DENSO
Crafting the Core

Semiconductor Strategy

June 1, 2022

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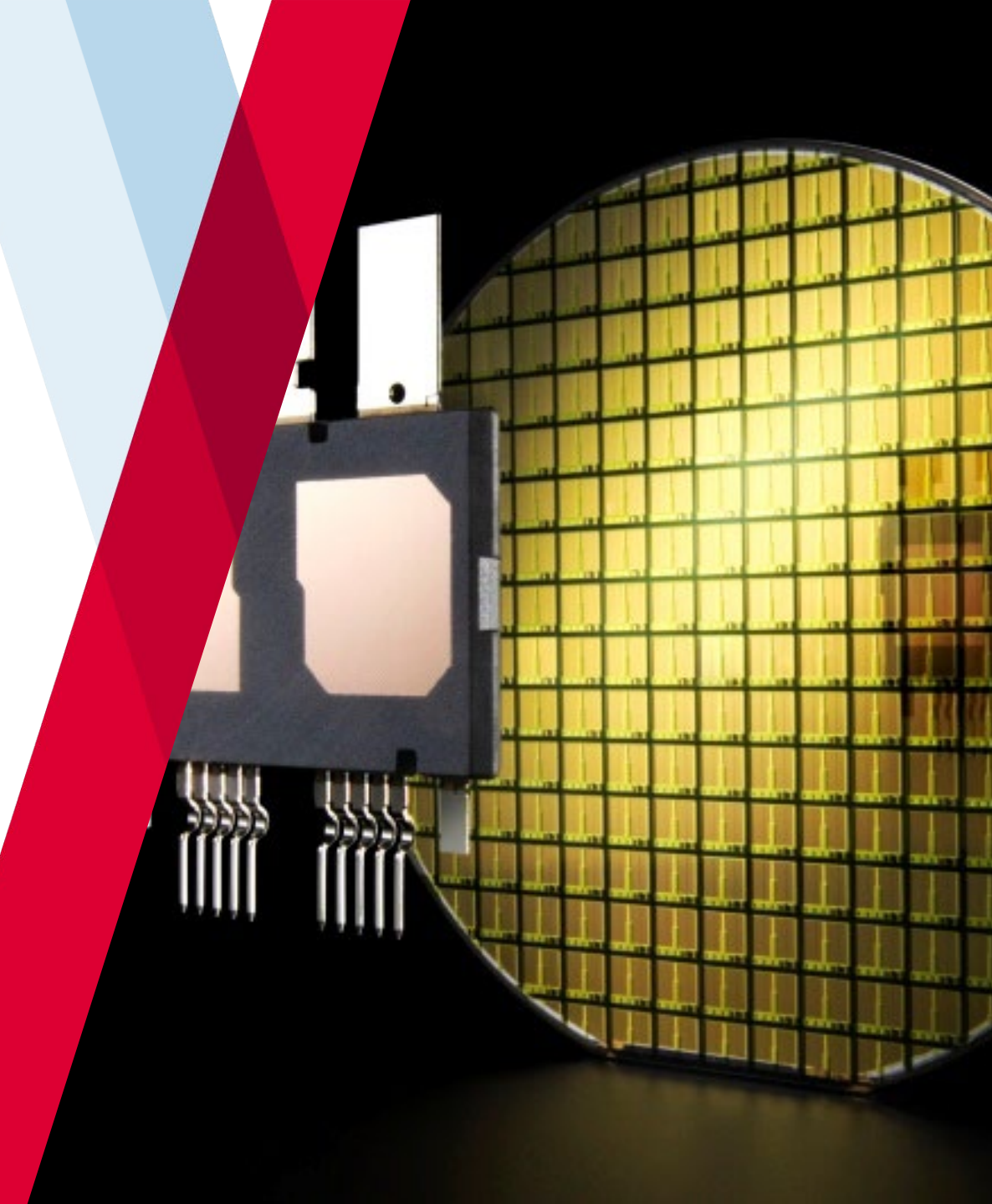
Senior Executive Officer, CTO
DENSO Corporation

DENSO supports the Sustainable Development Goals (SDGs).



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Response to the Semiconductor Shortage

DENSO's Response to the current and mid to long term semiconductor shortage

DENSO's response to the semiconductor shortage (1)

Collaboration with suppliers, and Efforts to secure supplies by taking full advantage of the procurement volume of vehicle semiconductors, which is among the highest in the industry

STEP 0

Utilization of risk inventory

In operation since 2012 in response to the Great East Japan Earthquake in 2011

Keep the risk inventory in stock at both suppliers (trading companies) and DENSO

STEP 1

Optimization of allocation of parts

Allocate across the global DENSO Group and utilize the pipeline inventory

STEP 2

Switching to alternative parts

Recovery through quick acquisition of certification for alternative parts after the Great East Japan Earthquake and fire at semiconductor plant

Study the possibility of using alternative parts for critical model numbers

STEP 3

Priority production and increase in production capacity

Mechanism to put priority on the process and increasing capacity (in-house/addition of foundries)

STEP 4

Optimization of production priority

Change the priority of production for DENSO at suppliers and optimize production

Promote activities to maintain the supply chain with suppliers to secure supplies.

DENSO's response to the semiconductor shortage (2)

Prevent risks, and expedite initial action in an emergency by establishing a structure for cooperation with suppliers and by introducing DX.

Sharing of Future Trends

Long term

Trends of technology and volume over the next ten years

Short term

Fixed order placement

Short-Term to Long-Term Order Placement (three months → ≥ a year)

	N + 1 years	N + 2 years
2021	Fixed order placement	
2022	Fixed order placement	Unofficial notification

Fire Prevention Measures and Strengthening Earthquake Resistance

Example

Increase inspection items for fire prevention measures based on experience

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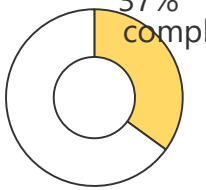
On-site check of plants at suppliers

Progress in on-site check



Systematic promotion

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To be completed in FY2022

Reinforcing Supply Chain and Preventive Management

Identify social changes and visualize issues

Changes in geopolitical risks, etc.
(collaboration with external specialized organizations*)

↕ Linkage

Issues in the supply chain
Such as oligopoly
(collaboration with suppliers)

* Government-affiliated agencies, overseas diplomatic bodies, trading companies, financial institutions, etc.

Introducing DX to risk inventory management (will start in October 2022)

Centralized internal and external inventory information (visualization)

↓

Expediting initial action

In normal times

Improvement of inventory management level (real-time visualization of volume)

In an emergency

Reduction in lead time to calculate the day on which parts will run out

Greatly strengthen the capability to maintain the supply chain in close cooperation with suppliers.

1

DENSO’s Basic Strategy for Semiconductors

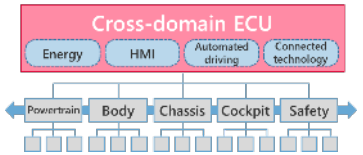
DENSO classifies the automotive semiconductor into three areas and formulates strategies for each area, taking into account the technology used, the industries driving that technology, and the companies driving mass production, etc.

Vehicles and Semiconductors in the Era of CASE

1. Changes in the Electronics Platform

Single ECU

Integrate ECU



Microcomputer & System on Chip (SoC)

2. Expansion of Electrification

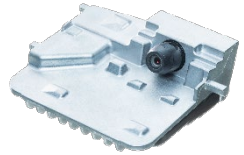
Power Control Unit

Battery Monitoring ECU

Power & Analog

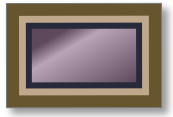
3. Evolution of Driver Assistance

Vision Sensor



Millimeter wave radar

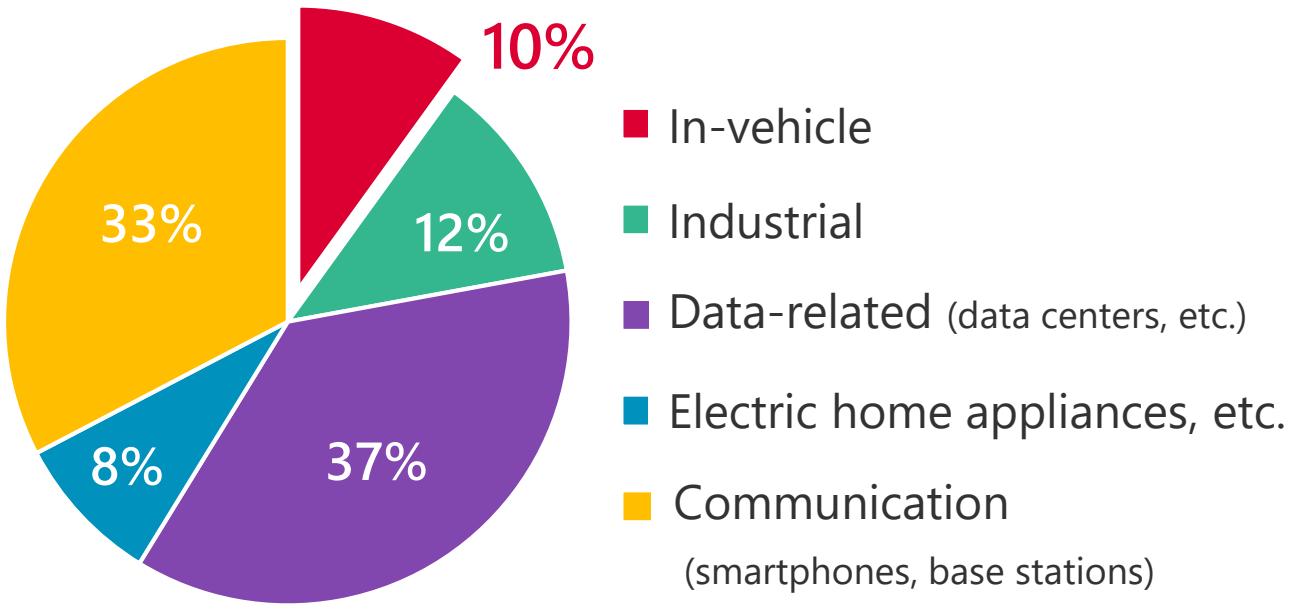
Sensor



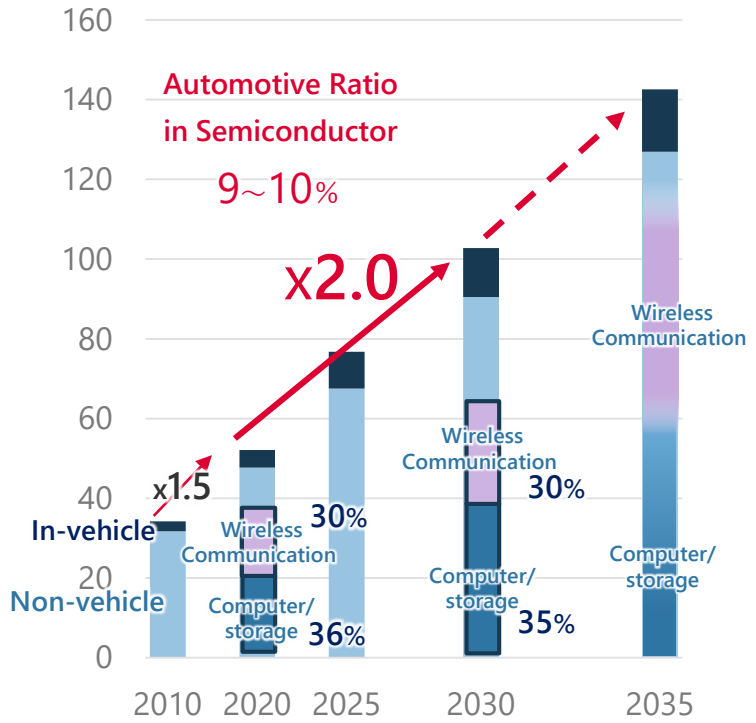
Semiconductors are the key to achieving these solutions.

Position of in-vehicle products in the semiconductor market

Semiconductor market in 2020: 53 trillion yen



Source: Omdia & in-house survey



Source: Omdia & in-house survey

As the semiconductor market expands, automotive semiconductors will continue to increase.

Strategy formation and collaboration between the automotive and semiconductor industries are essential for the advancement and stable procurement of in-vehicle semiconductors.

Basic strategy of DENSO's semiconductor business

Develop novel and rugged in-vehicle semiconductors while taking full advantage of existing semiconductors, depending on fields.

Microcomputer & SoC

- Division of labor into Specifications, Design and Manufacture
- Require Upstream Strategic Collaboration

Specifications → Design → Manufacture

DENSO Crafting the Core | Microcomputer vendor SoC vendor | TSMC UMC

Develop and Present Specification with Strategy and Maintain Stable Procurement

Power & Analog

- Require Performance which Fits in-vehicle Environment
- Automotive Industry Drives Technology

In-House Manufacture Semiconductors that Differentiate from Competitors

Sensor

- Utilize non-automotive technologies
- Collaborate with automotive sensor semiconductor vendor

DENSO Crafting the Core | automotive sensor semiconductor vendor

Collaborate with strategic partners

2

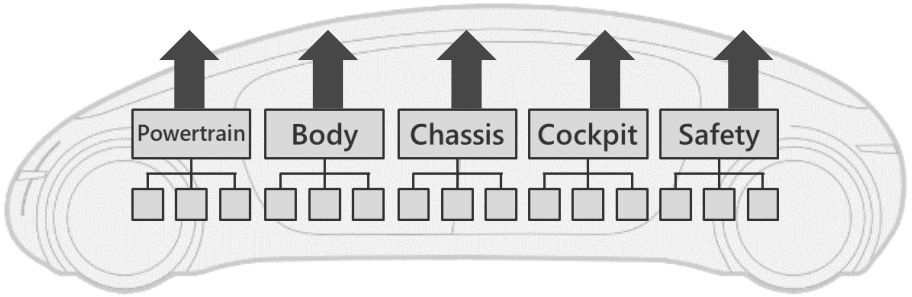
Microcomputer & SoC

Performance improvement, function development and establishment of a stable procurement network

Changes in the electronics platform and impact on in-vehicle semiconductors

Past

Evolution of each single domain

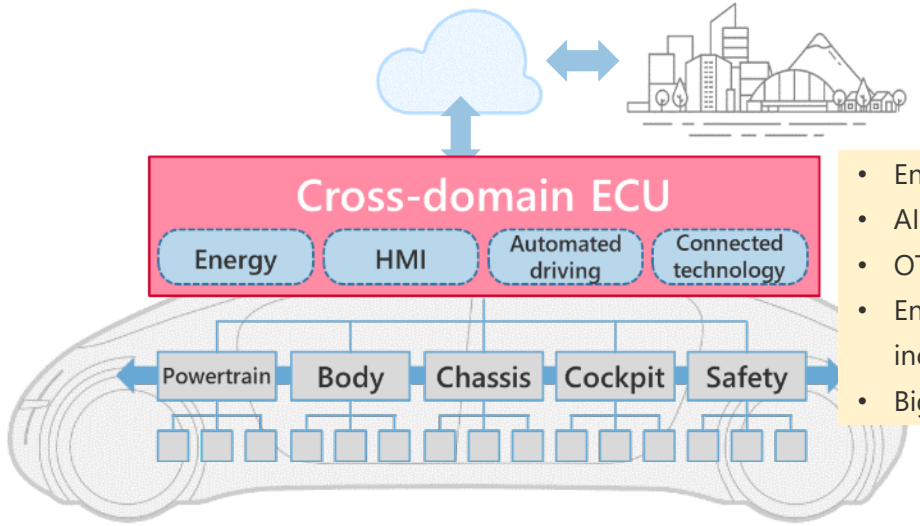


Logic semiconductor: Microcomputer

Application: Actuator control

Future

Cross-domain evolution



- Environment Recognition
- AI processing
- OTA、Connected Services
- Energy Management including City and Vehicles
- Big Data Edge Processing

Advanced actuator control ⇒ Microcomputer

AI, Image Processing, OTA, Cloud Cooperation, etc. ⇒ SoC

Microcontroller performance for control will be improved and SoC will be responsible for cross-domain function development.

DENSO's Vision

Promote two activities to secure stable procurement of advanced logic semiconductors

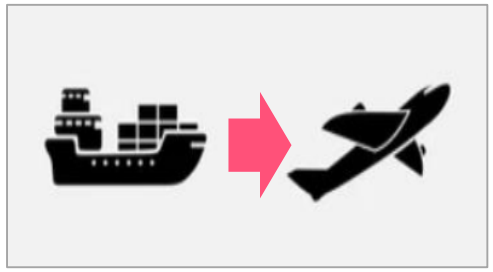
Promoting Development and Standardization and Deepening the Cooperation with Specialized Manufacturers

Present Strategic Specifications and Promote Standardization

Have Several Sites to Produce with Standard Manufacturing Process and Strengthen BCP

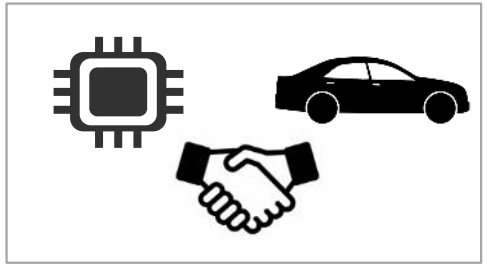
More in-depth response, including development and manufacturing

Activities to Maintain the Supply Chain



Short to Medium Term

Take Advantage of the Procurement Volume (Transport, alternative parts, and change)



long term

Optimize the Gap Between Automotive and the Semiconductor Industry

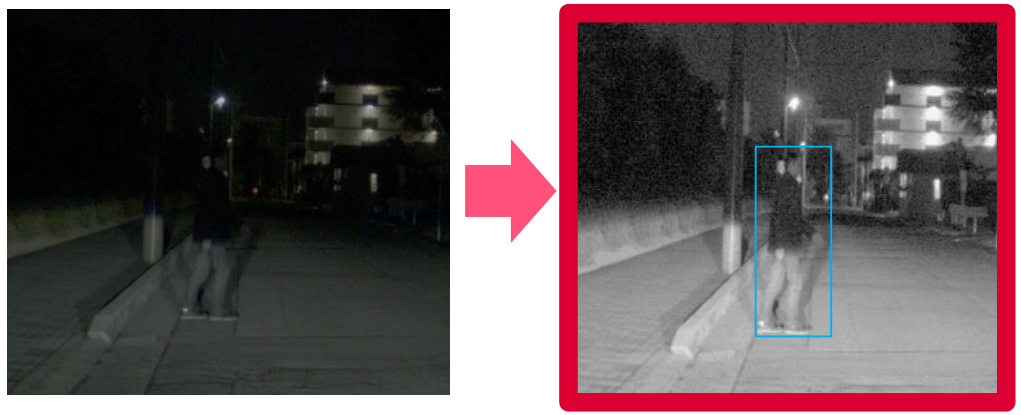
Promote optimization of semiconductor procurement structure

Efforts (1)
Promote development and standardization and deepen the cooperation with specialized manufacturers

DENSO's strength

Present Strategic Specification for Automotive

Development to improve the recognition performance at night



Before application　　After application

Artificial intelligence IP of SoC for image recognition systems

Jointly develop driver assistance SoC with semiconductor vendors

Prepare for Production of 28nm Microcomputers in Japan

jasm

*JASM: Japan Advanced Semiconductor Manufacturing

tsmc　SONY　DENSO Crafting the Core

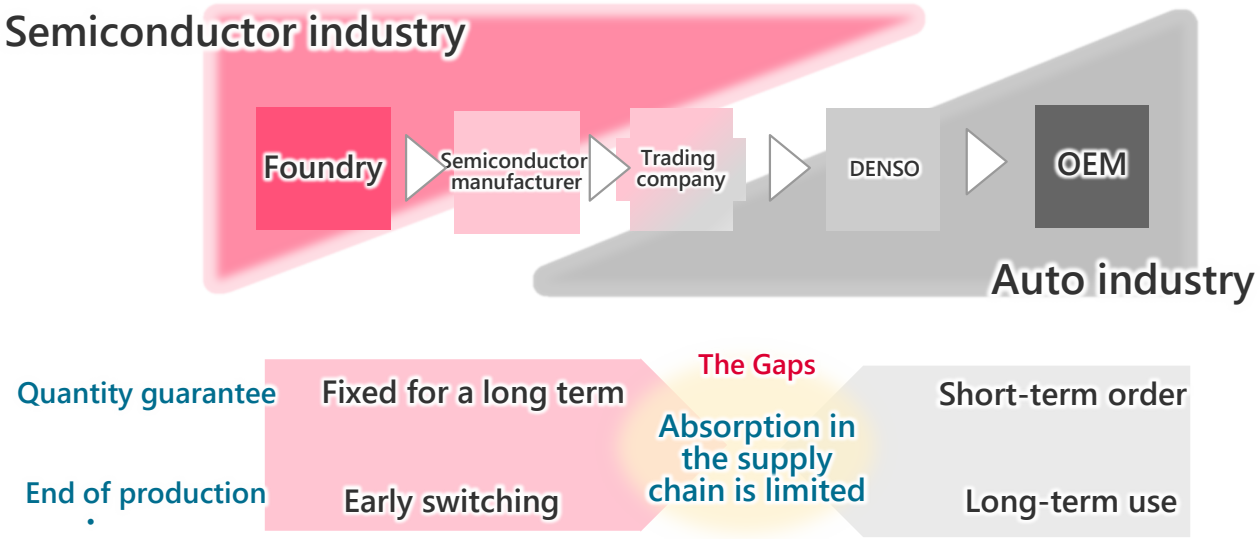
Taking a minority stake in JASM (announced in February 2022)

Efforts (2)
Reform the semiconductor procurement structure

DENSO's strength

Make proposals by Taking Advantage of Experience and Volume of Semiconductor Procurement

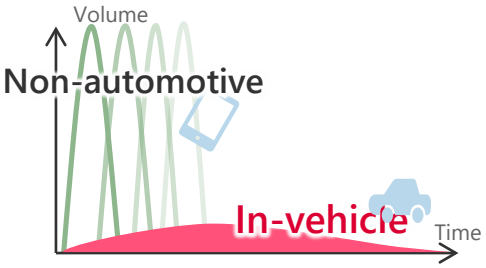
Gaps between industries (examples)



Key points in reforming the procurement structure

1. Share the medium- to long-term trends across the supply chain
2. Mechanism for industry standardization by taking advantage of the total volume
3. Switch earlier based on market trends

Example: Product life cycle



Small volume and long-term supply
- Cost increase to maintain production lines
- Response to discontinuation of old models

Leveraging DESNO's strengths to reform the procurement structure

3

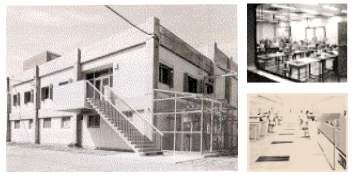
Power & Analog

The differentiation area driven by automobiles, materials, design, and manufacturing processes are insourced, semiconductors are also manufactured in-house.

History of in-House Manufactory of Semiconductors at DENSO

Expansion of wafer production facilities

1949 DENSO established
1967 IC Research Center established



1975 Head office wafer plant
1991 Kota wafer plant
2012 Iwate wafer plant

(transferred from Fujitsu Semiconductor)

2020 Hirose wafer plant

(transferred from Toyota Motor Corporation)

2023 collaboration with USJC

Global History of Semiconductor Development

1967 An electronic calculator (TI) developed
1968 Intel Corporation established
World's first CMOS IC (RCA)

The development of ICs accelerated globally in the 1960s.

Increase Production Capacity through M&A and Collaboration

Ranking by in-Vehicle Semiconductor Revenues in 2021

Unit: billion yen

	Manufacturer	Country	Revenue
1	Infineon		695.9
2	NXP		608.5
3	Renesas		508.5
4	ST Micro		477.2
5	DENSO		420.0*

*Equivalent to sales

Source: Gartner & in-house survey

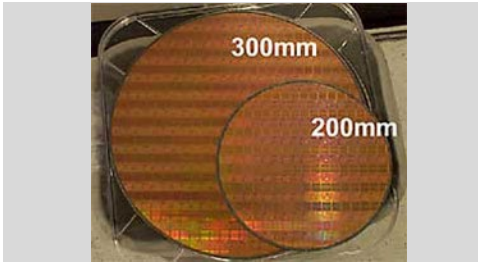
*DENSO's CAPEX in semiconductors: 160 billion yen (total for past three years)

DENSO has produced in-vehicle semiconductors for nearly 50 years

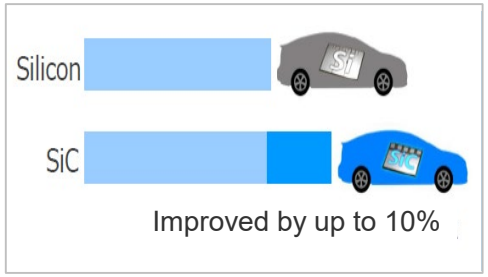
DENSO's vision

Develop and Manufacture in-House "Devices & Wafers" and "Manufacturing Processes" to Maximize System Competitiveness

Power: Devices & Wafers



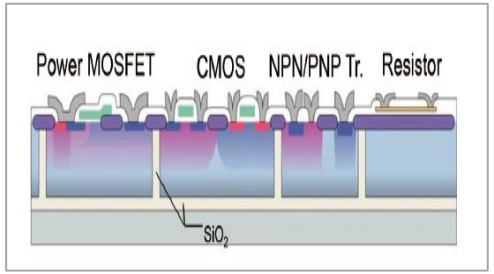
Production of Large-Diameter Silicon Wafers with Strategic Partners



Full-Scale Launch of Silicon Carbide, which is Advantageous for BEVs

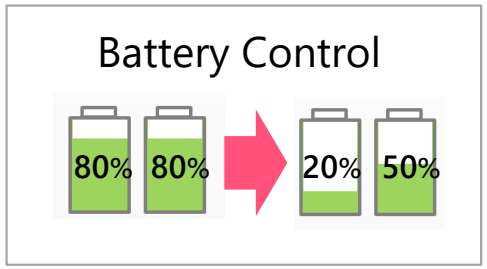
Strengthen competitiveness of high voltage power semiconductors

Analog: Manufacturing Processes



SOI-BCD Process Attains the Performance Required for the in-Vehicle Environment

BCD: Bipolar-CMOS-DMOS



Design Capabilities to Anticipate and Meet System Needs

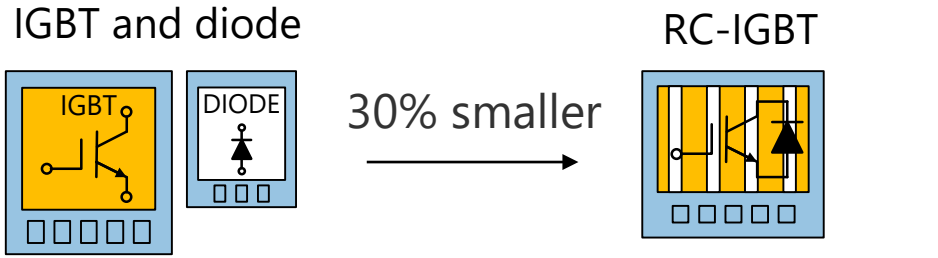
Strategic ASIC development

ASIC: Application Specific IC

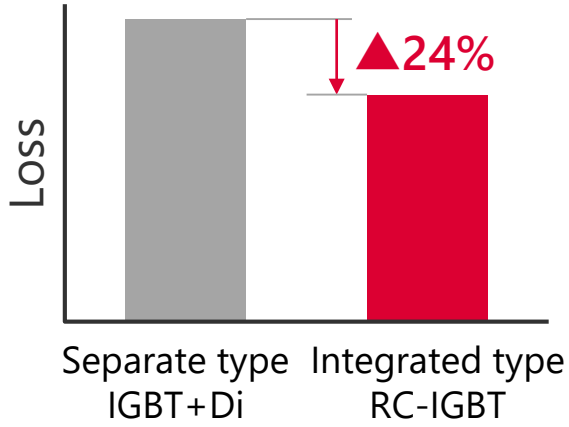
Efforts (1)
Improve Cost Competitiveness of Silicon Power Semiconductors

DENSO's strength

Reduce the Loss by Integration

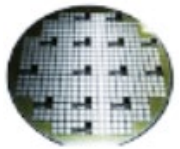


IGBT: Insulated Gate Bipolar Transistor

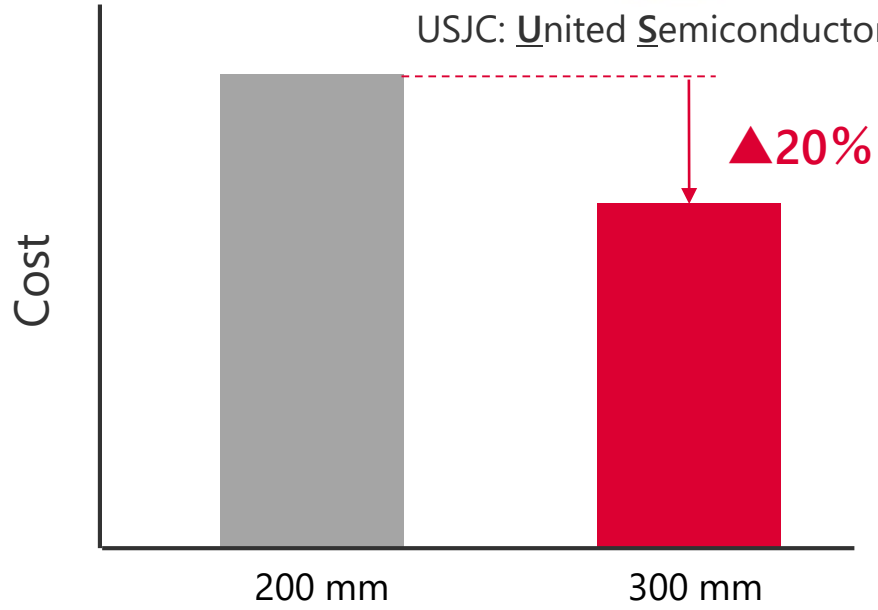


Compact and low-loss device structure

Large-Diameter Wafers (300 mm)



USJC: United Semiconductor Japan Co., Ltd.



Agreed to cooperate in production with USJC
(Announced in April 2022)

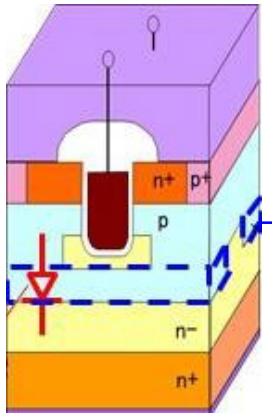
Efforts (2)
Improvement of performance of SiC power semiconductors

DENSO's strength

Achieving Both High-Voltage Resistance and Low On-Resistance

Using electric-field-limiting trench MOS

Patented technology



Electric-Field-Limiting Structure

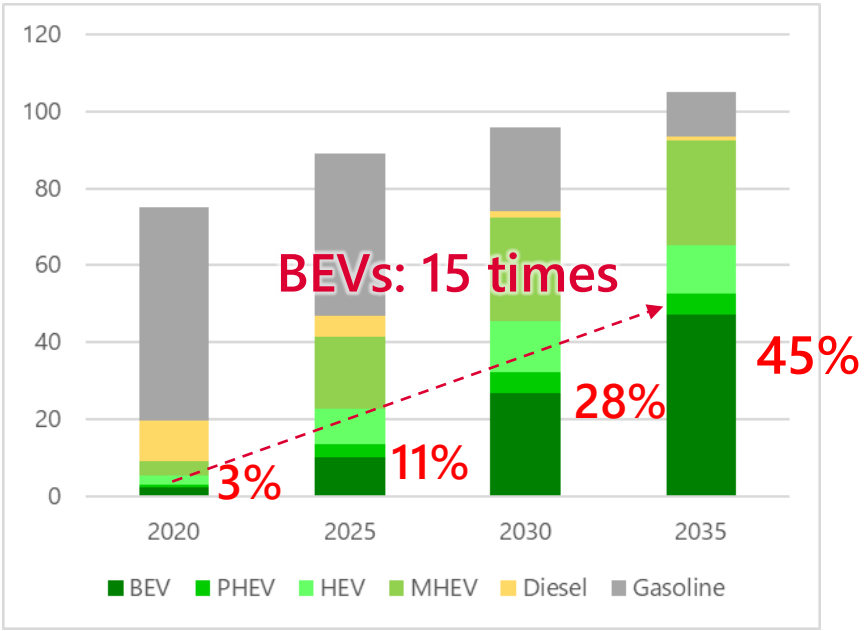
* Patented technology

High Reliability in Large Currents

Device structure with high-voltage resistance and low on-Resistance

Forecast for Global car sales

Unit: million cars



Source: BCG analysis (April 2021)

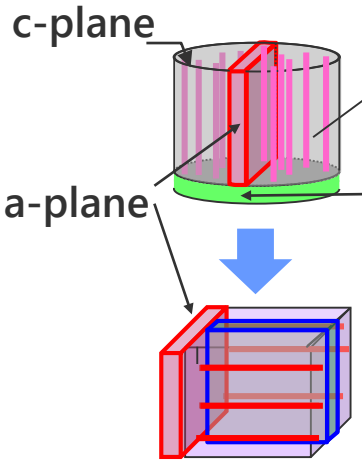
Widespread use of silicon carbide due to rapid expansion of BEVs

Efforts (3)
Improvement of Cost Competitiveness of Silicon Carbide Power Semiconductors

DENSO's strength

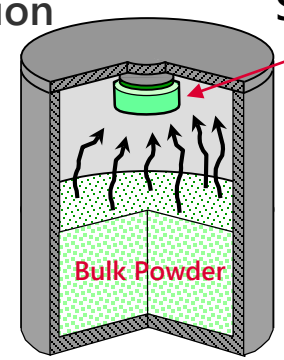
"Manufacturing capabilities" to Fabricate Equipment in-House

RAF Method

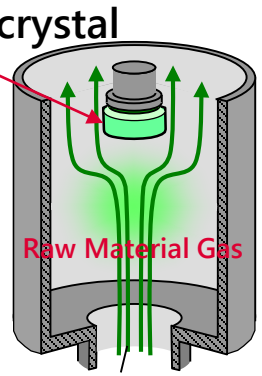


RAF: Repeated A-Face

Sublimation Method

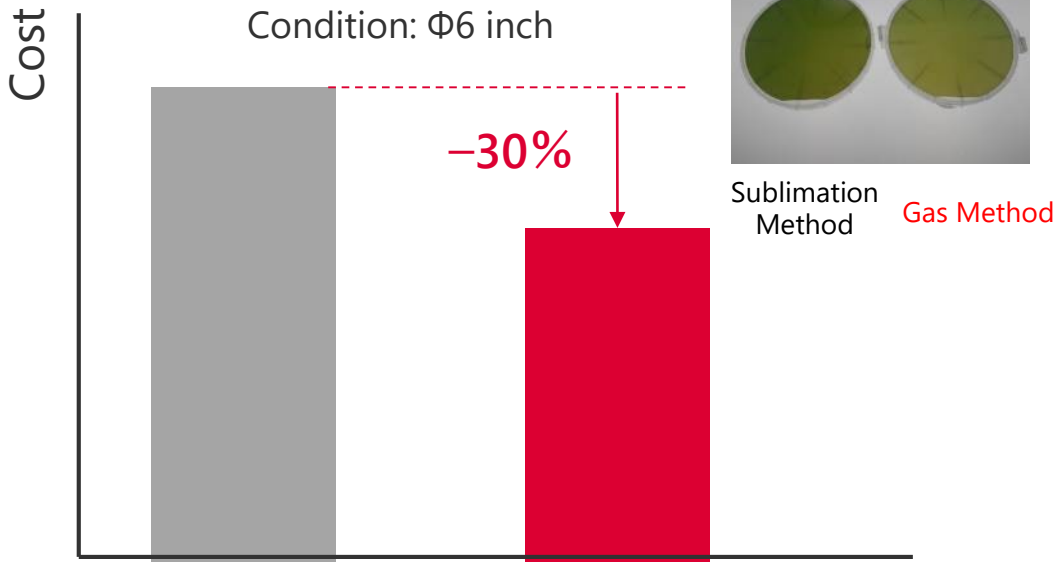


Gas Method



Growth Speed 0.2 mm/h → 15 times → 3 mm/h

Increasing the Wafer Growth Speed 15 Times



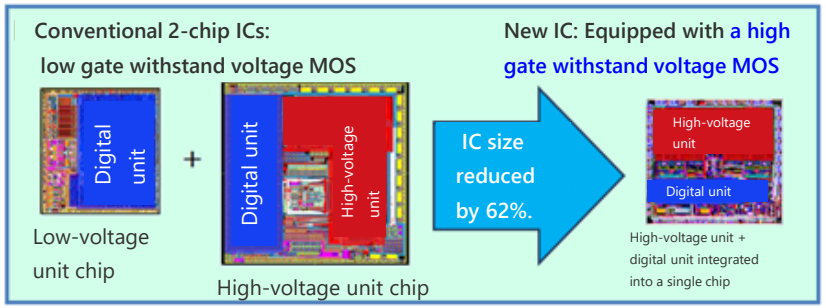
CO_2 emissions during manufacture reduced by 90%

Achieving of high-quality and inexpensive SiC wafers

Target Cost: ▲30% from current level

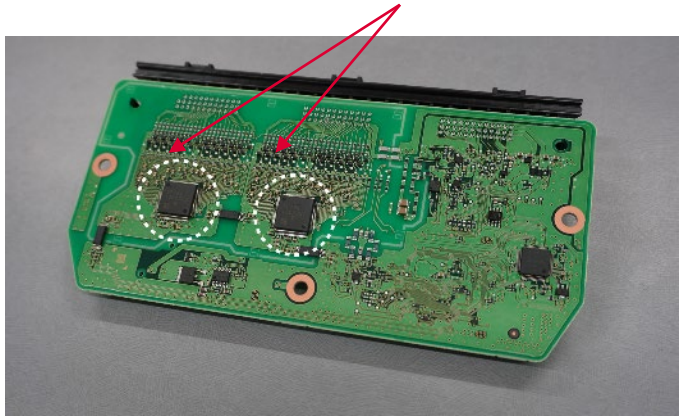
Efforts (4) Strategic ASIC development

DENSO's strength **150V High-Voltage Resistant Process**



World's first **Achieving Both High-Accuracy Detection and Monitoring of Many Cells**

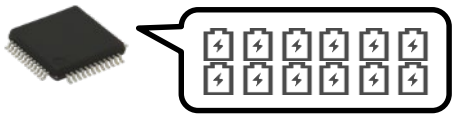
Lithium-ion battery monitoring IC



- Battery voltage detection accuracy: ±3 mV or less
- Number of battery cells that can be monitored is 25 cells/IC

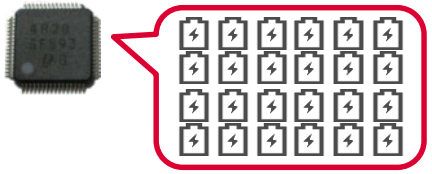
Competitor's product

Monitoring of 12 cells



DENSO's product

Monitoring of 25 cells



The number of battery cells monitored is double that of a competitor's product.

Anticipate and meet the need for battery control

4

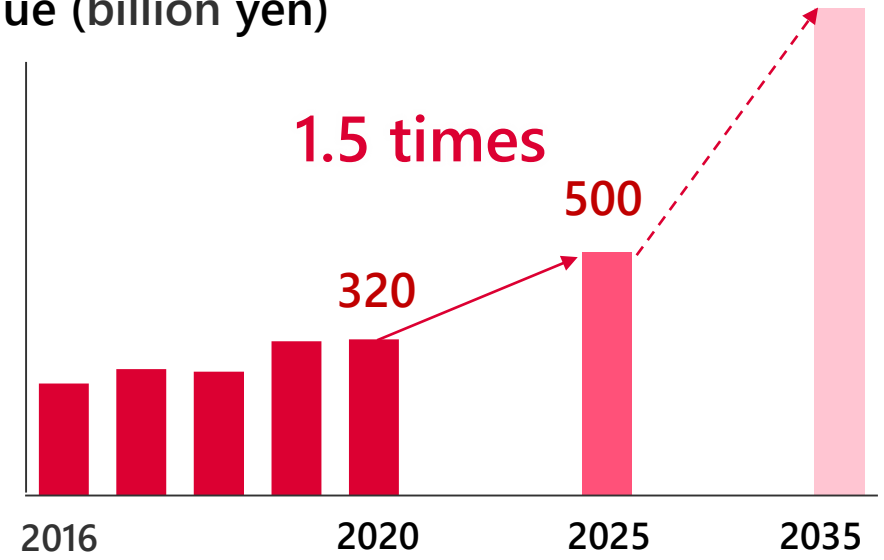
Sensor

ADAS and AD etc. sensors work with strategic partners who are willing to work with in-vehicle

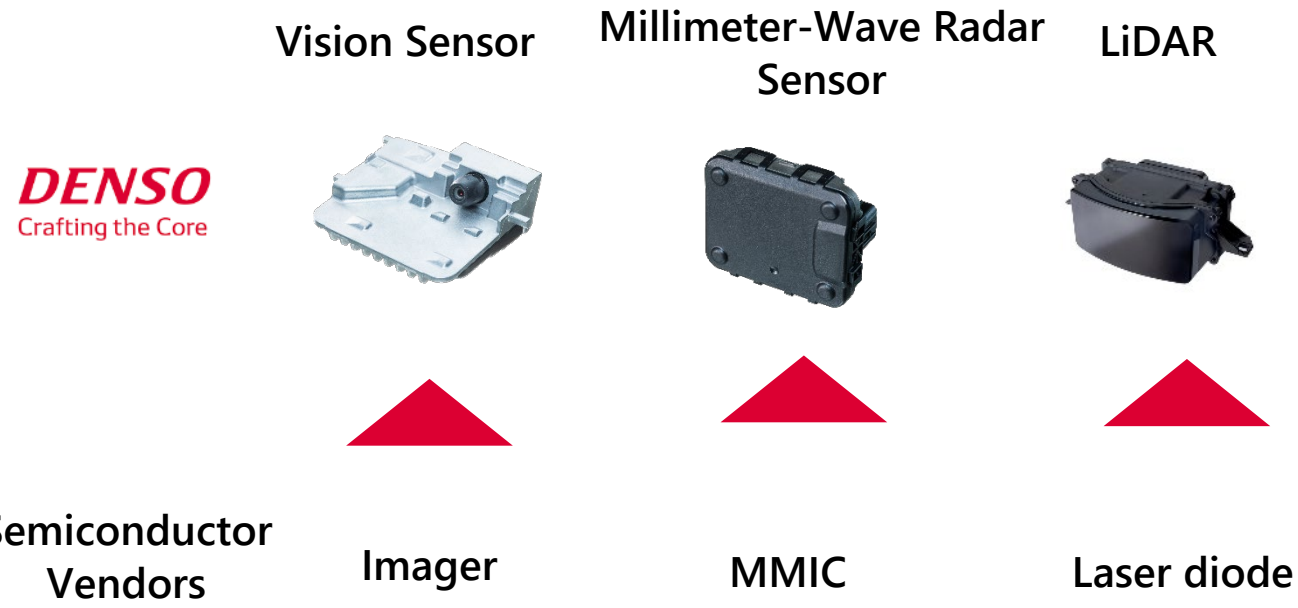
Sensor Semiconductors for Safety System Products

AD & ADAS Business

Revenue (billion yen)



Various Semiconductors for AD & ADAS Products



Expand safety system products through competitive strategic partnerships.

DENSO's vision

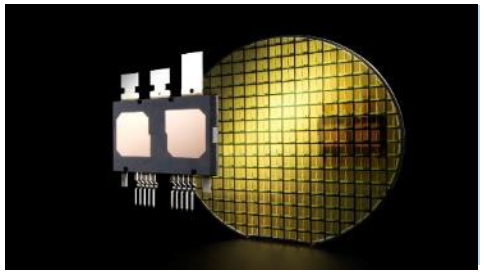
Strengthen the "judgment capabilities" for current situation and "realization capabilities" for the future to achieve competitive strategic partnerships.

Judgment capabilities

Anticipate rapidly changing technology trends

Disseminate in-vehicle trend to strategic partners

Realization capabilities



Plan novel semiconductors in the era of CASE

Develop structure to achieve the vision

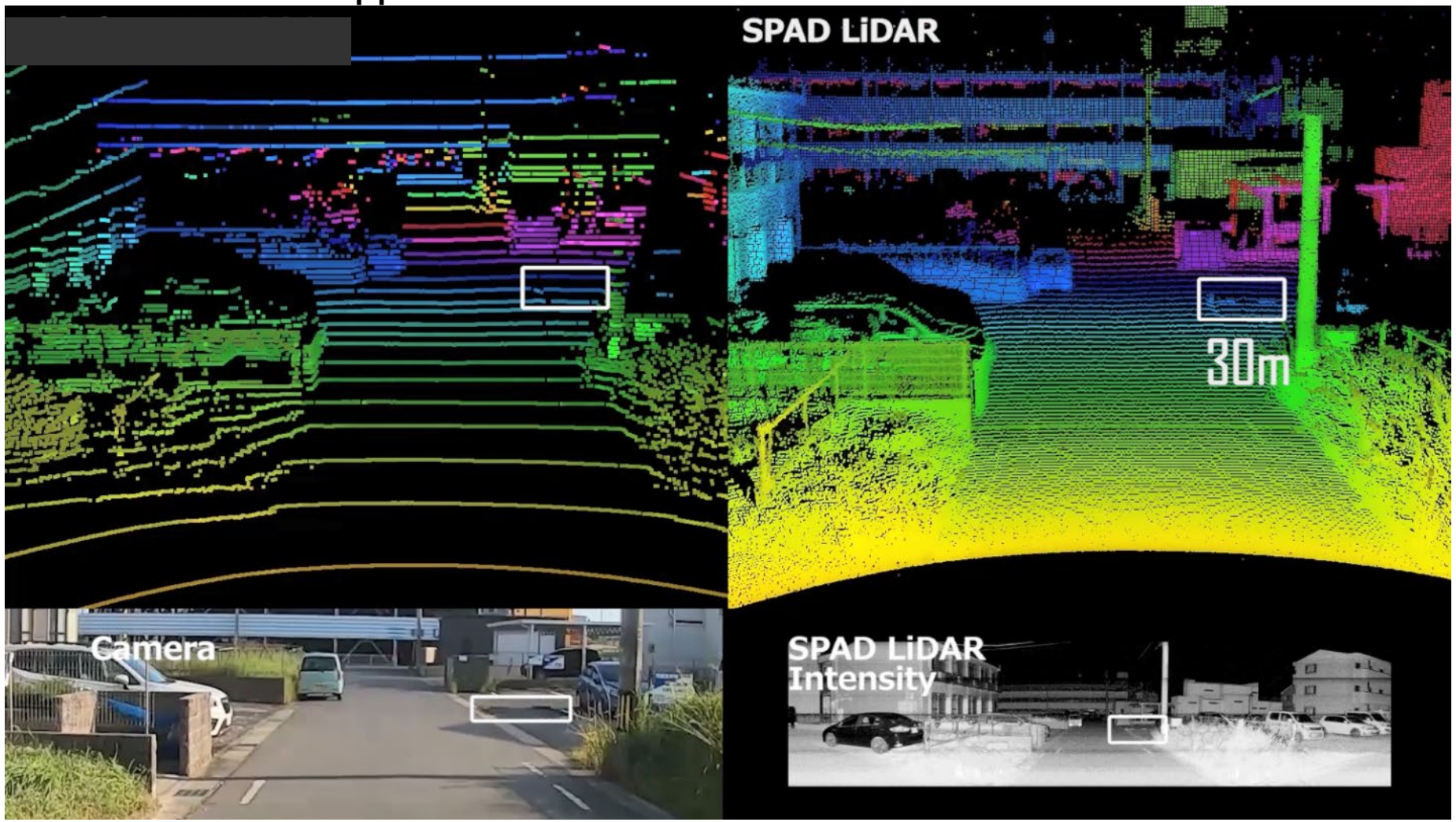
Competitive strategic partnerships

Development of sensors for autonomous driving

Efforts (1)
Development of SPAD LiDAR for Autonomous Driving

Another Supplier

DENSO



DENSO's goals

Semiconductors

Maximize system competitiveness using rugged in-vehicle semiconductors through collaboration with strategic partners.

	Goal	Basic Strategy (Business Policy)	Attainment Level at Present	Target for 2025
1. Microcomputer & SoC	Promoting development and standardization, deepening the cooperation with specialized manufacturers and working on maintain the supply chain to secure stable procurement	**Establishment of a stable procurement network** (1) Utilize standard products and manufacturing processes (2) Reform the semiconductor procurement structure	Equity participation in partners of design and manufacture has been completed.	**Bridging the gap between the automotive and semiconductor industries, promoting standardization and strengthening the supply chain**
2. Power & Analog	Develop and Manufacture in-House "Devices & Wafers" and "Manufacturing Processes" to Maximize System Competitiveness	**In-House Manufacture Semiconductors that Differentiate from Competitors** (1) Strengthen competitiveness of high voltage power semiconductors (2) Strategic ASIC development	Revenues of 420 billion yen for in-house manufacturing semiconductor*	**Revenues of 500 billion yen for in-house manufacturing semiconductor**
3. Sensor	Strengthen the judgment capabilities for current situation and realization capabilities for the future to achieve competitive strategic partnerships	**Collaboration with strategic partners** (1) Collaborate with competitive partners (2) Develop sensors for automated driving	Mass production of Global Safety Package 3	**Developing compact & high performance environmental recognition sensor for advanced driver assistance of Lv3 or higher**

*Part of in-house manufacturing power semiconductor, ASIC and sensor

Resolve social issues in "green" and "peace of mind" by offering rugged in-vehicle semiconductors.

DENSO

Crafting the Core