

Mitsubishi Electric R&D Strategy

February 13, 2019

Masahiro Fujita, Executive Officer
Corporate Research and Development Group

Promotion of R&D for Sustainable Growth

Corporate Mission

The Mitsubishi Electric Group will continually improve its technologies and services by applying creativity to all aspects of its business.
By doing so, we enhance the quality of life in our society.

Creating new value through innovation and promoting R&D that pursues sustainable growth

Contributing to realizing Society 5.0 and achieving the goals of the SDGs

Net Sales 5 trillion JPY or more
OPM 8% or more

Sustainable growth

2018

2020

Society 5.0

—ともに創造する未来—

SUSTAINABLE DEVELOPMENT GOALS

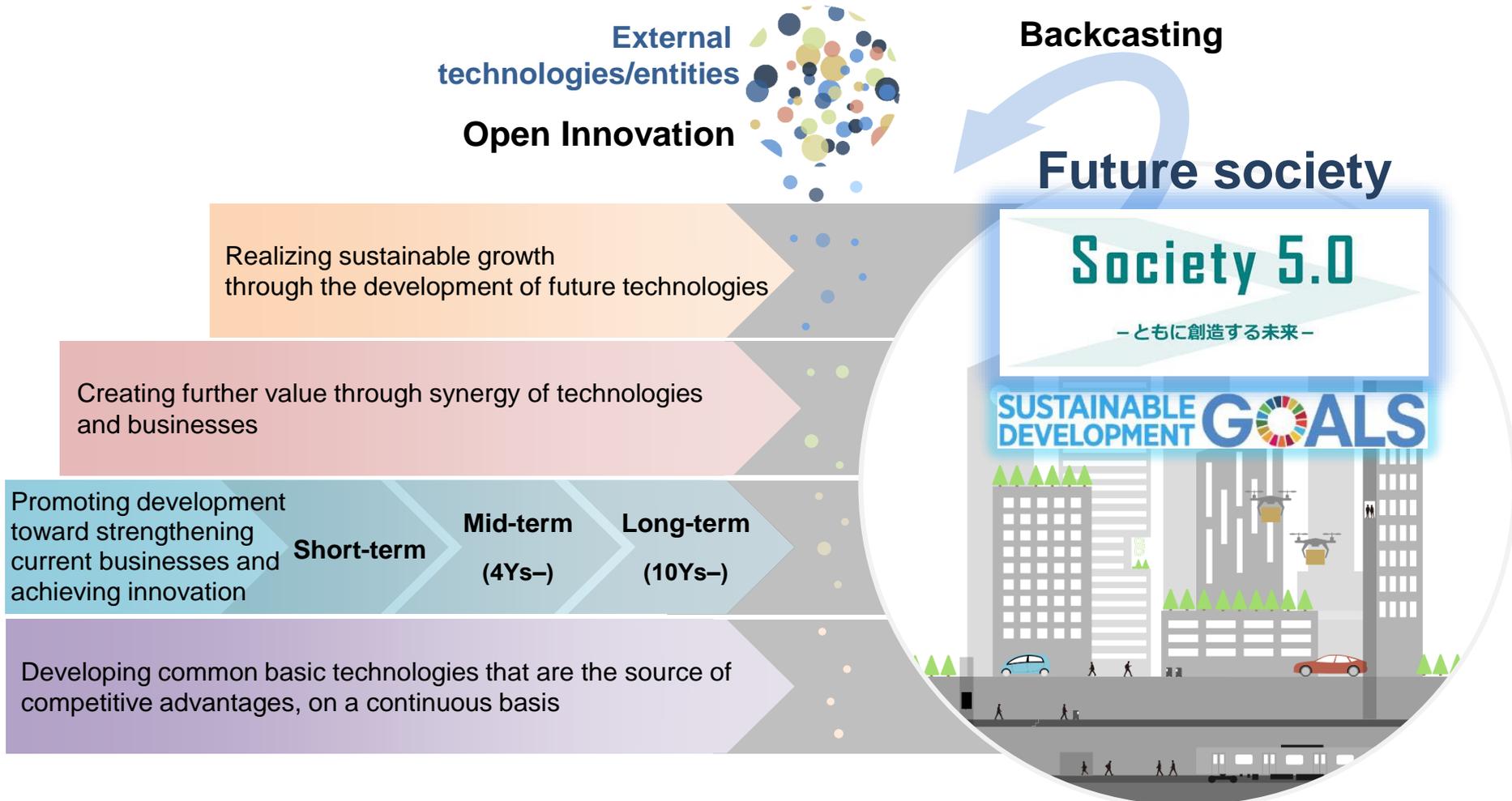


Society 5.0: It is contained in the 5th Science and Technology Basic Plan approved by the Government of Japan in Jan. 2016.

SDGs: "Sustainable Development Goals" adopted by the United Nations as goals to achieve towards 2030

Basic R&D Policy

Well balanced short-, mid- and long-term R&D

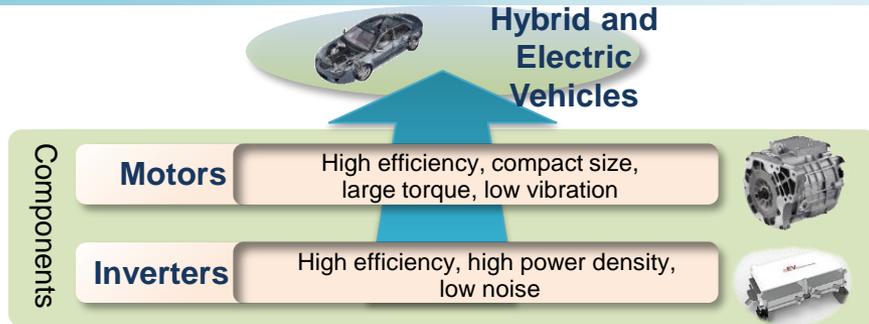


Society 5.0: It is contained in the 5th Science and Technology Basic Plan approved by the Government of Japan in Jan. 2016.

SDGs: "Sustainable Development Goals" adopted by the United Nations as goals to achieve towards 2030

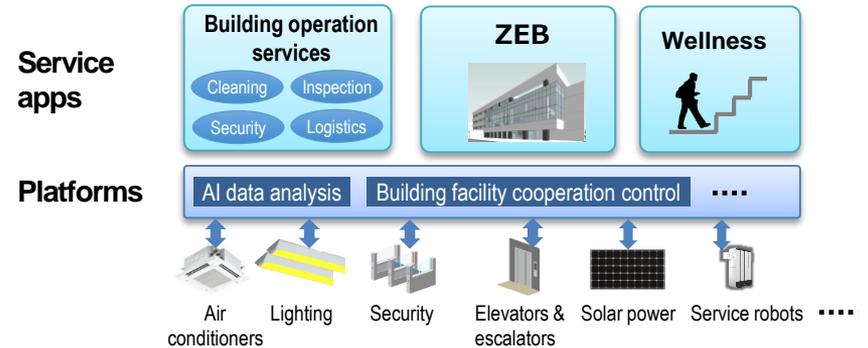
R&D Based on the Basic Policy

Promoting development toward strengthening current businesses and achieving innovation



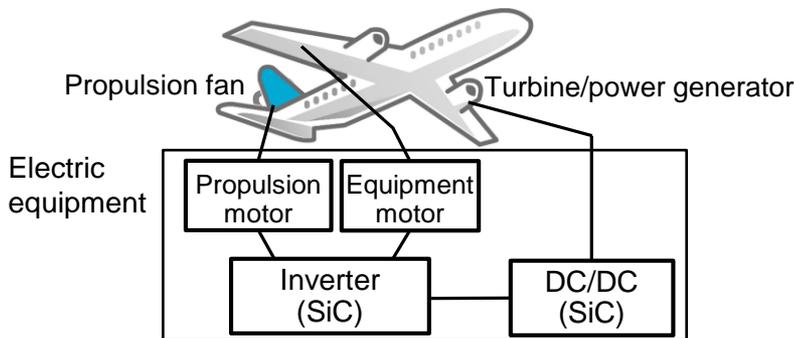
Development of compact high-efficiency, high power motor and inverter

Creating further value through synergy of technologies and businesses



Development of smart buildings by automating building operation services and incorporating ZEB, wellness, etc.

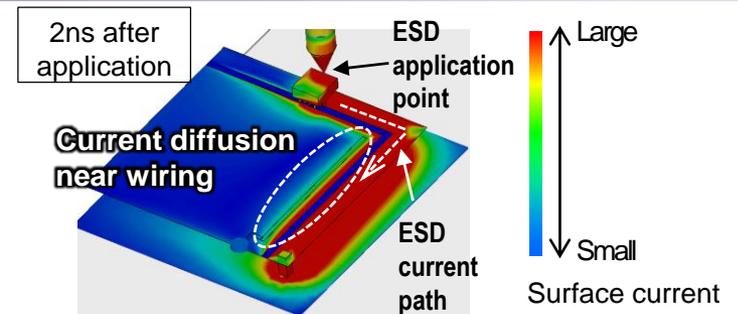
Realizing sustainable growth through the development of future technologies



Development of lightweight, high-efficiency electric equipment toward the electrification of aircraft

*Part of this research is supported by The New Energy and Industrial Technology Development Organization (NEDO)

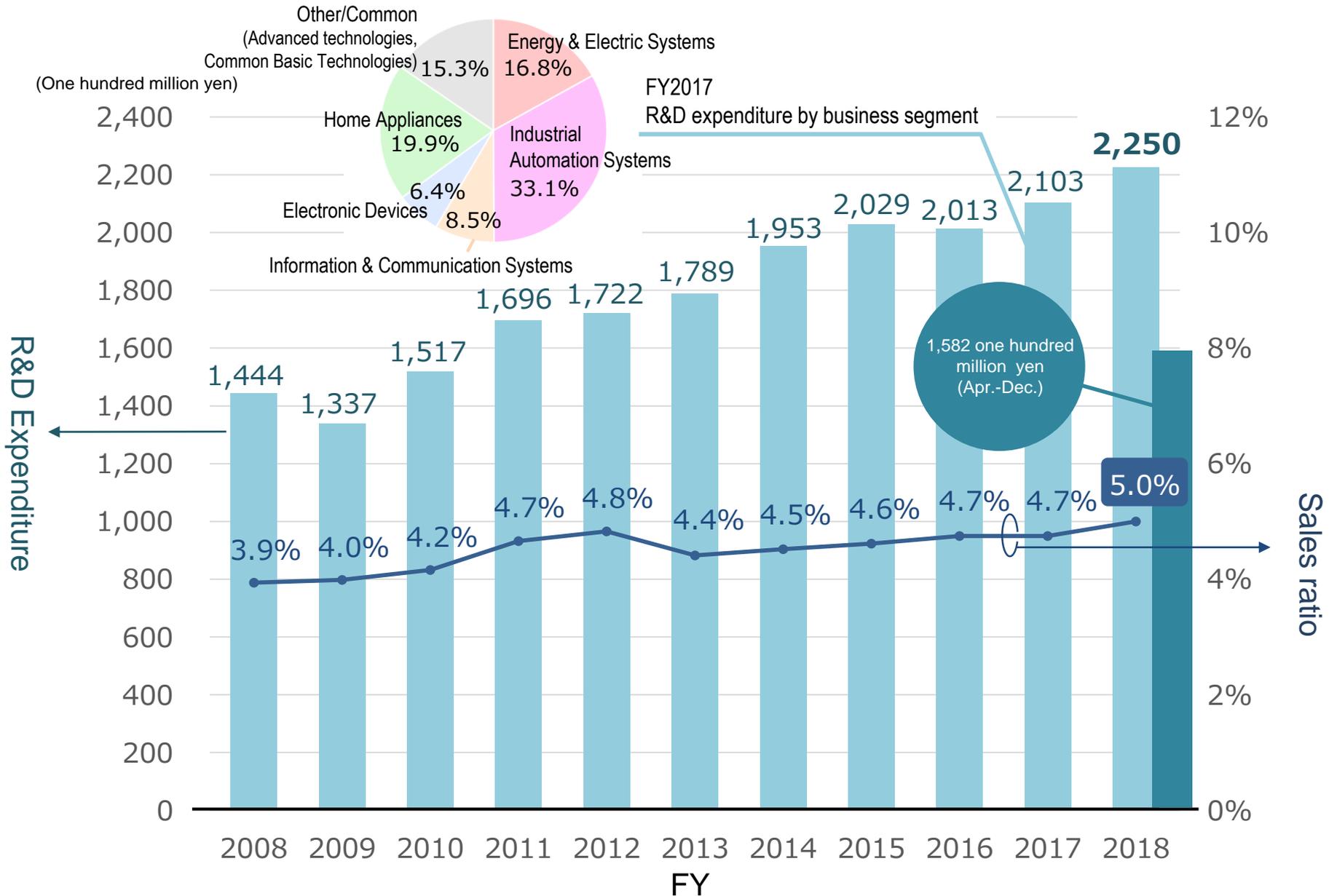
Developing common basic technologies that are the source of competitive advantages, on a continuous basis



Development of technology for visualizing noise propagation to facilitate ESD resistant designs

ESD: Electrostatic Discharge

R&D Expenditures (Consolidated)



Global Advancement of R&D

 **Mitsubishi Electric R&D Centre Europe (MERCE)**

- Communication
- Software reliability validation technology
- Power electronics
- Heat management technology



 **Mitsubishi Electric Research Laboratories (MERL)**

- Signal processing technology
- Control technology
- Optimization technology
- Modeling simulation technology
- AI technology




 **Mitsubishi Electric China (R&D promotion department)**

- Development of technologies for China
- Market surveys

 **Advanced Technology R&D Center**

- Power electronics
- Electromechanical technology
- Mechatronics
- Environmental energy, materials
- Device technology
- System technology
- Image technology



Amagasaki, Hyogo Pref.

 **Information Technology R&D Center**

- Information technology
- Communication technology
- Media intelligence
- Electro-optics, wireless technology

 **Industrial Design Center**

- Design
- Creation of user experience



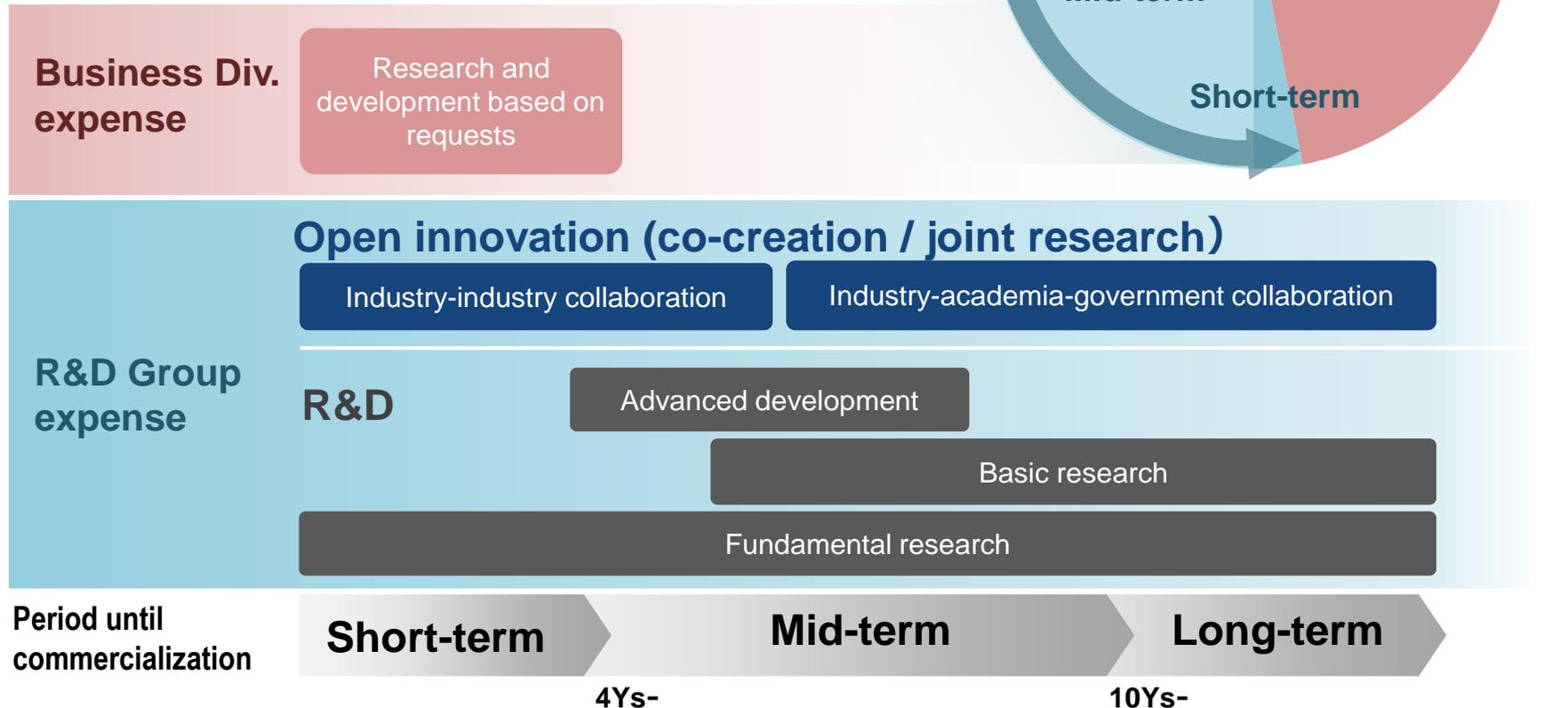
Kamakura, Kanagawa Pref.

R&D Framework and Allocation of Resources

• Allocation of R&D resources

Promotion of short-term, mid-term, long-term and fundamental R&D at a balance of roughly **5 : 3 : 1 : 1**

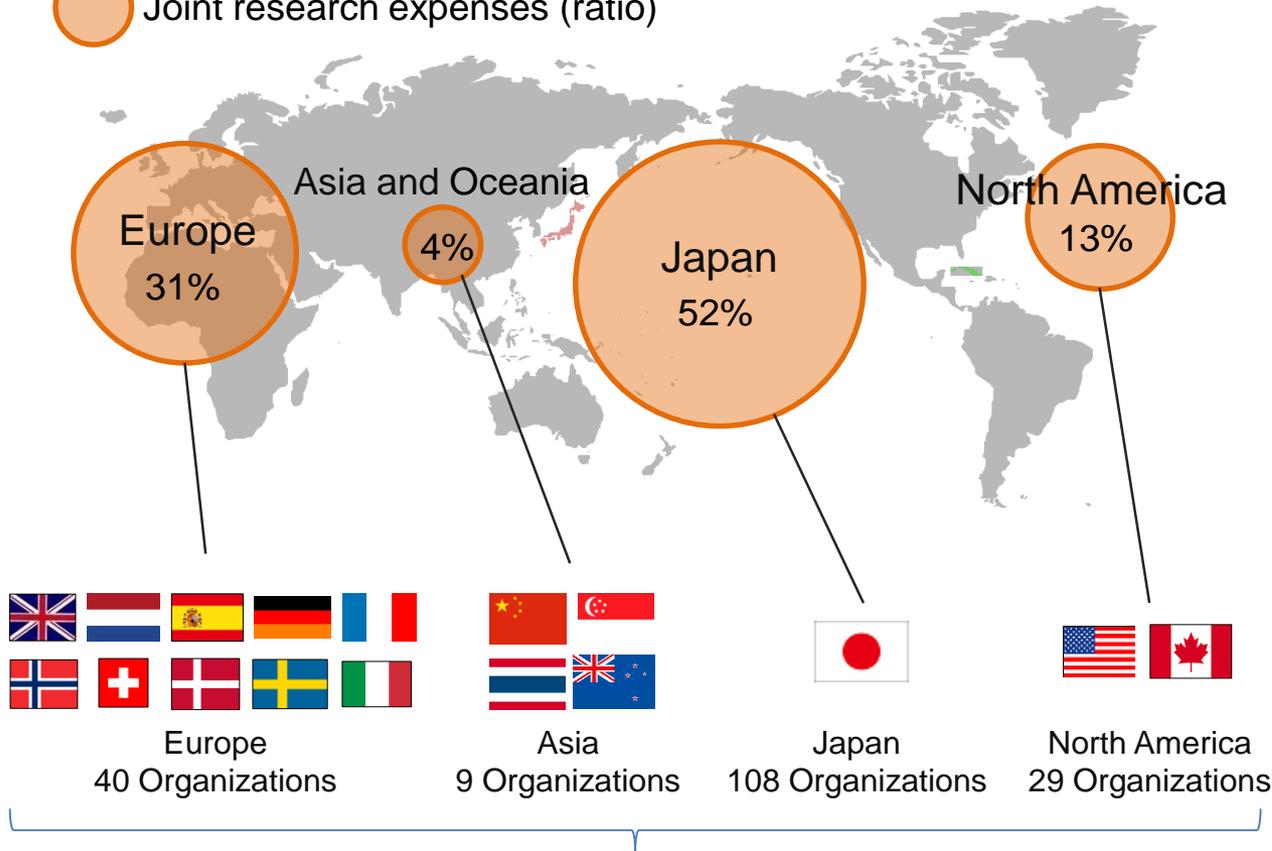
• R&D Framework



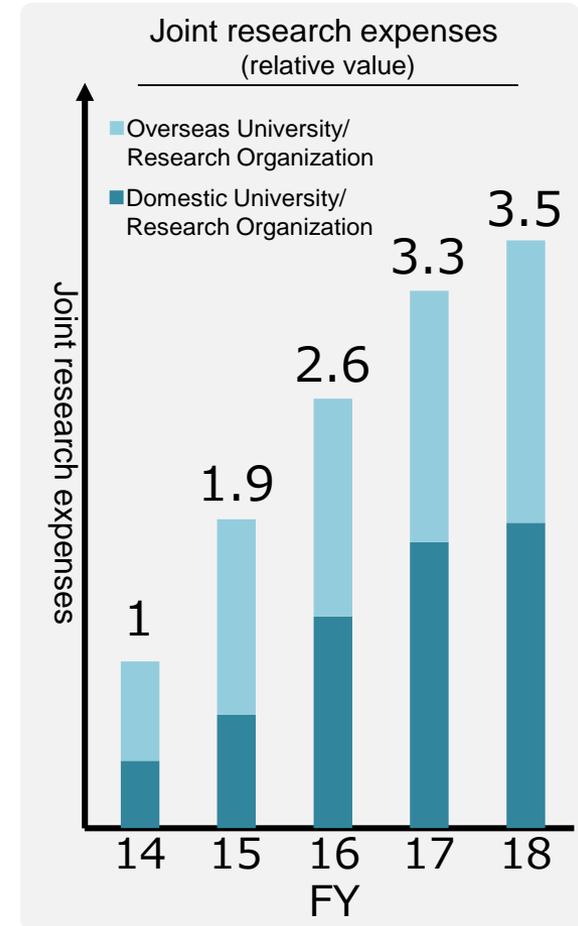
Open Innovation

Creation of technologies for winning the global competition
in collaboration with organizations possessing world-leading technologies

Joint research expenses (ratio)

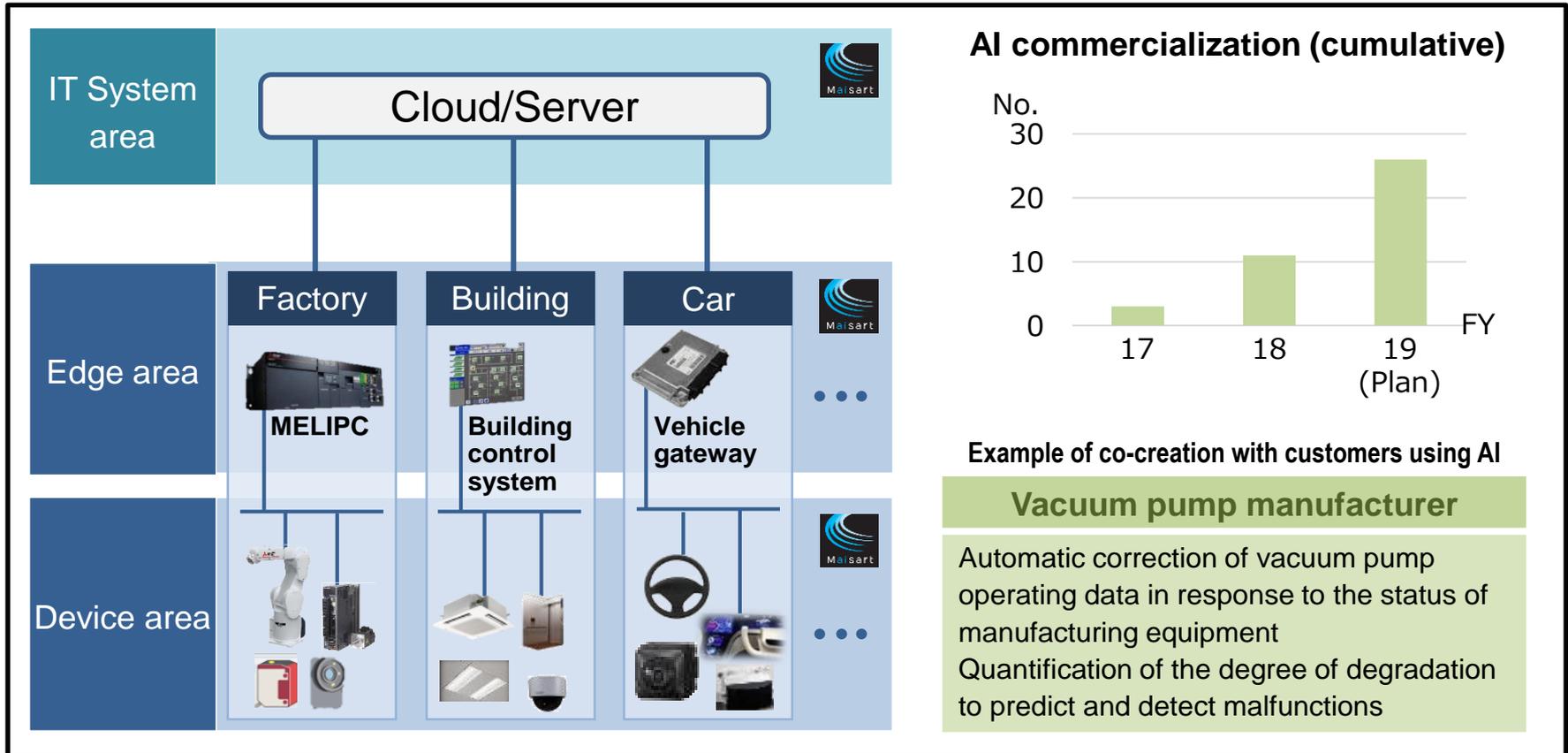


Collaboration with 186 worldwide organizations



AI Development Strategy

We develop smart devices/edge AI technology by using our strength of possessing a broad portfolio of devices and machinery.



AI Technology Brand “Maisart®” 

- Compact
- Utilization of device knowledge

Construction of Test Facility for ZEB Technologies

We aim to realize net Zero Energy Buildings (ZEB), which generate all of their necessary primary energy to operate independently. Further, we will accelerate technology development and tests based on our original *ZEB+* concept to create further added value.



ZEB+ is a registered trademark of Mitsubishi Electric Corporation. In addition to ZEB, ZEB+ aims to create added value in efficiency, ease of use and comfort to offer a sustainable building solution and services that cater to the life cycle of buildings

Location: 5-1-1 Ofuna, Kamakura City, Kanagawa Prefecture
(inside the Information Technology R&D Center)

Area & structure: Building area – approx. 2,000m², Total floor area – approx. 6,000m²;
steel-framed building with four aboveground floors

Start of operation: June 2020

Recent Recognition and Awards

Room Air Conditioner



Kirigamine FZ Series

**Energy Conservation Grand Prize
Prize of the Commissioner of Agency of
Natural Resources and Energy**

FTTH (Fiber to the home) Devices

Device for carrier buildings Device for users' homes



GE-PON system device and optical device
GE-PON: Gigabit Ethernet Passive Optical Network

**Ichimura Prize in Industry for
Excellent Achievement**

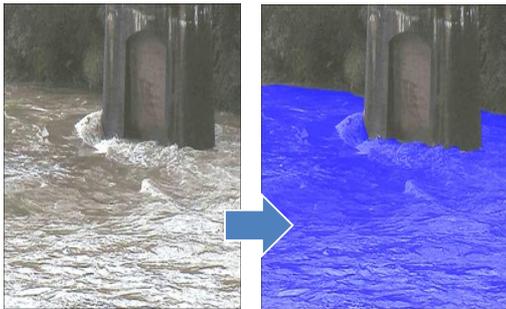
Electromagnetic Noise Countermeasure Design



Downsized noise filter achieved through
the development of a dual mode choke

**Electrical Science and
Engineering Promotion Award**

Water Level Measurement Imaging Device*



Identification of the riverbank using AI technology
*Product of Mitsubishi Electric Engineering Co., Ltd.

2018 R&D100 Awards

Smart Meter Transmission System



**Japan Industrial Technology Grand Prize
MEXT Minister's Prize**

Environment-Resistant IoT Communication Gateway



**Red Dot Design Award
Best of the Best Award
in the Product Design category**

SUSTAINABLE DEVELOPMENT GOALS

2018 2020 2030 2040

Society 5.0

Social issues

Aging population in advanced countries
Traffic jam in cities
Global warming
Energy/water shortage
Natural disasters
Aging infrastructure
Man-made threats



Keywords for solving issues and creating value

Smart production

Smart mobility

Comfortable space

Infrastructure for safety, security & relief



Smart production

Optimization of manufacturing as a whole by connecting various equipment and facilities by IoT, and realization of mass custom manufacturing that responds to diverse needs at low cost



Smart mobility

Pursuing the safety, security and convenience of people on the move based on advanced systems and solutions founded on strong components as befitting today's CASE era



CASE : Connected, Autonomous, Shared, Electric



Comfortable space

Creation of an environment-friendly, convenient and affluent society where people and things are connected by IoT and the comfort of homes and buildings are enhanced by AI



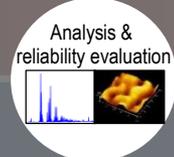
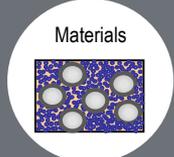
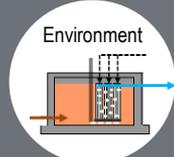
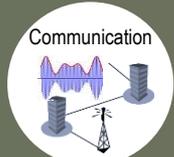
Infrastructure for safety, security & relief

Realization of infrastructure for safety & security in response to changes in the environment and market as a contribution to realizing a sustainable society



Common technologies

Promotion of digital innovation and ongoing development of basic technologies

 <p>AI</p>	 <p>Information processing</p>
 <p>Power electronics</p>	 <p>Machines & mechatronics</p>
 <p>Electrical machinery & energy</p>	 <p>Analysis & reliability evaluation</p>
 <p>Materials</p>	 <p>Environment</p>
 <p>Media</p>	 <p>Electronic devices</p>
 <p>Communication</p>	 <p>Design</p>

Overview of R&D Achievements on Display



Smart production



AI for Rapid FA Equipment Setup in Factories



Fast Stepwise-learning AI Shortens Motion learning



Behavioral-analysis AI Detect Slight Differences in Human Movement

Laser Wire DED Type Metal 3D Printer



Smart mobility



Super Compact Power Unit and High Power Density Electric Machine for Hybrid Electric Vehicle

Robust Sensing for Autonomous Driving

Multi-layered Defense Technology for Vehicle System

Smart, Natural HMI for Smart Mobility



Comfortable space



Visualization Technology for Use Domestic Power Consumption Management

Multi Air Conditioner for Buildings using R32 Refrigerant and Water

Simulation Technology for ZEB Operation

Passive Rope-sway Control Device for Elevators in High-rise Buildings



Infrastructure for safety, security & relief

New Energy-management Technology using Electric Vehicles as Storage Batteries

New Gas-insulated Switchgear Technologies for Electric Power Applications

Enhanced Tsunami Detection Technology

High-Performance Injection-molded-resin Slotted Waveguide Array Antenna

Common technologies



Ultra-Wideband Digitally Controlled GaN Amplifier for Mobile Base Stations

Sensor Security Technology for Accurate Attack Detection



Compact GAN



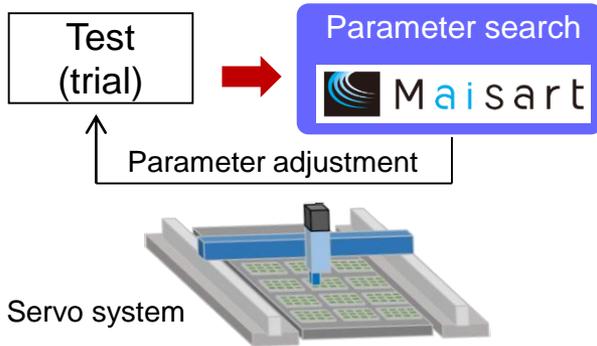
Seamless Multilingual Speech Recognition

A World's Highest-responsivity Graphene-based Infrared Photodetector

Award-Winning Designs of 2018

Smart Production Development Results

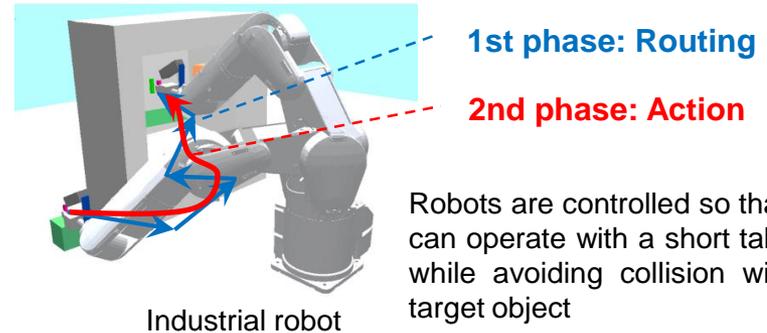
AI for Rapid FA Equipment Setup in Factories



Preparation work that took 5 days by skilled workers is automatically completed in a day

*Joint research with National Institute of Advanced Industrial Science and Technology (AIST)

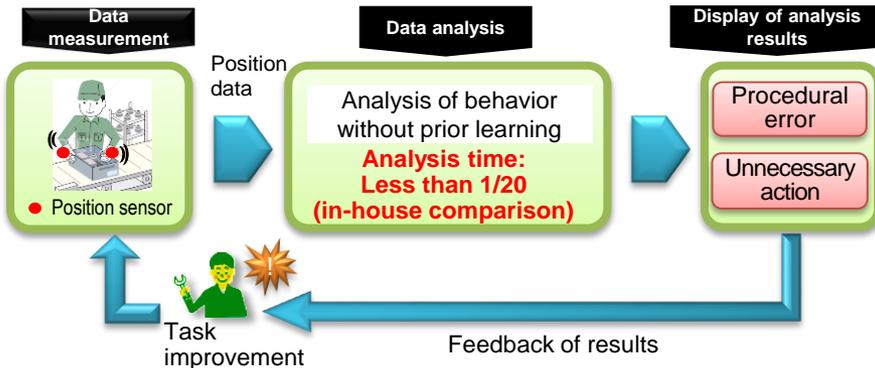
Fast Stepwise-learning AI Shortens Motion learning



Robots are controlled so that they can operate with a short takt time while avoiding collision with the target object

The time required for tuning is shortened to one-tenth as compared to human operators

Behavioral-analysis AI Detect Slight Differences in Human Movement

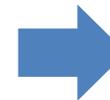


Task improvements suited to each worker contribute to increasing productivity

Laser Wire DED Type Metal 3D Printer



Consecutive forming (conventional)



Dot forming (new)

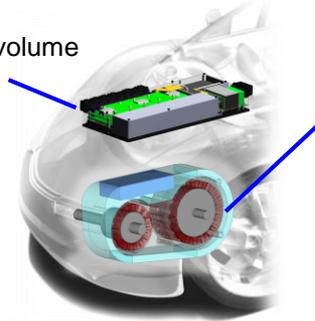
DED: Direct Energy Deposition

The shape accuracy of cylindrically shaped items is increased by 60%

Smart Mobility Development Results

Super Compact Power Unit and High Power Density Electric Machine for Hybrid Electric Vehicle

World's smallest* 2.7L-volume power unit

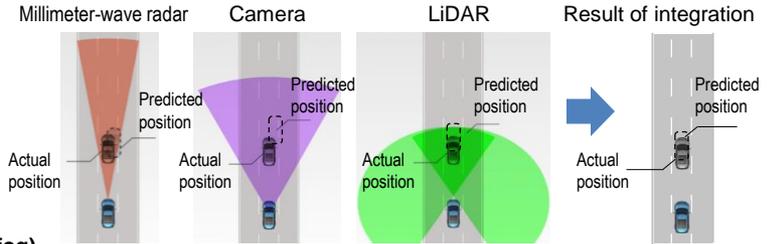


World's highest-class* motor with high power density of 23kW/L

*In-house survey

Ultra-small Power Unit and High-power Density Motor

Robust Sensing for Autonomous Driving

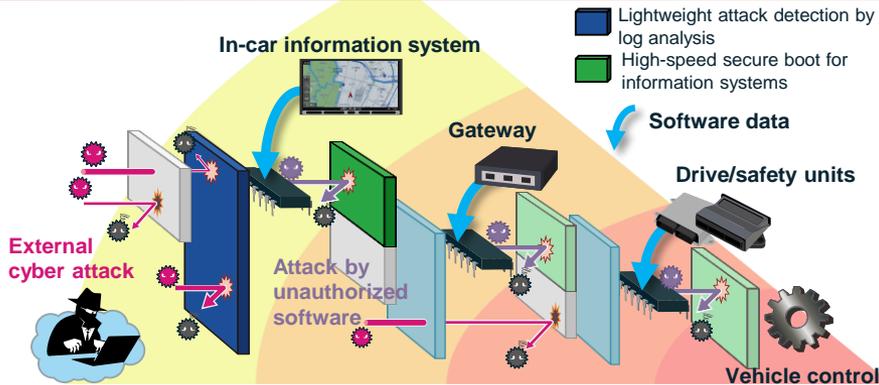


Reliability (in a dense fog)

Position (horizontal)	Low	Medium	High	High
Position (vertical)	High	Low	Medium	High
Speed	High	Low	Medium	High

Selects and integrates information from multiple sensors to realize highly accurate detection even in bad weather

Multi-layered Defense Technology for Vehicle System



In-vehicle multi-layered cyber attack defense technology

Smart, Natural HMI for Smart Mobility



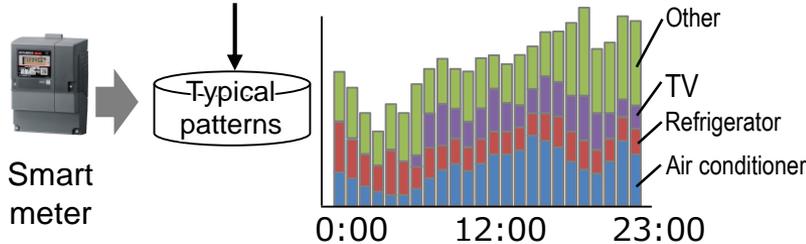
Alerts the driver about out-of-sight-line objects

Comfortable Space Development Results

Visualization Technology for Use Domestic Power Consumption Management



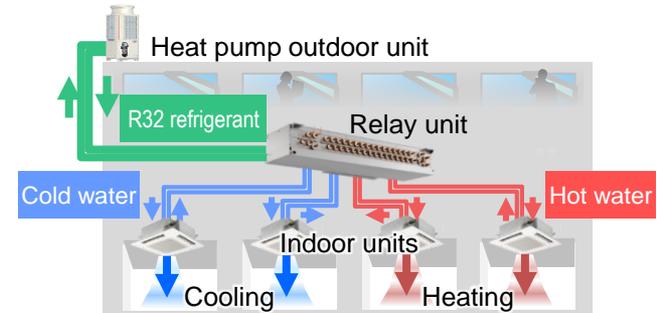
Characteristic power consumption per household appliance is recorded as a pattern



Power consumption is estimated per household appliance with high accuracy based on smart meter measurement values

*Joint-research with Tohoku Electric Power Co., Inc.

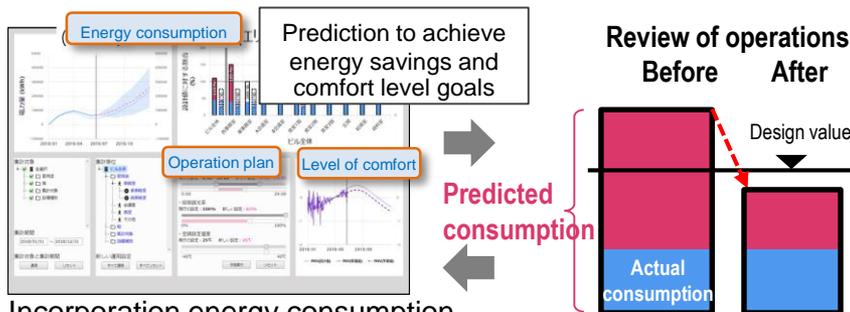
Multi Air Conditioner for Buildings using R32 Refrigerant and Water



The usage of greenhouse gases (CO₂ conversion) is reduced by a maximum of 84%*

* Comparison with a Mitsubishi Electric conventional product (R410A multi air conditioner for buildings)

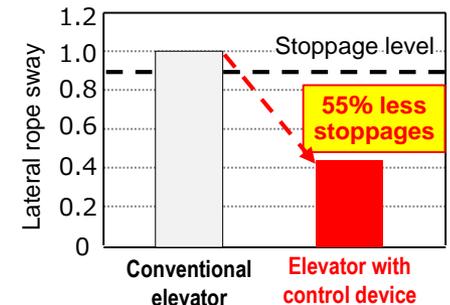
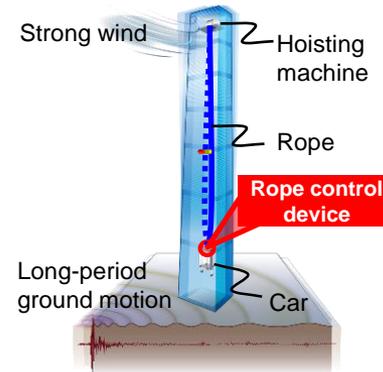
Simulation Technology for ZEB Operation



Incorporation energy consumption analysis in operation planning

Energy consumption and comfort are predicted with high accuracy based on operation plan

Passive Rope-sway Control Device for Elevators in High-rise Buildings

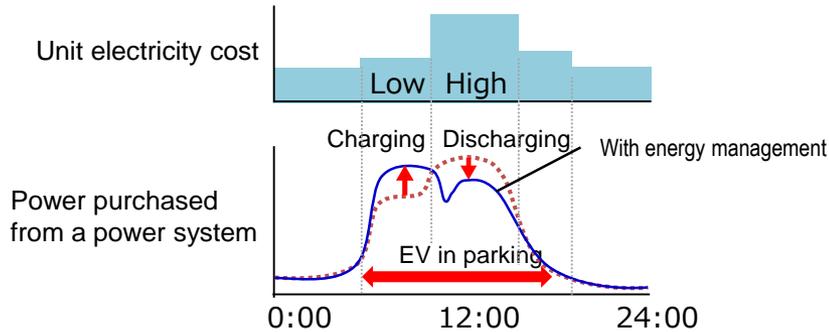


Result at SOLAÉ test tower (height: 173m)

* When a conventional sway is given a value of 1.0

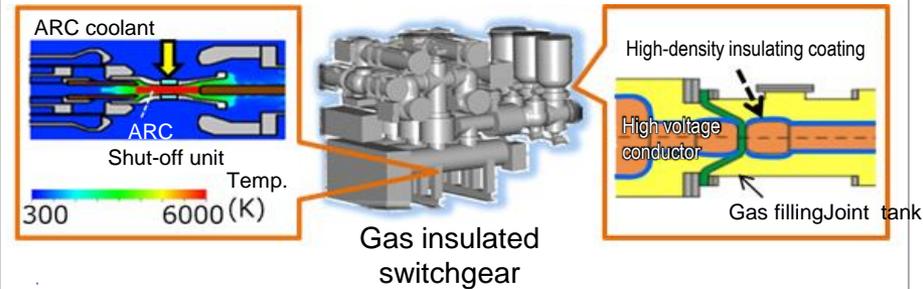
Stable operations are realized by reducing elevator stoppage frequency

New Energy-management Technology using Electric Vehicles as Storage Batteries



The power cost of buildings is reduced by 5% by optimizing the EV charge/discharge schedule

New Gas-insulated Switchgear Technologies for Electric Power Applications



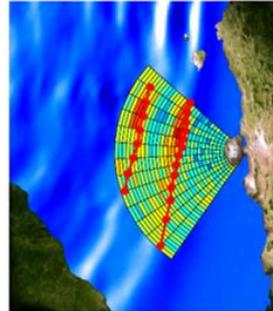
Compactness is achieved by increasing shut-off and insulating performance.

Reduces the amount of SF₆ gas used.

Enhanced Tsunami Detection Technology



Tsunami occurrence

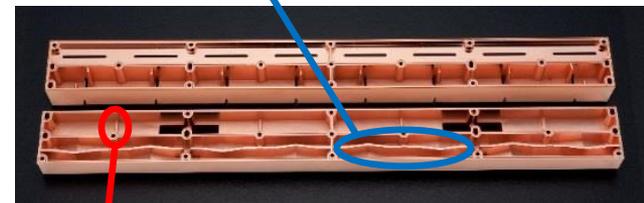


Detection of tsunami wavefronts

Accurate and timely measurement of tsunami size, sea levels and direction

High-Performance Injection-molded-resin Slotted Waveguide Array Antenna

Novel ridge structure (contributes to improving performance)



Boss-iris structure (provides both a screw securing structure and adjustment of electrical characteristics)

A high-performance, lightweight antenna is realized at low cost

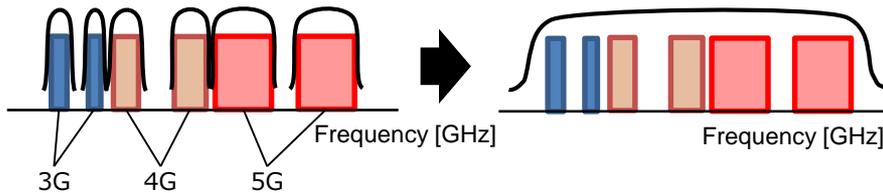
*Joint-development with Hiroshima Institute of Technology, with support from the Japan Science and Technology Agency's A-STEP program

Ultra-Wideband Digitally Controlled GaN Amplifier for Mobile Base Stations



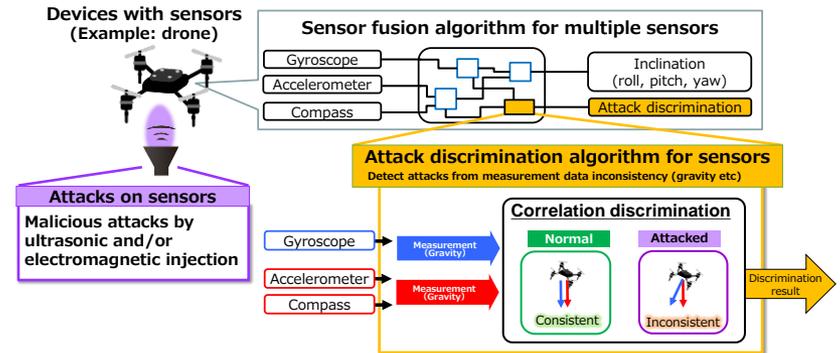
[Conventional product]

[Newly developed product]



Multiple frequency bands, including 5G mobile communication systems, can be supported by a single amplifier

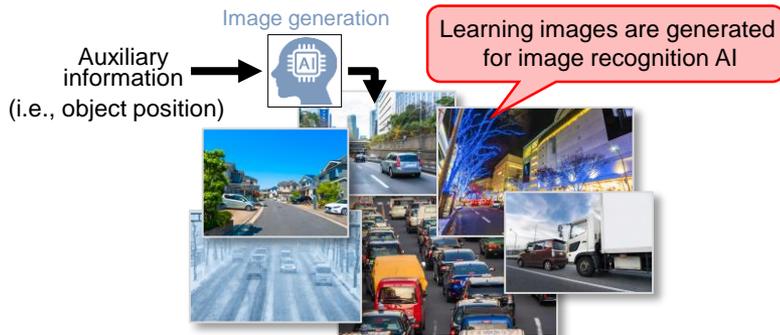
Sensor Security Technology for Accurate Attack Detection



Attacks that cleverly deceive multiple sensors can be detected

*Part of this research is supported by The New Energy and Industrial Technology Development Organization (NEDO)

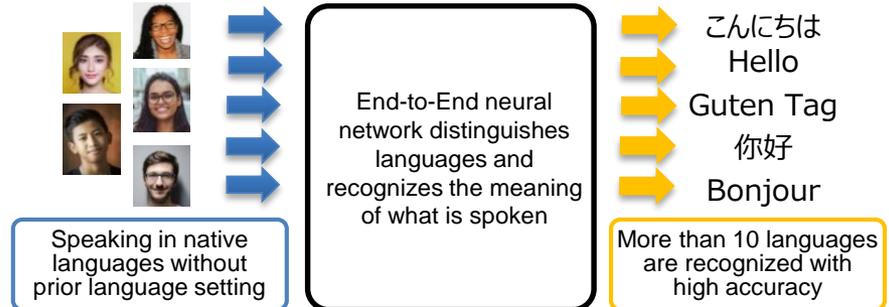
Compact GAN



Learning images for AI are efficiently generated with low computational complexity and memory

*GAN: Generative Adversarial Networks

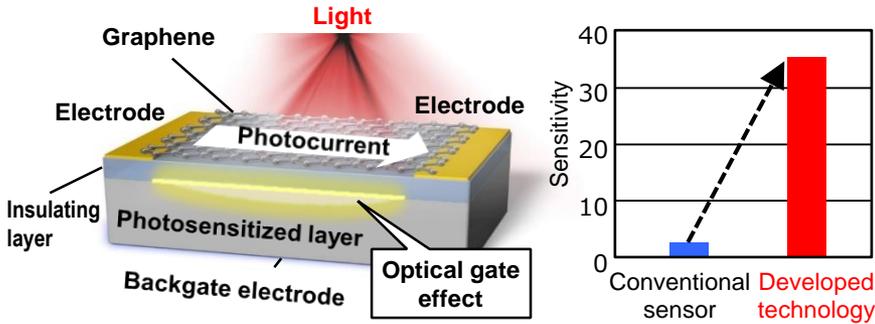
Seamless Multilingual Speech Recognition



Voice recognition is possible even in situations where it is not known what languages will be spoken by an indefinite large number of users

Common technologies Development Results

A World's Highest-responsivity Graphene-based Infrared Photodetector



Allows weak infrared light to be detected with ten times greater sensitivity

*Joint-research with Osaka University

Award-Winning Designs of 2018



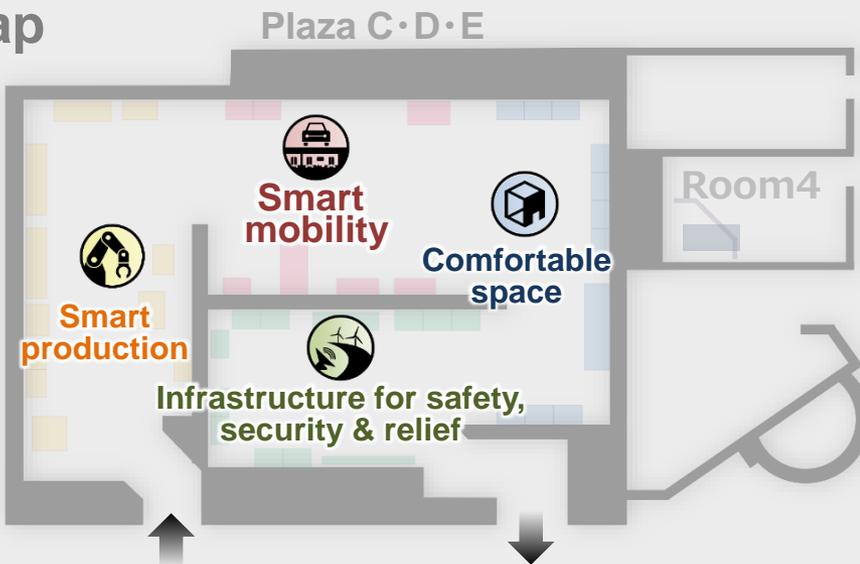
Animated light guiding system



Home-use air conditioner design

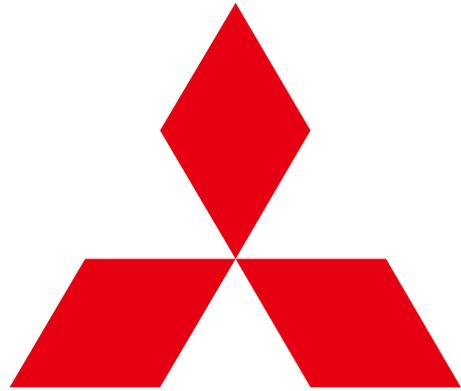
Awards have been received for broad-ranging design activities

Floor Map



Info Gallery

Common technologies



**MITSUBISHI
ELECTRIC**

Changes for the Better