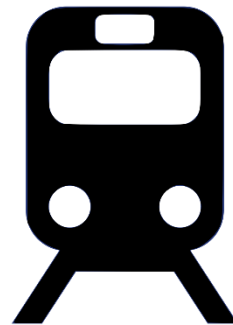# Ground transportation systems & autonomy
- Introduction -

INTRODUCTION

Why this course ? (with the student perspective)

❑ More and more students end up working in companies linked with transports :

- Car manufacturers (e.g. PSA, Renault, BMW, Mercedes, …)
- Car suppliers (e.g. Bosch, Valéo, Infineon…)
- Truck manufacturers (e.g. Daimler, Renault Trucks, Volvo, …)
- Train manufacturers or suppliers (e.g. ALSTOM, …)
- Shuttle bus or delivery platforms (e.g. Navia, …)

❑ The increasing need of engineers in this area is due to the increasing autonomy of those vehicles.

❑ This course will give you a few notions in this huge area (you will not become an expert in 24 hours)

Why this course ? (with the society perspective)

❑ Knowing that :   Sources : CCFAI, INRIX 2016, OMS

- More than a billion car are driving in the world
- In 2016 in Paris, drivers spent 65 hours in traffic jam (104h in Los Angeles)
- 1,3 million people die on the road every year in the world, and twice more because of pollution
- In 2050, cities might condense 70% of the world population

❑ With a growing population it means :

- More traffic jam
- More death (people and nature in general) by accidents and pollution

➜ Need to reduce our vehicle fleet ➜ Solution : shared autonomous vehicule fleet

What's the course content ?

	Matin (8h-12h15)		Après-midi (13h30-17h45)	
	Groupe 1	Groupe 2	Groupe 1	Groupe 2
Lundi			Cour intro (1h30) In-Vehicle-Networking (2h30) - R. Leber -	
mardi	Cour V2X (2h) - A. Massouri- Cour SDV Technology (2h) - R. Leber -		TP1 - R. Leber - - A. Massouri -	
mercredi	TP2 - R. Leber - - A. Massouri -		Formation Archi sécu - G. Vibert (ALSTOM) -	TP2 (seconde partie) En autonomie
jeudi			TP2 (seconde partie) En autonomie	Formation Archi sécu - G. Vibert (ALSTOM) -
vendredi	Formation SdF - G. Vibert (ALSTOM) -	TP2 (seconde partie) - R. Leber (en chat) -	TP2 (seconde partie) - R. Leber (en chat) -	Formation SdF - G. Vibert (ALSTOM) -

Practical work environnement

avsim2D : Autonomous Vehicle Simulator 2D - with CanBus drive by wire - by Raphaël LEBER
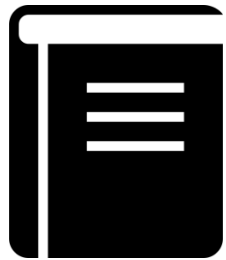
How will you be graded ?

❑ Practical Work (12h + 8h autonomy)

- student alone (or with one mate, with a grade coefficient of 0,8)
- 50% of the final grade
- ~~Material : Car electronic dashboard~~
- Computer : Linux

❑ A final exam (2h)

- ~~On a paper sheet~~
- ~~No documents allowed~~
- 50% of the final grade

TERMINOLOGY

A few acronyms…

❑ SDV : Self-Driving Vehicule

❑ ADAS : Advanced Driver-Assistance Systems

❑ SAE : Society for Automotive Engine

❑ DBW : Drive-By-Wire

❑ V2V : Vehicle to Vehicle communication

❑ V2I : Vehicle to Infrastructure communication

❑ V2x : Vehicle to everything

Autonomous Vehicle

❑ "Autonomous Vehicle" is not precise enough

❑ Precise automotive vocabulary is define in NOR: CTNR1807401K (journal officiel, legifrance.gouv.fr) with french-english equivalents

❑ **Six levels of automation** described in *J3016 Driving Automation Taxonomy** published by *Society for Automotive Engine* (**SAE**) *Internationnal*

❑ Other classifications exists :

- ▪ BASf : German Automotive Supplier

- ▪ NHTSA : From the US. With 5 levels instead of the 6 in SAE

- ▪ VDA : German Association of the Automotive Industry

Vehicle autonomy classification

	Level 0
DRIVER	Constant monitoring is required from the driver.
VEHICLE	The driver always controls all driving functions.
SAE (J3016)	No automation
BASt	Driver only
NHTSA	0
VDA	Driver only
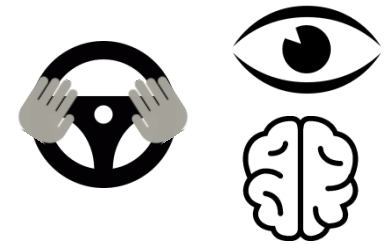
Vehicle autonomy classification

	Level 1
DRIVER	The driver must observe the drive and be ready to resume full control immediately
VEHICLE	The vehicle can operate steering **OR** acceleration/deceleration in specific use cases
SAE (J3016)	Driver assistance
BASt	Assisted
NHTSA	1
VDA	Assisted
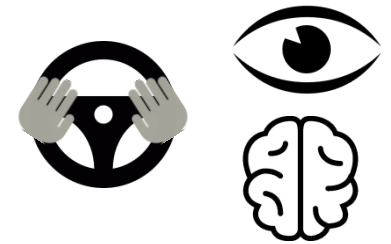
Vehicle autonomy classification

	Level 2
DRIVER	The driver must observe the drive and be ready to resume full control immediately
VEHICLE	The vehicle can operate steering **AND** acceleration/deceleration in specific use cases
SAE (J3016)	Partial automation
BASt	Partially automated
NHTSA	2
VDA	Partly automated
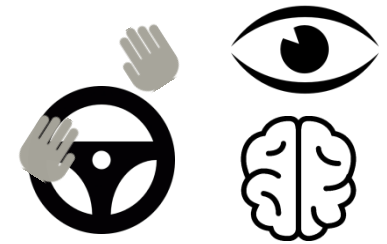
Vehicle autonomy classification

	Level 3
DRIVER	The driver does not need to observe the drive but must be ready to resume control shortly after alerted
VEHICLE	The vehicle can operate steering **AND** acceleration/deceleration in specific use cases, The system can recognize its limits, alert the driver and maintain control until the driver takes over.
SAE (J3016)	Conditional automation
BASt	Highly automated
NHTSA	3
VDA	Highly automated
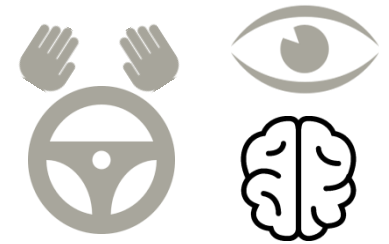
Vehicle autonomy classification

	Level 4
DRIVER	No driver needed
VEHICLE	The vehicle can operate under limited driving conditions
SAE (J3016)	High automation
BASt	Fully automated
NHTSA	3 / 4
VDA	Fully automated

Vehicle autonomy classification

	Level 5
DRIVER	No driver needed
VEHICLE	The vehicle can operate all driving conditions
SAE (J3016)	Full automation
BASt	-
NHTSA	3 / 4
VDA	Driverless

Vehicle autonomy classification : Summary

Level	0	1	2	3	4	5
DRIVER						
SAE (J3016)	No automation	Driver assistance	Partial automation	Conditional automation	High automation	Full automation

SDV TECHNOLOGIES OVERVIEW

Sensors overview

Long-Range Radar

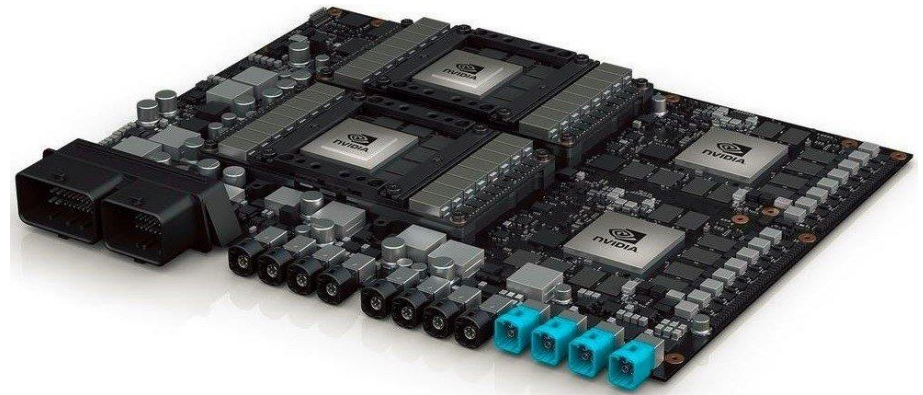Short/Medium Range Radar

Camera

Lidar
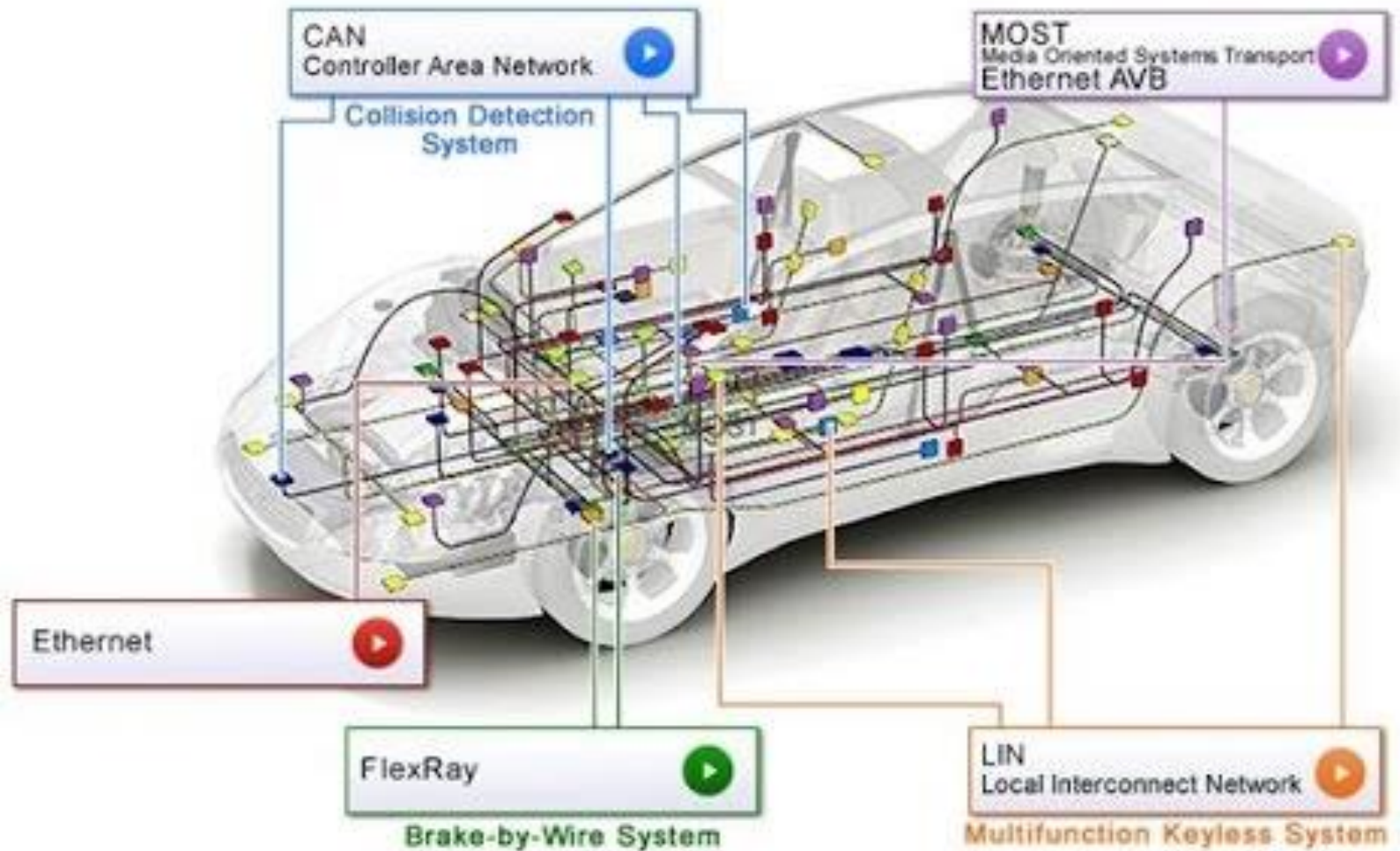
Ultrasonic

CPE
LYON
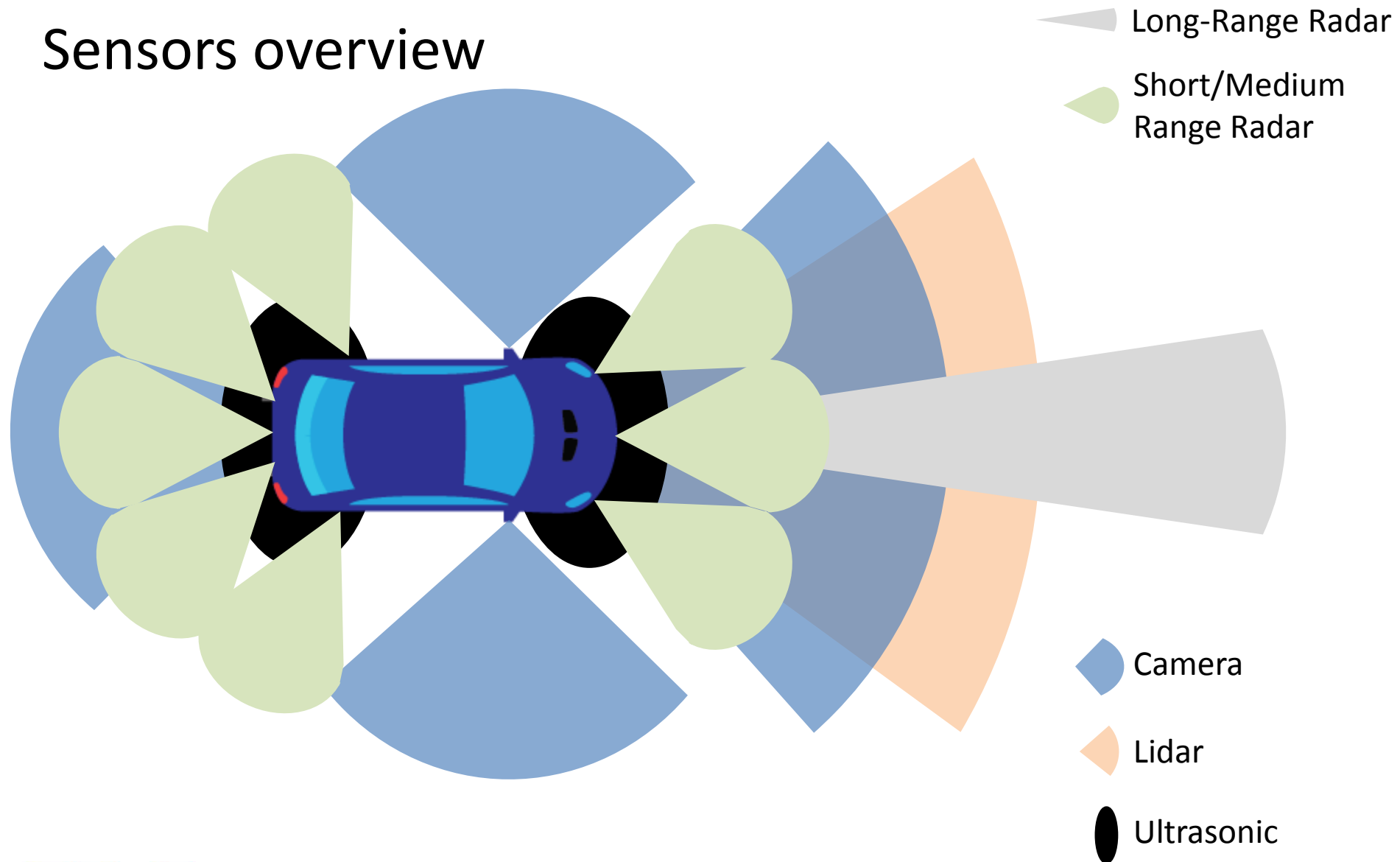
Computing platform

❑ Key consideration :

- ▪ Data rate
- ▪ Computing power
- ▪ Energy consumption
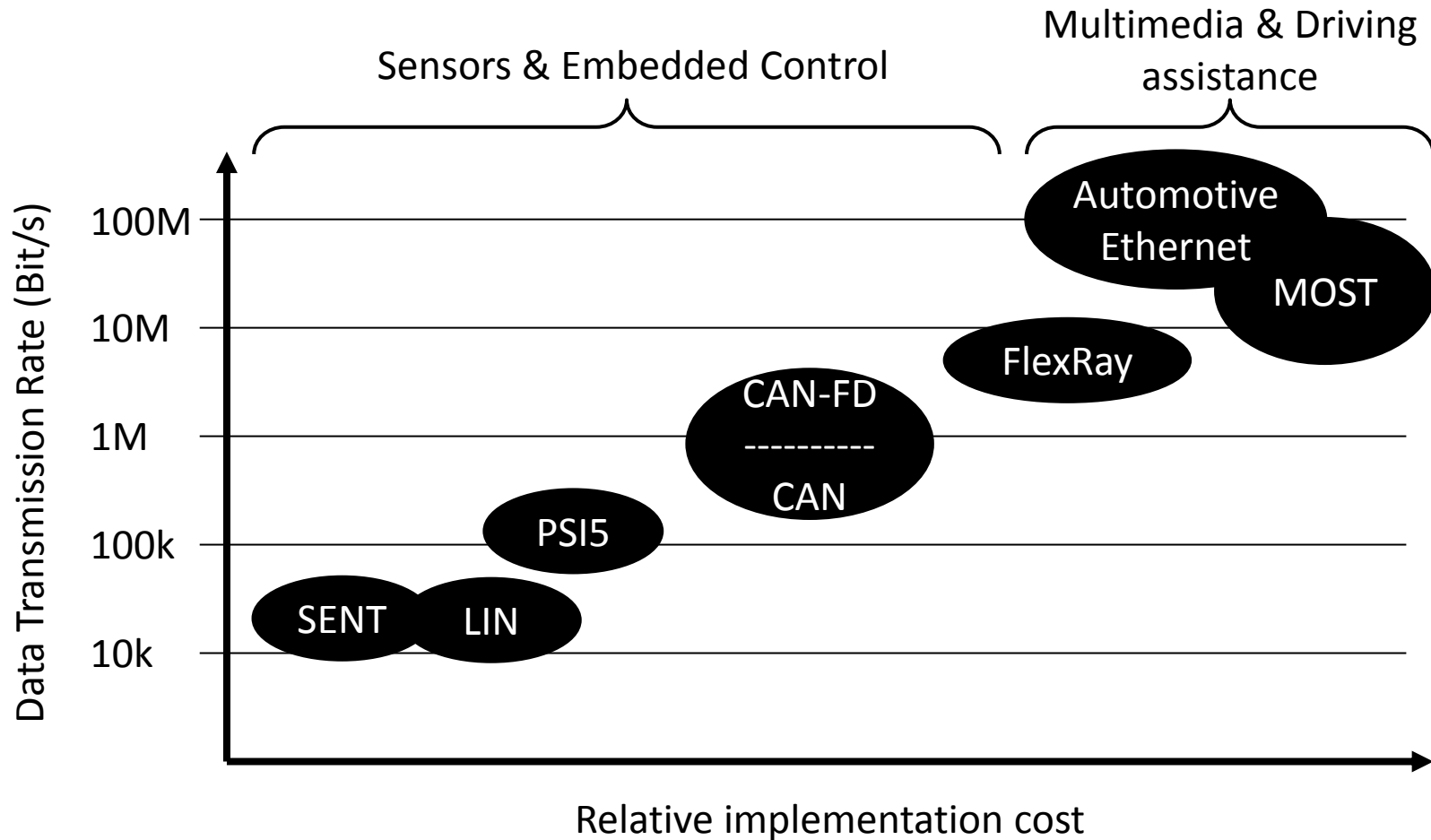- ▪ Robustness

NVIDIA DRIVE AGX Peagasus computing platform
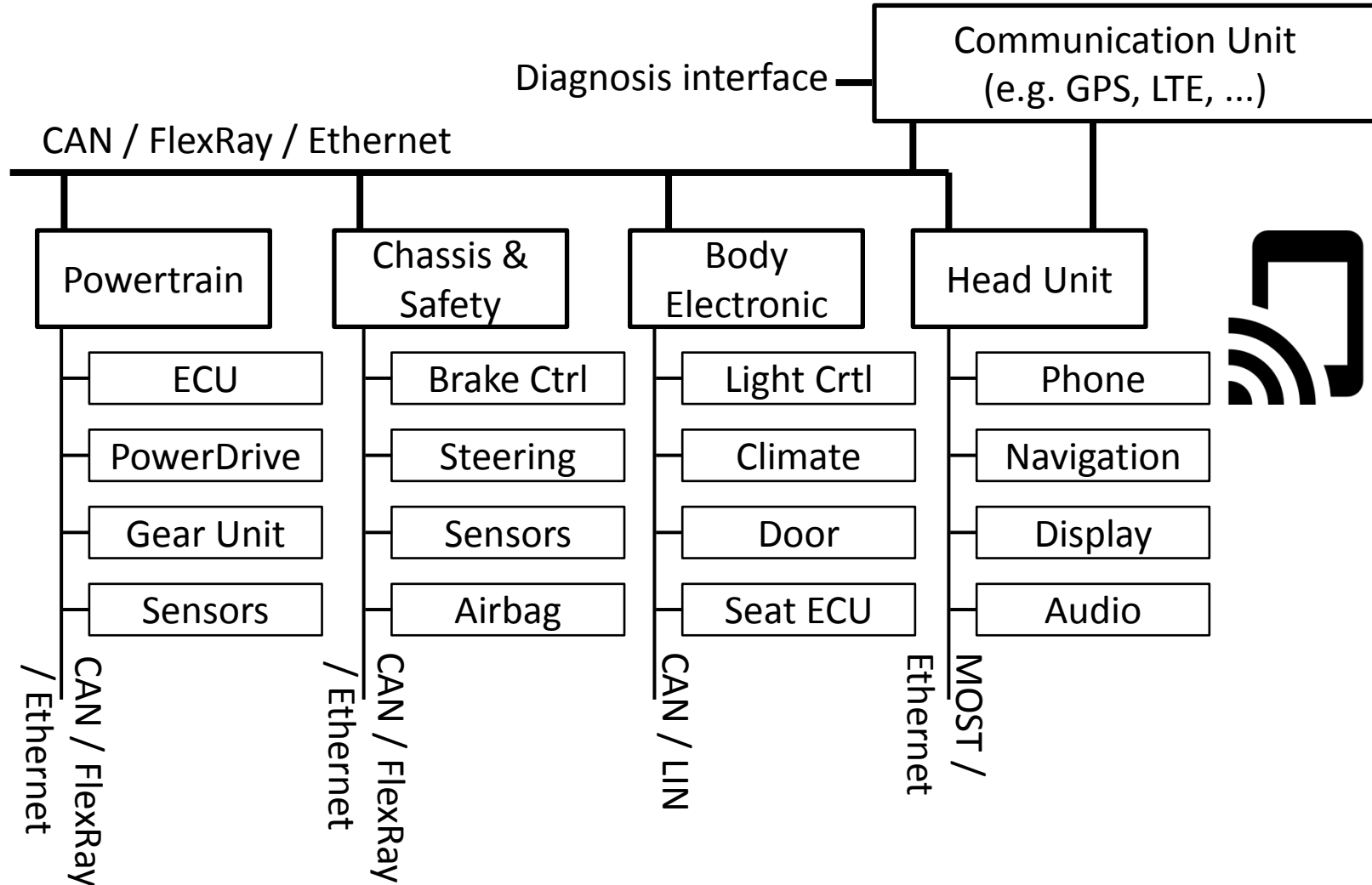
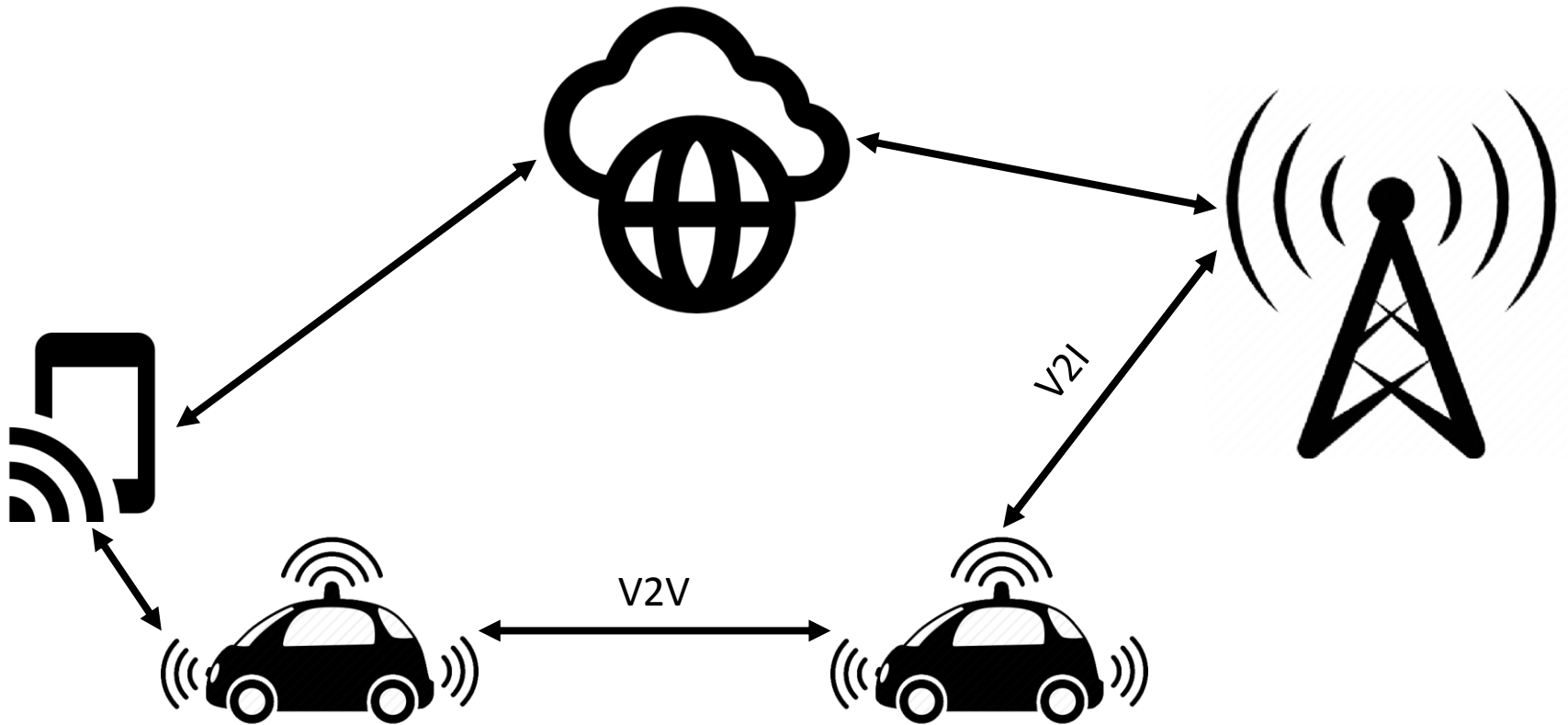# Vehicle Network : « Normal » car case

Rate vs Cost

Inspired from [1], p192

Vehicle Network : « Normal » car case

Diagnosis interface — **Communication Unit (e.g. GPS, LTE, …)**

CAN / FlexRay / Ethernet

Powertrain	Chassis & Safety	Body Electronic	Head Unit
ECU	Brake Ctrl	Light Crtl	Phone
PowerDrive	Steering	Climate	Navigation
Gear Unit	Sensors	Door	Display
Sensors	Airbag	Seat ECU	Audio

CAN / FlexRay / Ethernet

CAN / FlexRay / Ethernet

CAN / LIN

MOST / Ethernet

Vehicle Network : V2x

V2I

V2V

Functional safety & security issues :

❑ Reduce bugs and errors by following common vehicle standards (electronics/software) : AUTOSAR, MISRA, …

❑ Respect ISO26262 "Road vehicles – Functional safety" :

  ▪ « The absence of unreasonable risk due to hazards caused by malfunctioning behavior of electronic and/or electric (E/E) systems »

  ▪ Safety management, Engineering processes and requirements, …

❑ Anticipate malicious security issues :

  ▪ Physical attack (sensors attack)

  ▪ Wireless attack

  ▪ Cloud fleet management attack
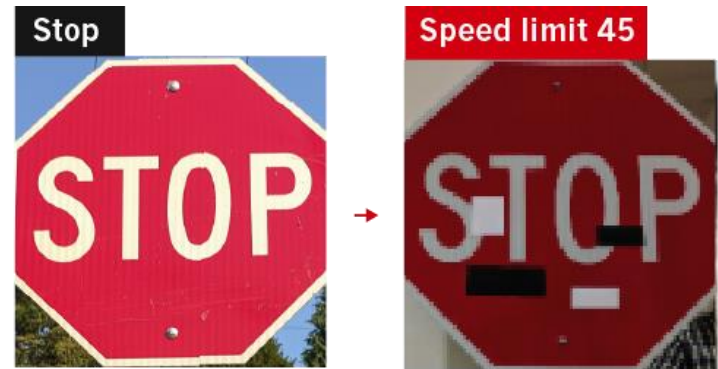
Bibliography

❑ [1] Paret D., Rebaine H. (2019). *Véhicules Autonomes et Connectés.* Dunod.

❑ [2] Sjafrie H. (2020). *Introduction to Self-Driving Vehicle Technology*. CRC Press