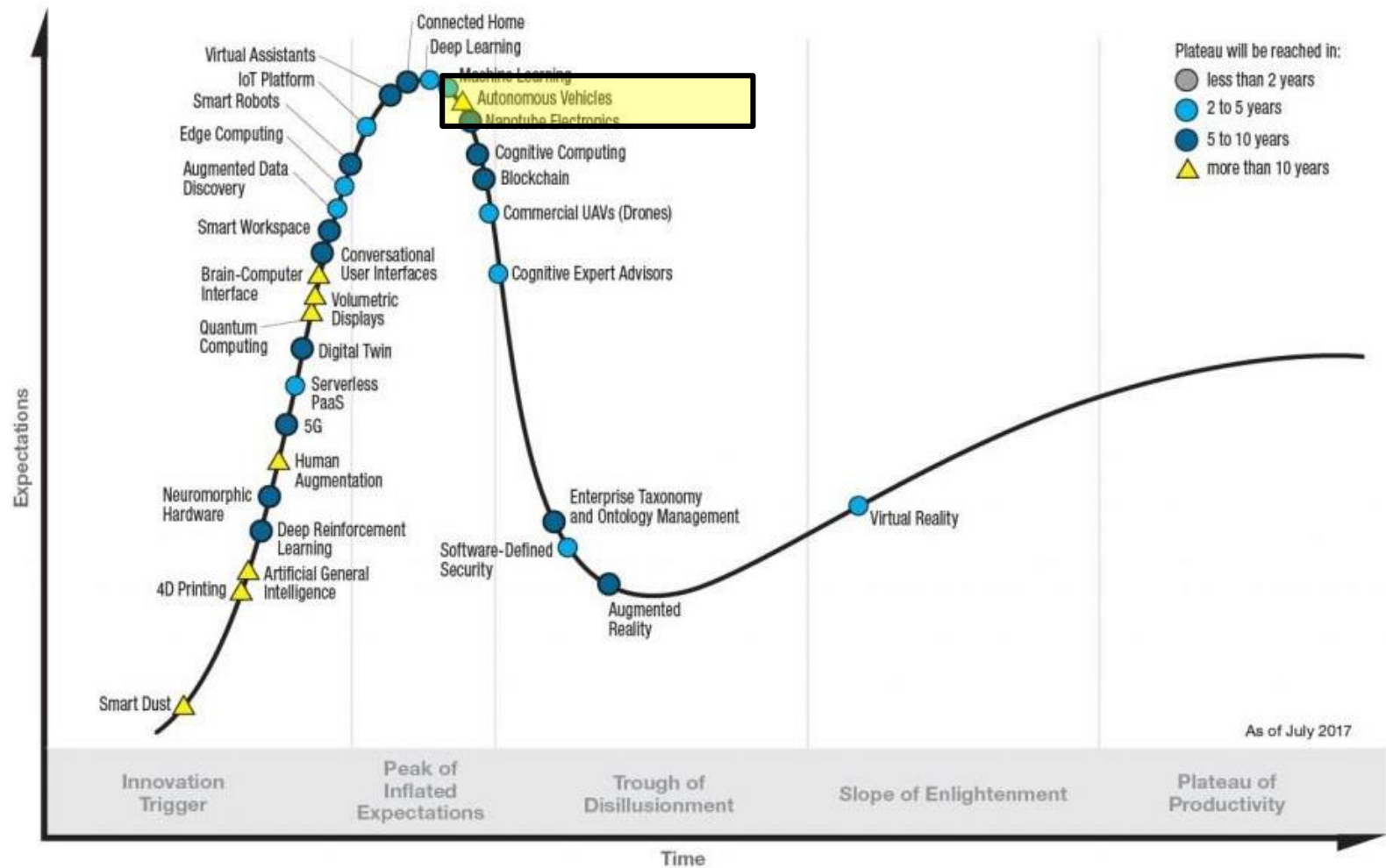
...and 19 days for Pokemon Go

Back to 2012 : the ADAS demonstrate their real contribution to safety, customer satisfaction...
... Autonomous Vehicles are seen in next 5 to 10 years...



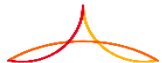
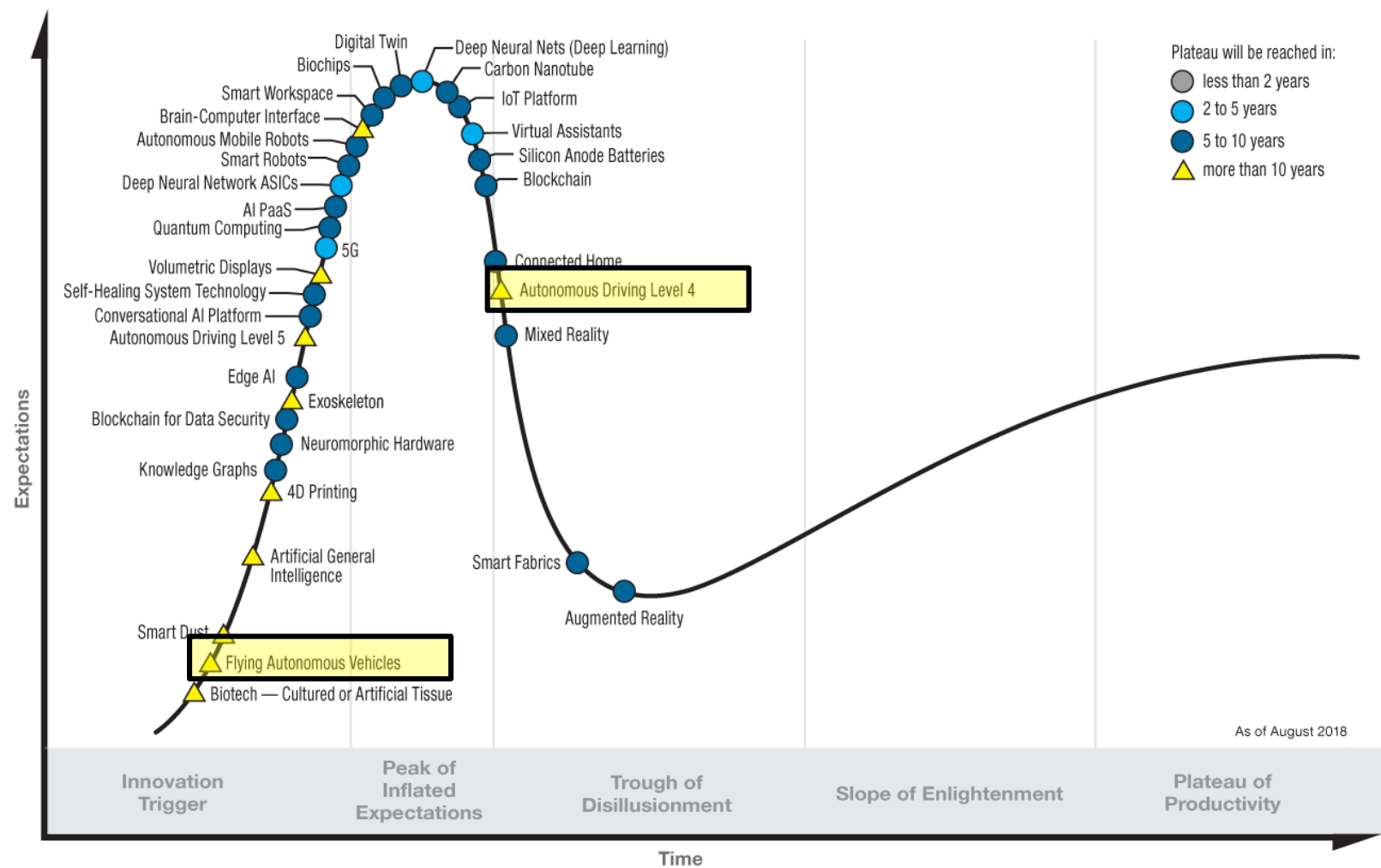
In 2017, ADAS are continuously deployed...

...AD are seen in more than 10 years



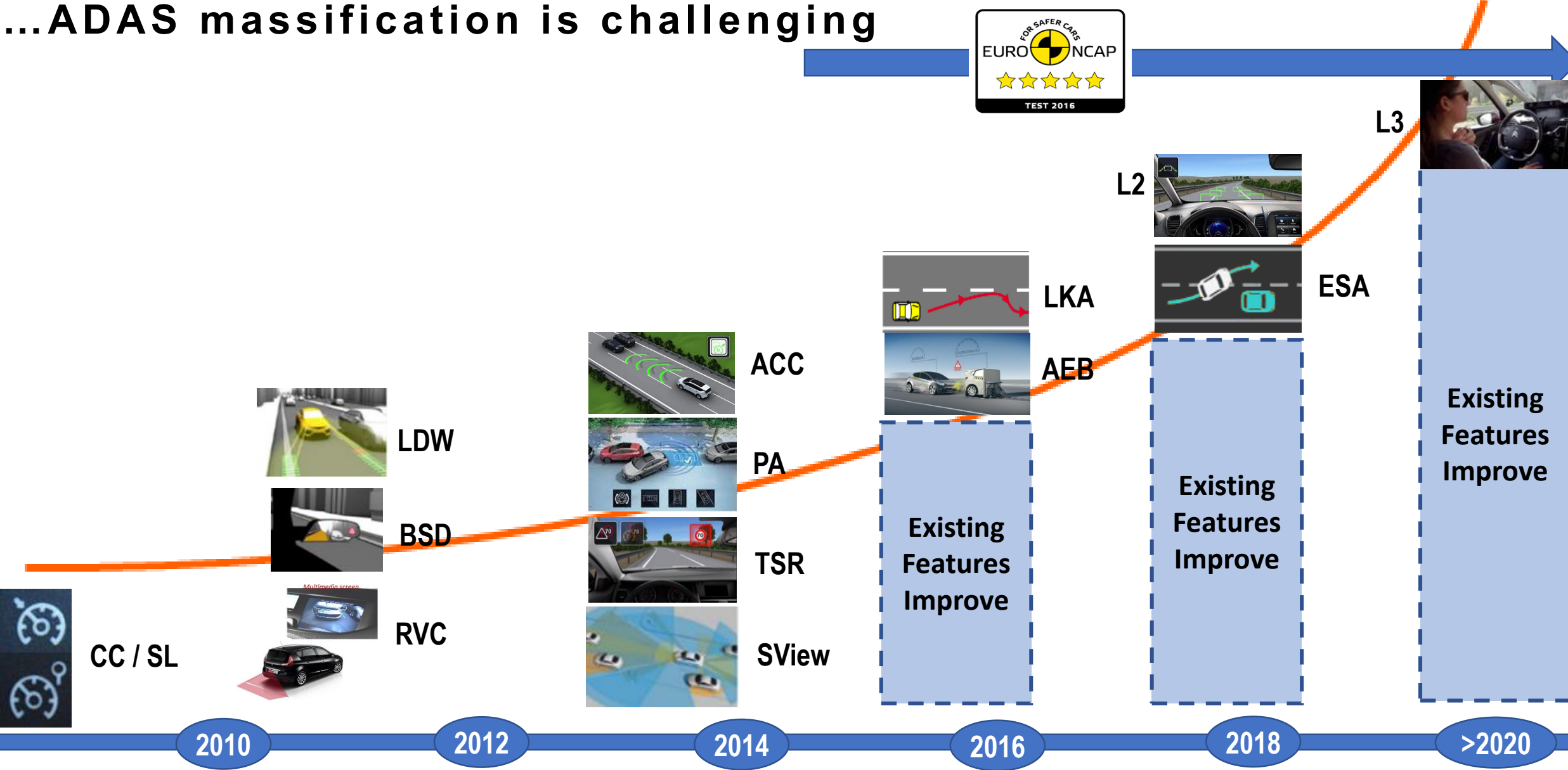
In 2018 AD are seen in more than 10 years...

... And enters the “trough of disillusionment”



AD are highly mediatic ...

...ADAS massification is challenging

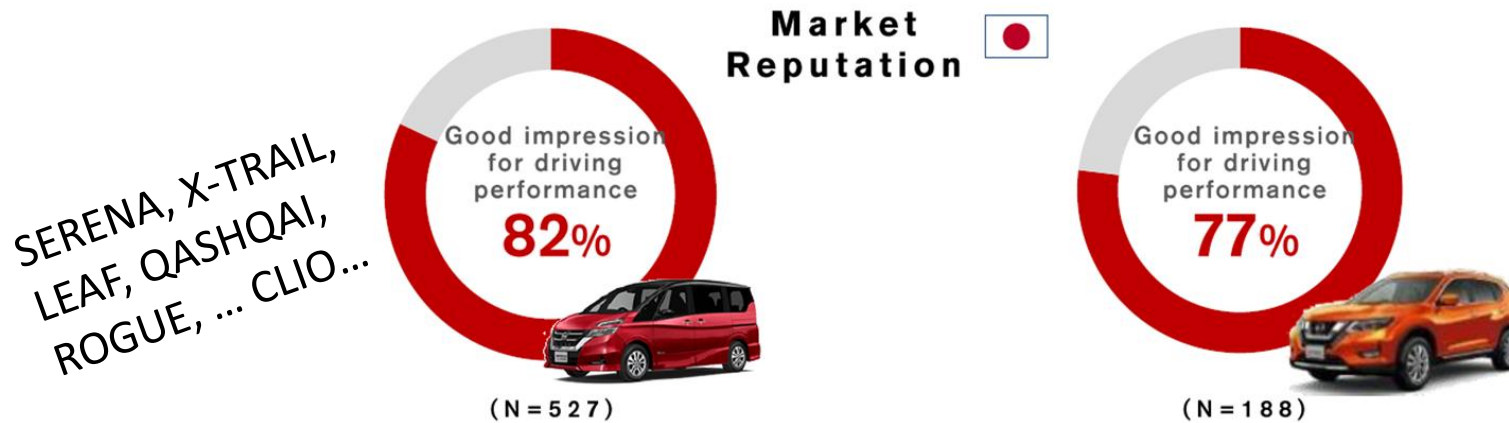


Alliance already introduced AD1 (SAE level 2) in Japan and USA

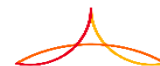
Customers impressions are encouraging!

Highway single-lane autonomous drive technology Adoption

- Support the scenes for driving and traffic on highway by Intelligent Cruise Control (ICC) and Lane Keep Assist (LKA)

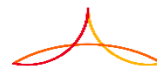


- First Tests in France in 2017 on SAE L3 & L4 with non expert Driver on French open Roads gave High rate of acceptance after few minutes !!!

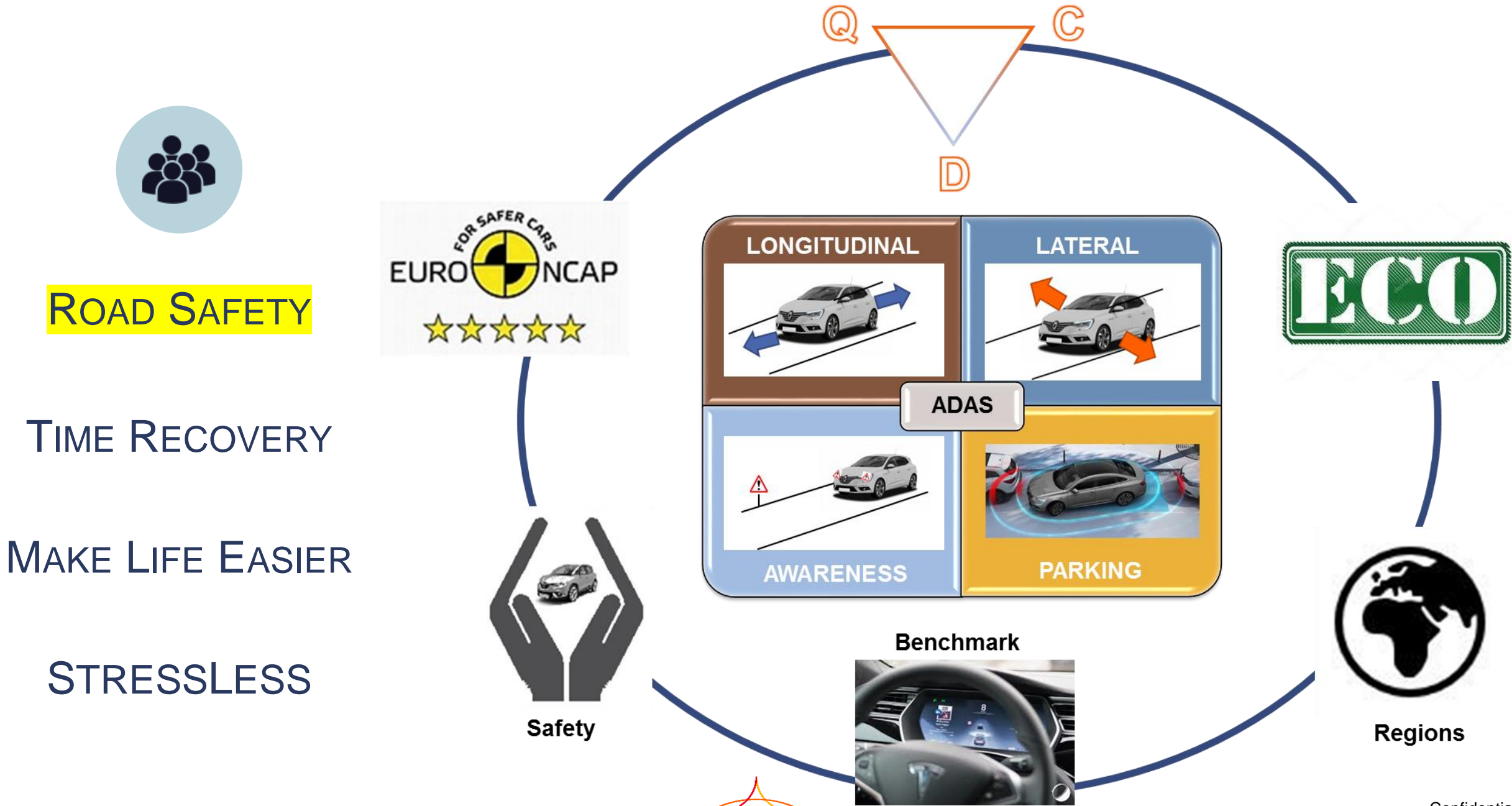


SAE L3 and above remaining challenges...

- SW & Data management to address complexity
- Legal framework & RASIC – Self certification?
- Transition Delegation
- Social acceptance: what is the value? Safety?
- Test & Simulation.. To V&V – Mature Partnerships?
- ...sensors maturity L3 & + , cost performance?
- Infrastructure & V2X? In safety loop?
- Scenario database? Near Accidents?
- Manufacturing end of line checks?
- In operation feed backs?

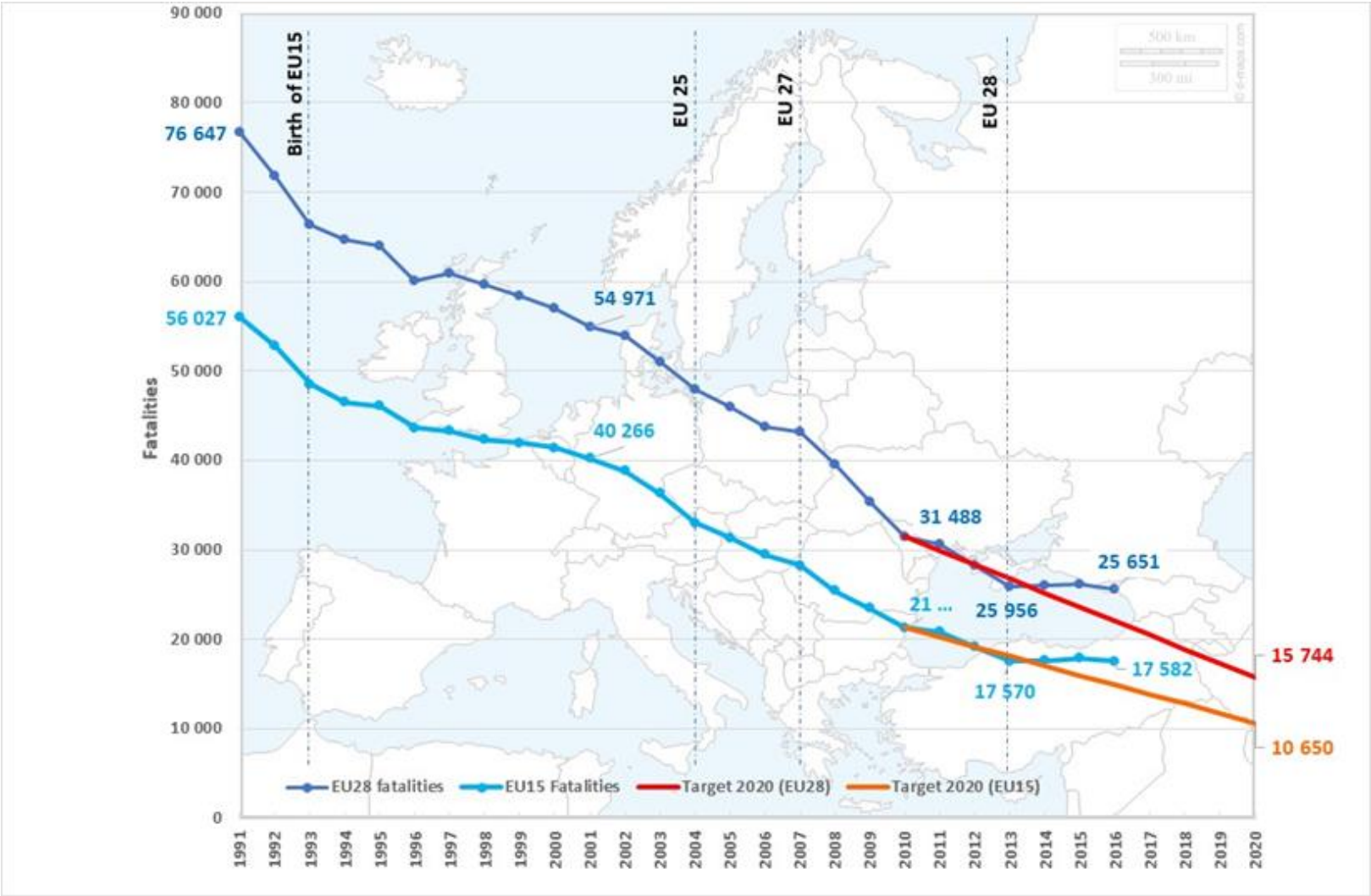


For ADAS & AD, safety is paramount...

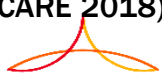


Europe achieved outstanding improvements on road safety over the past 25 years...

Europe - CARE



Evolution of the road fatalities in the EU from 1991 to 2016
(CARE 2018)



...working on behaviors, cars and infra in a holistic approach

REGULATIONS

M
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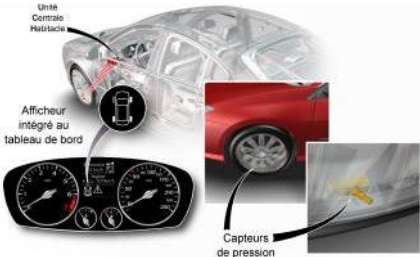


HUMAN

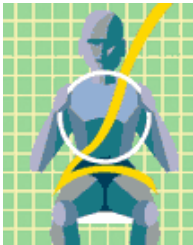
MACHINE

ENVIRONMENT

PRE-EVENT



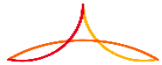
EVENT



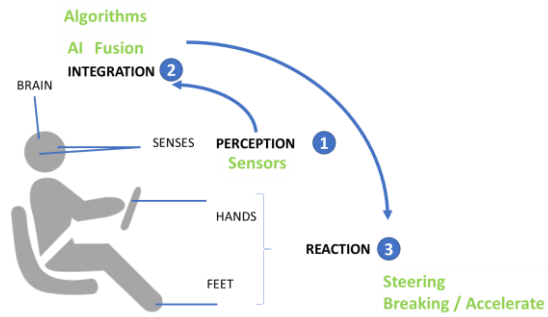
POST-EVENT



..completed with norms, trainings and expérience...



Automated Vehicle deployment shall improve the road safety...and we have to be able to demonstrate it ...



Connectivity

Infrastructure

Cybersecurity

Others agents



PERCEPTION

1

INTEGRATION

2

ACTION / REACTION

3

1

SENSORS

2

ALGORITHM & ARTIFICIAL INTELLIGENCE

3

VEHICLE BEHAVIOUR SYSTEMS

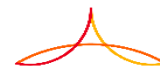
SAFETY COMPLIANCE

Autonomous Driving ?

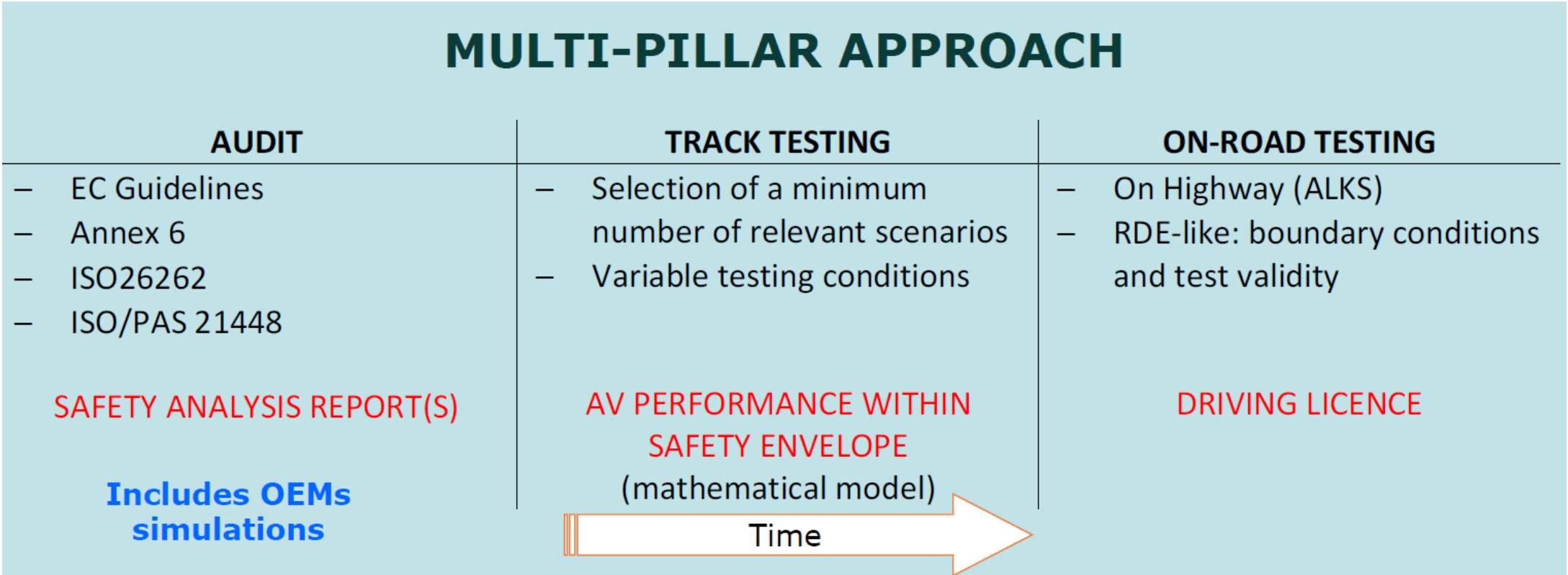
Conception robustness
Validation robustness
Standards & Regulation

 $\Sigma (\text{vehicle systems}) > (\text{Human})$

Within ODD



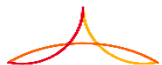
AD safety demonstration should rely on a multi-pillar approach



4th PILLAR: In-use data reporting?



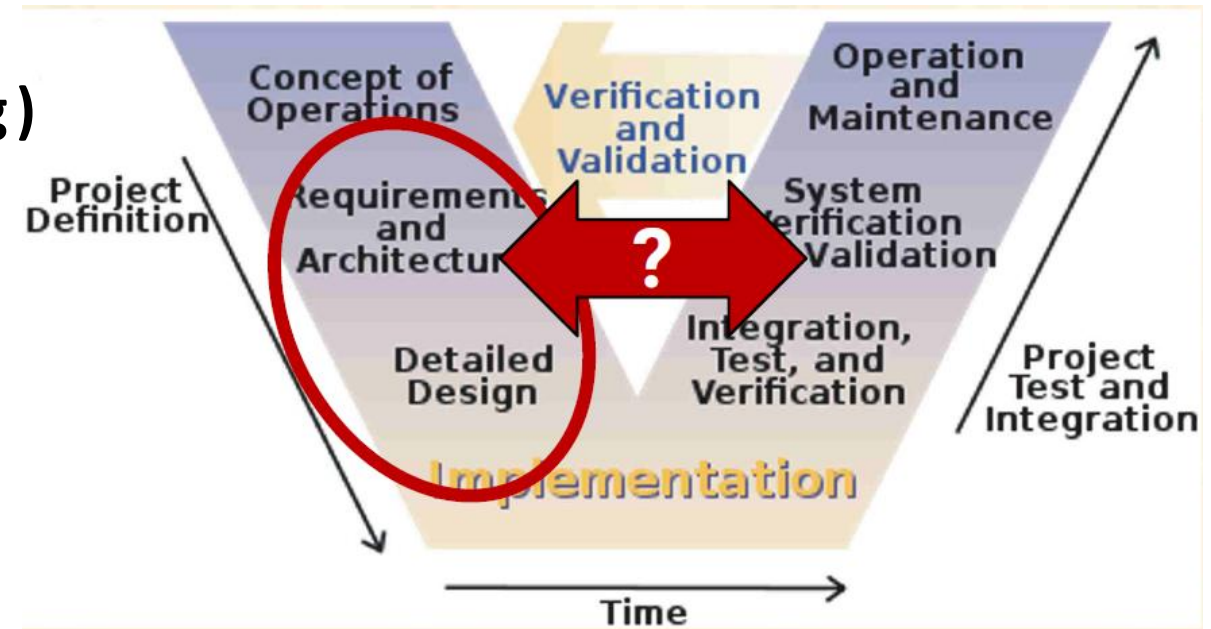
Source: JRC proposal for Safety Assessment of Automated Vehicles



Some approaches may not be sufficient...

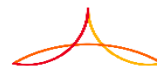
Machine Learning (inductive training)

- ➔ No requirements
- Training data is difficult to validate
- ➔ No design insight
- Generally inscrutable



We should expect the extreme, weird, unusual

- ➔ Unusual road obstacles
- ➔ Extreme weather
- ➔ Strange behaviors



Autonomous vehicles should avoid accidents that would have occur with a human driver...

...And there are at least 3 types of accidental situations that can occur with AD

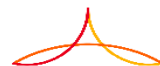
1) The same accidental situations as in manual driving:

For instance, the jump of an animal hidden by bushes in front of the car at the last second

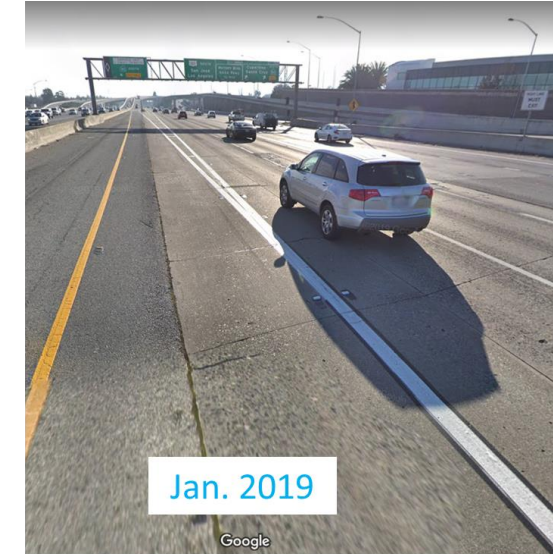


2) **New accidental situations:** they are not encountered during manual driving, for example due to poor quality road marking

3) New accidents due to a **different dealing of the critical situation** from the way a human driver would have done.



AD are even more dependent on infrastructures than manually driven cars



Source:
Google Maps

Autonomous vehicles may face or generate new accident situations...

An SAE level 2 March 2018 fatal accident mountain view (California) case



Safety argumentation for AD is a Global stake...

SAFETY ARGUMENTATION FOR AUTOMATED VEHICLE SAE LEVEL OF AUTOMATION 3 AND 4

❖ “Automated Vehicle deployment shall improve the road safety”

- This overall intention helps to define the ISO/PAS21448 requested SOTIF acceptance criteria.

❖ “The automated vehicle is free from unreasonable risk”

▪ Qualitative safety principles

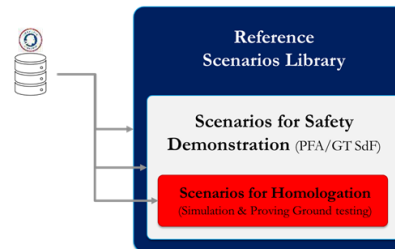
- The vehicle shall comply with a set of **high-level safety rules** contributing to safety, whether or not their safety impact can be quantitatively assessed,
- Design and **verification & validation phases** shall take into account relevant **driving scenarios**, including relevant **misuses**.

▪ Quantitative approach: SOTIF acceptance criteria

- ISO/PAS21448 request “acceptance criteria” to be defined.
- Our “acceptance criteria” is a **validation stop quantitative criteria**,

▪ Field experience

- **Field experience** shall be taken into account to continuously improve vehicle safety.
- Lessons learned from the field should be **shared** as far as possible.



Germany white Paper Daimler-BMW ++

- Démarche dans la démonstration semblable à Livrable ISO 26262 + Etude SOTIF
- notions de distance entre accidents et de « **positive risk balance compared to human driving performance** »

Japan - JAMA – SAKURA

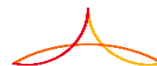
- Safety Assurance Kudos for Reliable Autonomous vehicles

China: ICV information security test technology standard

- **risk** conversion probability, calculation, impact.
- OTA **safety**, data safety, network safety, application safety, system safety and hardware safety to judge ICV information safety level

USA

... with too few coordination



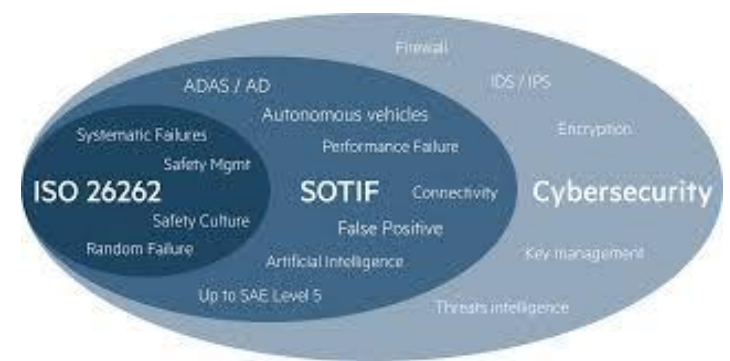
Safety relies on robust standard...

2

sensors, data fusion, scene understanding, decision making, infinity of use cases, ..

1

mechanics, hydraulics, E/E ..



1 – Well known technologies - well known issues and established State-of-the-art :

- Regulations
- Norms : IATF-16949, ISO-26262 (E/E Functional Safety), ...
- OEM best practices, methods and tools

State-of-the-art is efficient: NHTSA “Critical reasons for Crashes ...” (DOT-HS-812-115)
→ vehicle is one of the “crash critical reason” in less than 2 % of the cases

=> **State-of-the-art shall be applied**



...with some improving ones

2 – New technologies (sensor, fusion, .. AI ...) and their new type of issues (malfunction w/o failure, decision making)

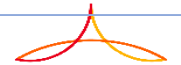
New sources of risk (eg. weather, surrounding traffic, ..)

No established State-of-the-art :

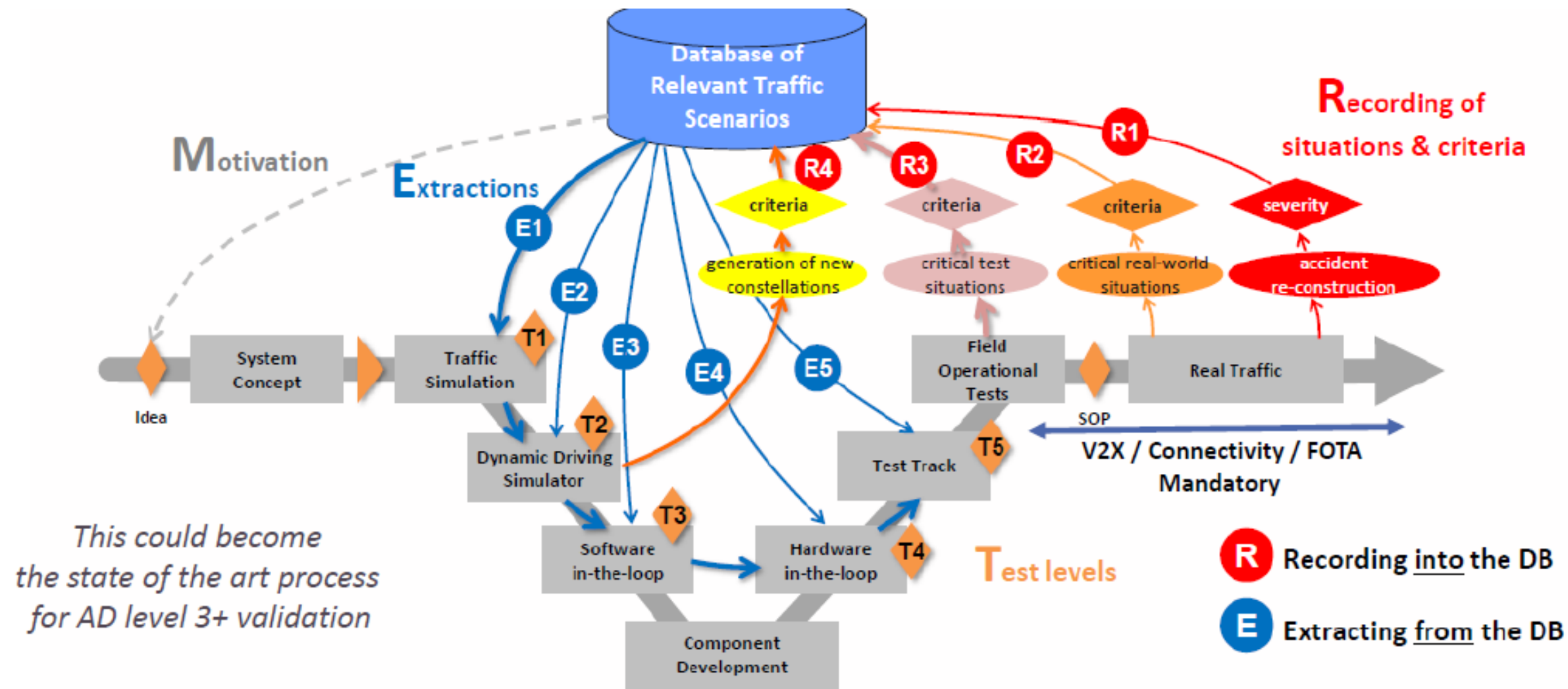
- on going regulations
- on going Norms – eg. ISO PAS 21448 (SOTIF), ...
- on going practices, methods, tools to define use case, validate, ..

=> ISO PAS 21448 (SOTIF) shall be applied but only cover today Level 2 systems

=> to be enriched (eg. by using GAME method to define a Validation Criteria)

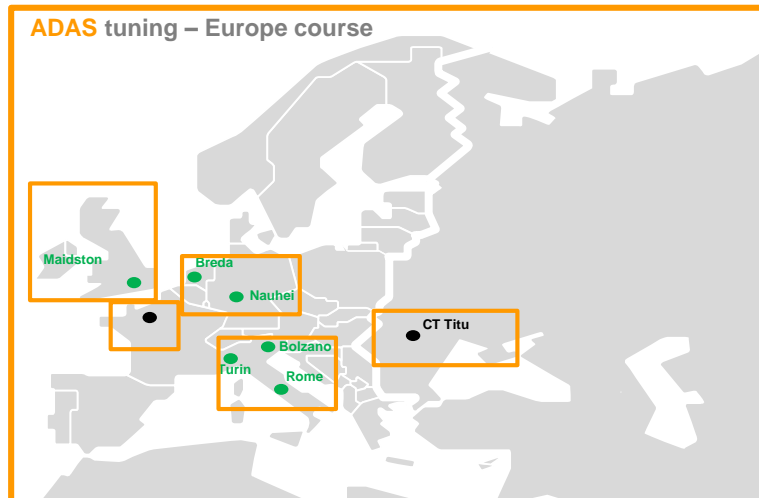
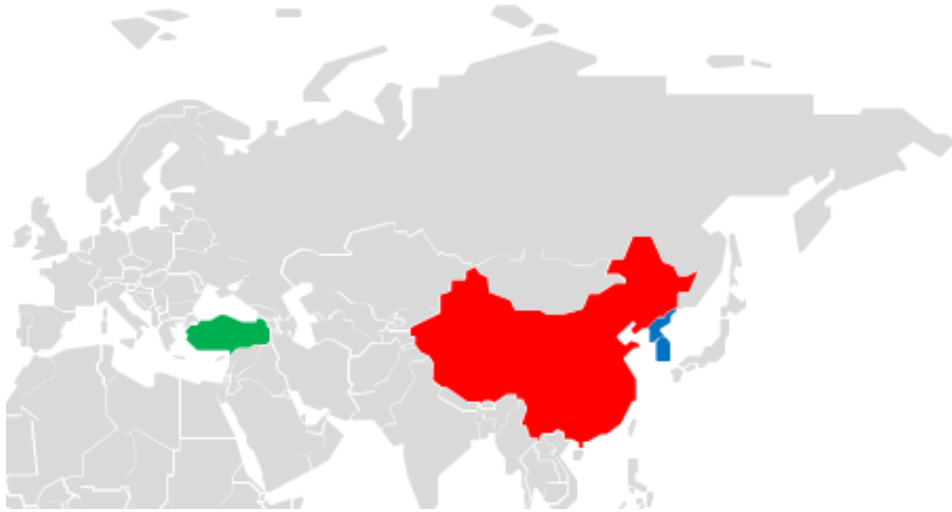


... all steps are SCENARIO based, through an extended and continuous V process...



(*) FROM GERMAN PEGASUS PROJECT PROPOSAL

... with regional specifics



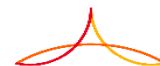
Highways with large curves



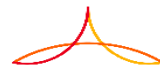
Tunnel entrance



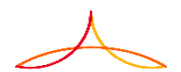
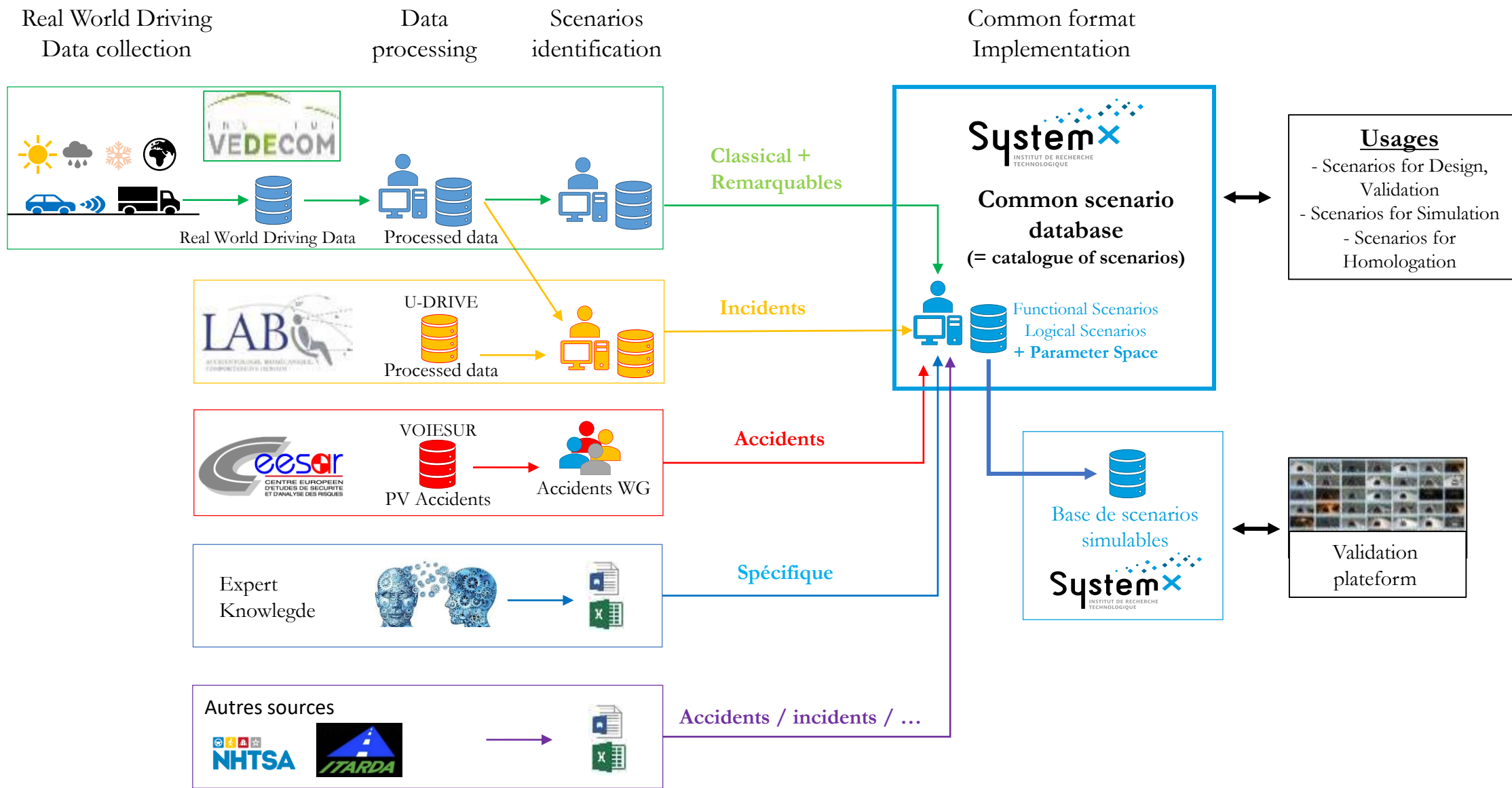
Mountain roads with critical curves



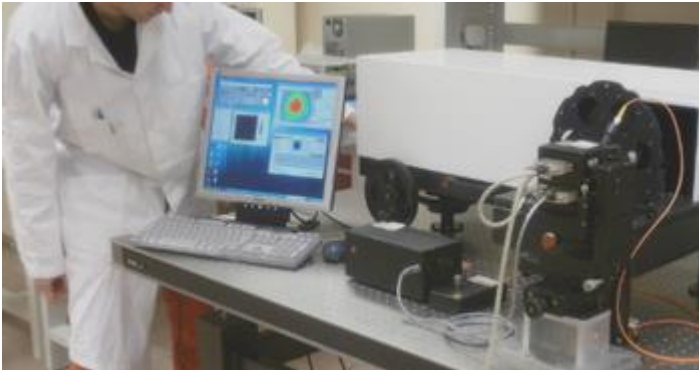
...AD scenario construction is a Global activity...



Alliance builds a catalog of scenario from various sources...



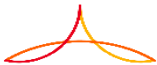
AD validation requires Road tests, simulation, HIL, and tracks



RELIABILITY TESTS ON SCENARIO CATALOG	102_Stop_ID1002	Scene Description	Corresponding Renault Nr	Integration Level	Judgment K2	Judgment K3
		<ul style="list-style-type: none">Vehicles are driving and stop until they stand stillNote: $v \approx v_func_max \rightarrow 0$ km/h	TM-201 TM-202 TM-203 RI-502 TM-501	1	Positive Scenario	Positive Scenario

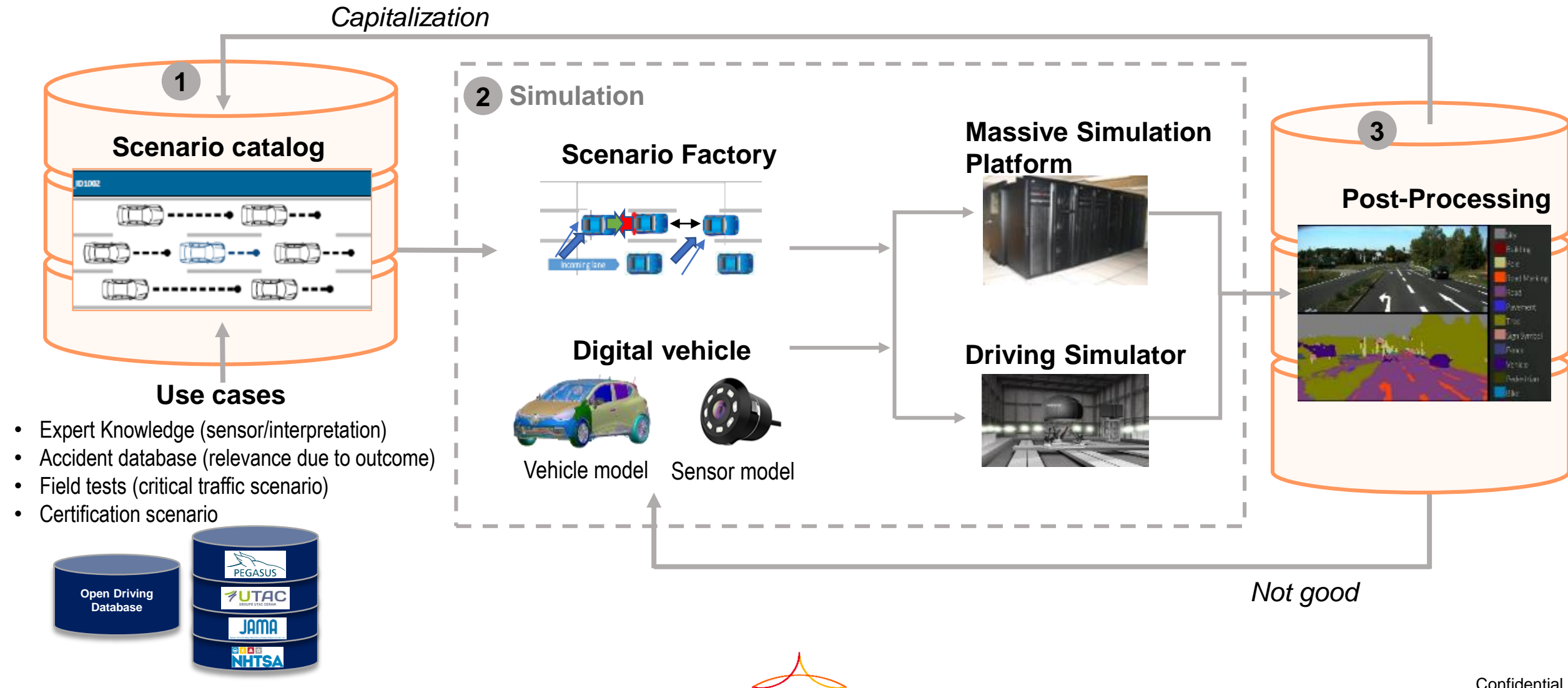
SIX STEPS OF THE AD PROCESSING CHAIN : UNITARY TESTING OF EACH

SENSORS	IMAGE / SIGNAL PROCESSING	DATA FUSION	OBJECT CATEGORY	DECISION	DRIVING COMMANDS

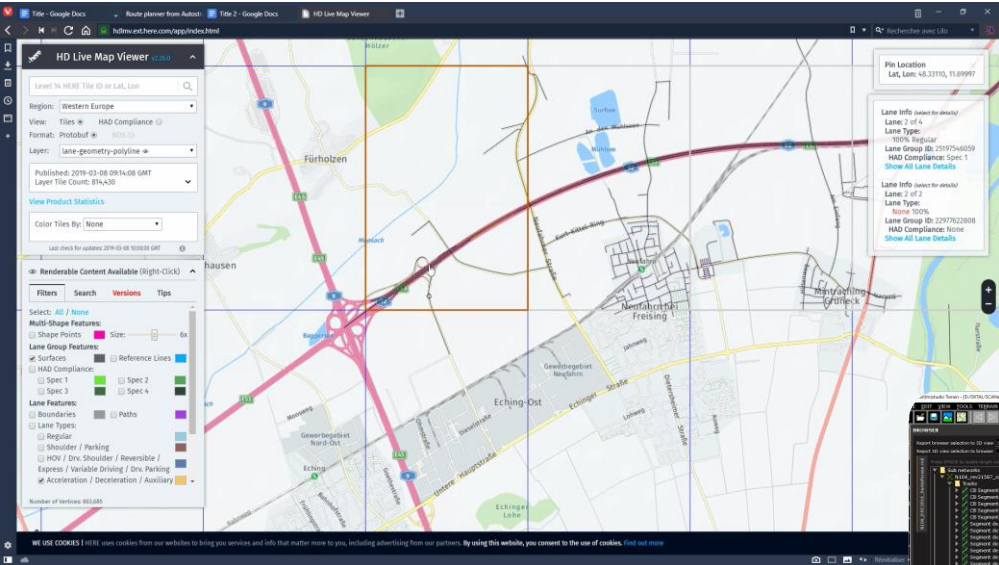


Alliance has developed a validation tool chain for autonomous vehicles

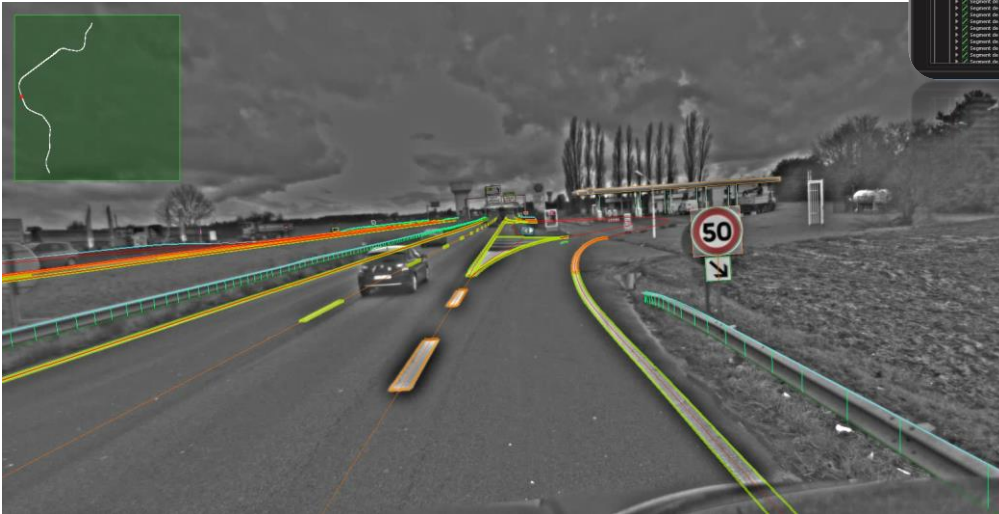
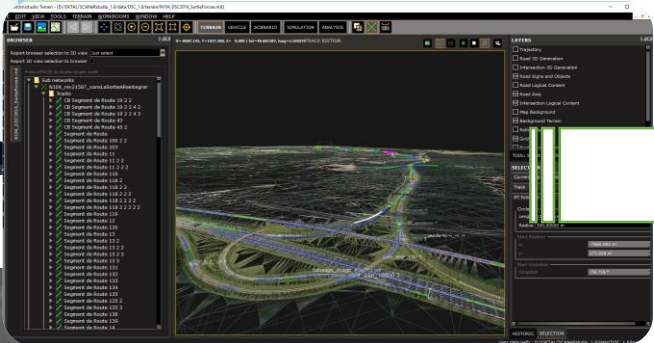
It is starting from SCENARIO and massively using SIMULATION...



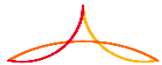
Simulation starts from digital world setting, with SCANeR™



HD Maps



Acquisitions
SCANeR™ studio



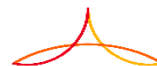
Courtesy of



Simulation plan is fitted to drive test, from real data...



- Very sensitive to the test data quality
 - Ego position must be accurate
 - bad detection → bad scenario.
- Vehicle position and road position matching



... and then allows our scenario factory to generate tests cases for robustness study...



0. Original



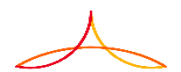
Cut-in 1



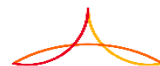
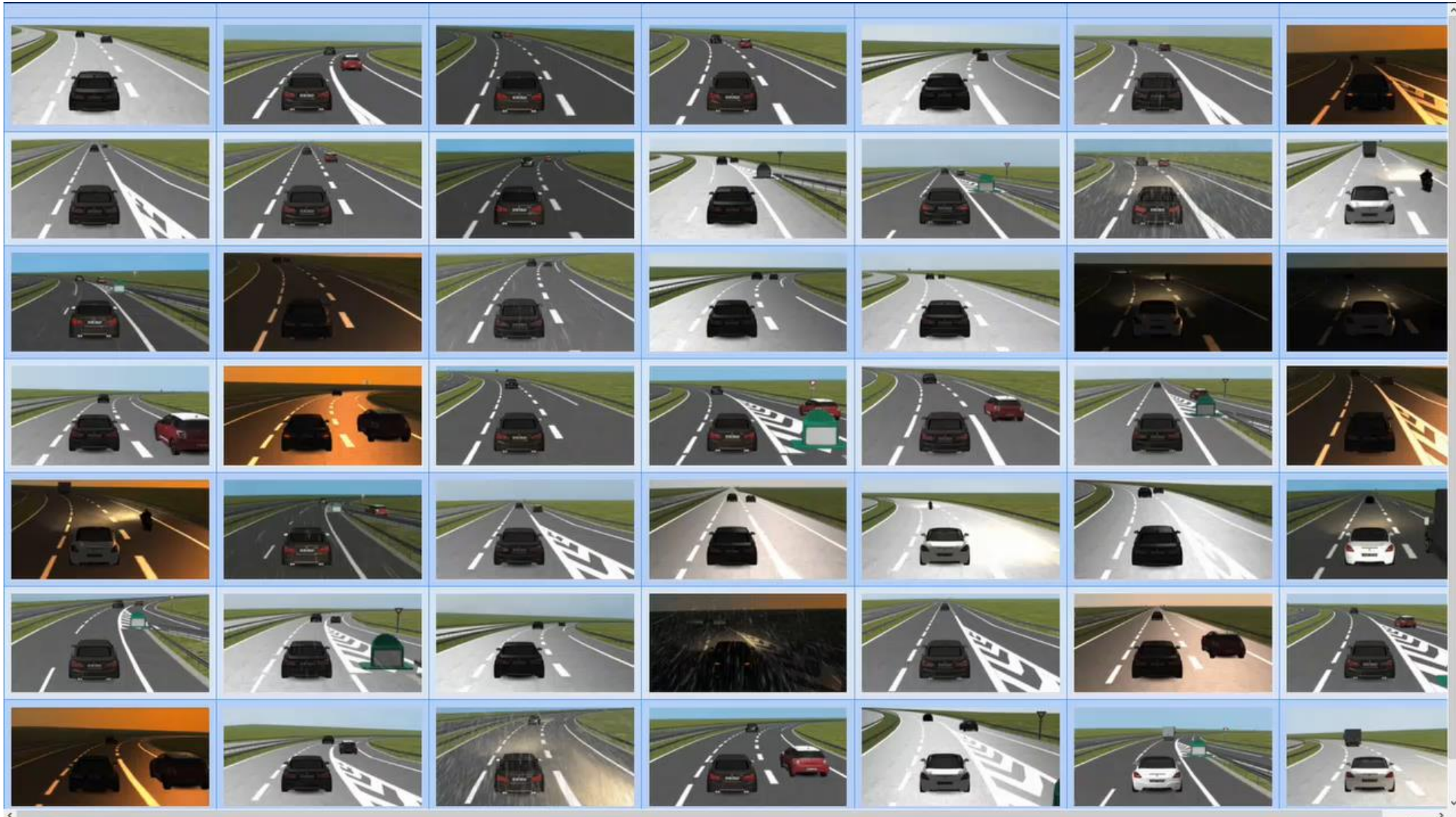
Cut-in 3



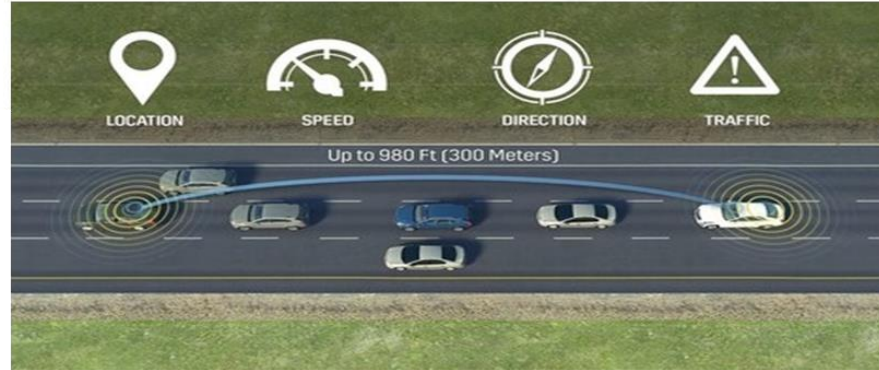
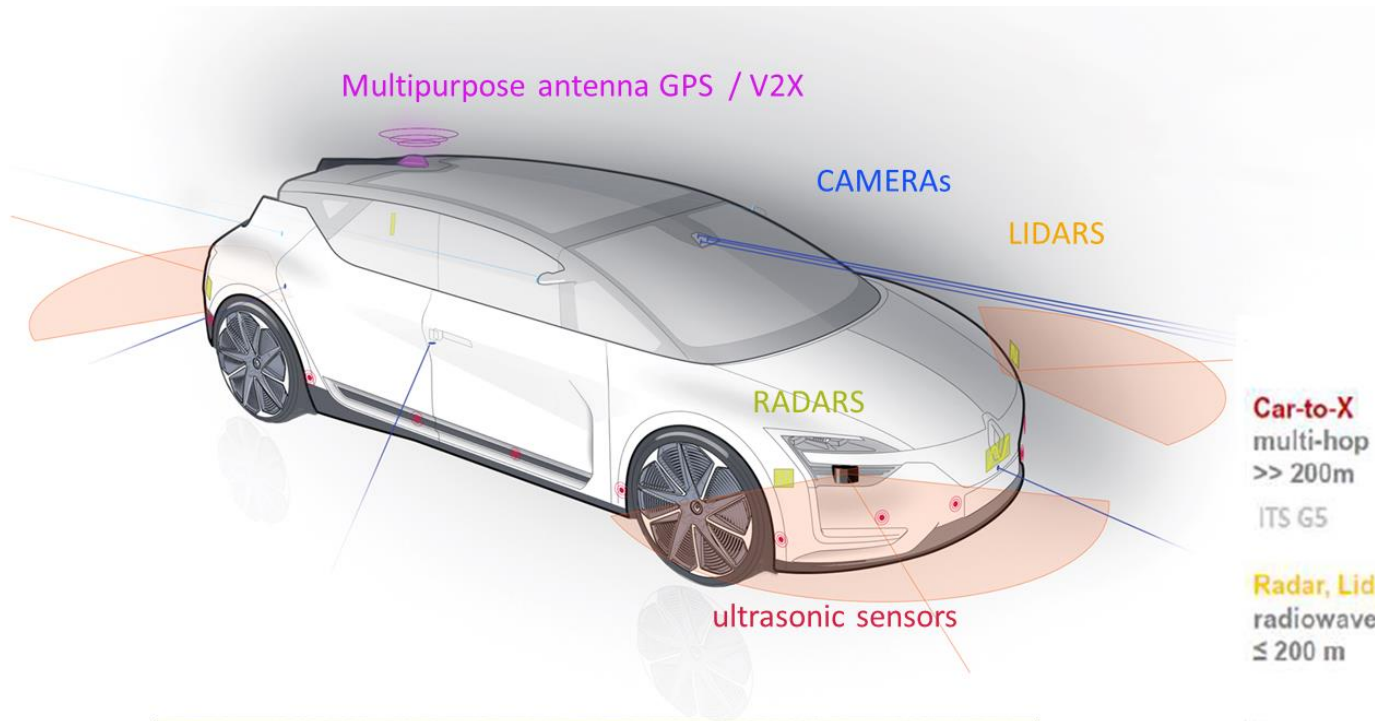
Cut-in 2



... integrating huge diversity



Main challenges: sensing systems



Need to use a complementary set of sensor technology

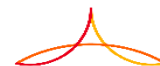
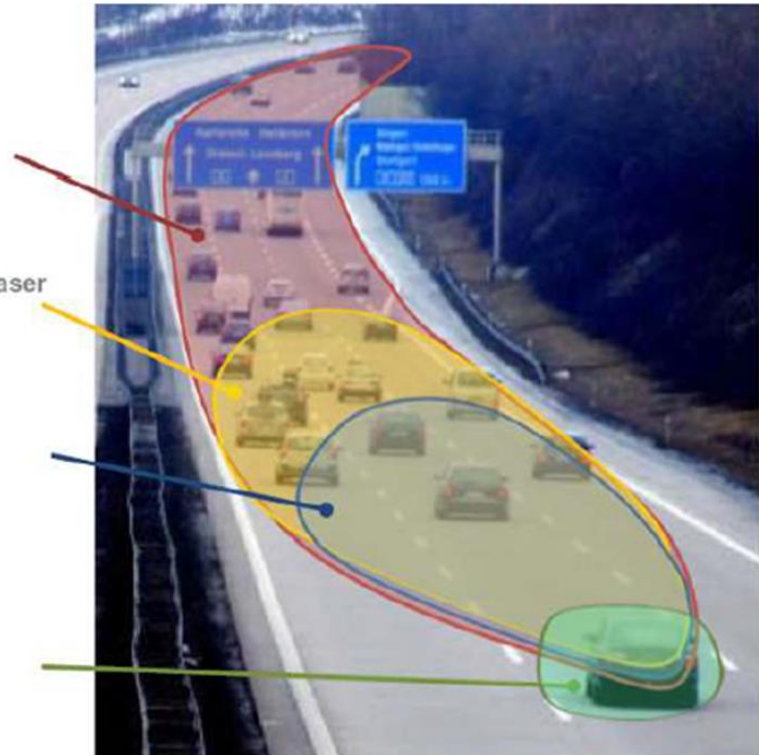
Car-to-X
multi-hop
>> 200m

ITS G5

Radar, Lidar
radiowaves, laser
 ≤ 200 m

Camera
optical
 ≤ 80 m

Sonar
ultra-sound
 ≤ 4 m



Sensors validity domain is still to extend... ...while reducing its overall cost

- Weather conditions perturbations

- Rising sun
- Spray
- Heavy rain
- Snow
- Fog
- Night
- Shadow
- ...



rFPRO courtesy



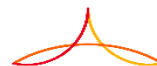
- One sensor is not enough...

- Redundancy needed

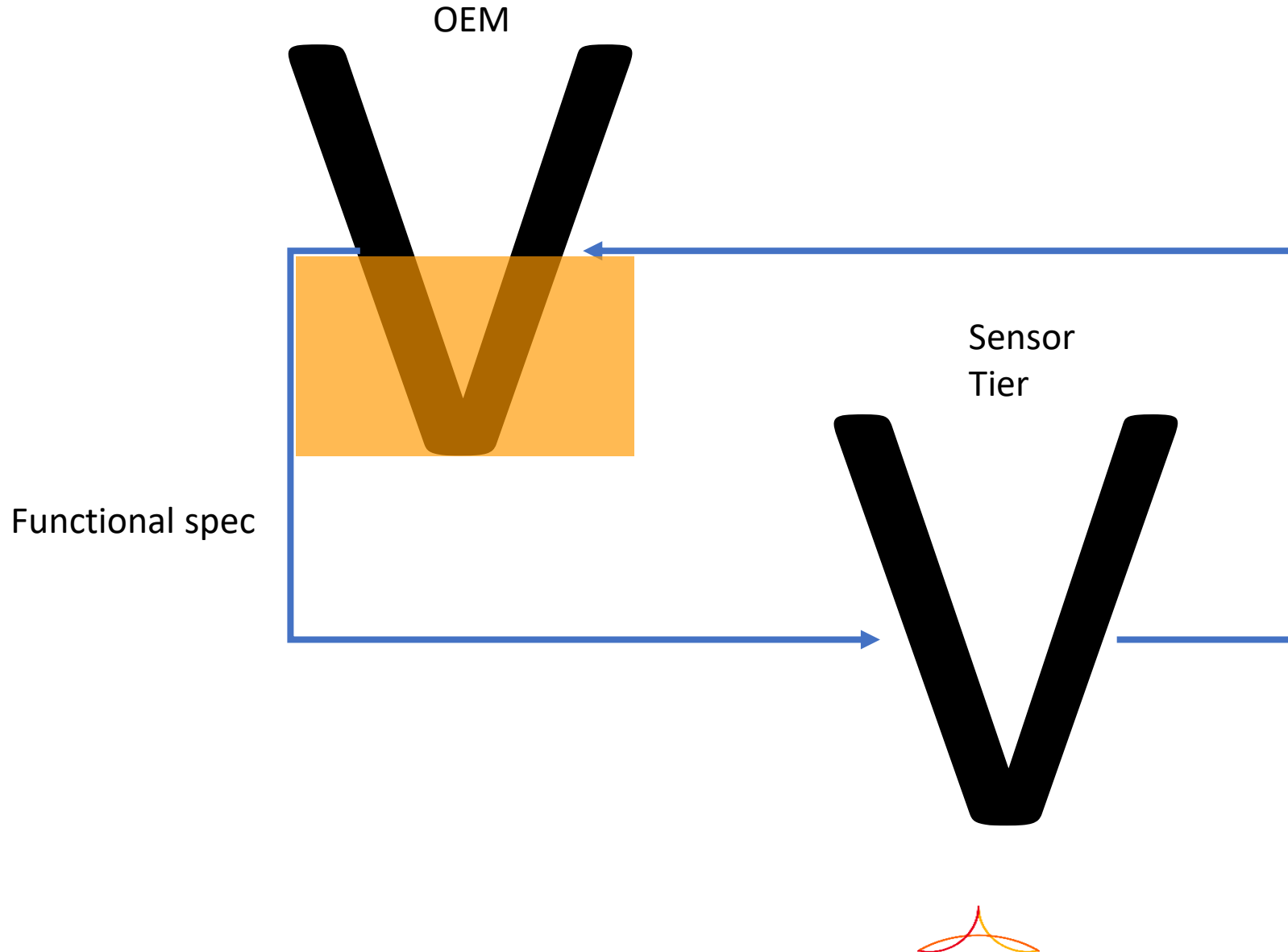


- Strong cost reduction / design freedom integration / operational domain extension are expected for sensors

- Life cycle reliability (cleaning, moisture, ...)

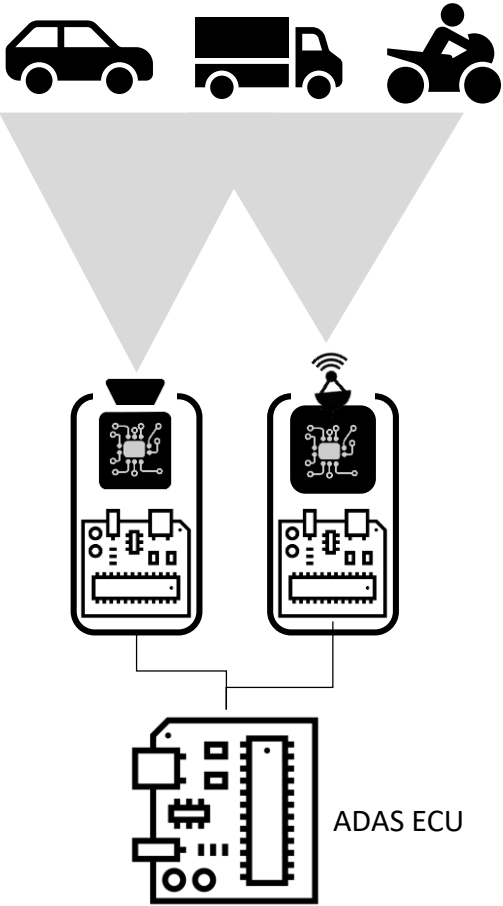


A clear JobSplit towards robust sensors validation is needed!

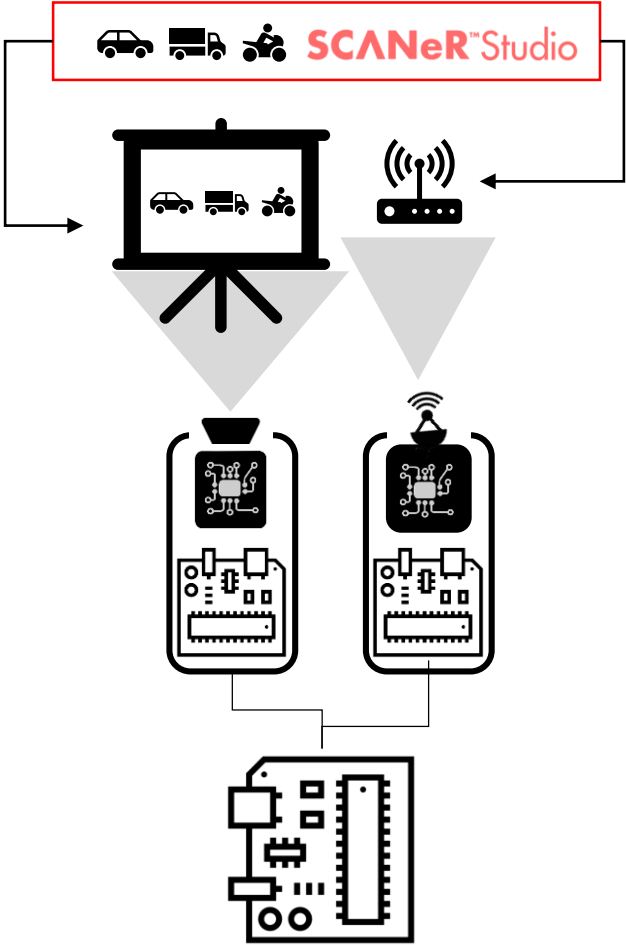


- Physical parts tested
- Models
- Datasheet with diversity: uncertainty / safety confidence level / per country
- Robustness level

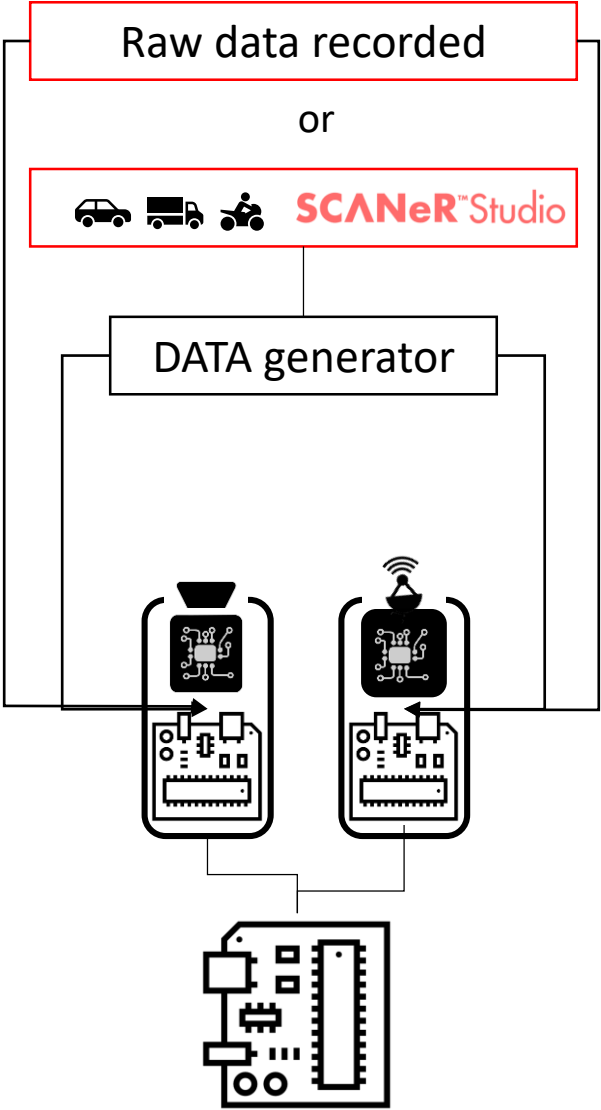
Various simulation in testing will provide agility and save prototypes!



Real situation

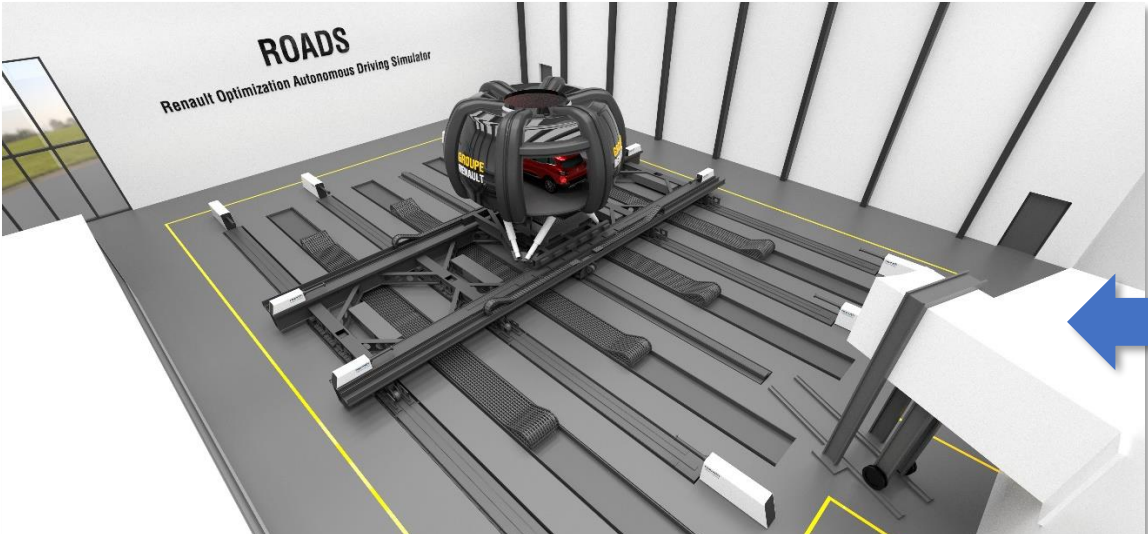


Sensors stimulation



Data injection

Corner cases and transition delegation , HMI design are assessed with Driver in the Loop – Driving simulator 1:1

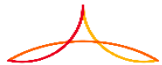


High performance
Driving Simulator
Delivery : Q2 2020

NISSAN DS
Delivered : 2017



Motion system : 1g in X&Y / 15m x 15m
Projection system : 360° / 3D



Testing is mandatory for calibration, tuning...

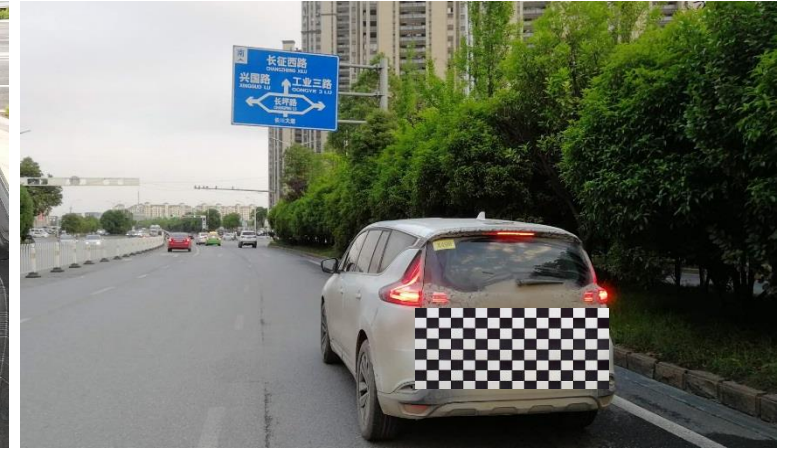
Public **road test**



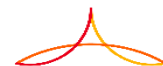
Localization calibration & tuning



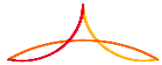
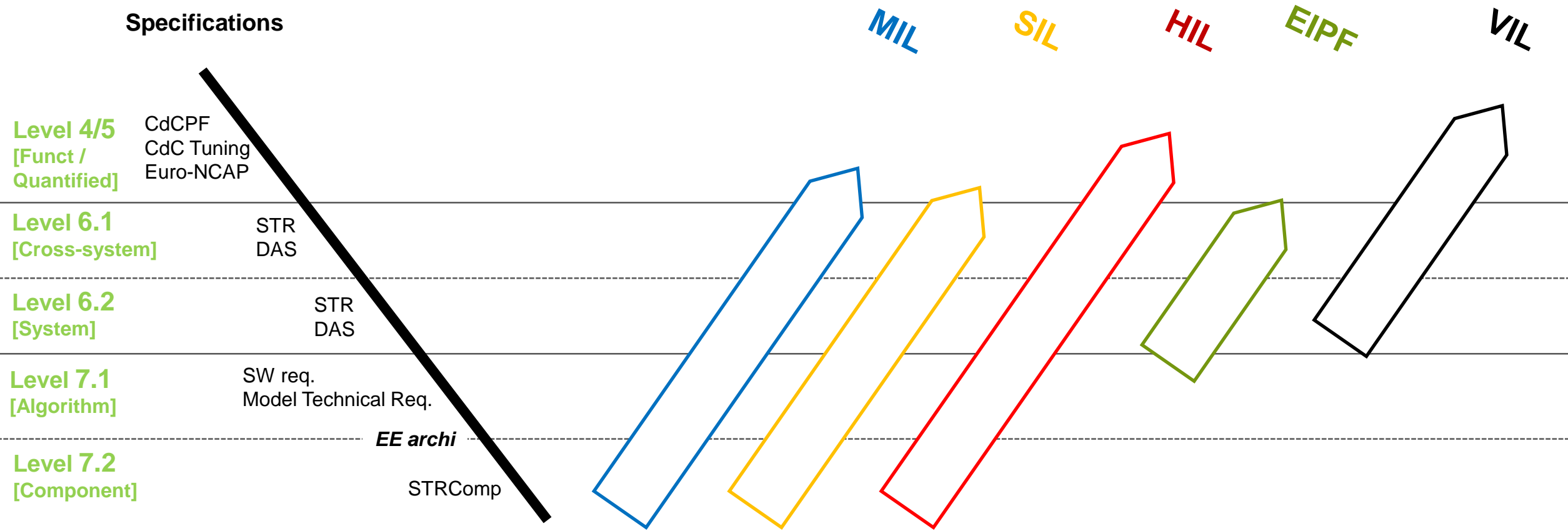
Localization validation



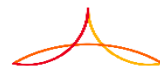
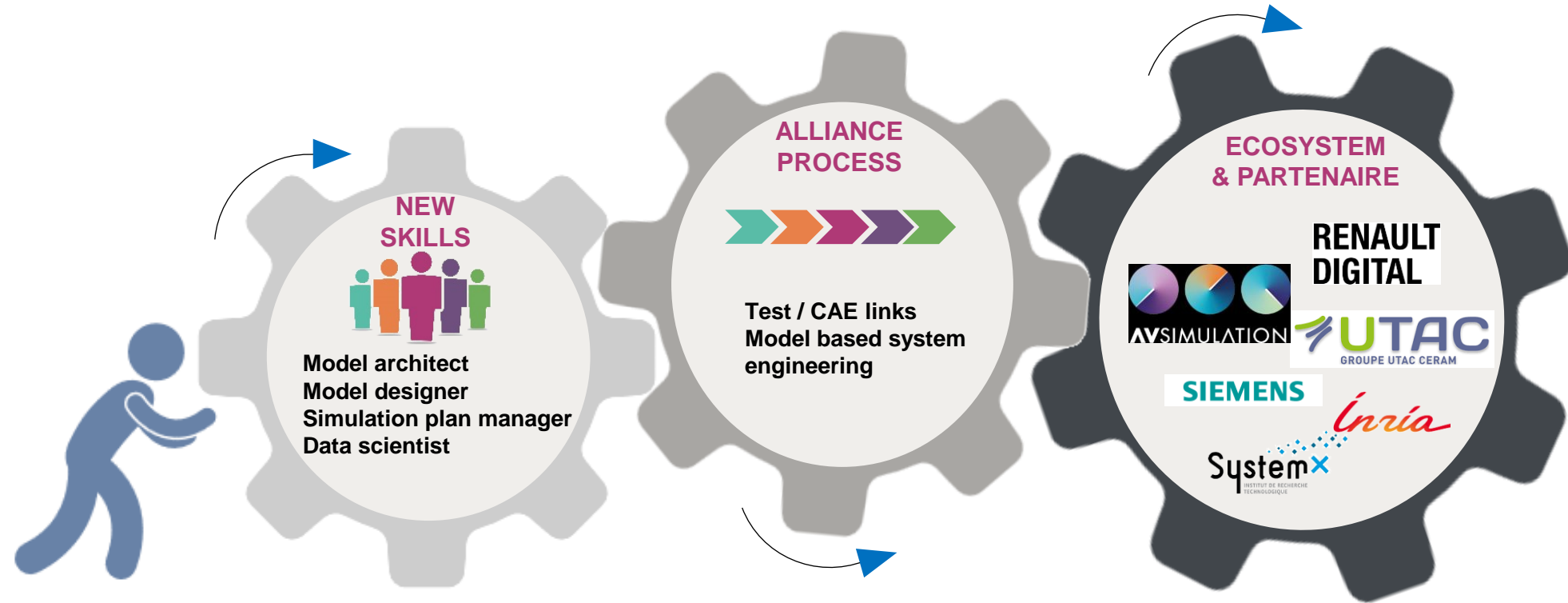
...it requires heavy equipments



The Verification & Validation System ensures safety ...with scrutability in an overall Alliance V&V platform



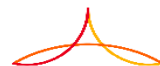
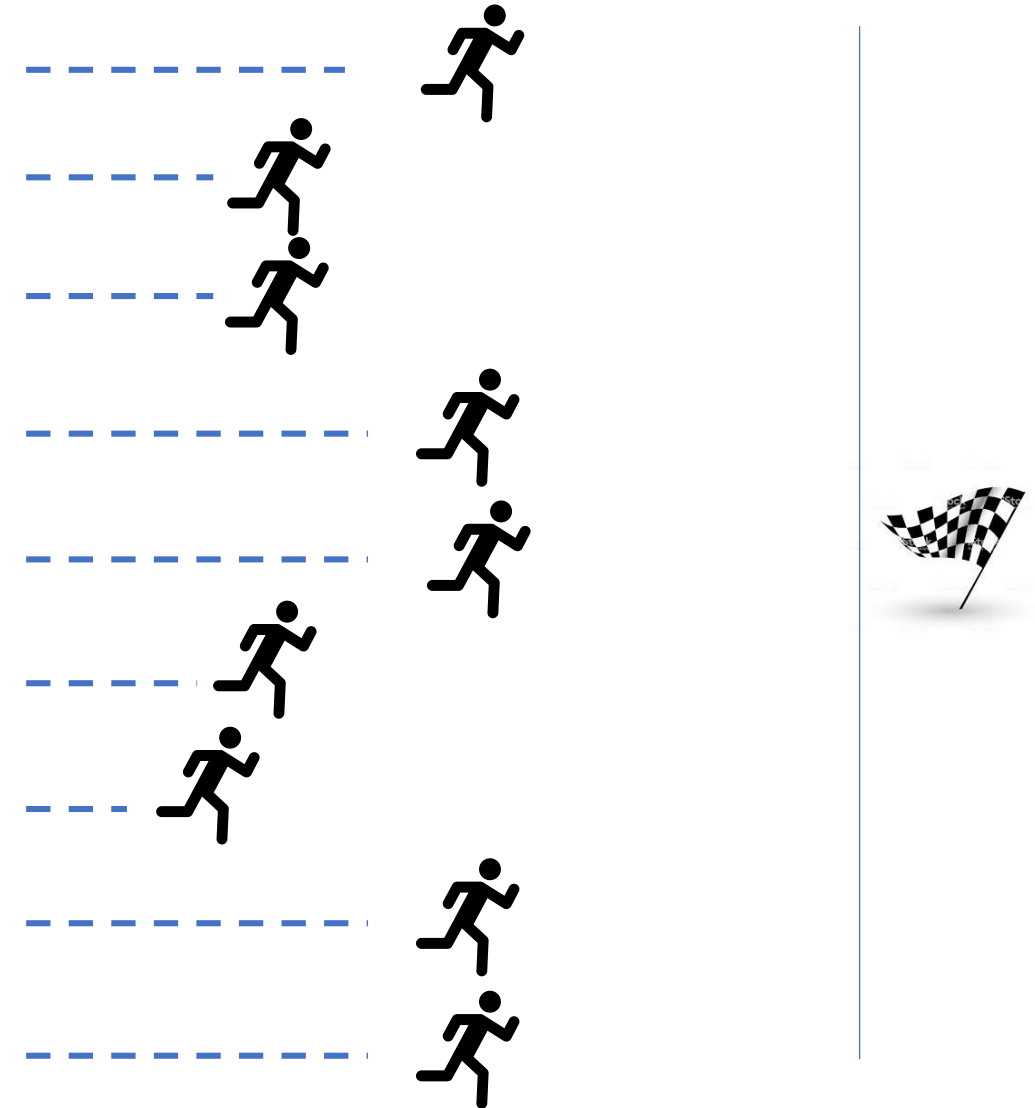
Need for a powerful extensive ecosystem of validation...



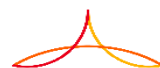
...and still a lot of work to do, not only technical!

Situation Q4 2019..... 20??

- SW & Data management to address complexity
- Legal framework & RASIC – **Self certification?**
- Transition Delegation
- Social acceptance: what is the value? Safety?
- Test & Simulation.. To V&V – Mature **Partnerships?**
- ...**sensors** maturity L3 & + , cost performance?
- Infrastructure & **V2X?** In safety loop?
- **Scenario database?** Near Accidents?
- Manufacturing end of line checks?



THANK YOU!





RENAULT NISSAN MITSUBISHI

DSC 2019 EUROPE VR
STRASBOURG, FRANCE | September 6th , 2019

From Assistance to Autonomous Driving: New safety Validation Challenges

Marc PAJON

Expert Leader Testing & Measurement Technologies

