

Mitsubishi Electric Key Growth Businesses

< Automotive Equipment [xEV / ADAS] >

November 9, 2021

Mitsubishi Electric Corporation

1

Promote growth strategies that contribute to society toward the realization of a decarbonized society.

- Enhancement of compact, high-power, high-efficiency technologies for supporting automobiles electrification
- Flexible response to the expanding HEV/BEV market amid rapid changes

2

Promote growth strategies that contribute to society toward the realization of safe and secure vehicles and the resolution of social challenges by mobility innovation.

- Proposal of authentic ADAS technology by integrating multiple in-house technologies
- Applying technology acquired by ADAS development to dedicated short range autonomous driving systems

3

Set the electrification/ADAS business, which is expected to expand in the future, as key growth business and set the sales target for FY 2025 at 250 billion yen (p. 11)

1. Business Overview

1-1. Business Structure

1-2. Automotive Equipment Strengths

1-3. Business Management Policy

2. Medium-term Management Plan of Key Growth Businesses

2-1. Business Environment

2-2. Recent Business Environment and Medium-term Target

2-3. xEV Growth Strategy

2-4. ADAS Growth Strategy

2-5. Exhibiting at CES2022

2-6. Initiatives on Social Challenges

Note

FY2018 : April 1, 2018 -March 31, 2019

FY2019 : April 1, 2019 -March 31, 2020

FY2020 : April 1, 2020 -March 31, 2021

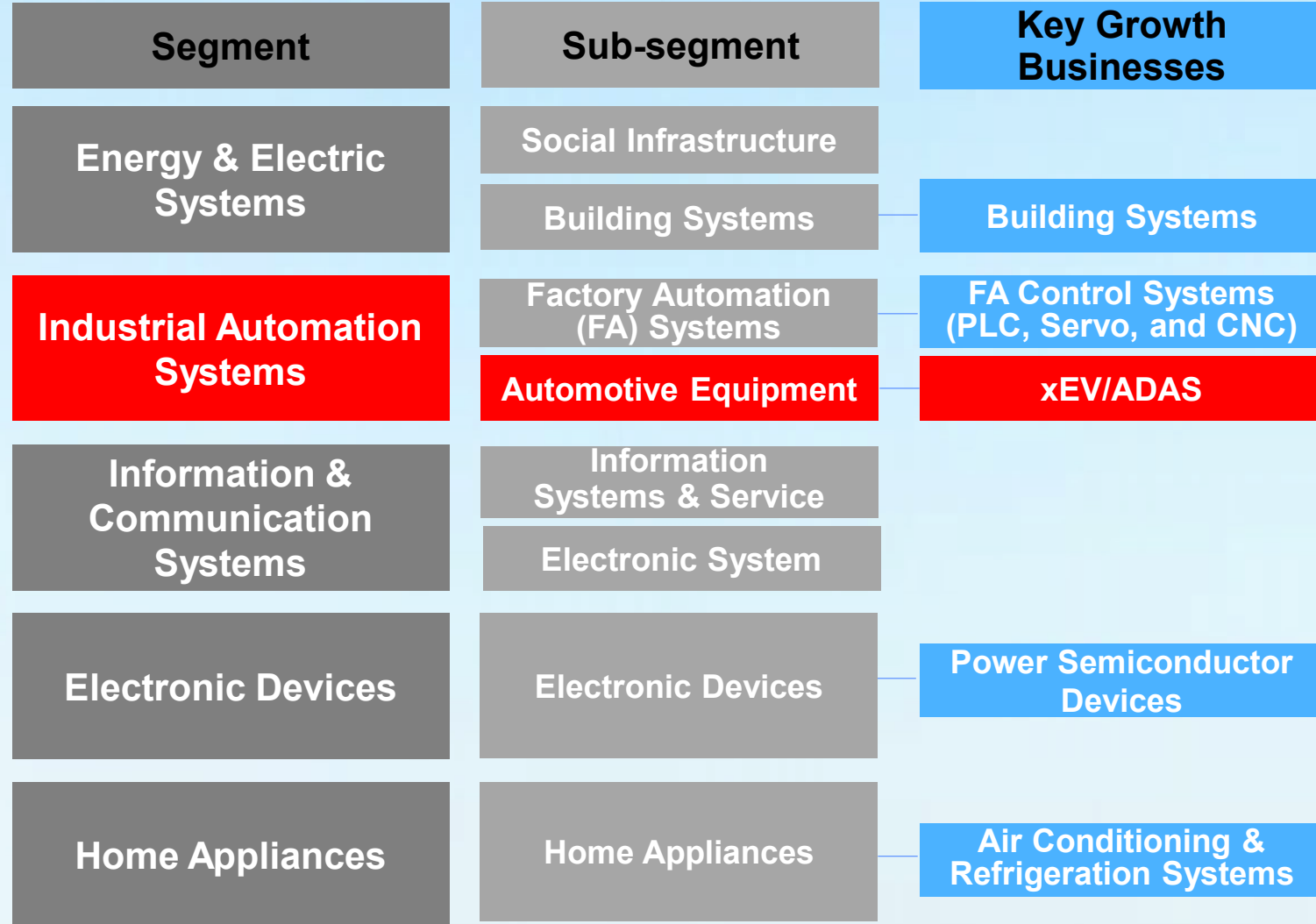
FY2021 : April 1, 2021 -March 31, 2022

FY2025 : April 1, 2025 -March 31, 2026

1

Business Overview

Business Structure



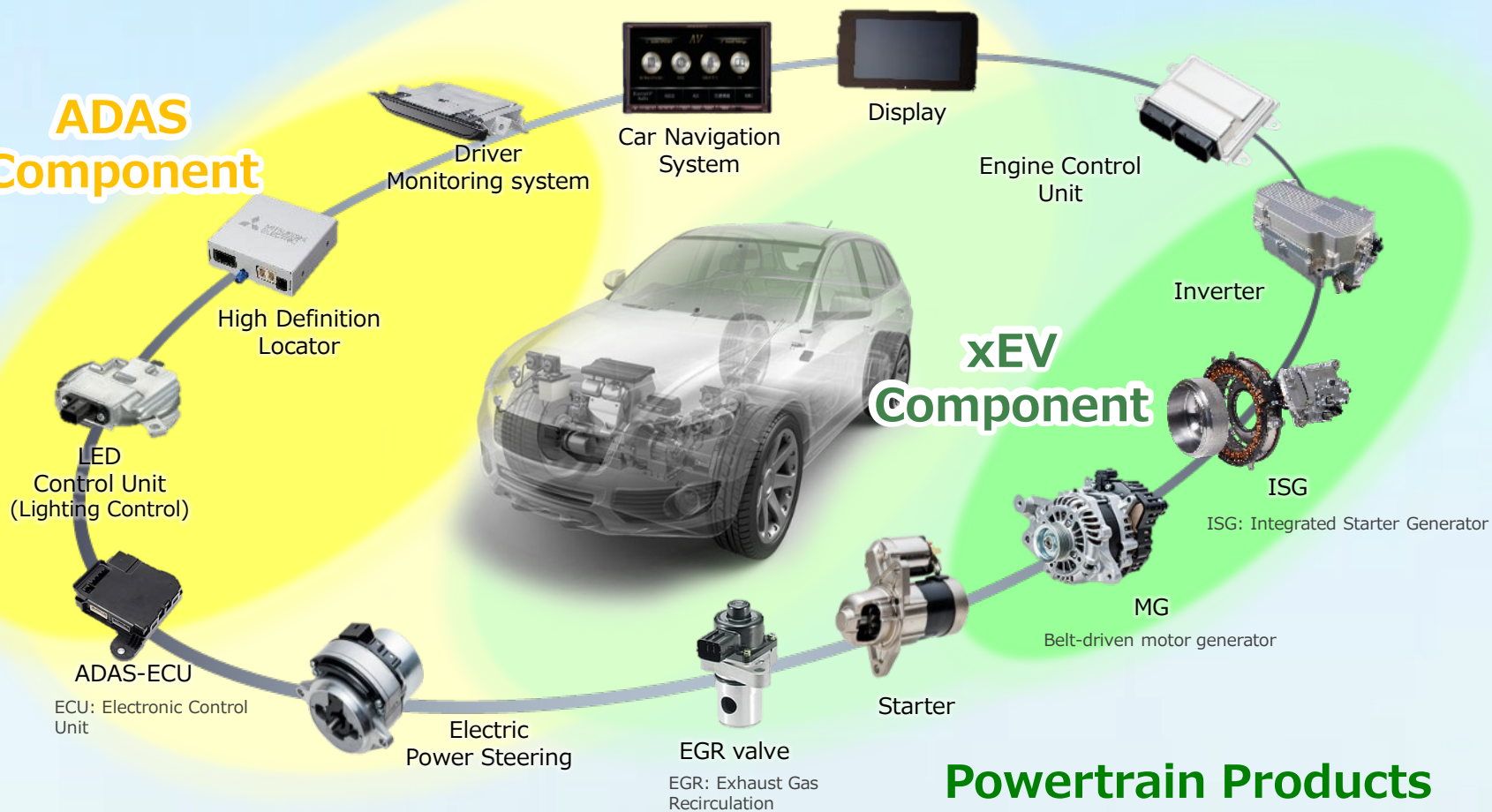
Enhance ADAS and xEV technologies and expand the business by leveraging the knowledge and assets accumulated in the automotive equipment business for vehicle control, powertrain and other products.

Vehicle Control Products

ADAS Component

xEV Component

Powertrain Products



*Main products are listed. Product groups related to information and communication systems such as car navigation and ITS are also included in vehicle control.

Interaction of the technology of engine and electric vehicle products in the automotive equipment business and the extensive knowledge/experience of other business fields in our company makes a wealth of synergies and then creates new value in a future society of safe, secure, and comfortable automobiles/mobility.

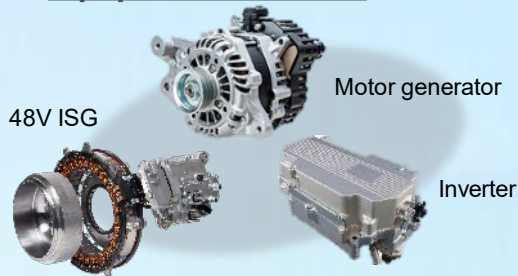
Technologies, products and systems in the automotive equipment business

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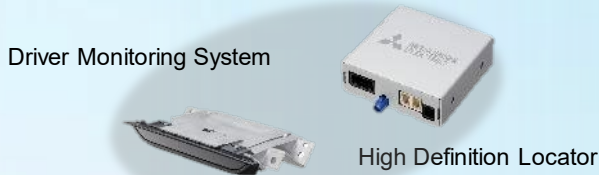
Knowledge in a wide range of business areas

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Contributing to the Global Environment, Safety and Security



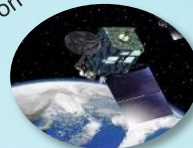
Electrification



Sensing



Control



Expand the lineup of motors and inverters from HEV to BEV For growing demand of electric vehicles

Create safe and secure autonomous driving systems by integrating technologies cultivated in various markets, and further develop dedicated short range autonomous driving.

Objectives of Prioritized Growth Projects

- Provide all people with equal opportunities for safe, low-cost and accessible mobility with low environmental impact
- Contribute to the sustainable development of society and grow our company business by expanding the value provided to customers and the market through the enhancement of our company's strong technologies (Motor, Power Electronics, Control, Communication, and IT)

Prioritized Growth Business Areas

Electrification

- Reduction of air pollution
- Minimizing environmental impact
Proposal to combat climate change and realize a decarbonized society

ADAS

- Elimination of traffic accidents
- Providing comfortable transportation opportunities
- Reduction of congestion
- Proposal to labor shortages

SDGs Contributing to Prioritized Growth Business Areas



2

Medium-term Management Plan of Key Growth Businesses

Rapid growth of electrification toward realization of a decarbonized society

- Implementing renewable energy and expansion of charging infrastructure investment toward the goal of carbon neutrality
- Complying with CO2 regulations and electric vehicle sales obligations by car manufacturers
- High demands for securing supply of important components for rapid expansion of electric vehicles

New added value for security, safety and comfort

- Installation of autonomous driving level 2/2+ is increasing
- Acceleration of the initiatives to address MaaS solutions, such as car sharing service using autonomous driving and connected technology

Changes in the industrial structure surrounding automobiles

- Changes in the industrial structure through joint development and alliances between car manufacturers and suppliers, and cross-industry alliances

Carbon neutrality: Balancing greenhouse gas emissions and removals

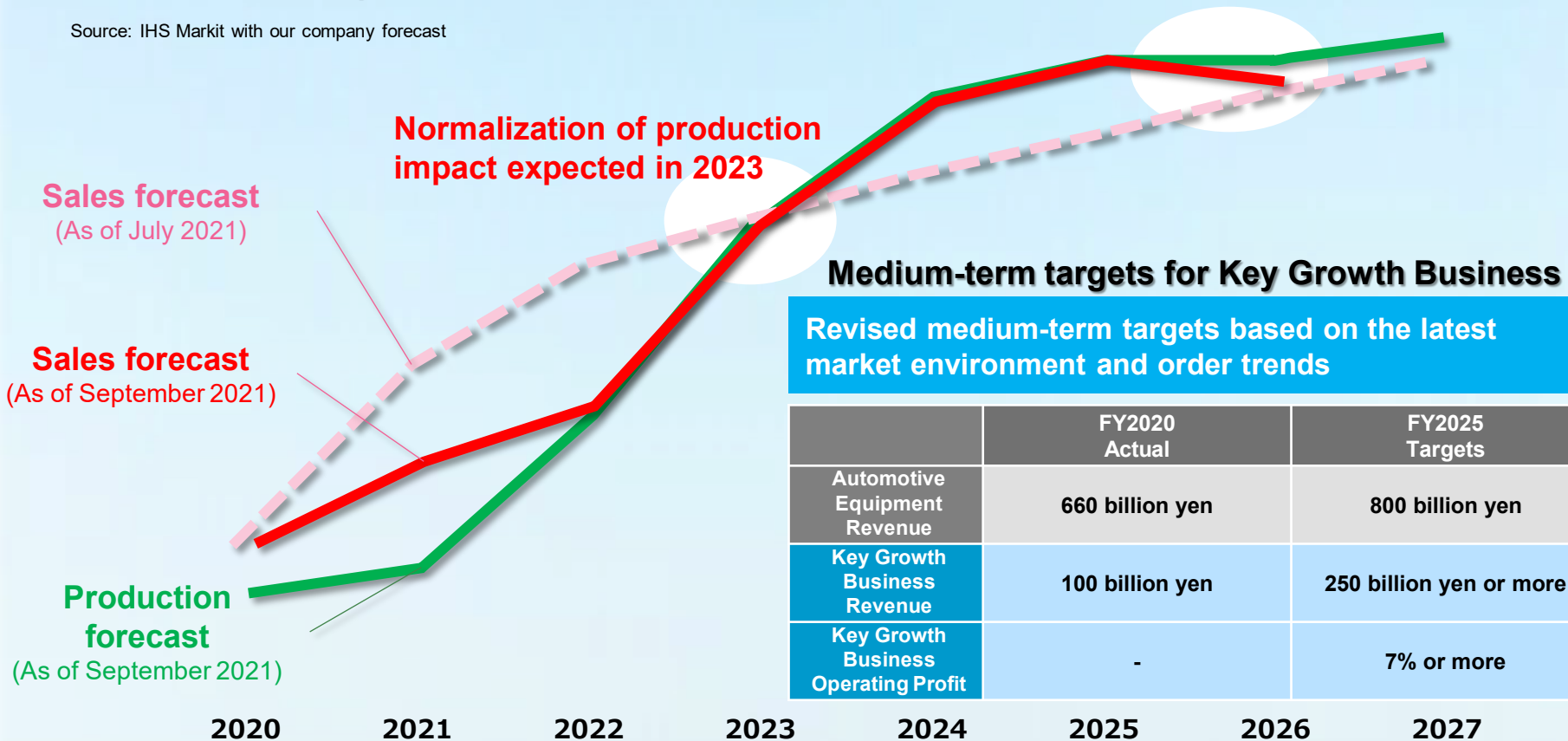
Autonomous driving level: A numerical value that indicates the degree of autonomous driving, defined by 6 levels of level 0 ~ 5.

MaaS: Mobility as a Service (a new concept of mobility as a service)

Automobile production was severely constrained in 2021 due to the resurgence of COVID-19, supply shortage and high demand for semiconductors. Automobile sales are expected to be affected in 2022 and beyond. It will take a long time to normalize the market inventory of automobiles. Recovery is expected in 2025.

Global automobile production and sales forecast

Source: IHS Markit with our company forecast



Medium-term targets for Key Growth Business

Revised medium-term targets based on the latest market environment and order trends

	FY2020 Actual	FY2025 Targets
Automotive Equipment Revenue	660 billion yen	800 billion yen
Key Growth Business Revenue	100 billion yen	250 billion yen or more
Key Growth Business Operating Profit	-	7% or more

xEV Growth Strategy

Market environment

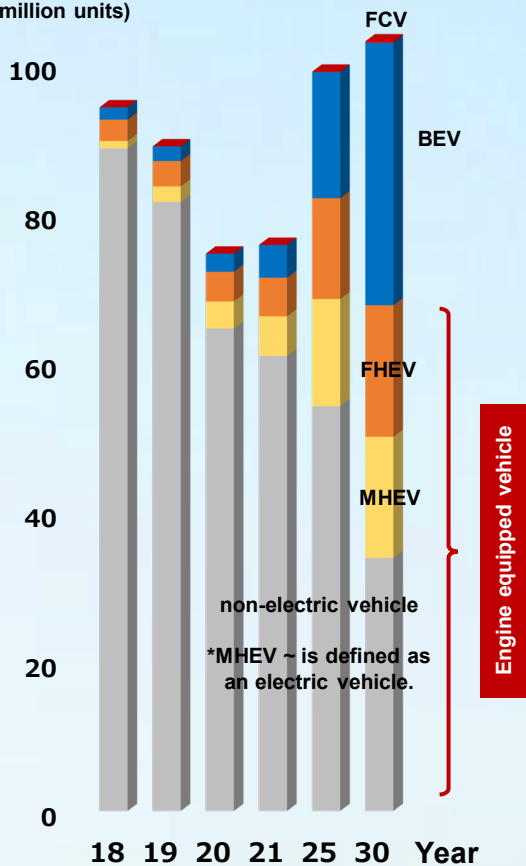
As a medium- to long-term trend, both HEV and BEV will expand until 2030. After 2030, the demand of BEV is expected to increase rapidly due to the serious efforts to become carbon neutral.

Forecast of automobile production by powertrain

(as of September 2021)

Source: IHS Markit with our company forecast

(1 million units)



2030-

Full-Scale spread of BEV through efforts to become carbon neutral

- 125 countries and 1 region including EU, UK, and Japan have declared to be carbon neutral by 2050. China aims to achieve by 2060.
- Usage of BEV will be expanded due to the policies for promoting renewable energy and development of charging infrastructure in each country
- Several car makers/brands announced banning engine equipped cars

-2030

Complying with CO2 regulations, both HEV and BEV will expand in electric vehicle market

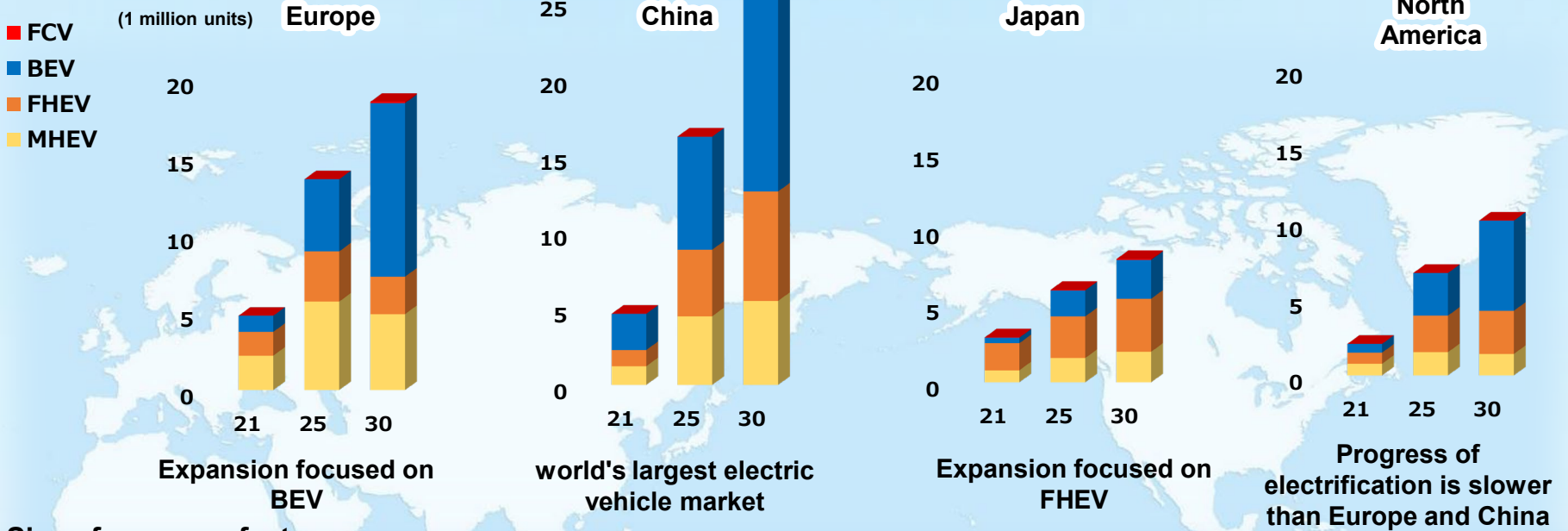
- Electric vehicle market will expand due to more severe fuel economy/CO2 emission regulations and promotion of measures for electrification in each country
- Each company adopts various methods for electrification
- There still be certain numbers of engine-equipped vehicles available

FCV: Fuel Cell Vehicle
 FHEV: Full Hybrid Electric Vehicle (hybrid system system enabling self-running by motor)
 MHEV: Mild Hybrid Electric Vehicle (Hybrid system for the purpose of engine assistance)

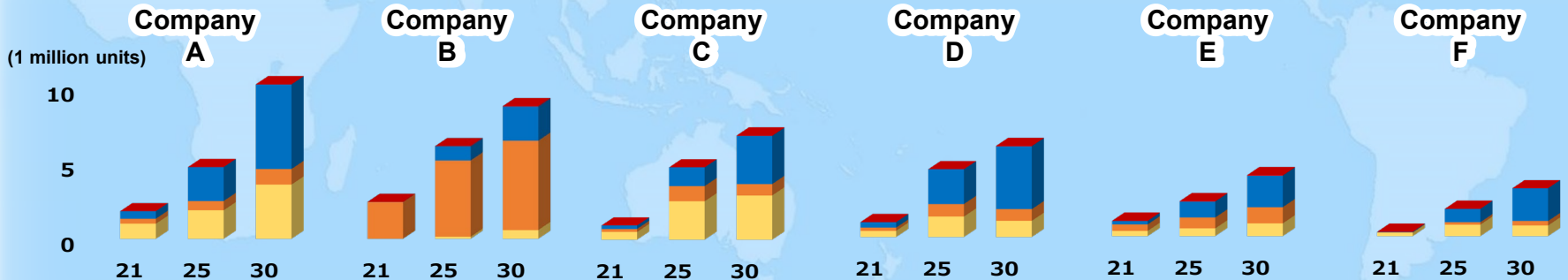
In response to the needs for electrification, which are progressing at various rates for each market and customer, it is necessary to standardize and evolve technologies from MHEV to BEV to meet market needs.

Market size (as of September 2021)

Source: IHS Markit with our company forecast



Size of car manufacturers (as of September 2021)

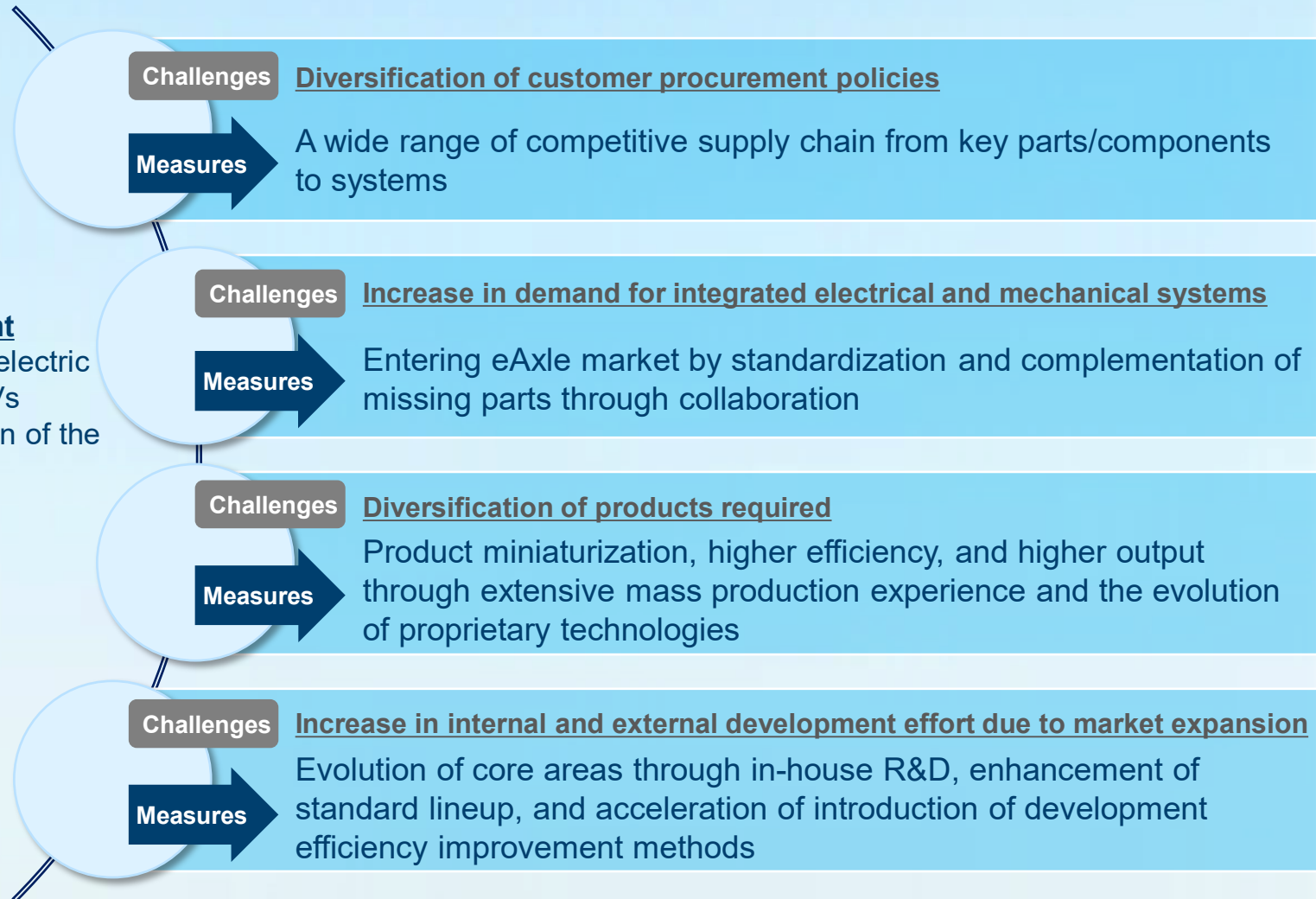


Car manufacturers are developing various electrification systems in accordance with their main sales regions and main models (vehicle class).

To respond to customers' regional and full-line strategies in the diverse HEV and rapidly expanding BEV markets, we will expand our lineup of electric parts by expanding our supply model variations.

Market environment

- Replacing non-electric vehicles to HEVs
- Rapid expansion of the BEV market

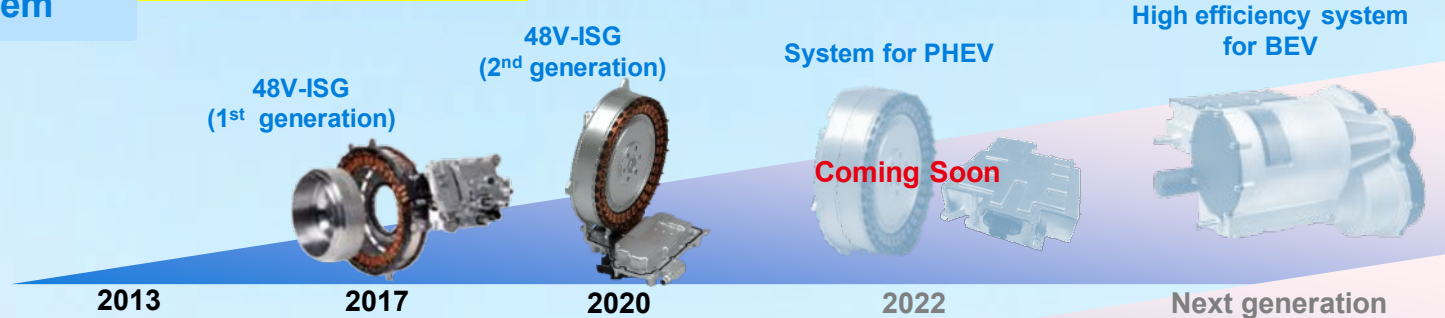


With over 20 years of experience in the electrification market and a wide range of products from 48V ISG to HEV/BEV, we can meet various needs for electric vehicle from power devices to integrated motor/inverter systems.

Motor/Inverter system

Our company: 600,000 units

*Market performance is as of July 2021. The number of vehicles to be installed.



Motor Generator(MG)

Our company: 4 million units



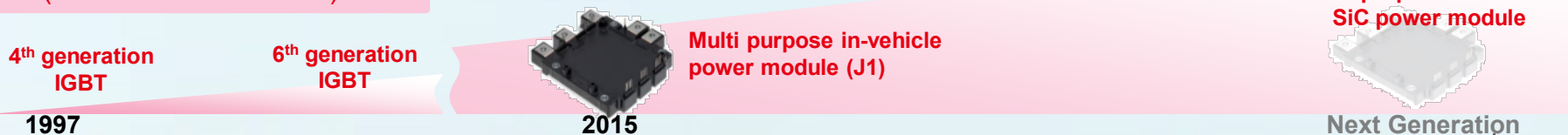
Inverter (Power Unit)

Our company: 5 million units



Power device (for electric-vehicle use)

Our company: 19 million units

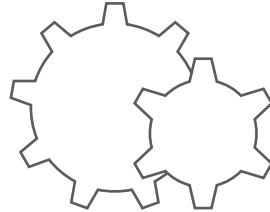


eAxle Support for Full-Scale EV Popularization


Establish a business structure that enables selective and combined supply of eAxles, components, key parts, etc., to follow procurement and development policies (in-house manufacturing/outsourcing, etc.) of car manufacturers and Tier 1 suppliers

Maximize benefits by
complementing missing parts

eAxle/Gear Maker



- Shift, clutch design and production
- Gearset design and production
- Integrated housing design and production
- eAxle ASSY Design and Production


**MITSUBISHI
ELECTRIC**
Changes for the Better


- Motor development, design and production
- Inverter development, design and production
- Motor and powertrain control technology

GOAL

- Access to the eAxle market through collaboration, etc.
- Contribution to realize optimal eAxle costs through the standardization and production design of inverters and motors

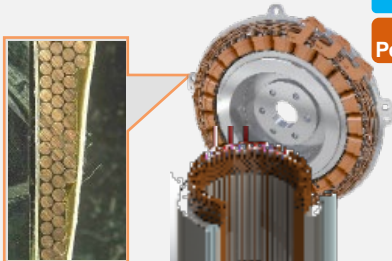


Differentiated Technologies

Using advanced in-house key parts and control technologies developed in various businesses, our company achieves downsizing, weight reduction and high density of motors and inverters, and improves both of driving performance of electric vehicles and fuel economy / electricity costs.

High-Density winding motor

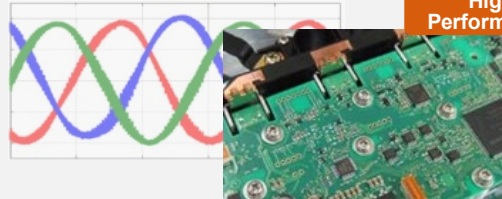
- Downsize
- Low Cost
- High Performance



Industry's highest level of **high-density winding technology** for minimizing coil loss

High efficiency and high response motor control

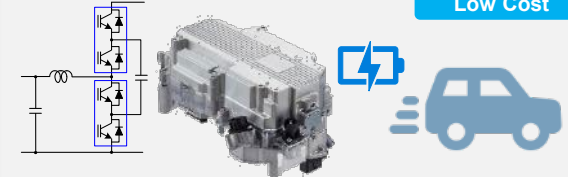
- Lower electric consumption
- Low Cost
- High Performance



Low-loss drive control that minimizes the loss of the inverter and motor according to the driving scene

Boosting and variable voltage circuit

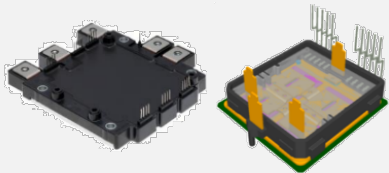
- Lower electric consumption
- Downsize
- Low Cost



Achieve highly efficient drive of motor regardless of battery voltage by **unique booster circuit method**, reducing battery size and weight

internal power module

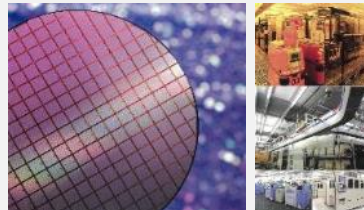
- Lower electric consumption
- Downsize
- Low Cost



Achieve **heat radiation performance exceeding double-sided cooling** with single-sided cooling structure advantageous for miniaturization, height and weight reduction

in-house power device

- Lower electric consumption
- Downsize
- High Performance



The world's highest level of SiC devices and high performance achieved by using SiC with abundant experience and achievements

Synergies with internal operations

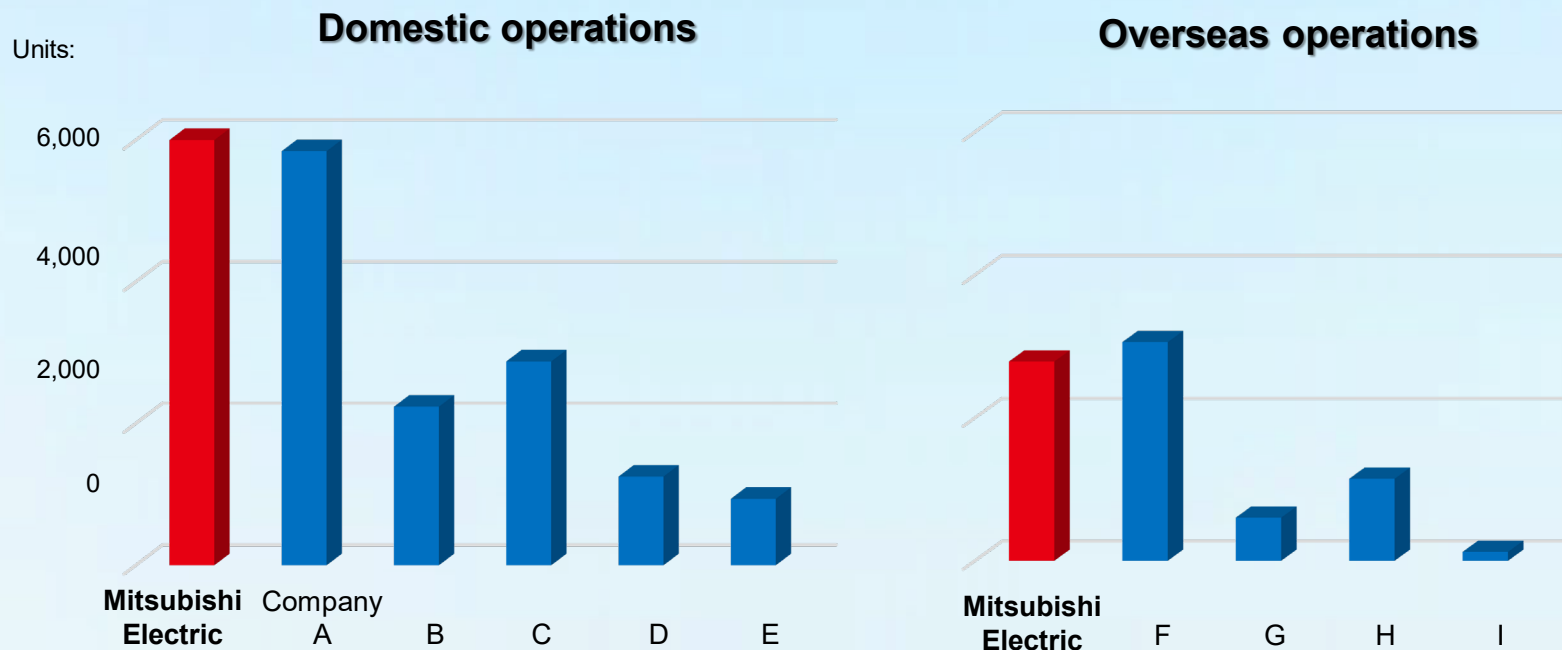


Contributing to the creation of new mobility through collaboration with advanced communications and security technologies and infrastructure businesses

**Example of strength analysis of in-house technology
(intellectual property benchmarking)**

Our company holds similar number of patents as competitors in the technical fields we focus on. The partnership strategy aims to improve competitiveness by utilizing our company's intellectual property rights.

Number of patent families owned by each company (Electrification)

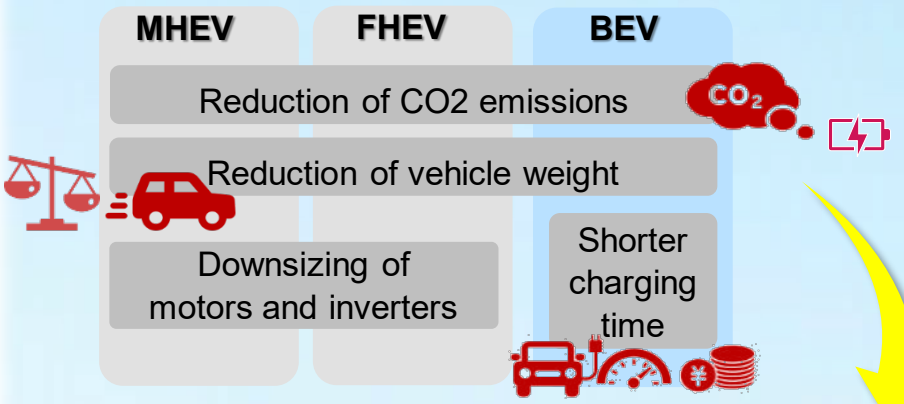


Intellectual Property Benchmark: Comparison of the number of effective patent families held by each company based on the International Patent Classification for patents related to our company's automotive business (as of September 2021)

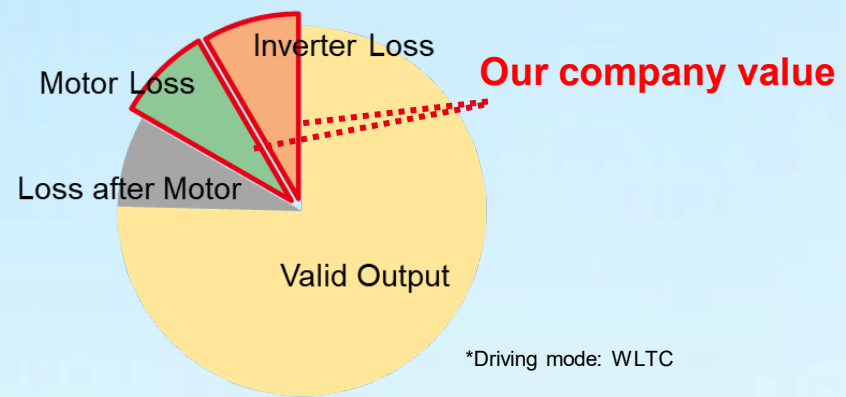
Expanding the contributable areas and company value with differentiated technology

The importance of power conversion efficiency increases as motors and batteries will be the main drivetrain for vehicle. The roles and demands of high-efficiency power devices, inverters, motors, and controls will increase more than ever.

Problems and targets of each system



Breakdown of energy loss in BEV vehicles



Contribution by our differentiated technology

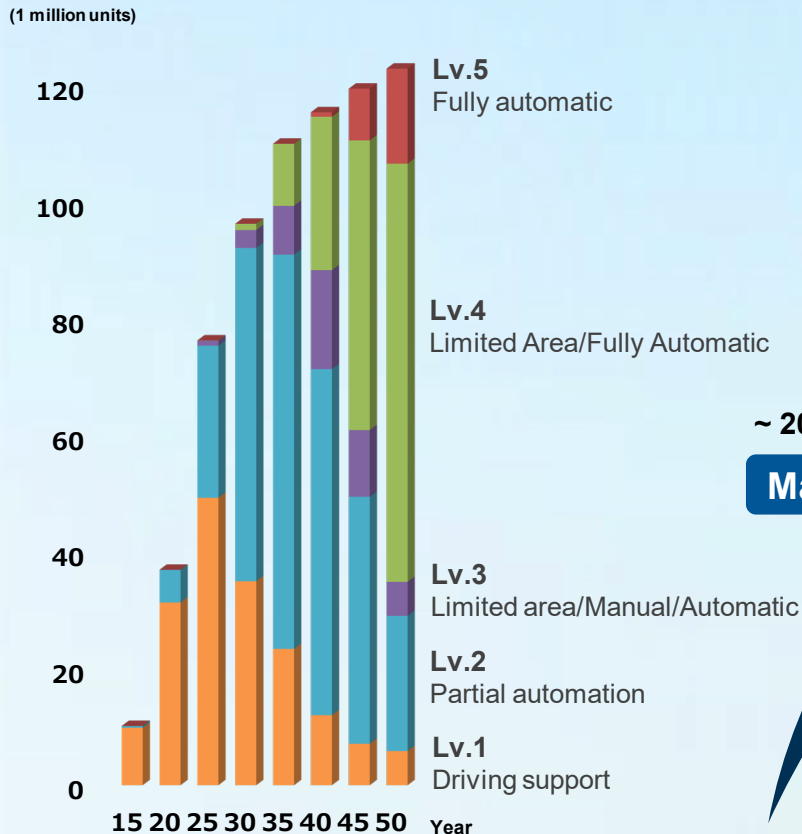


ADAS Growth Strategy

Market environment

Business opportunities will increase due to the expansion and diversification of social needs for automobile safety and comfort, while automakers and suppliers will be required to invest heavily in development and strengthen their development capabilities to meet these needs.

Forecast of vehicle production by autonomous driving level



Source: Strategy Analytics

2030 ~

Spread of level 4/5 mainly to MaaS

- Widespread adoption of Level 4 mainly on automated driving services such as MaaS
- Fully Automatic Level 5 will begin to become widespread after 2040

~ 2030

Mainstream automatic operation level 2/2 +

- Development of ADAS for accident-free and comfortability
- Increased demand for ADAS products due to stricter regulations and safety assessments in each region
- As a solution to the increase in the scale and complexity of in-vehicle software development, the standardization of electronic platforms has been actively promoted.

Changes in the business environment

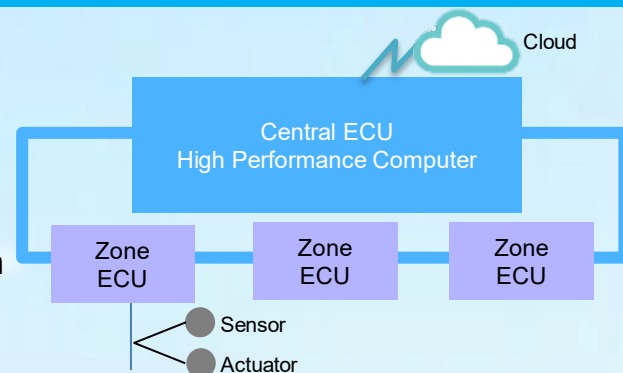
- On-board Electronics & Electrical architecture : In order to cope with the increasing complexity of systems and the increasing size of SWs due to the increase in required functions, consolidation of ECUs for centralizing information and Hardware/Software separation are being made.
- Selling HW including SW will be changed to HW + SW (integrated ECU) and then to selling SW.

Full-scale dissemination from around 2030

Centralized Architecture

- Brains are integrated into the central ECU. Sensors and actuators are connected to the zone ECU as a hub.
- High-speed Ethernet will be adopted as in-vehicle communication network, and some functions will be moved to cloud.

Central consolidation

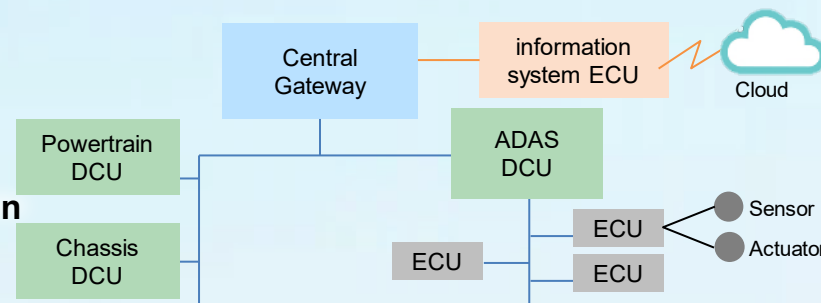


Full-scale dissemination from around 2025

Domain-centralized Architecture

- ECU is integrated into each functional domain, and domain controller (DCU) is adopted.
- Trend of integrating DCU is also coming

Domain consolidation

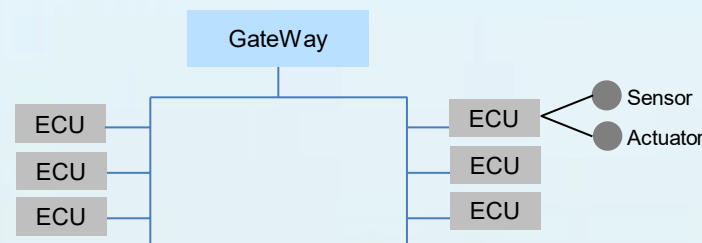


Present (continued scale in 2030)

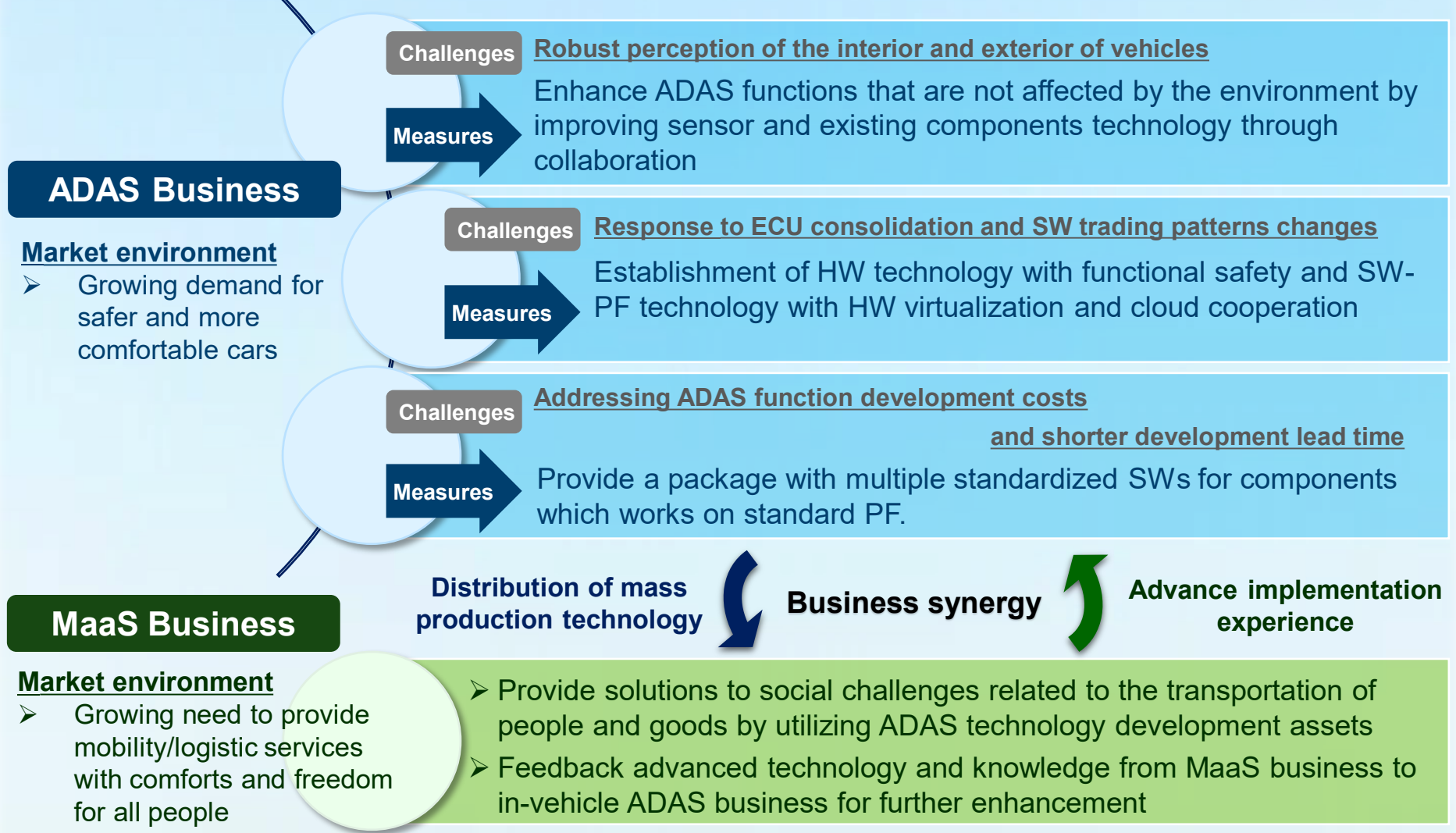
Distributed Architecture

- Functional ECUs are communicating each other by connecting to in-vehicle network

Modular structure

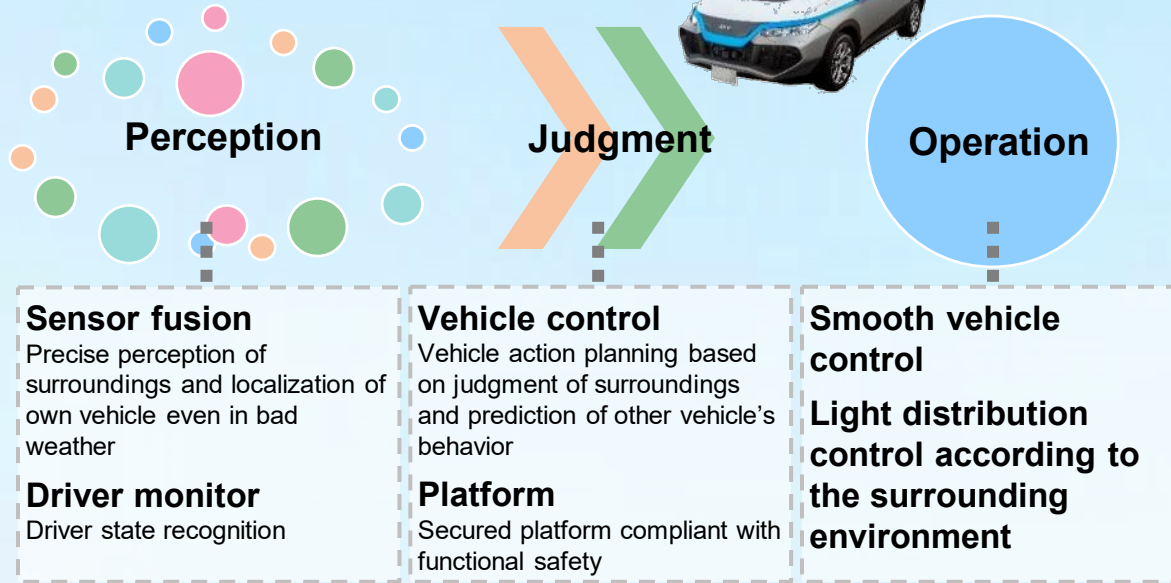


Establish an ADAS system which responds to changes by complementing necessary technologies through cooperation and evolving existing components. We are going to adapt the ADAS technology into MaaS businesses to propose solutions to social challenges

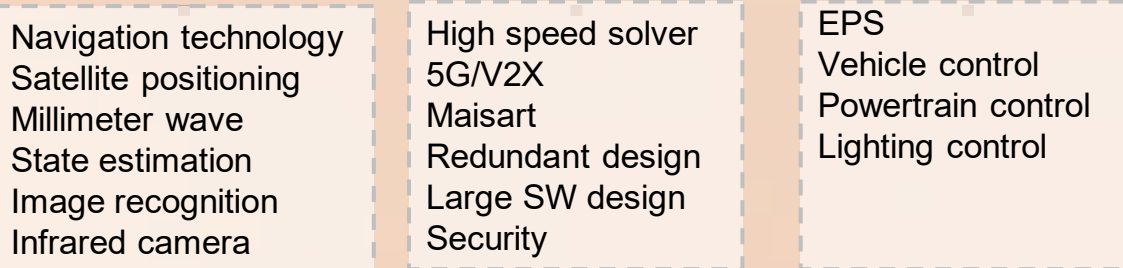


Aim to reduce development costs, development time, and to expand the business by letting customers to be able to select H/W, S/W or combination of them with our technology elements for perception, judgement, operation, and all required functions on ADAS system

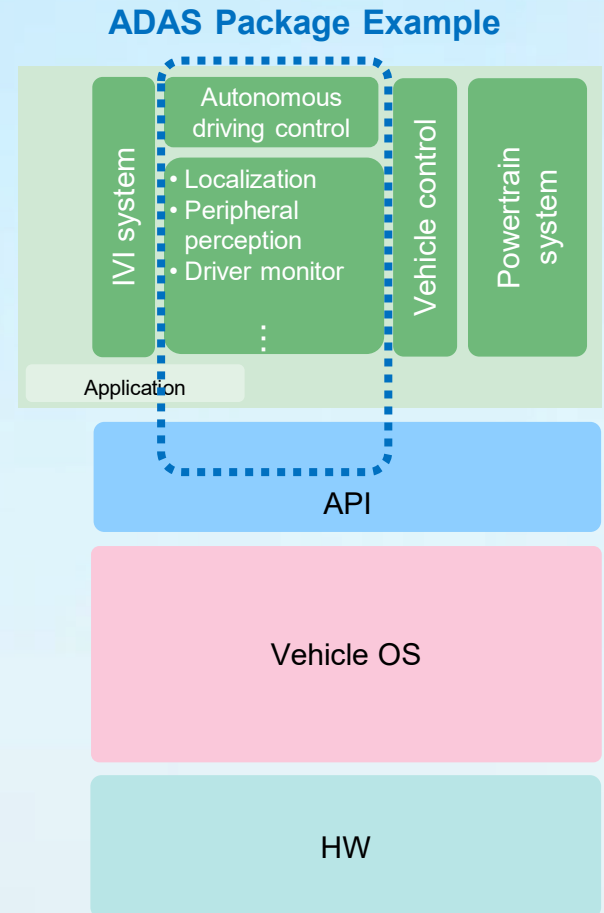
Our company ADAS System Area



Our company technology



Integrated ECU structure

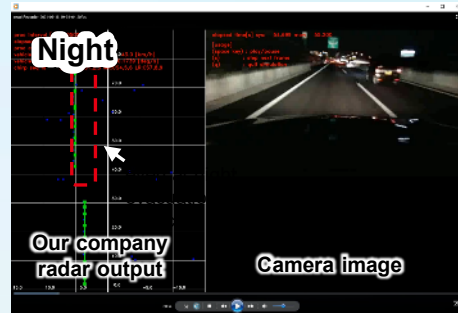
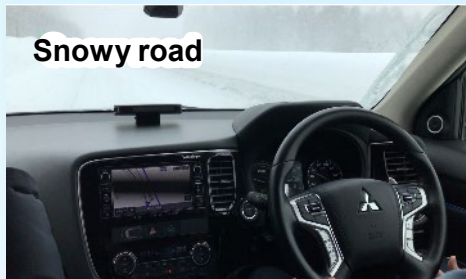


2-4 ADAS Growth Strategy

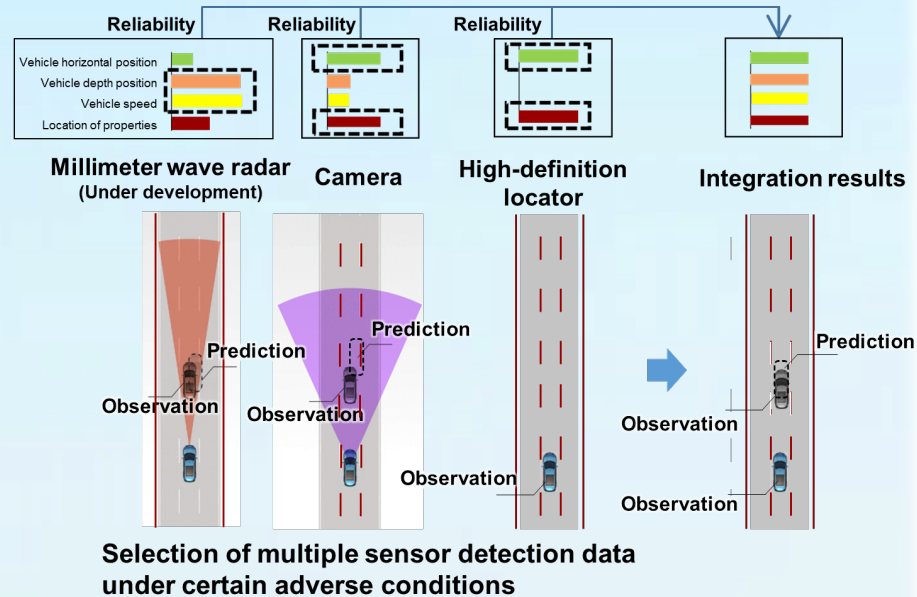
Differentiated Technology: Environmentally Independent Sensor Fusion Technology

Our ADAS function would be active even in environments where other companies' system could not maintain. This is due to our sensor fusion technology that considers the reliability of each sensor including high-definition locator. In addition, the combination with light distribution control provides a safer and more secure vehicle.

Maintain ADAS functions by utilizing high-definition locator and millimeter-wave radar even in environments where performance of camera is decreased



Sensor Fusion Technology Considering Reliability



Our high-definition locator and millimeter wave radar will be useful for scenes where performance of camera is decreased.

The reliability of each sensor is calculated one after another and integrated to cope with bad weather conditions.

Differentiation Technology:
“Driver Monitor” technology which detects sudden changes in physical condition

Contribution to zero fatal accidents by integrating industry's first proprietary image processing technology that solves the problem of low resolution with wide-angle cameras, a non-contact biometric sensing technology using near-infrared and millimeter waves, and a human condition estimation technology using AI.

**Careless detection /
Distraction Detection**



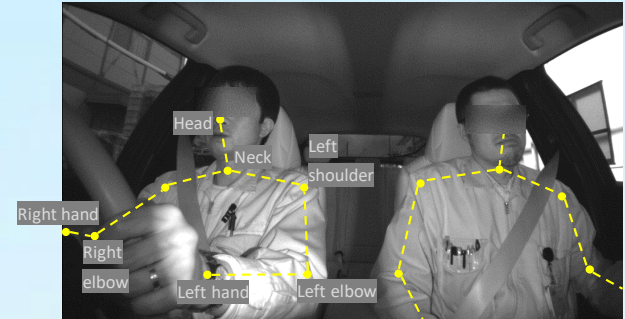
Detect behavior that interferes with driving

Wakefulness estimation



Alert when wakefulness is low

Physique detection



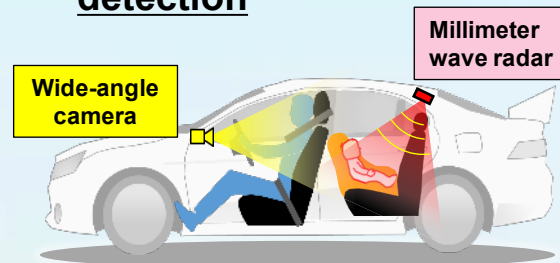
Optimal control of airbags according to body size

**Detection of Critical condition
/Sudden sickness**



Vehicle automatically stops by detecting critical condition/
sudden sickness by non-contact pulse estimation, etc.

**Infant abandonment
detection**



Millimeter-wave detection of infants
left in camera blind spots

**Seat belt fastening
determination**



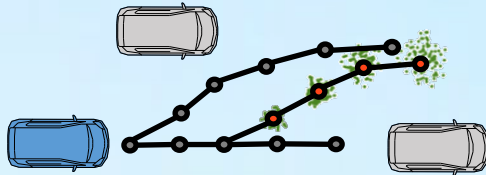
Check if the seat belt is fastened.

Differentiated Technology: Smooth Vehicle Control Considering Surrounding Environment

Path planning that realizes smooth vehicle behavior and adaptability to complicated environments.
Precise vehicle control with Model Predictive Control using a high-speed solver (to be mass produced soon for the first in the world)

Smooth Path Planning with PF – RRT

Route generation for avoiding stopped vehicle

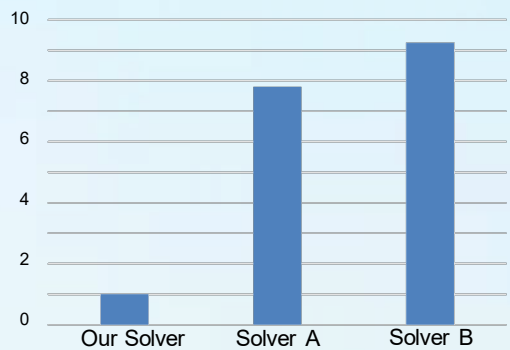


Select the safest and smoothest path for avoiding obstacles

The solution of flexible route is easy to be acquired even in complicated driving environment.

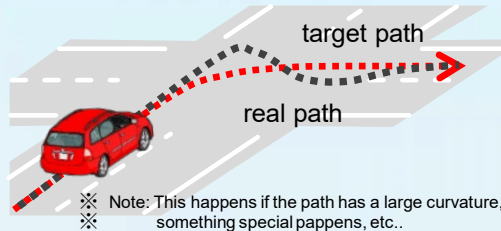
Smooth vehicle control by model predictive control

Ratio of computation processing time
(our company = 1)



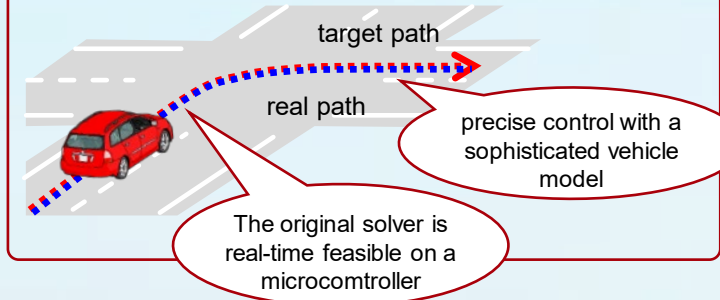
Current technology

Unsteady behavior against a target path occurs due to steering delay.



Development technology

High-precision and stable tracking of the target path while predicting the future several seconds ahead by realizing predictive control with low computation using a nonlinear model



Our original solver for model predictive control is 7 times faster than other solvers (example)

*Solvers A and B are open-source optimization solvers

Solver: Computation software (the ability to calculate the best value for multiple variable changes)
PF-RRT: A path planning method using a Particle Filter (PF) that realizes smooth vehicle behavior and adaptability to complicated environments.

Autonomous driving service in dedicated area cooperated with infrastructure

Our company will develop this system into a platform which the technology is based on ADAS development to solve various social issues

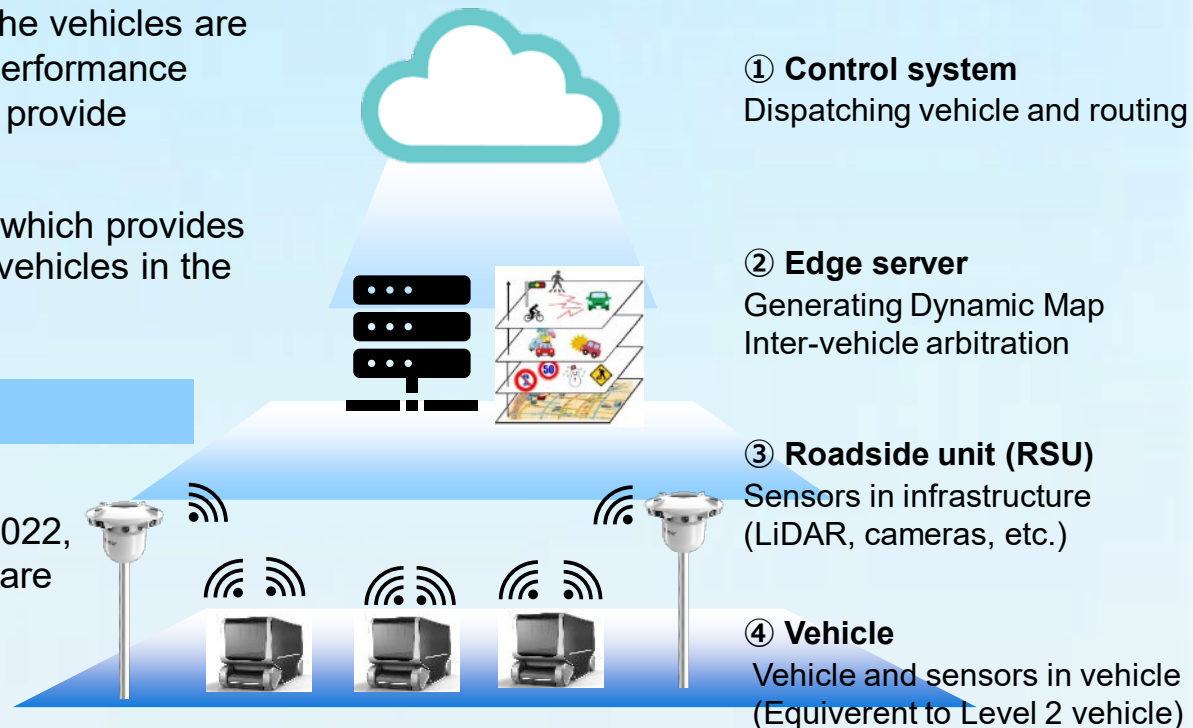
Based on the operational know-how which we obtained throughout this service, we would propose it as a differentiated functions for vehicle to car manufacturers.

① Features and Differentiators

- Achieve Level 4 performance even the vehicles are Level 2 or lower by equipping high-performance sensors on the infrastructure side to provide surrounding information to vehicles.
- Contribute to ensure safety by RSU which provides “blind spot free” dynamic maps for vehicles in the area.

② Targets

- Internal and external demonstration experiment will be completed in FY 2022, and proposals for commercialization are ongoing.
- Aim to commercialize after 2022.



Dynamic Maps: A Technique for Real-Time Dynamic Information Representation on Accurate Maps

Internal and external verification tests: FY 2021 “Project to Accelerate the Implementation of Advanced MaaS Driverless Automatic Operation” from the Ministry of Economy, Trade and Industry (Advanced Mobility Services R & D and Social Demonstration Project (Theme 1)) Responding to consignment business

Our company will be exhibiting at CES 2022. In Mobility exhibition, we will introduce future visions such as ADAS technologies and products, infrastructure-coordinated dedicated short range autonomous driving, and various use cases through videos, and hands-on/live demos.

Date of the event: Wednesday, January 5, 2022 - Saturday, January 8
Our company booth: West Hall, Las Vegas Convention Center



Image of our company Booth
*The appearance may be changed.

An example of the exhibition concept

Driving support and crew watching



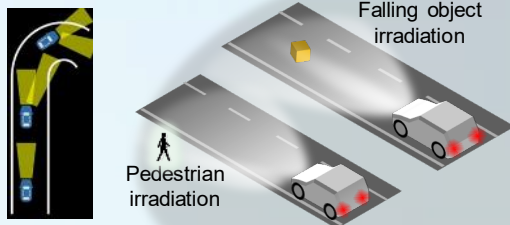
Sensors and cameras are used to check occupants' conditions and attributes, and to detect children who are left behind.

Infrastructure cooperative designated short range automatic operation



Contributing to autonomous driving through cooperation with roadside unit and other infrastructure

ADAS-cooperated lighting control technology



Combining lane information and vehicle location information with optimal light distribution to illuminate destinations and obstacles

Indoor and outdoor logistics



Service mobility in cooperation with traffic control contributes to autonomous indoor and outdoor driving and unmanned delivery

*Joint development with Stanley Electric Co., Ltd.

Contributing to the resolution of social challenges to achieve sustainability

Contributing to the resolution of social challenges such as decarbonization and a safe and secure society through business expansion of electrification and ADAS with core technologies

Materiality to realize sustainability

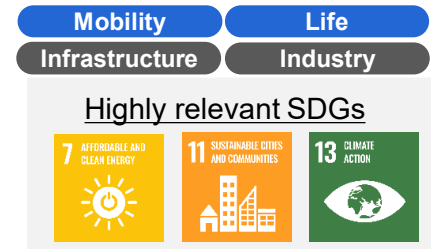


Provide solutions to social challenges through our business

- Realize a sustainable global environment
- Realize a safe, secure, and comfortable society

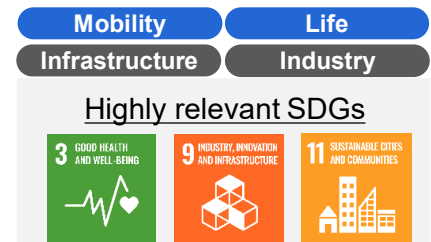
1. Electrification business

Contributing to the Reduction of Air Pollution, Climate Change Measures, and the Realization of a Decarbonized Society by Providing High-Efficiency Electric Vehicle Products

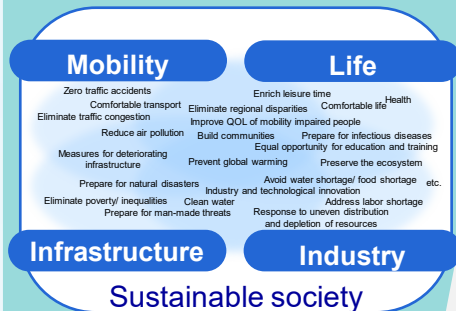


2. ADAS Business

Eliminating traffic accidents and providing comfortable transportation opportunities to contribute to a safe, secure, and comfortable society, and to solving social challenges such as labor shortages and the aging of society



Social Challenges



Cautionary Statement

While the statements herein including the forecast of the Mitsubishi Electric Group are based on assumptions the Group considers to be reasonable under the circumstances on the date of announcement, actual results may differ significantly from forecasts. Such factors materially affecting the expectations expressed herein shall include but are not limited to the following:

1. Any change in worldwide economic and social conditions, as well as laws, regulations, taxation and other legislation
2. Changes in foreign currency exchange rates, especially JPY/dollar rates
3. Changes in stock markets, especially in Japan
4. Changes in balance of supply and demand of products that may affect prices and volume, as well as material procurement conditions
5. Changes in the ability to fund raising, especially in Japan
6. Uncertainties relating to patents, licenses and other intellectual property, including disputes involving patent infringement
7. New environmental regulations or the arising of environmental issues
8. Defects in products or services
9. Litigation and legal proceedings brought and contemplated against the Company or its subsidiaries and affiliates that may adversely affect operations or finances
10. Technological change, the development of products using new technology, manufacturing and time-to-market
11. Business restructuring
12. Incidents related to information security
13. Large-scale disasters including earthquakes, typhoons, tsunami, fires and others
14. Social or political upheaval caused by terrorism, war, pandemics, or other factors
15. Important matters related to the directors and executive officers, major shareholders and affiliated companies of Mitsubishi Electric Corporation

