MATLAB EXPO

2024.06.11 | 그랜드 인터컨티넨탈 서울 파르나스

The Future and Reality of Autonomous Driving

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MathWorks

I. Recent Trends

Mobility Technology & Industry Big Bang : only 13years

Source: US National Archives.

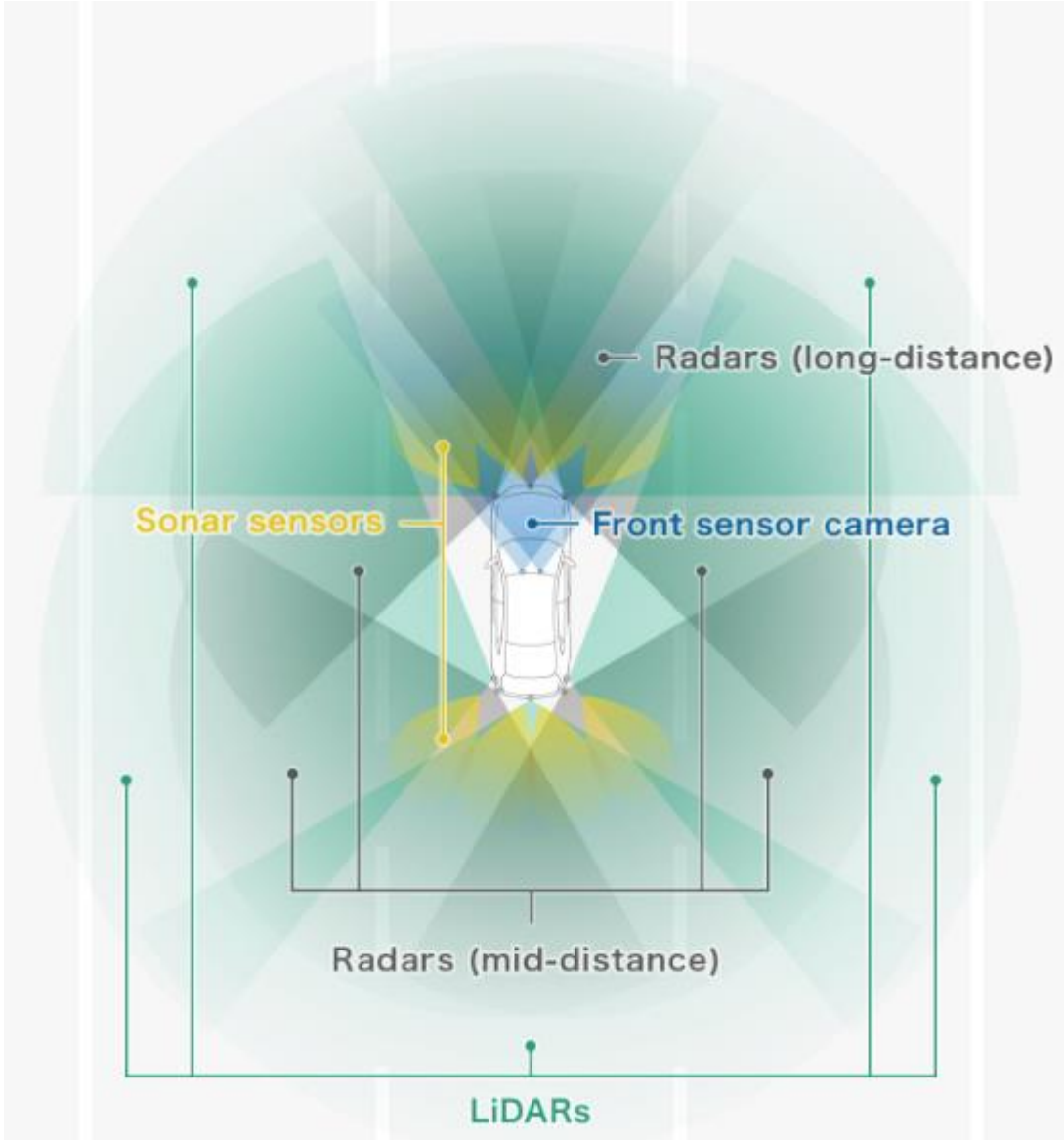
Source: George Grantham Bain Collection.

New York Fifth Avenue, **1900**

New York Fifth Avenue, **1913**

* source : LG Business Research

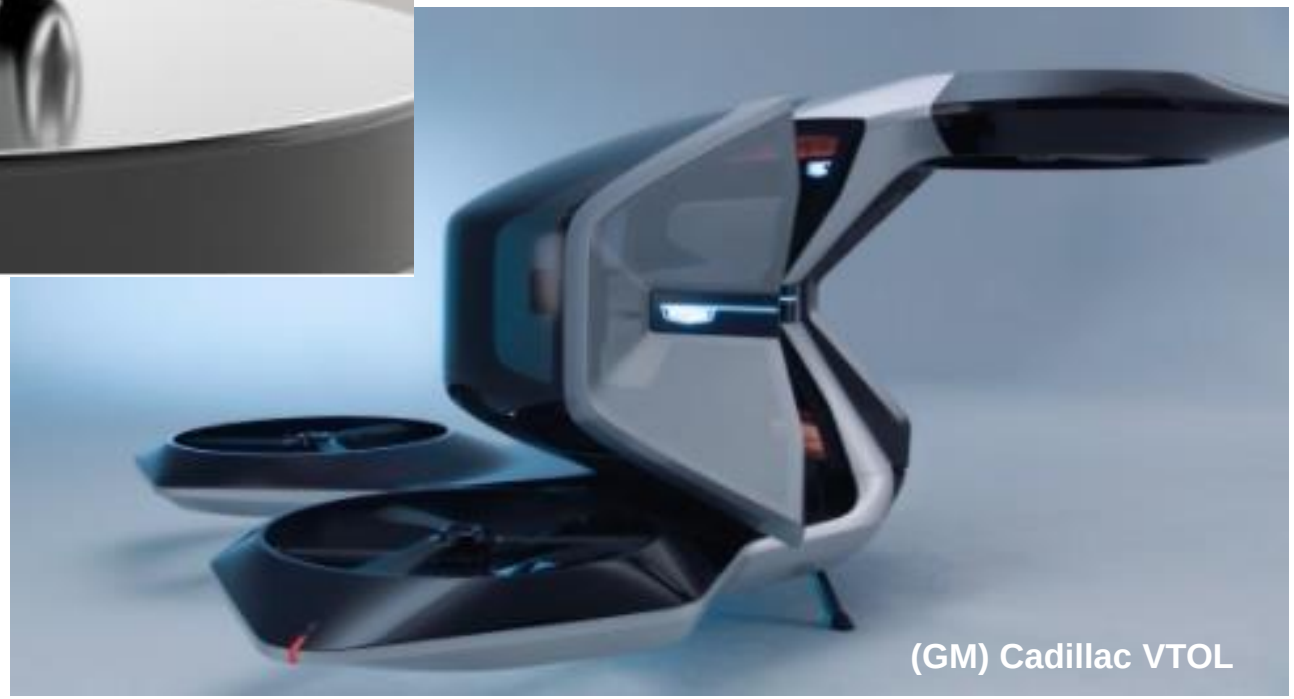
March 2021, Lv.3 Legend “Honda SENSING Elite - Traffic Jam Pilot”



* source : Honda

GM's Future Vision : Zero Crashes, Zero Emissions, Zero Congestion

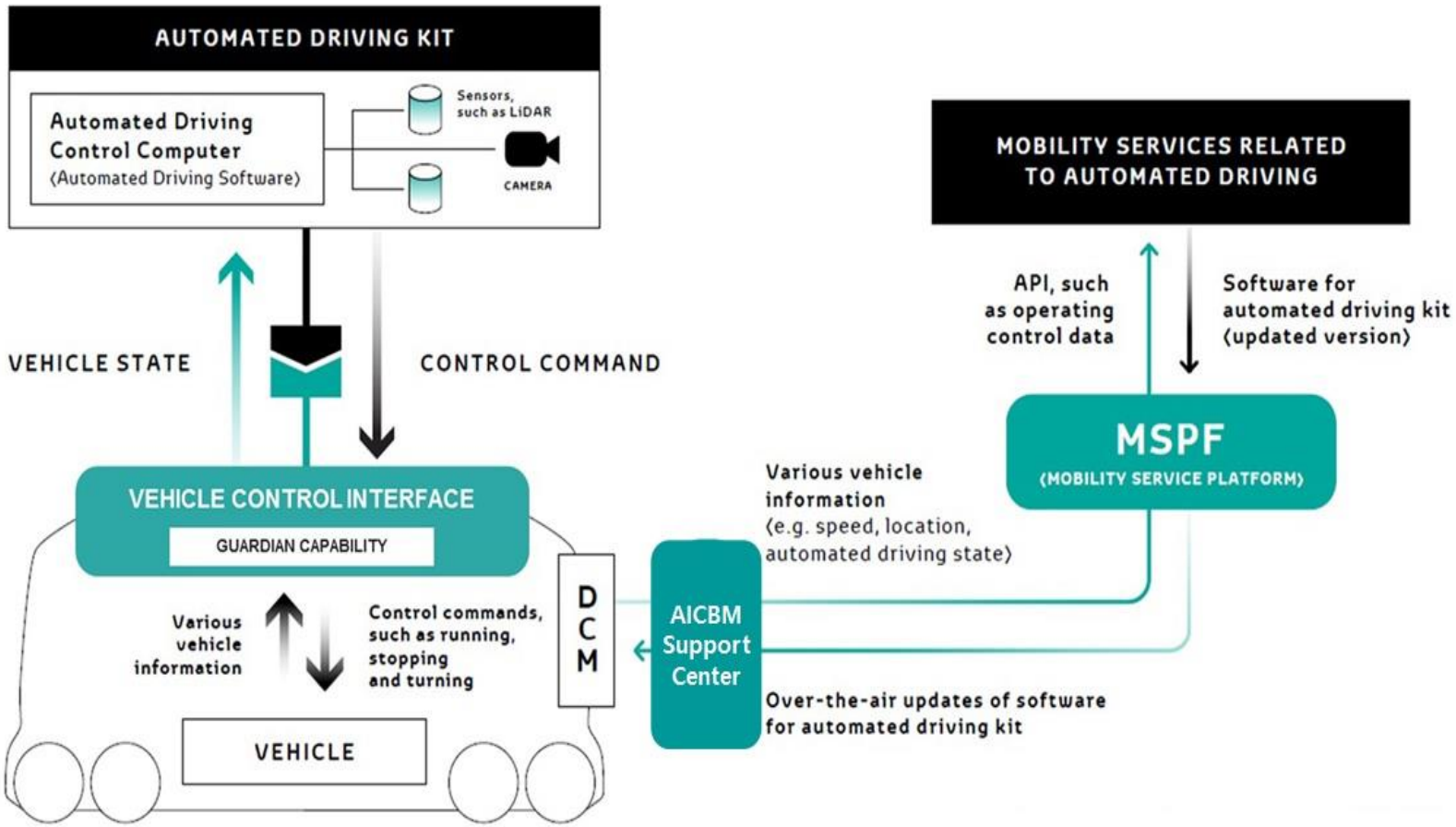
(GM) Cadillac PAV



(GM) Cadillac VTOL

* source : CES 2021

Toyota e-Palette, Mobility Service Platform Provider

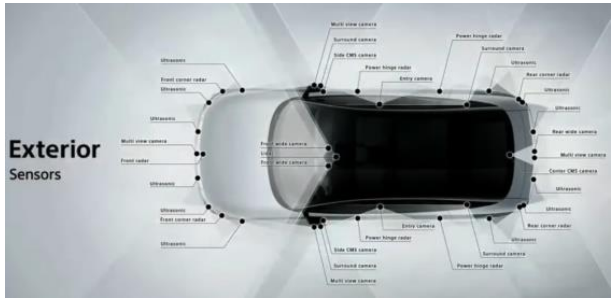


* source : Toyota

Mobility driven by sensing technologies and AI = “AFEELA Prototype”

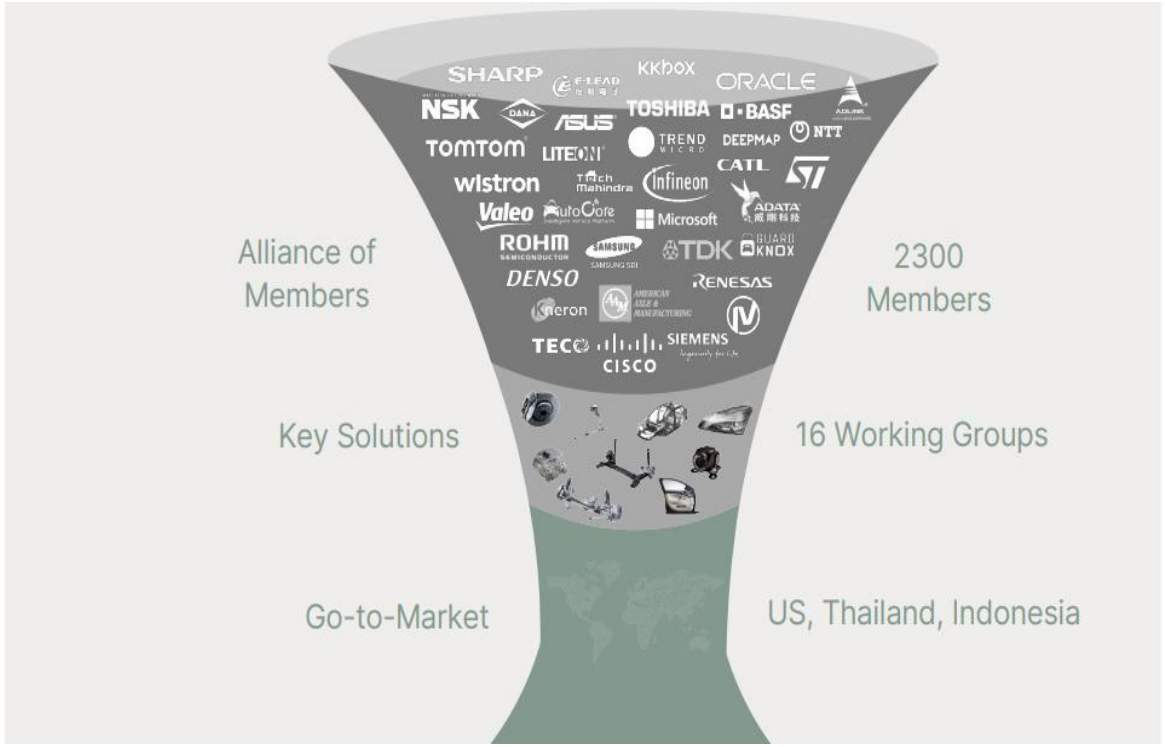
Delivery to North America
in Spring 2026

Sony Honda Mobility (’22.10)



* source : Sony Honda Mobility

Foxconn, Mobility in Harmony Consortium (2,748 members)



Next Generation of EV, Autonomous Driving & Mobility Service Applications

* source : MIH

Changan & Tencent, Joint Venture for Smart Mobility

April 2016, Chongqing ⇒ Beijing (2000km), successful test of long distance autonomous driving

July 2018, Baidu, autonomous shuttle based on Apollo platform

* source : Changan, Tencent, Baidu

Technology Development + Consumer Demand □ Future Market

Now

Simple Mobile

* source : Hello Drive

Driving Support Mobile

* source : MOBIS SCC

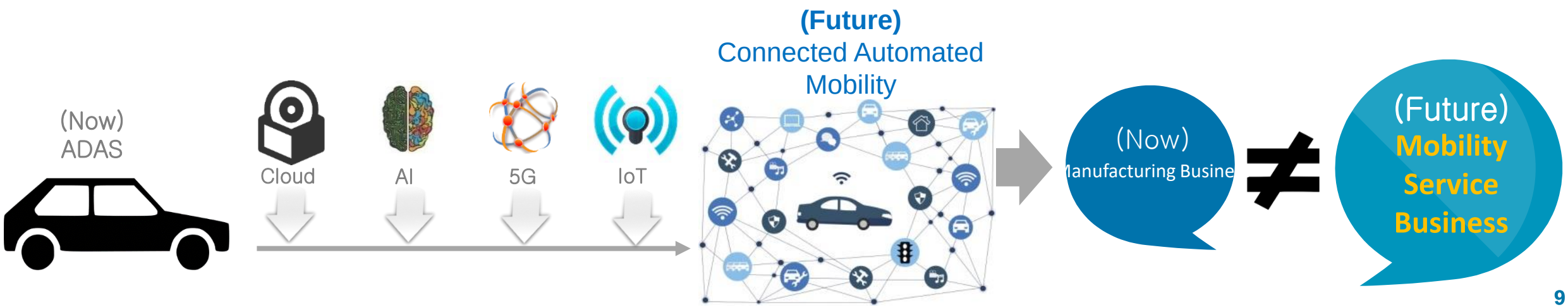
Future

Living Space Mobile

* source : VW

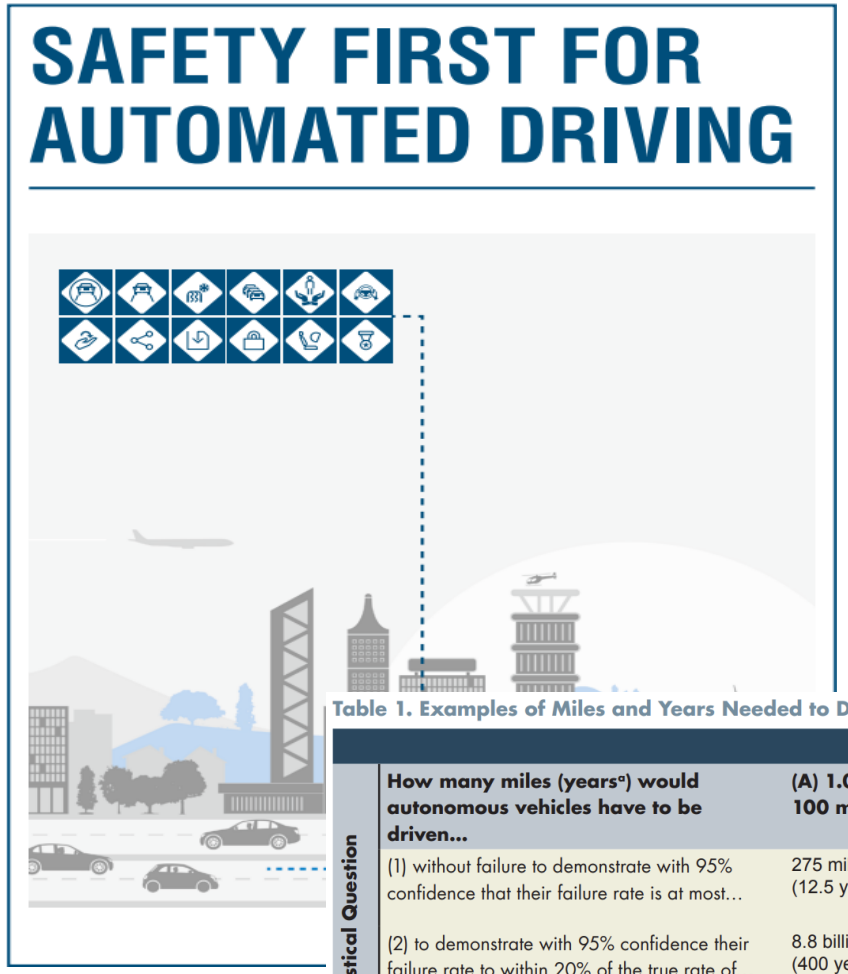
Mobile Office

* source : GM



II. Major Issues

Safety & Security of Autonomous Driving Technology and Production



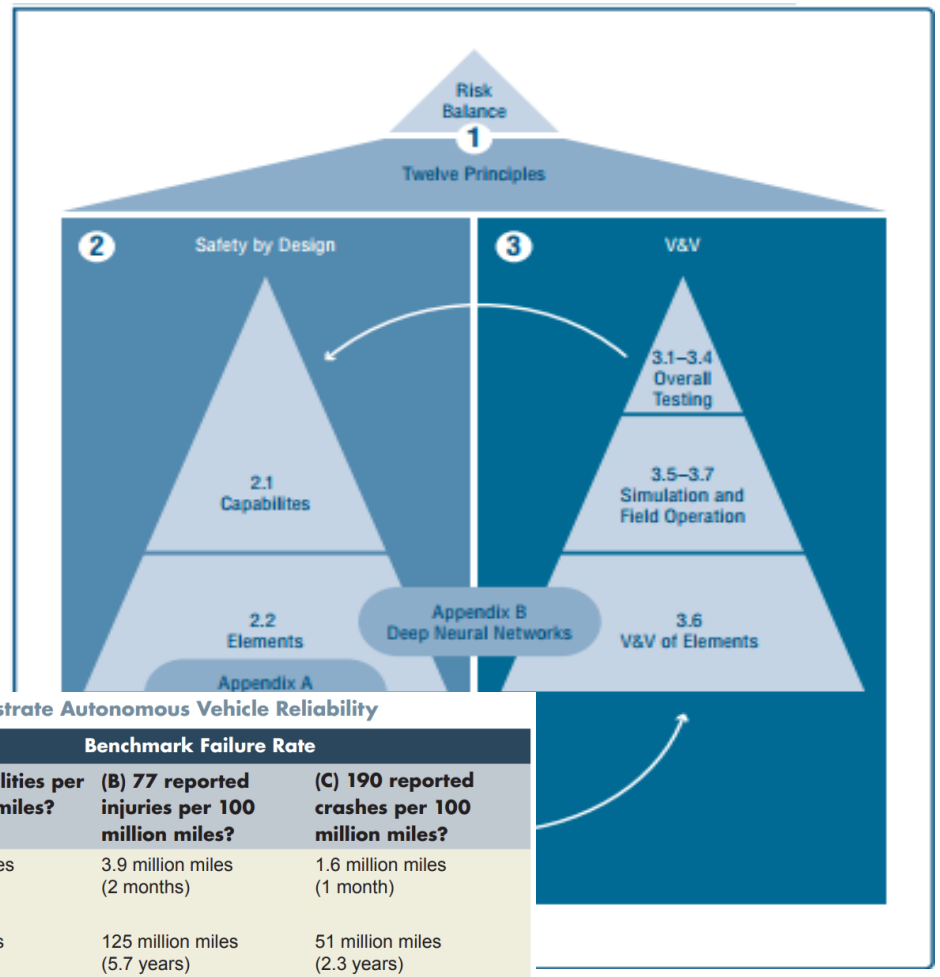


Table 1. Examples of Miles and Years Needed to Demonstrate Autonomous Vehicle Reliability

		Benchmark Failure Rate		
Statistical Question	**How many miles (years[a]) would autonomous vehicles have to be driven...**	**(A) 1.09 fatalities per 100 million miles?**	**(B) 77 reported injuries per 100 million miles?**	**(C) 190 reported crashes per 100 million miles?**
	(1) without failure to demonstrate with 95% confidence that their failure rate is at most...	275 million miles (12.5 years)	3.9 million miles (2 months)	1.6 million miles (1 month)
	(2) to demonstrate with 95% confidence their failure rate to within 20% of the true rate of...	8.8 billion miles (400 years)	125 million miles (5.7 years)	51 million miles (2.3 years)
	(3) to demonstrate with 95% confidence and 80% power that their failure rate is 20% better than the human driver failure rate of...	11 billion miles (500 years)	161 million miles (7.3 years)	65 million miles (3 years)

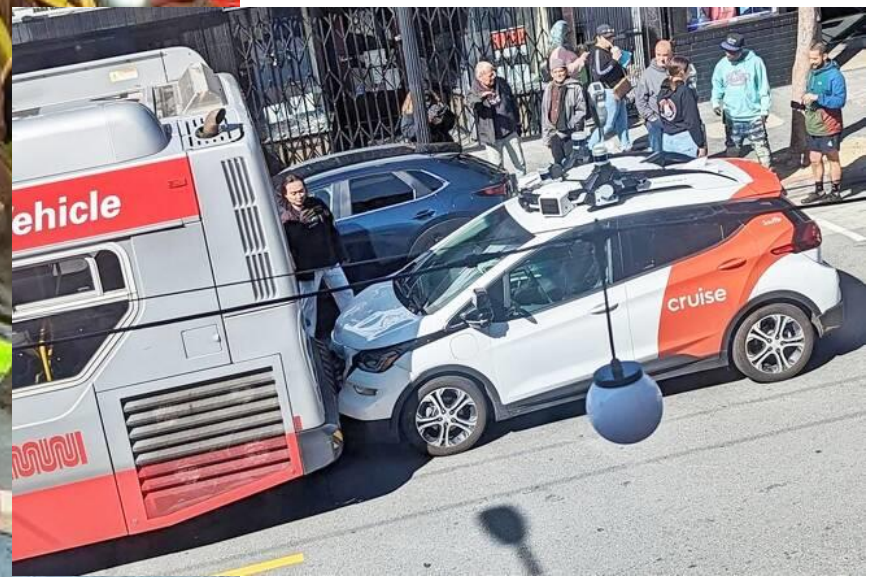
[a] We assess the time it would take to compete the requisite miles with a fleet of 100 autonomous vehicles (larger than any known existing fleet) driving 24 hours a day, 365 days a year, at an average speed of 25 miles per hour.

⇨ Test period : 12.5years

* source : Benz

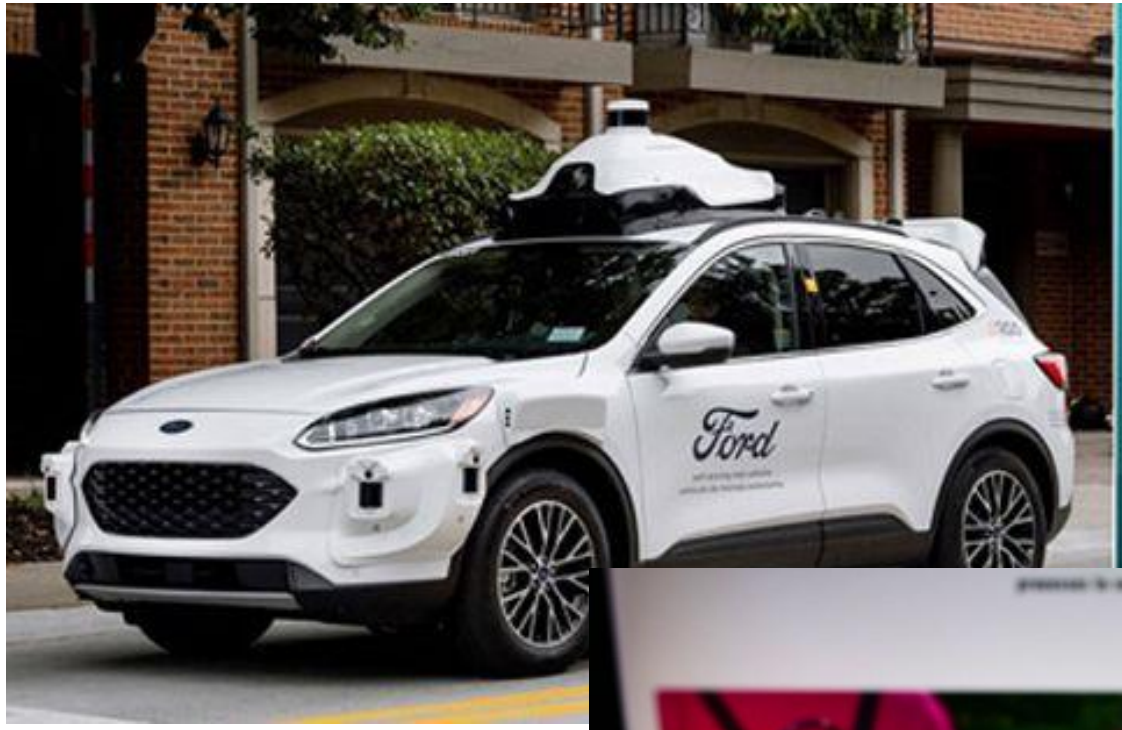
Accident : Tesla Model3 “Autopilot”, June 2020

Accident : Cruise “Driverless Taxi”, October 2023



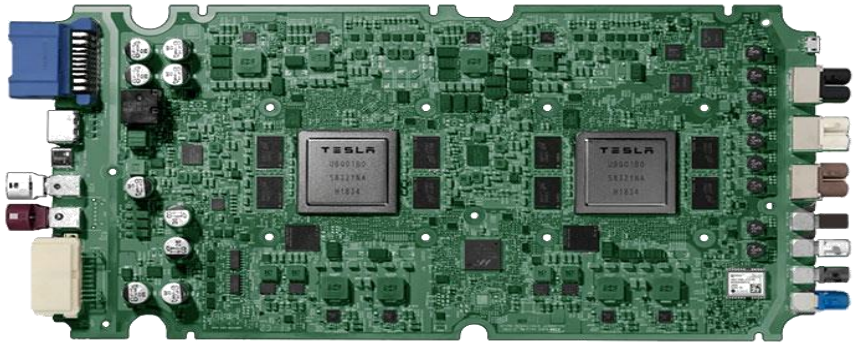
* source : SBS, X(twitter)

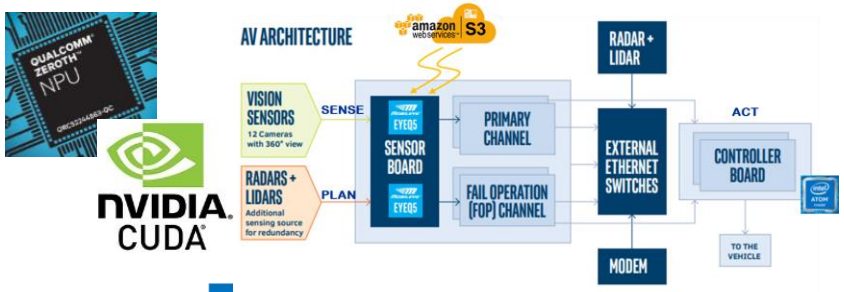
Shutdown : Ford & VW backed Argo AI, October 2022

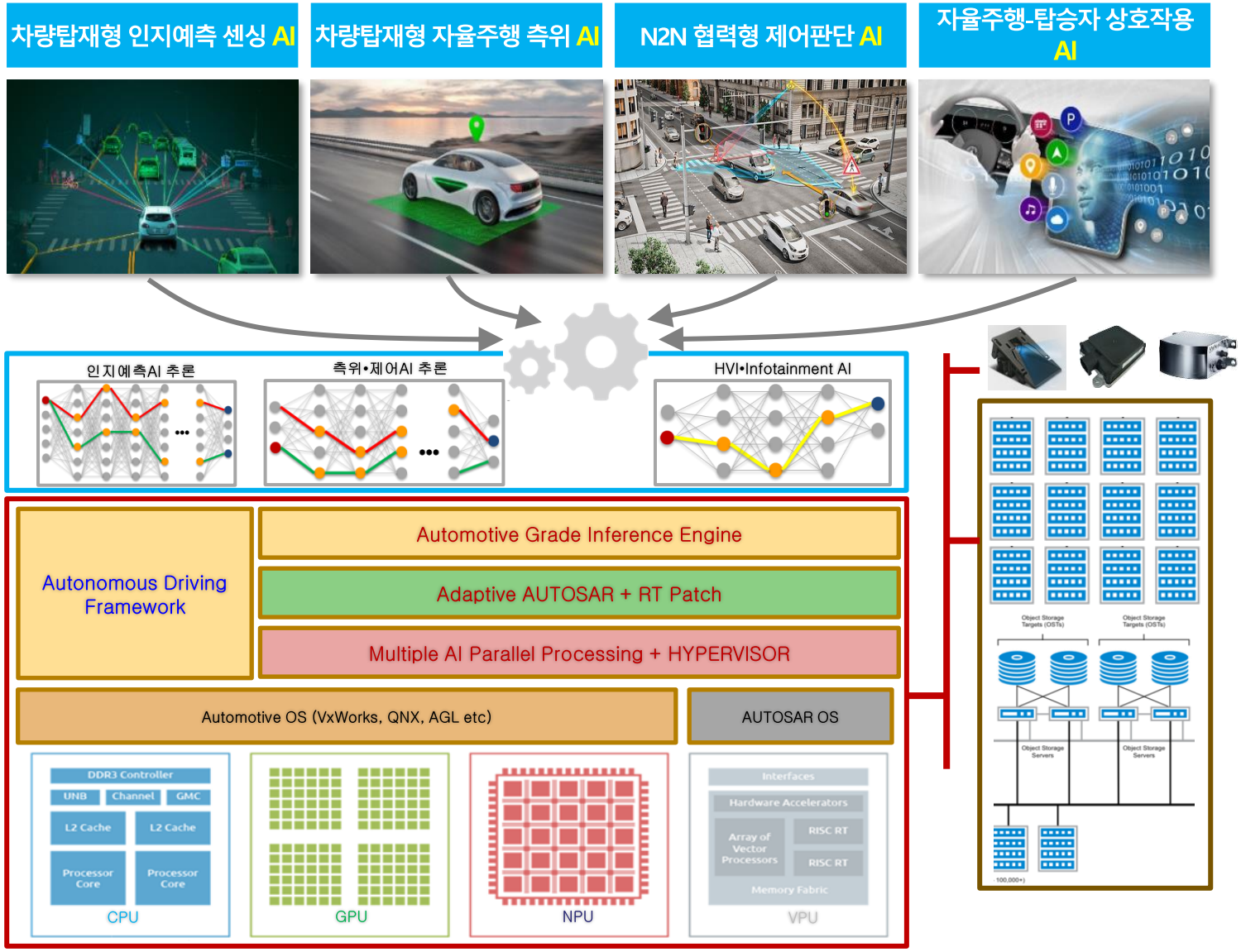


* source : Google

Computing Platform : GPU/NPU parallel processing, High reliability



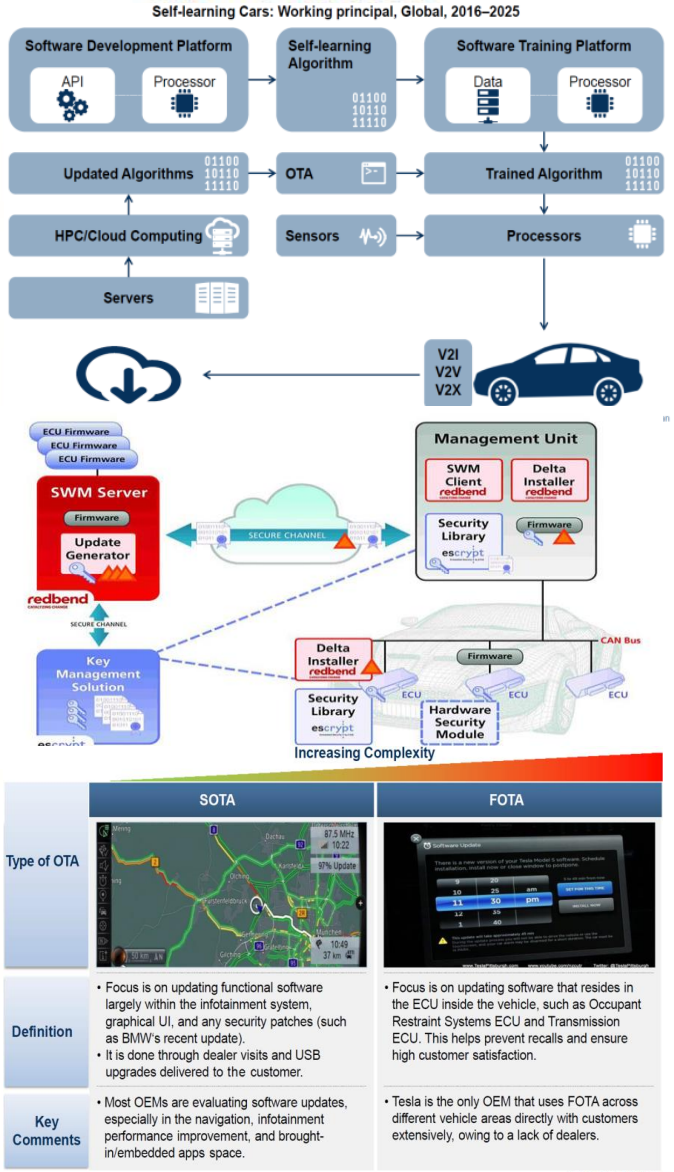




* source : F&S

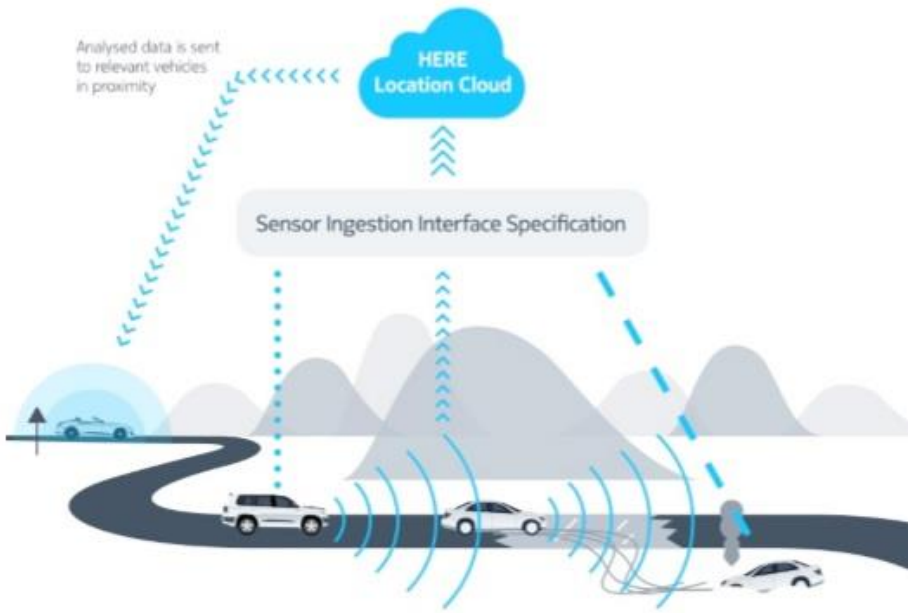
Sensing : High performance, Deep learning, Big data, Sensor fusion

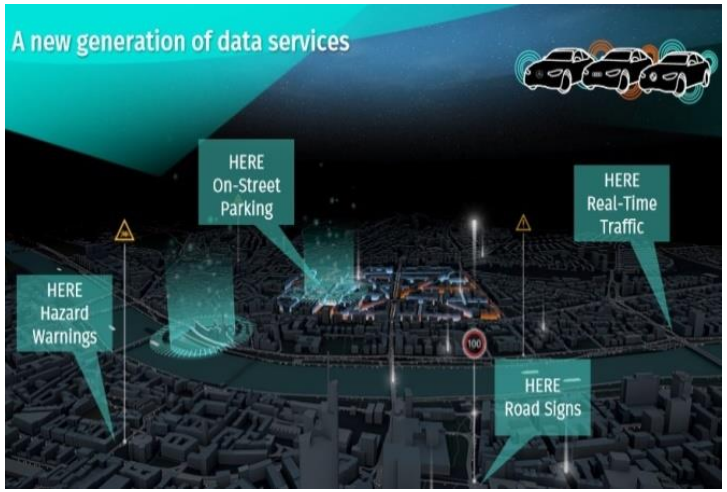
	SRR 24GHz UWB	LRR 77GHz	LIDAR	Ultra sonic	Vision	Infra Red
Short distance (0 to 2m)	*****	**	****	*****	**	*****
Nominal distance (2 to 30m)	*****	*****	*****	**	**	*****
Long distance (30 to 100m)	**	*****	*****	*	**	***
Narrow range <10deg	***	***	*****	*	*****	*****
Wide range >30	**	**	*****	****	*****	****
Angular resolution	**	****	*****	*	*****	****
Object speed measurement	*****	*****	*	****	*	*
Bad weather operation	*****	***	**	***	**	****
Blockage (impurity on sensor)	*****	*****	****	***	*	***
Night operation	*****	*****	*****	*****	*	*****
Cost	****	****	*	*****	***	**

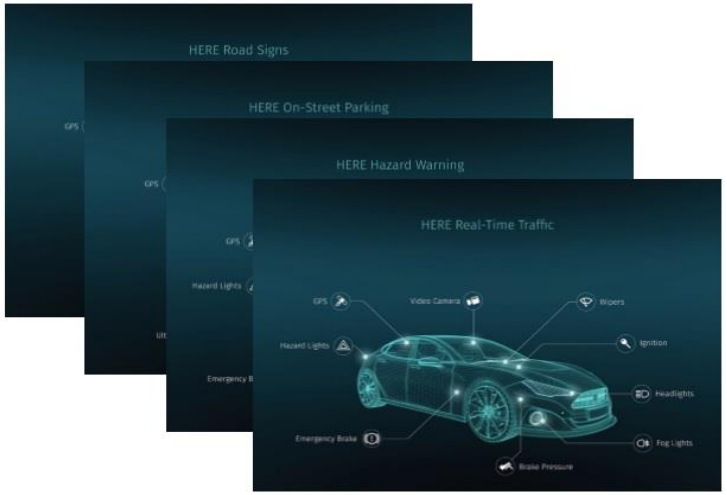


* source : F&S

Mapping : Cloud digital map, Dynamic map, Landmark

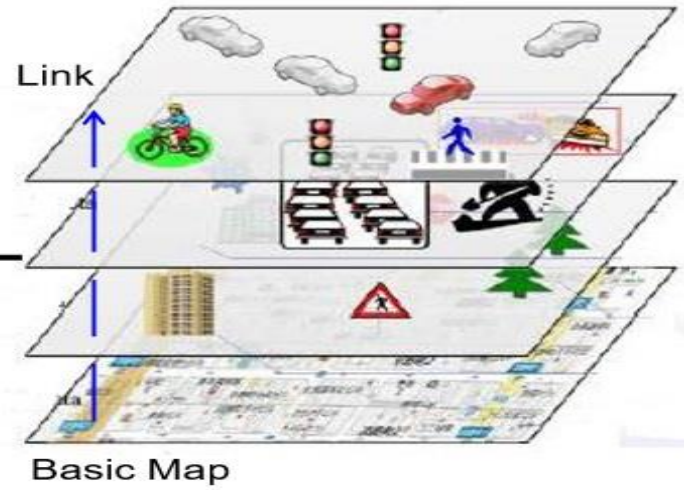






Time frame

Linked layers



Information through V to X
- surrounding vehicles
- pedestrians
- timing of traffic signals

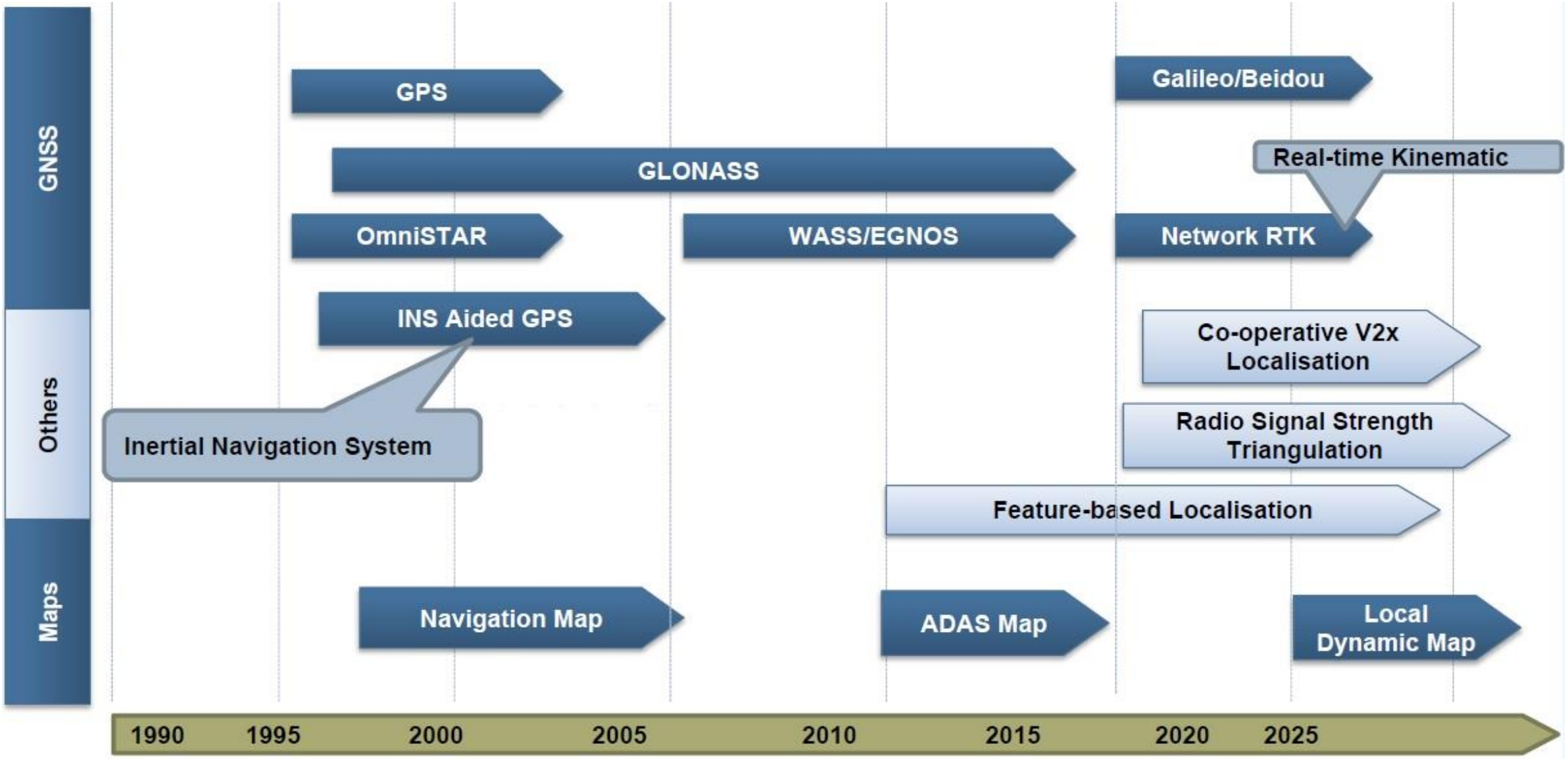
Traffic Information
- accidents
- congestion
- local weather

Planned and forecast
- traffic regulations
- road works
- weather forecast

Basic Map Database
- Digital cartographic data
- Topological data with unique
- Road Facilities

* source : HERE

Localization : Low cost DGPS, Dead reckoning, Digital map matching



* source : F&S

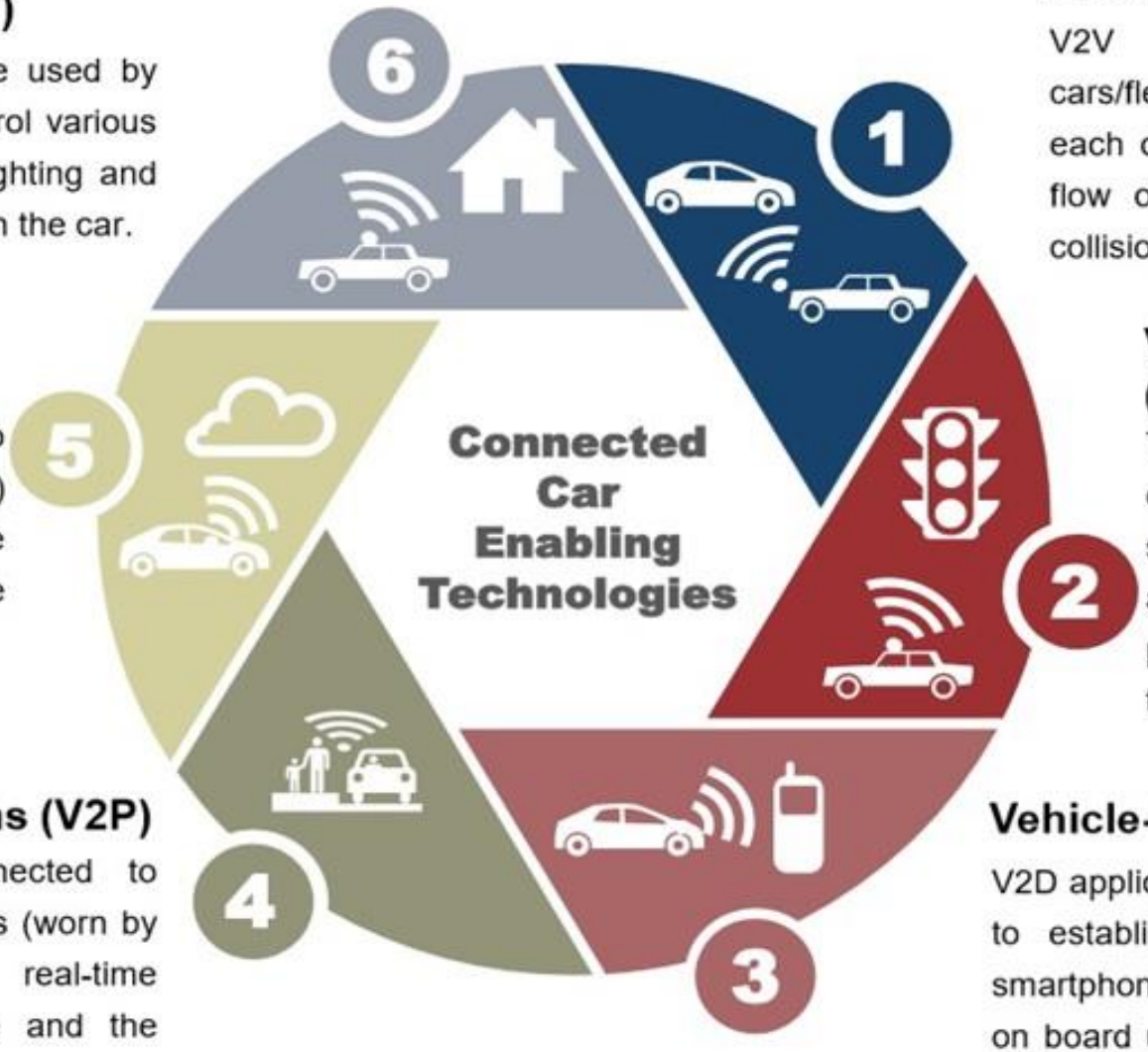
Connectivity : High reliability, Low-delay communication

Vehicle-to-home (V2H)

A connected vehicle can be used by the owner of the car to control various home appliances such as lighting and air conditioners while sitting in the car.

Vehicle-to-vehicle (V2V)

V2V technology enables cars/fleet to communicate with each other resulting in improved flow of traffic and reduction in collisions.



Vehicle-to-cloud (V2C)

A vehicle can be connected to the cloud for over the air (OTA) software upgrades to update information including the connected module.

Vehicle-to-infrastructure (V2I)

The connected vehicle can be connected to roadside units such as traffic lights, which act as communication nodes providing various safety and traffic updates.

Vehicle-to-pedestrians (V2P)

A vehicle can be connected to smartphones and wearables (worn by pedestrians) to provide real-time information to the vehicle and the pedestrians and avoid collisions.

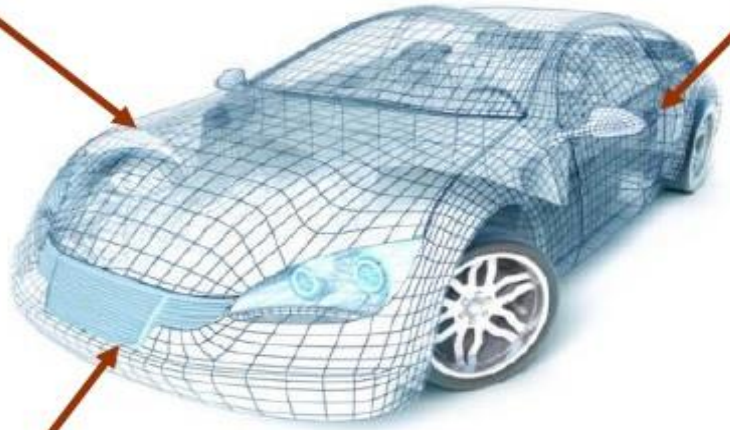
Vehicle-to-devices (V2D)

V2D application enables vehicle to establish connectivity with smartphone or other installed on board units (OBUs) such as infotainment systems.

* source : F&S

Cyber Security : Hacking prevention, Vehicle security architecture

Cyber Security Attack Points



Critical Vehicle Data

- Engine control unit
- Transmission control unit
- Body controllers (locks/lights)
- Air bag control unit
- Steering, suspension, and stability

External Interfaces

- Keyless entry
- Tire pressure monitoring system
- V2x communication
- Satellite data
- Sensor and camera data

Infotainment & Telematics

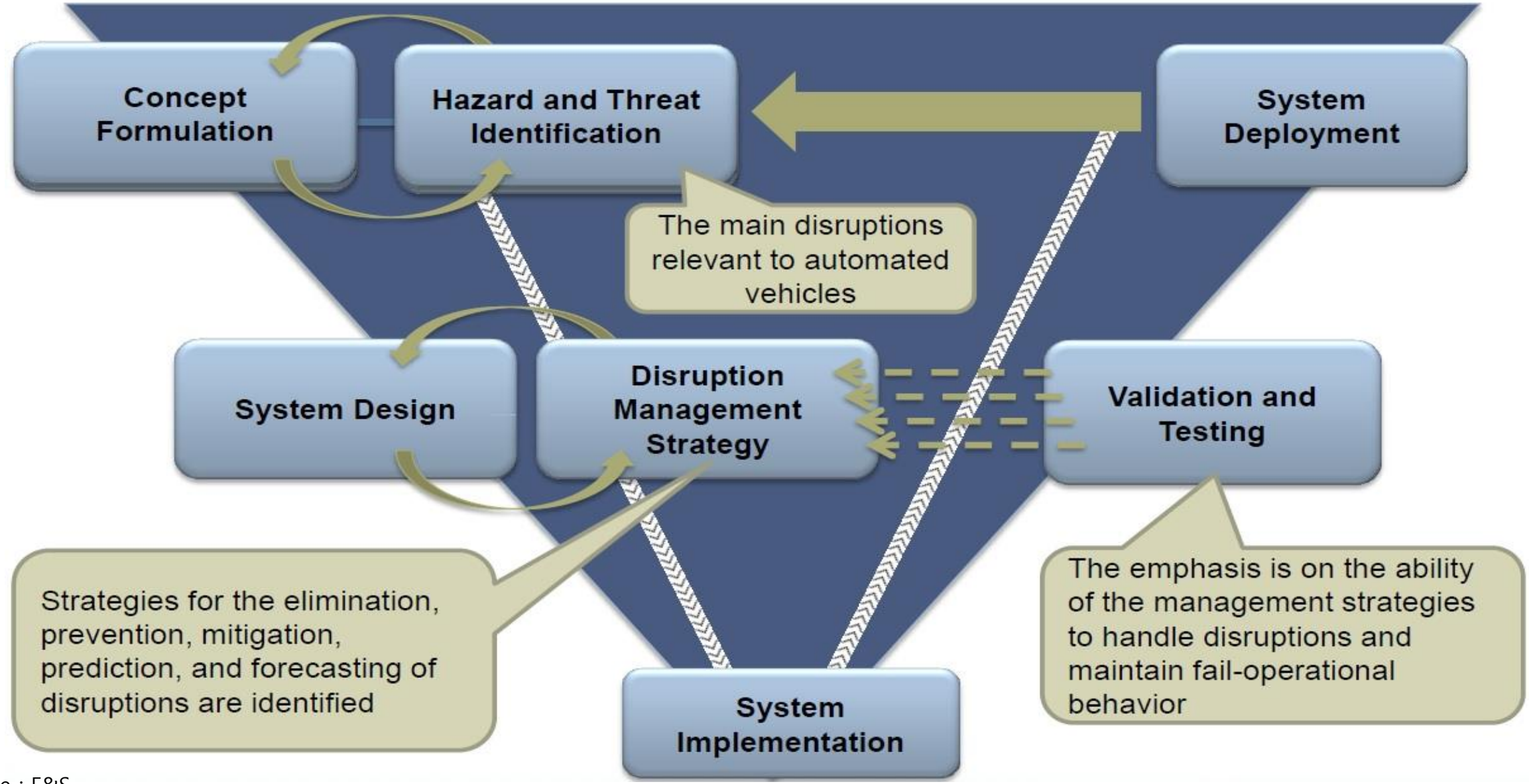
- Vehicle data from OBD II, GPS co-ordinates, driving patterns, diagnostics
- Internet, smartphone interfacing, Bluetooth, Wi-Fi, app store
- Radio and media streaming

OnStar's decision to keep track of unsubscribed vehicles and sell vehicle-related data created privacy issues. In the automated scenario, there is a high possibility of a car being compromised.

Heavy dependence remains on an Internet network, and the exchange of data is to be managed properly. Encryption of data exchange will bring third-party security solution providers into the value chain.

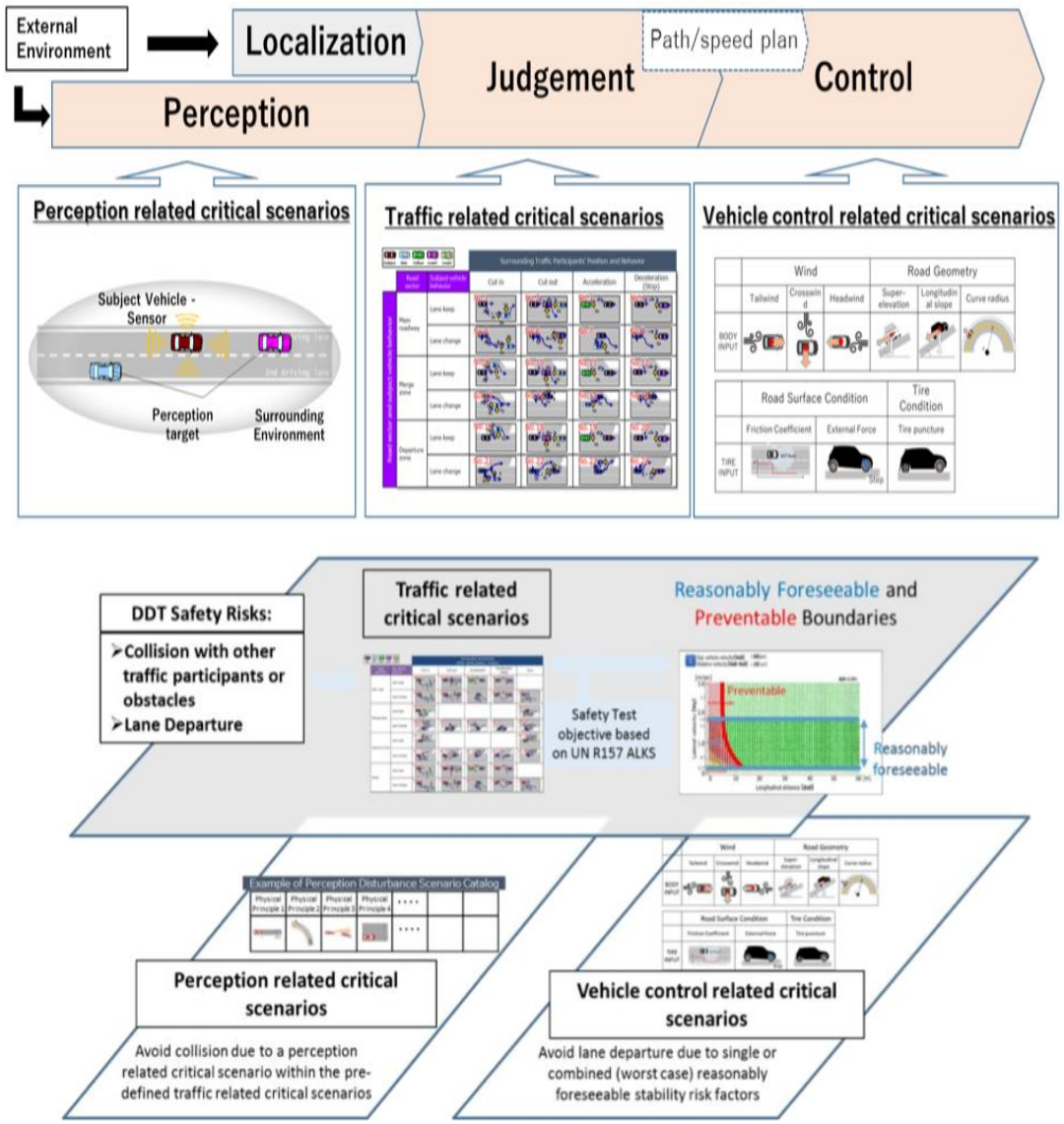
* source : F&S

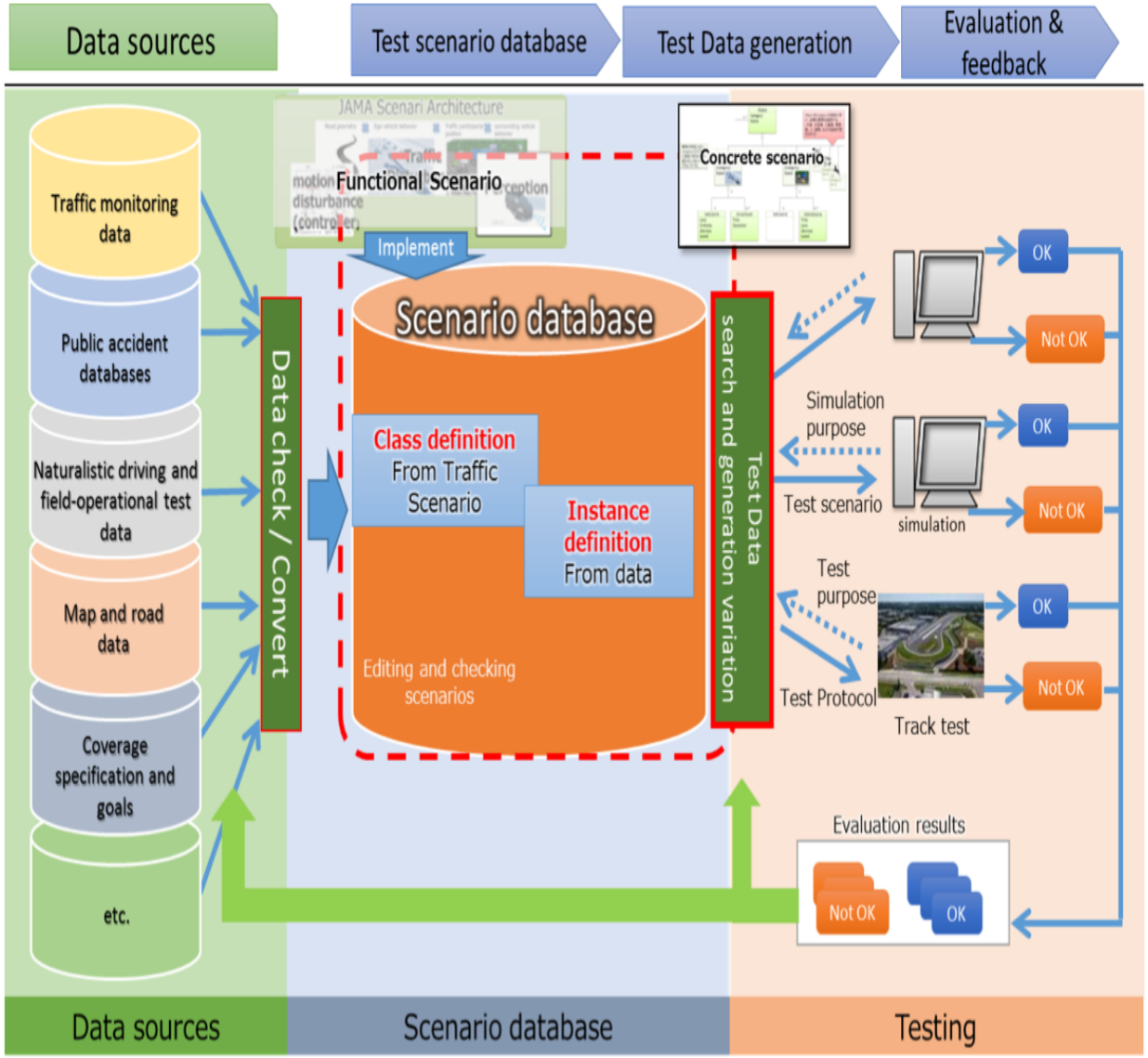
Safety Design : Fail-operational(ISO26262), SOTIF, Redundancy



* source : F&S

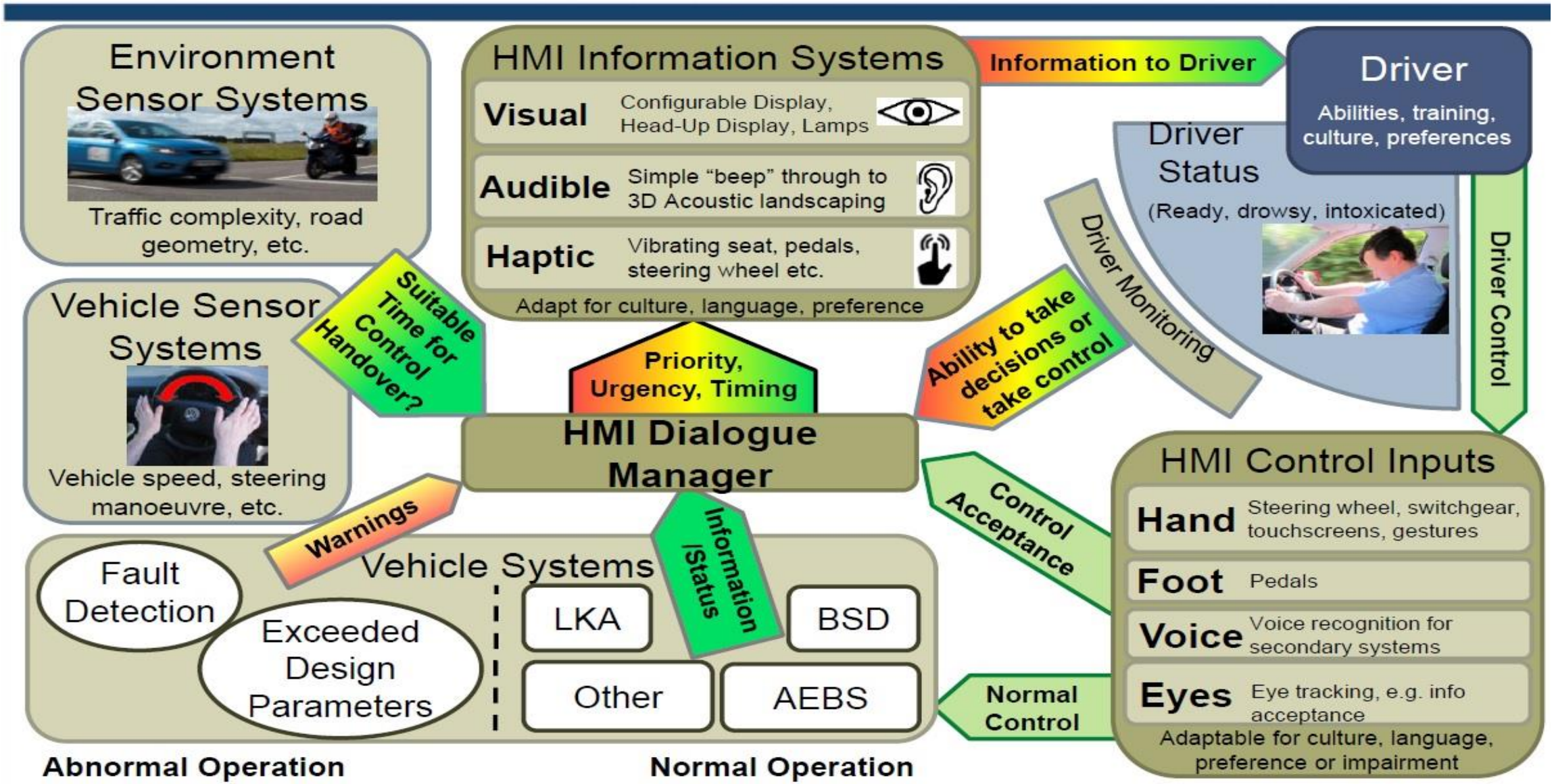
ISO DIS 34502 : Test scenarios for automated driving systems





* source : PEGASUS

Human Interaction : UI&UX, Driving control right, HMI dialogue manager



* source : F&S

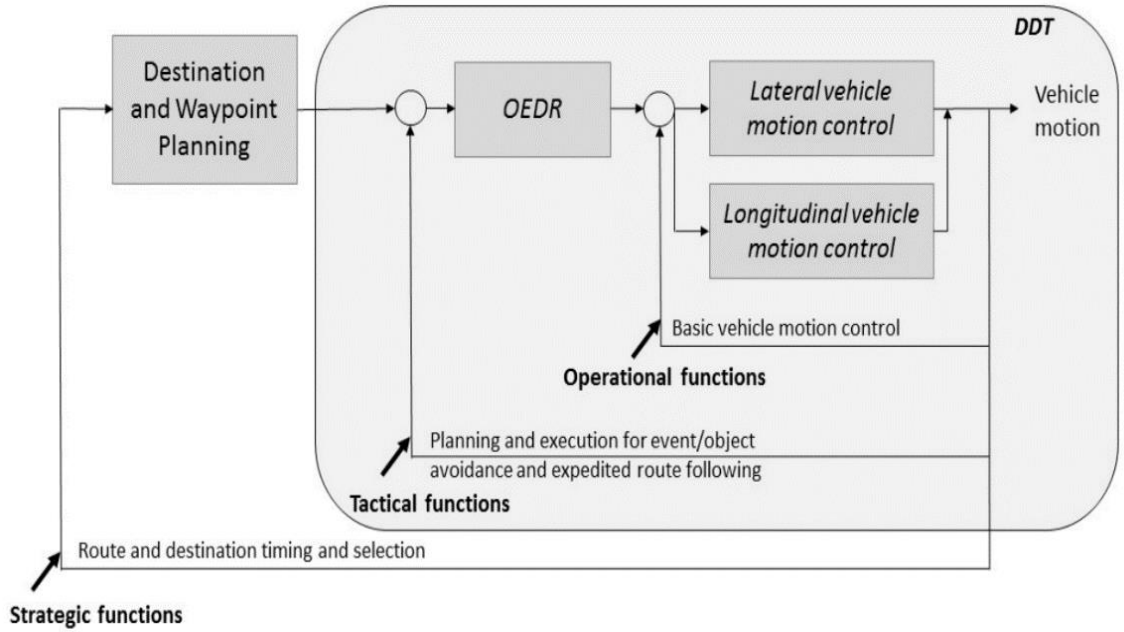
Ⅲ. Conclusion

DOT-NHTSA 12 safety elements, ISO/TS 5083 12 safety principles

Voluntary Guidance to Companies

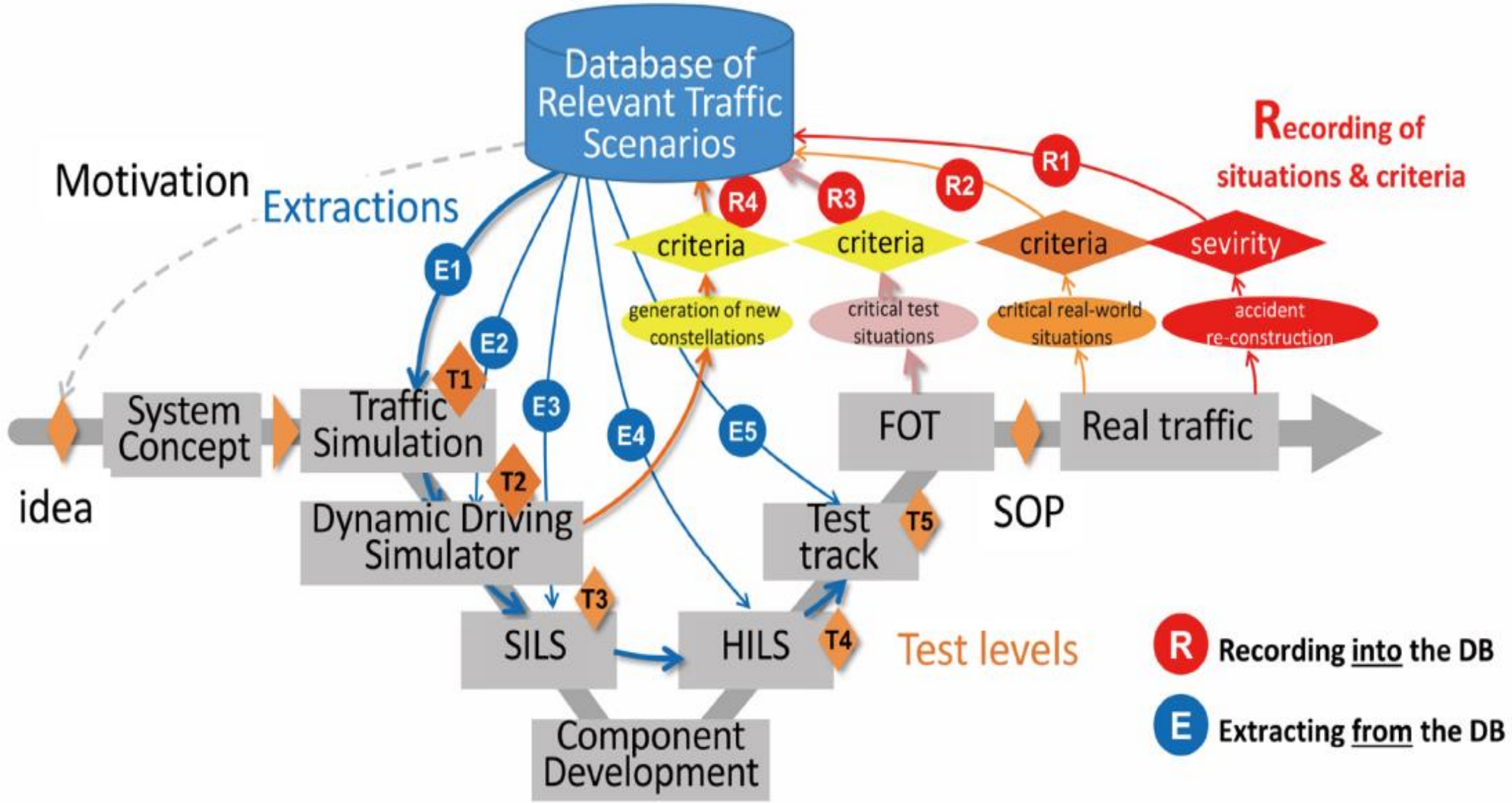
Companies to consider and document their consideration of 12 safety elements:

1. **Vehicle Cybersecurity**
2. **System Safety**
3. **Operational Design Domain**
4. **Object and Event Detection and Response**
5. **Fallback (Minimal Risk Condition)**
6. **Validation Methods**
7. **Human Machine Interface**
8. **Crashworthiness**
9. **Post-Crash ADS Behavior**
10. **Data Recording**
11. **Consumer Education and Training**
12. **Federal, State, and Local Laws**



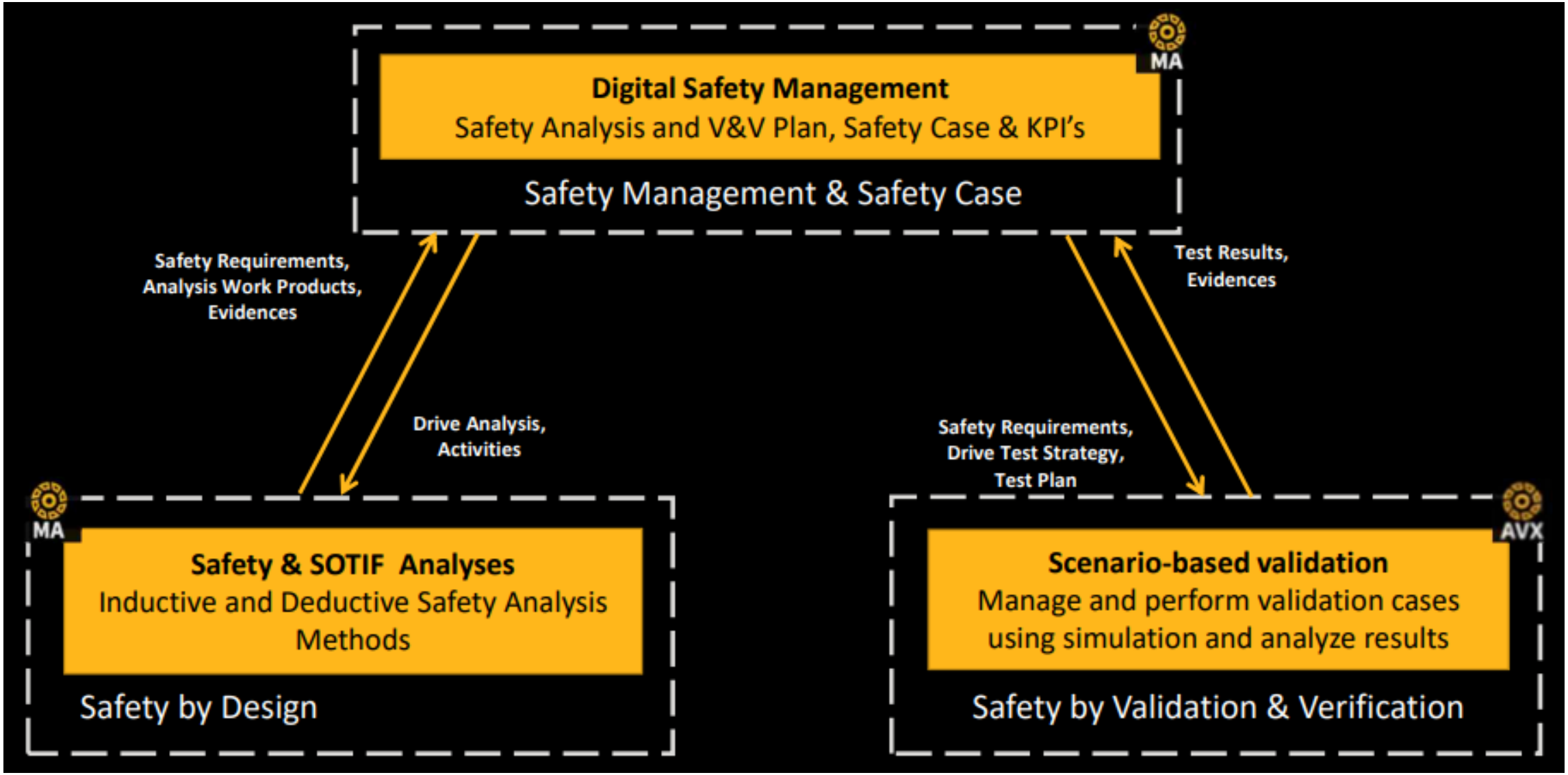
* source : DOT-NHTSA, ISO

MBSE linked standard verification & validation process



* source : PEGASUS

Digital engineering for safety & cyber-security of AD functions



* source : ANSYS

Testing to ensure safety & cyber-security based on test scenario

Scenario Analysis & Quality Measures

- What human capacity does the application require?
- What about technical capacity?
- Is it sufficiently accepted?
- Which criteria and measures can be deducted from it?

Implementation Process

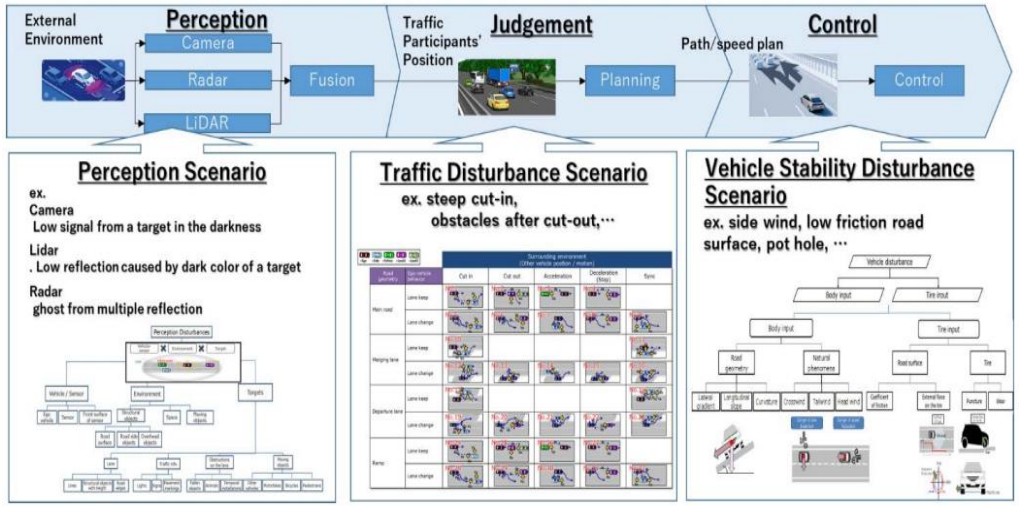
- Which tools, methods and processes are necessary?

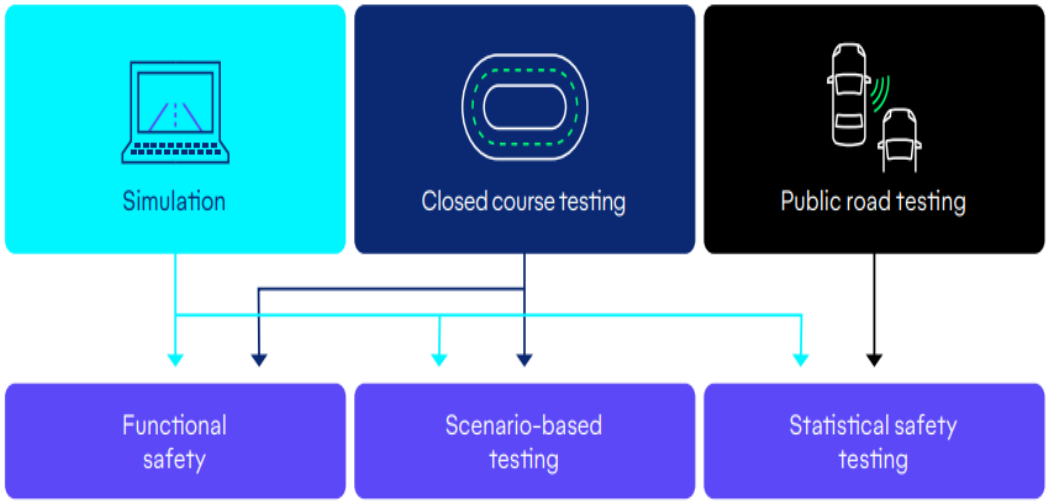
Testing

- How can complete-ness of relevant test runs be ensured?
- What do the criteria and measures for these test runs look like?
- What can be tested in labs or in simulation? What must be tested on proving grounds, what must be tested on the road?

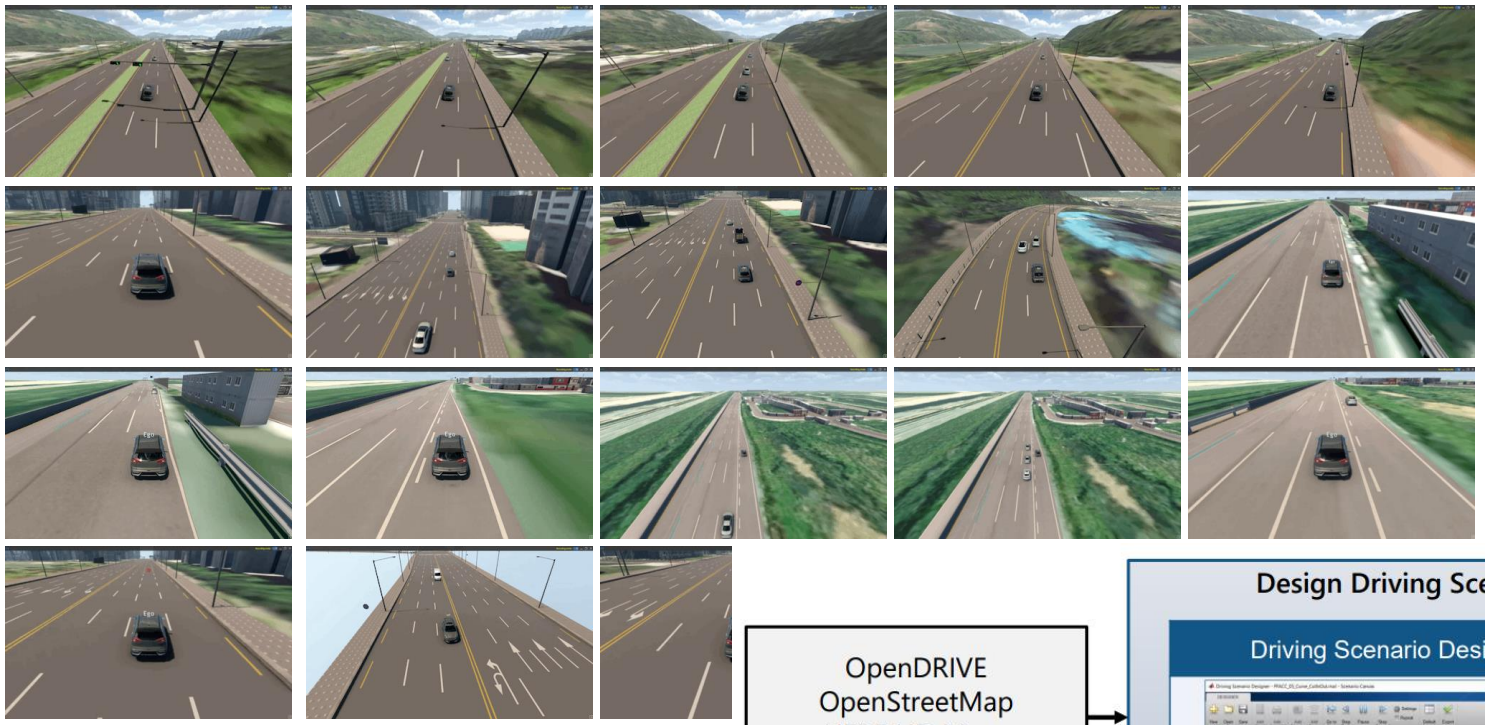
Reflection of Results & Embedding

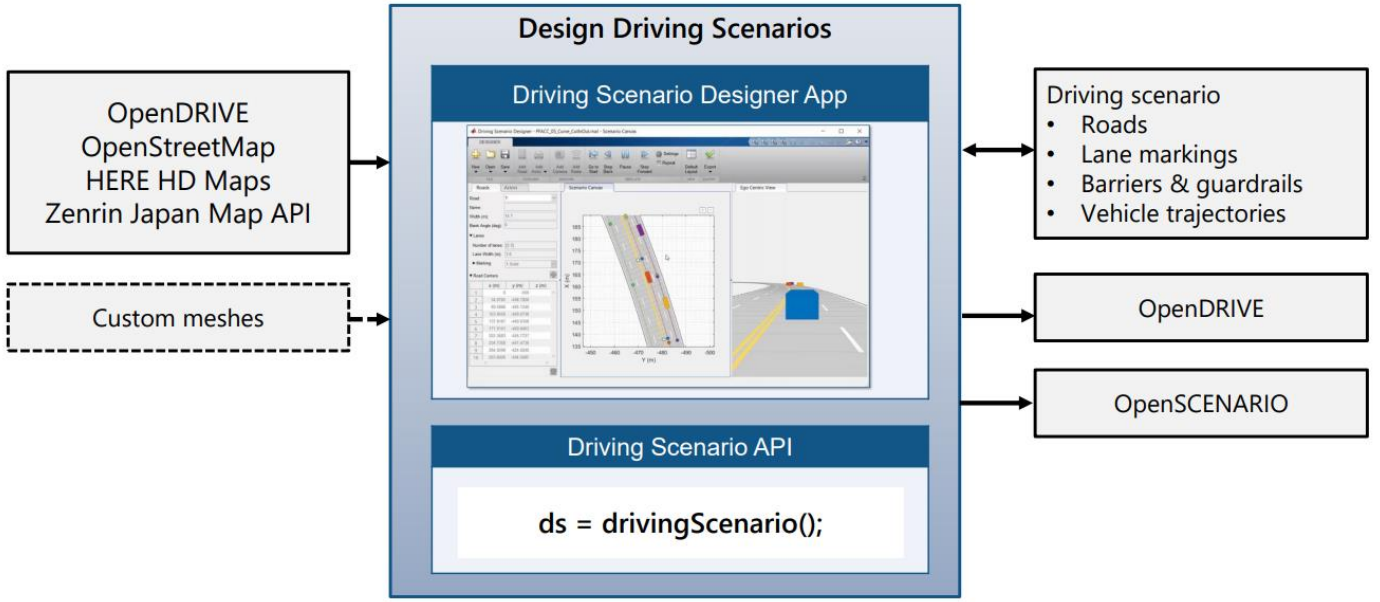
- Is the concept sustainable?
- How does the process of embedding work?





Test scenario simulation based on digital twin





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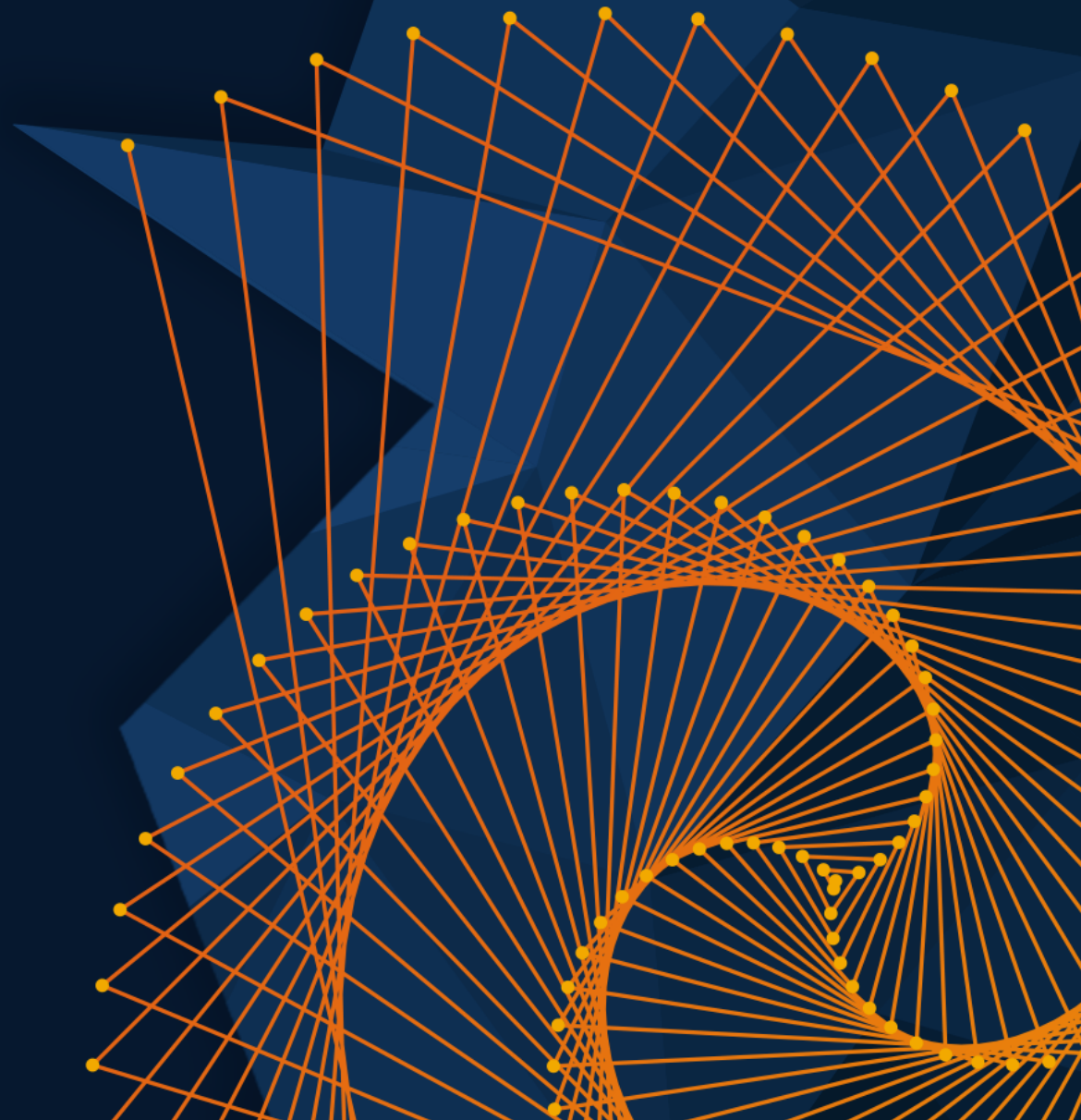

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