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TIER IV
L4 Custom Design Guidelines

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What is L4CDG

What is L4 Custom Design Guidelines?

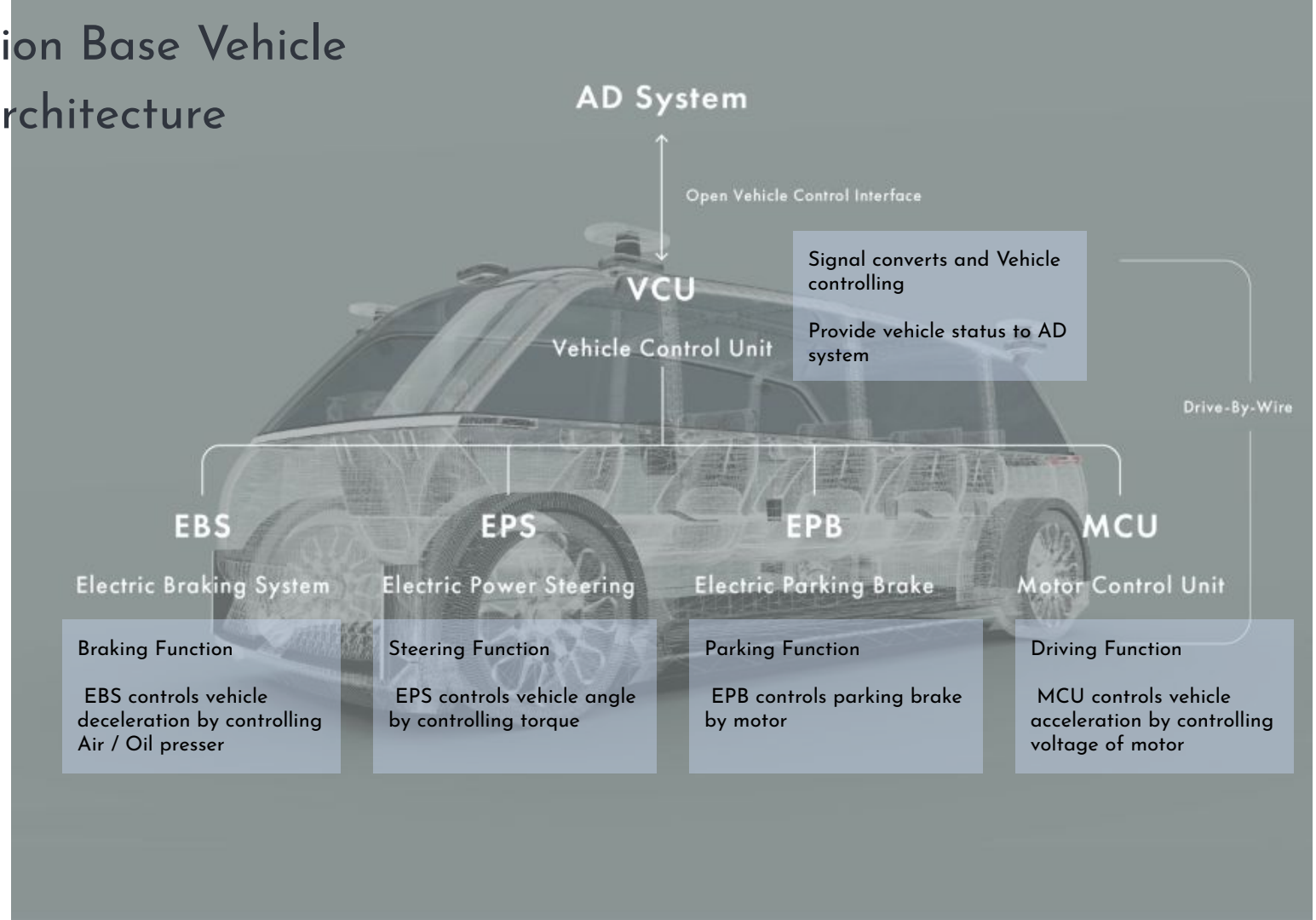
L4 Custom Design Guidelines was published by TIER IV on 20.Jun.

This document is a guideline that consolidates practical design guidelines for the development of vehicles with Lv.4 autonomous driving.

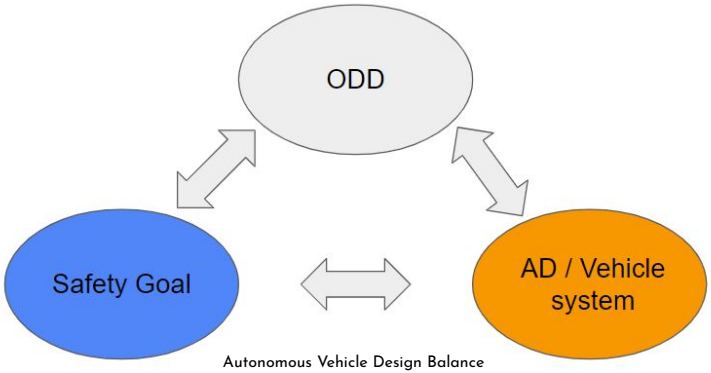
And also, each development process from design to evaluation is described.

The detail of L4CDG

Selection Base Vehicle
E/E Architecture



Drive by-wire



Autonomous Vehicle Design Balance

In this document, "Drive by-wire" means each component can be control by a electric signals.

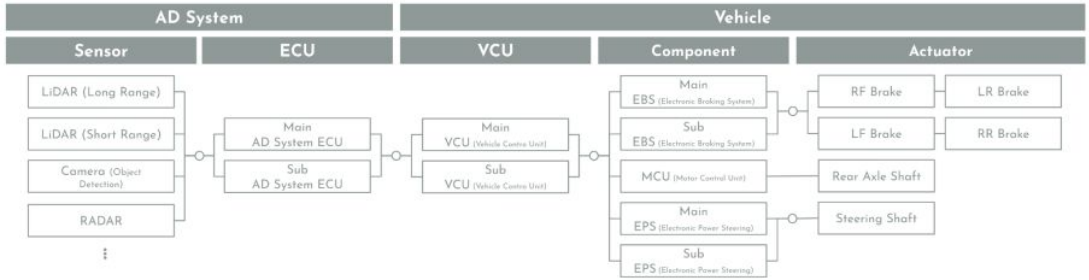
Safety and Performance requirements are derived from ODD, Safety Goals, and AD/Vehicle systems with balance.

Safety requirements and Performance requirements decide how to modify vehicles for Autonomous driving.

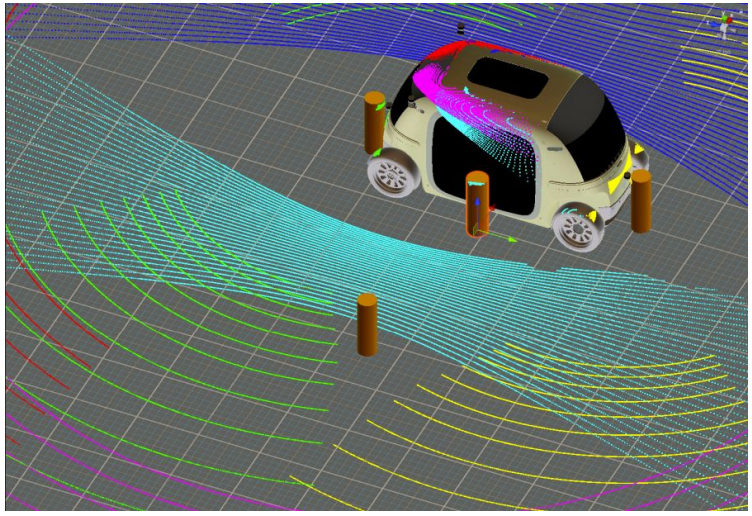
- Performance requirements is such as required high sensing performance
- Safety requirements is such as required redundancy for vehicle system

Performance Requirements

Category	Requirements
Acceleration Control	The error between the target acceleration and the actual acceleration is within 10% in all vehicle speed ranges
	Dead time is within 0.2 second and time constant is within 0.6 second
Brake Control	The error between the target acceleration and the actual acceleration is within 10% in all vehicle speed ranges
	Dead time is within 0.2 second and time constant is within 0.6 second
Steering Control	The error between the target steering angle and the actual steering angle is within 5% in all vehicle speed ranges
	Dead time is within 0.1 second and time constant is within 0.5 second
Vehicle speed	The error between the true vehicle speed and the measured vehicle speed is within 3%
	Vehicle speed can be measured at a frequency of 50hz or higher.
	The lower limit of the vehicle speed measurement range is 0.1m/s2
Steering angle	The error between the true yaw rate and the calculated yaw rate with measured steering angle and vehicle speed is within 3%
	Steering angle can be measured at a frequency of 50hz or higher.



Redundant Drive by-wire



Sensor Configuration

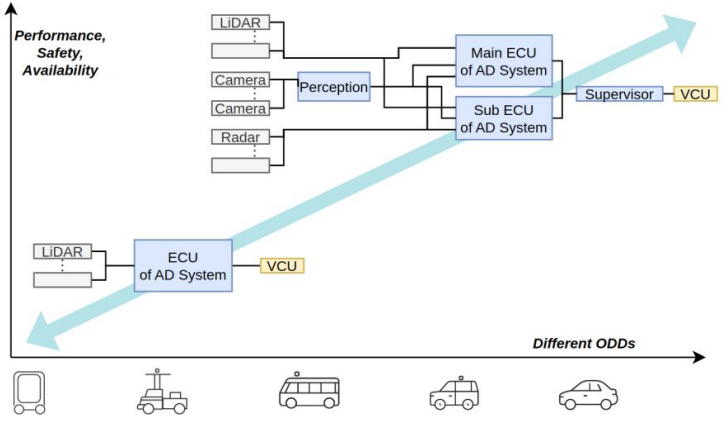
At first, Identify use cases that must be covered from the ODD and derive requirements for sensing functions and sensors.

The sensor selected according to the requirements, and consider the mounting position by simulation.

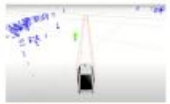
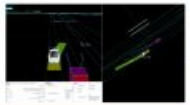
AD System Development

ECU configuration should be considered to MRM(Minimum Risk Maneuvers) operation required by Lv.4 Autonomous vehicles.

The ECU configuration such as upper right in figure, becomes more complex, but it allows for improved safety.



Evaluation

	Driving Log Replayer	Scene Simulator for Path Planning	Scene Simulator for Autoware (AWSIM)	Real Vehicle Test
Sensing	✔		✔	✔
Localization	✔		✔	✔
Perception	✔	(✔)	✔	✔
Planning		✔	✔	✔
Control		(✔)	✔	✔

Drive by-wire test is that confirm the vehicle can be used as an autonomous vehicle.

Sensor Test is in order to meet the sensor performance requirements validation through simulation.

The important thing is that the selection of the most appropriate evaluation method to conduct the assessment in order to the balance both safety and efficiency.

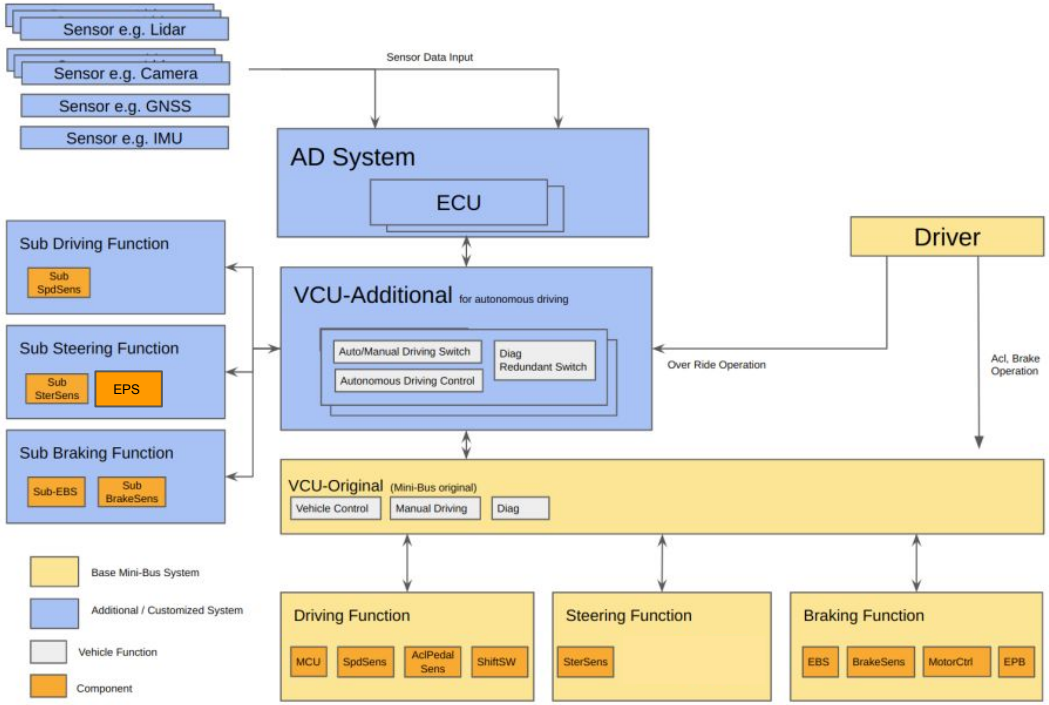
Case Study
mini EV bus

Case study of mini EV bus

TIER IV developed mini EV buses, based on manual driving vehicle.

This vehicle is under testing for get the Lv.4 Autonomous Driving approval from Japanese government.

E/E Architecture & Interface



E/E architecture of mini EV bus

Vehicle Interface of mini EV bus

Category	Item	Side note
Control Command	Control Mode	Manual Driving / Auto Driving
	Acceleration	Throttle Command (0 ~ 1.000)
	Brake Presser	Brake presser command (MPa)
	Steering Angle	radius
	Shift position	D / N / R
	etc …	Parking, Door Open / Close, Light, Wiper, Horn etc…
Vehicle Status	Current Control Mode	Manual Driving / Auto Driving
	Main / Sub Velocity	m/s
	Main / Sub Brake Presser	MPa
	Main / Sub Steering Angle	radius
	Current Shift Position	D / N / R
	DIAG	Drive / Brake / Steering Function etc..
	etc…	Parking, Door Status, Light, Wiper, Horn etc…

TIER IV designed the E/E Architecture and add the any component and control logic for satisfy the Performance and Safety requirements.

The vehicle interface modified for each component specification and Autoware specification.

Today's Summary

Today's Summary

The L4CDG is a introduction that consolidates practical design guidelines for the development of vehicles with Lv.4 autonomous driving.

Lv.4 autonomous vehicle have to satisfy performance and safety requirements which are derived from balance of ODD, Safety goals and AD/Vehicle system.

For Autonomous vehicles to become popular, make the common specifications such as vehicle interface and E/E architecture (include redundancy).

THANK YOU