

TRANSPORTATION SYSTEMS



MITSUBISHI ELECTRIC CORPORATION
HEAD OFFICE : TOKYO BLDG., 2-7-3, MARUNOUCHI, CHIYODA-KU, TOKYO 100-8310, JAPAN
www.MitsubishiElectric.com

MITSUBISHI ELECTRIC CORPORATION

Innovating your world for over 90 years.

As Mitsubishi Electric nears its 100th anniversary, our mission is clear — apply our technologies to contribute to society and enhance the quality of life around the globe. We are working to create a brighter future through innovation and ensure a more sustainable world. We are extending our global reach and pioneering developments in fields ranging from home appliances to satellites, introducing breakthrough after breakthrough for the benefit of society, industry, and individuals. Our path to the future is built on an untarnished record of innovation and excellence, and our tradition of “changes for the better.”

JUST A FEW OF OUR ACHIEVEMENTS



Power Semiconductor Devices

Power semiconductor devices are essential for making various kinds of power electronics equipment more energy-efficient, from traction and Electric Vehicle (EV) / Hybrid Electric Vehicle (HEV) to industrial robots and air conditioning systems.



Transformer Equipment Development Technologies

We verify the reliability of our transformers utilizing the largest environmental testing facilities capable of simulating severe natural environments, including extreme cold/heat, lightning earthquakes.



Micro-via-laser Drilling Technologies for Printed Circuit Boards

High-speed and high-accuracy, precise laser processing enables printed circuit boards to be pierced at 6,000 holes per second; an FA technology supporting the evolution of smartphones.



Autonomous Control Technologies for Spacecraft

Featuring advanced guidance, communications, data processing and power-supply technologies, our autonomous control module pilots Japan's first unmanned automated supply vehicle to the International Space Station.

* Pictures of the ISS and HTV have been provided by JAXA



Mobile Mapping System (MMS)

Consisting of equipment such as GPS antenna, laser scanners and cameras mounted on a vehicle, the MMS can acquire 3D position data including buildings, road contours, and other roadside data while driving. It has diverse applications such as public survey projects and infrastructure management.



SiC Train Circuit Systems

Ushering in an age of greener rail infrastructure, our silicon carbide (SiC) traction inverters, together with our regenerative braking systems and other technologies, are delivering unprecedented energy savings.



Continuous Industrial Revolution

While we are in the midst of the 4th industrial revolution Mitsubishi Electric automation products have and will continuously contribute to the advancement of manufacturing; from next generation PLCs, “the brains behind the production line”, to advanced robotics and precise servo and motion control Mitsubishi Electric is delivering manufacturing know-how that is a step ahead of the times.



Ultra-high-speed elevator in Shanghai Tower

Completed in 2015, three ultra-high-speed elevators serve the Observation Deck (119 floors above the ground), one of them The ultra-high-speed passenger elevators with a world-class speed of 1,230m/min.

► 1921
Establishment of Mitsubishi Electric Corporation



1928
Debut of EF52, the first large-scale electric locomotive produced in Japan



1935
Commencement of elevator and escalator production



1956
Start of electric refrigerator business



1964
Completion of radar equipment for the weather station atop Mt. Fuji



1980
Debut of Diamond Vision display at Dodger Stadium in the United States



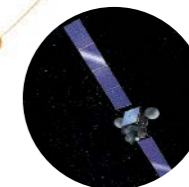
1990
Commercial release of the world's first car navigation system incorporating GPS



2000
Adoption of MISTY™ technology as encryption standard for 3rd-generation mobile phones



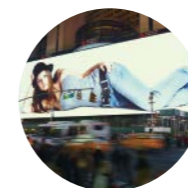
2007
Completed 173-meter-tall elevator testing tower (world's tallest at the time)



2008
Launched SUPERBIRD-C2, Japan's first domestically produced commercial satellite



2017
Developed a 19.9-millimeter-thin inspection robot for turbine generators



2014
Unveiled world's largest full ultra-HD video display* in Times Square, New York City
*As of Nov. 18, 2014 (based on total area)



2011
Debut of “Hayabusa” Series E5, holder of the Japanese speed record for a train



Every step brings the world closer to a brighter future.

Towards next generation safety, stability, comfort and energy conservation.
Advanced rail solutions that only Mitsubishi Electric can offer.

Safety

The pursuit of safety is an important task in the world of rail no matter what the era. Mitsubishi Electric's diverse array of advanced technologies, including automated technologies such as the Train Control and Management System (TCMS) and safety systems – which are able to monitor the status of a situation and apply control automatically – are supporting the creation of transportation systems that all passengers can feel secure.

Stability

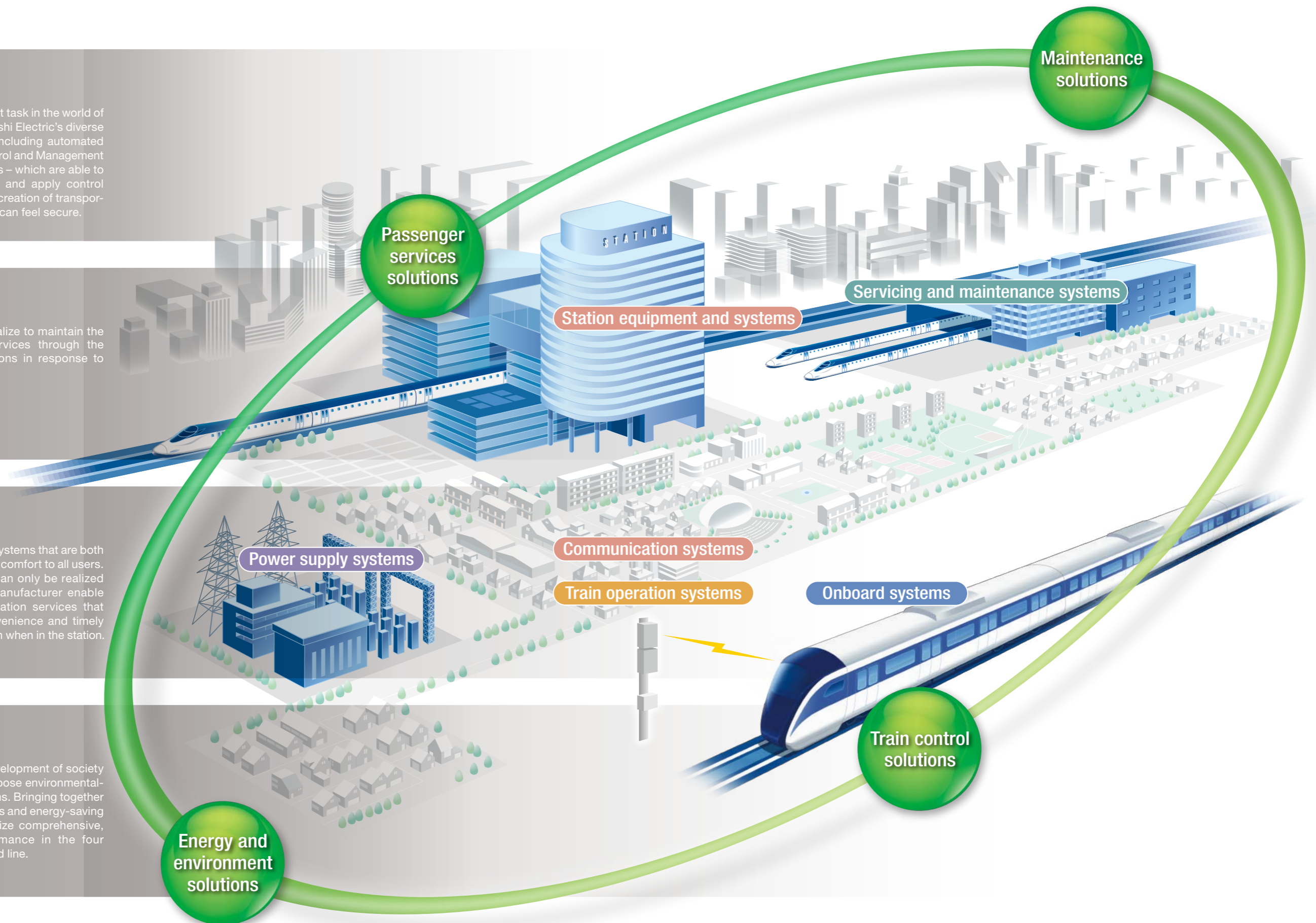
Mitsubishi Electric supports to realize to maintain the punctuality of transportation services through the provision of highly flexible solutions in response to diverse transportation needs.

Comfortable

We strive to create transportation systems that are both easy to use and offer a high level of comfort to all users. Wide-ranging technologies that can only be realized by a comprehensive electrical manufacturer enable integrated, high-quality transportation services that offer comfortable trains and convenience and timely access to the necessary information when in the station.

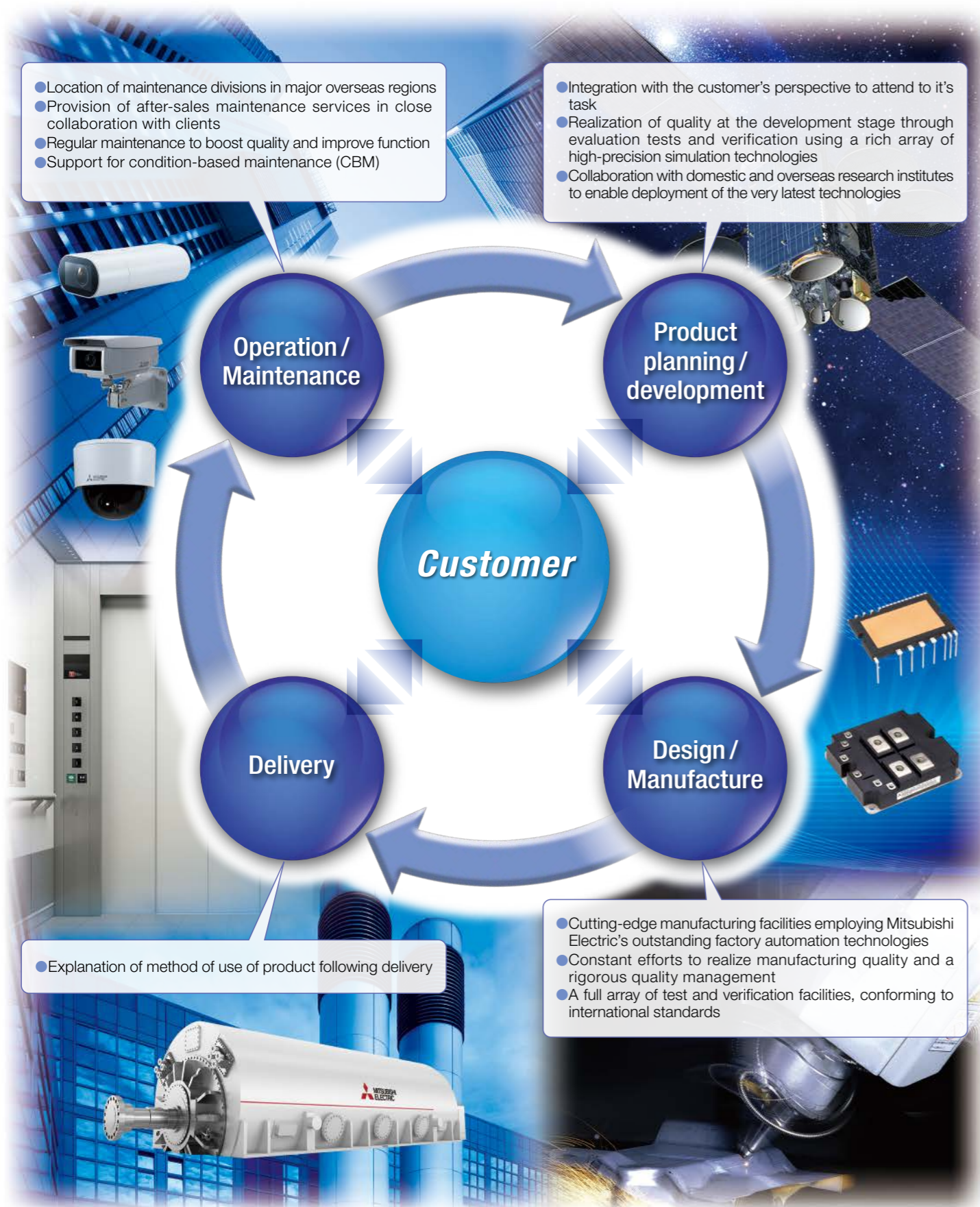
Ecology

For the sake of the sustainable development of society and our future ways of life, we propose environmental-conscious transportation systems. Bringing together monitoring and control technologies and energy-saving technologies, we are able to realize comprehensive, advanced environmental performance in the four domains of train, station, depot and line.



Leveraging the technological power of a comprehensive electrical manufacturer to create rail systems in close involvement with customers.

Mitsubishi Electric's proposal-based sales system, which allows us to grasp our customers' real needs face-to-face, ensures sincere and speedy responses. Offering backup via a comprehensive range of support systems, from the stage of formulation of the customer's introduction plan to post-introduction maintenance and management, we work with you to create optimal rail transport systems.



Evaluation tests / Verification

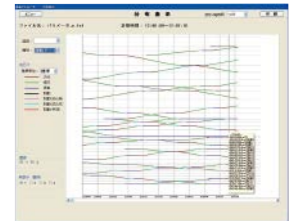
Actual train environment simulator

We are constantly working to improve the quality of our software in order to ensure exact reproduction of an operating train in the test environments employed in our factories.



Feeding network simulator

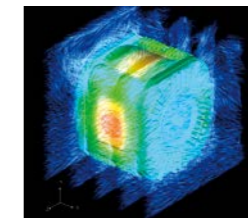
We conduct power simulations incorporating large-scale and complex feed circuit networks.



Train operating mode distribution

3D simulation

We have introduced 3D design in pursuit of even higher-quality development, enabling us to achieve high quality from the initial stage.



Thermal distribution on motor



Digital mockup based on 3D design

Test verification equipment



Verification in combination with traction systems

We conduct verifications by applying inertial loads to propulsion control systems and traction motors.



Vibration test equipment

We verify vibration resistance using equipment conforming to international standards (IEC).

International certification

We have CMMI and certification through third-party certification organization including IRIS, and are able to respond to overseas projects.



CMMI certification

[Subject of certification]

- Brake control unit
- Train propulsion control equipment
- Train information equipment
- Train depot systems



International Rail Industry Standard (IRIS) certification

[Subject of certification]

- Transmission & Distribution Systems Center Ako Factory: Main transformer for electric train

A system integrator that realizes “Powering,” “Braking,” “Control” and “Comfort” functions in a single company.

Realizing overall optimized control for train systems by incorporating the Train Control and Management System (TCMS) as the main component. Our creation of system platforms for the collection and utilization of train monitoring data in cooperation with wayside equipment enables us to also realize CBM^{*1}.

^{*1} Condition Based Maintenance

Propulsion systems / Power supply unit

Powering trains safely and stably

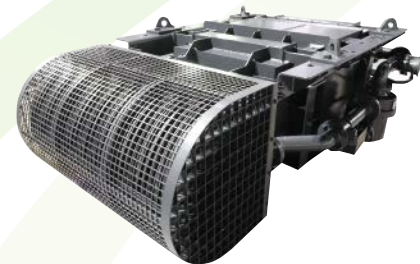
Propulsion control and power supply unit that incorporates leading-edge inverter control. We support safety and comfortable operation with proven AC motors and drive equipment in addition to the latest technologies.



Full-SiC^{*2} VVVF inverter

Using the next-generation material SiC, we have realized a 40% reduction in power consumption, in addition to 40% reduced volume and mass.

^{*2} Silicon carbide: A compound of carbon and silicon



Traction transformer

Saves energy, minimizes maintenance and reduces noise with a natural air cooling system.



SiC auxiliary power supply

Optimization of switching frequency realizes a 30% reduction in power loss and 20% reduced volume and mass.



Traction motor

40% reduction in traction motor loss and reduced noise; elimination of necessity for cleaning and use of cartridge bearings reduces maintenance time by 3/4.



Gear unit

The use of cylindrical roller bearings and a vertical suspension configuration simplifies maintenance and assembly. Test verification in comprehensive test facilities ensures complete reliability.



Hybrid SiC power module for traction applications

Contributes to realizing further increases in efficiency and reductions in size and weight in train devices.



Low-noise WN coupling

Optimal tooth shape design ensures reliability while realizing low noise even when coasting.

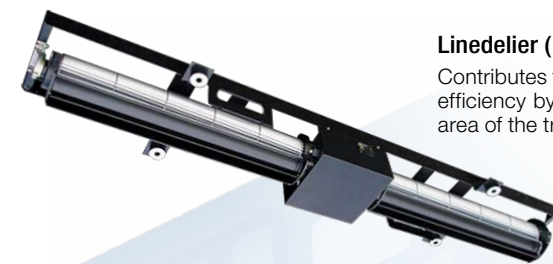
Services / Security equipment

Convenience and comfort / Providing spaces in which passengers can feel safety and secure

We contribute to improve passenger services with air conditioning considering both people and the environment, and image display incorporating the latest information technology. We also work to enhance onboard security.

HVAC (Air conditioning)

Multiple temperature sensors allow the onboard environment to be controlled to a comfortable ambient temperature.



Linedelier (Linear Fan)

Contributes to increased air conditioning efficiency by directing air across a wide area of the train interior.

Onboard display (Full-color LED)

Able to display more than 68.7 billion colors and multiple languages; formulating the data for display is also a simple matter.



Train Vision (Passenger Information System)

High-definition videos and animation displays boost advertising value; power consumption has also been reduced by 22%.



Onboard crime prevention systems

High-resolution cameras monitor and record every part of the train, deterring crime. Functions can also be expanded to live display of the driver's cabin, etc.

Train Control and Management System (TCMS)



TCMS

Employs high-speed and high-volume Ethernet conforming to international standards. Allows communication between trains and wayside equipment.

Wayside equipment



Brake control unit / Security equipment / Automatic Train operation

Safe and secure braking / Automatic control

We support safe train operation via brake control unit manufacture with a history of more than 90 years standing behind it, reliable failsafe technologies, and automatic operation technologies.



Brake control unit

A configuration that integrates electrical and pneumatic brake control sections reduces volume and mass by 80% against conventional systems.



Integrated security device

Apply to multiple signal systems like ATS^{*3}, ATC^{*4} and communications-based train control (CBTC), etc.

^{*3} Automatic Train Stop ^{*4} Automatic Train Control



Automatic Train Operation (ATO)

A learning function increases ride comfort and the precision of stops, while predictive control for busy periods realizes energy-saving operation.

Shinkansen

Today, “Shinkansen” is a word that the entire world knows. Mitsubishi Electric traction transformers and Converter-Inverter support the operation of the Shinkansen network. The advanced technologies that we cultivated during development for the Shinkansen, a domain in which limit performance is demanded, are highly regarded. Now it has been applied to urban lines and LRV*6 in AC catenary systems. Together with our air conditioning systems that create a comfortable onboard space, the application of these technologies continues to expand.

*6 Light Rail Vehicle



Converter-Inverter

The use of SiC module reduces size and increases efficiency.



Traction transformers for high speed railways

A proprietary configuration reduces oil use in addition to realizing reductions in size and weight; we have also worked to reduce the necessary maintenance.



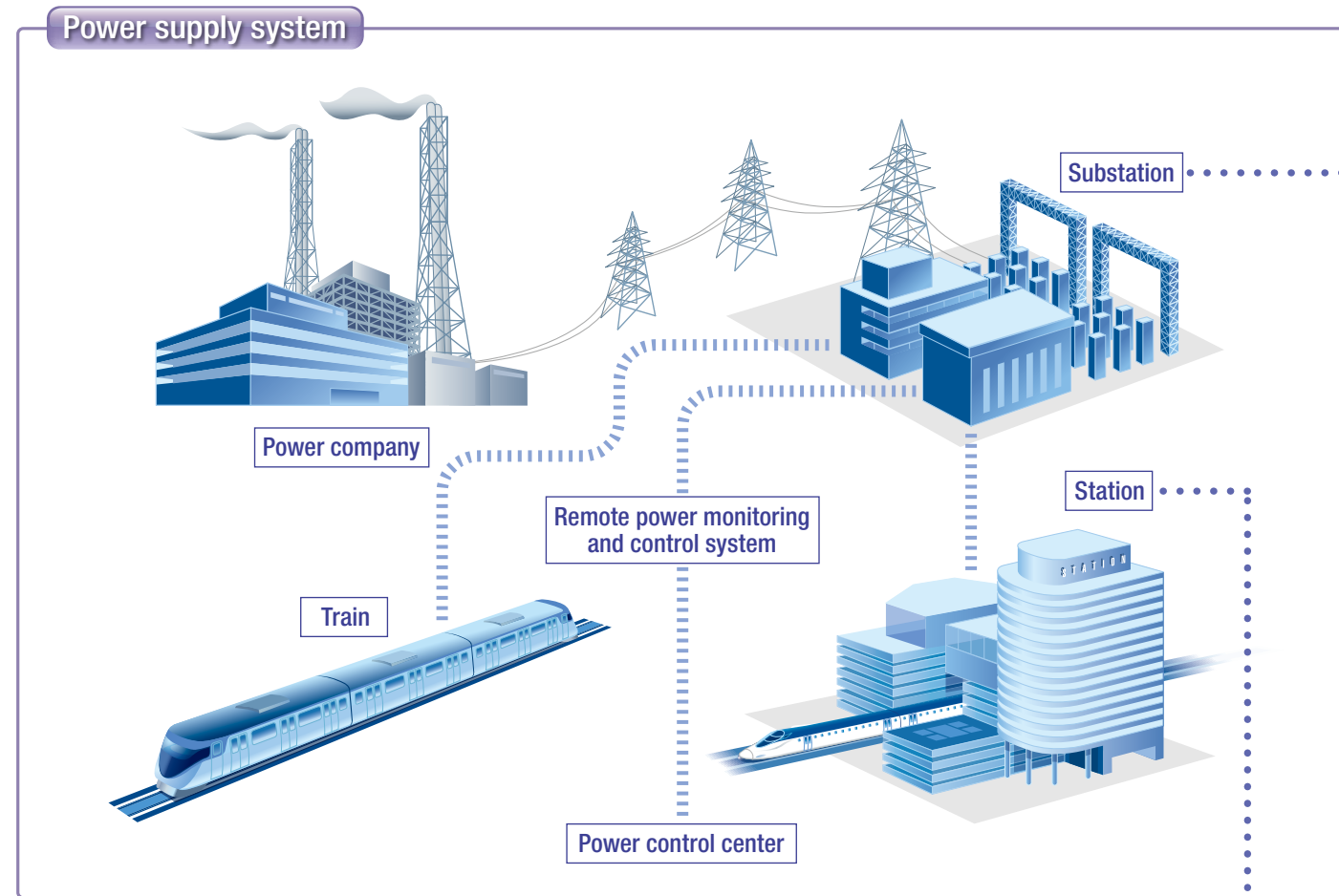
HVAC (Air conditioning) (Shinkansen)

Compressor controlled by inverter enables fine control of onboard temperature.



Contributing to the creation of more environmentally-friendly railway systems with diverse energy technologies.

From leading-edge power management systems to environmentally-conscious equipment. Cooperation between onboard equipment and wayside equipment makes it possible to use regenerative energy more effectively, enabling energy to be saved throughout the entire railway system.



AC substations

Power-receiving switchgear

We employ torsion bar spring-operated equipment with excellent energy transmission efficiency from 145kV to 550kV.



Feeding transformer

We have realized practical use of roof delta (RD) connected transformer for simple connection and a simple configuration. The equipment is also lightweight and saves space.



Control and protection equipment

The employment of an ME-type distributing board boosts reliability and operability, in addition to reducing the expenditure of labor power in maintenance.



DC substations

Control and protection equipment

The combination of advanced digital control technology and a self-diagnostic function results in a high-reliability system that also reduces maintenance manpower.



Power-receiving switchgear

Latest IEC Standard complied, compact size cubicle type gas insulated switchgear (C-GIS).



Regenerative inverter

These units conserve energy by converting train regenerative energy into AC and enabling it to be used for ancillary equipment. They enable stable operation even in response to rapid changes in regenerative energy.



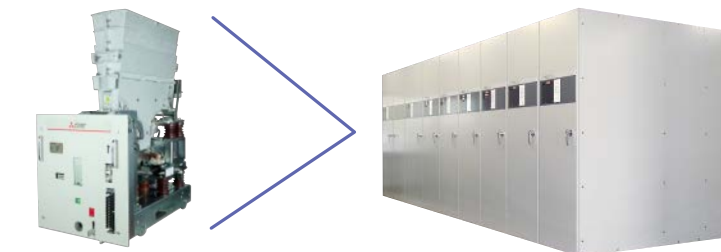
Transformer rectifier

We supply shell-type rectifiers employing a dense layout of silicon rectifiers incorporating shell-type transformers and high-voltage elements. The units save space and reduce loss.



DC Breaker

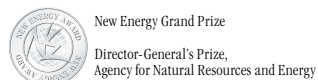
Large-capacity (100kA) DC breaker with high-speed breaking capability.



Station

S-EIV® (Station Energy Saving Inverter)

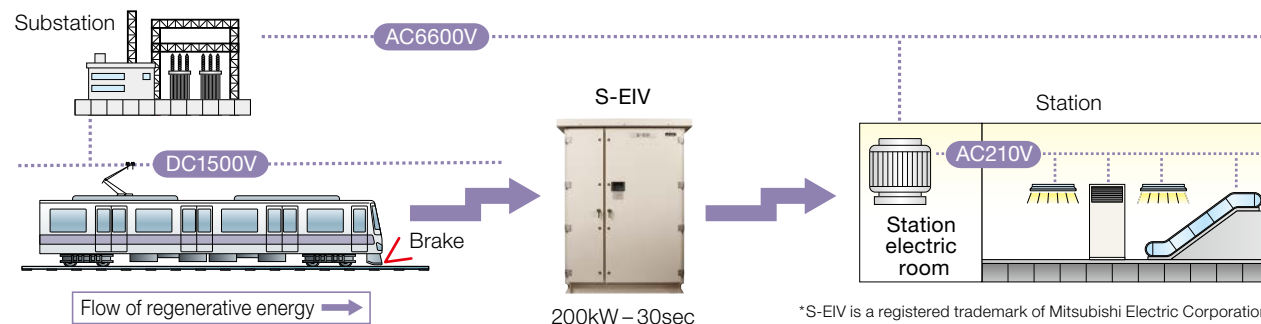
Supplies the surplus regenerative energy created by train's braking to station electrical equipment.



7.2kV composite insulated switchgear

Power switching equipment that employs dry air composite insulation and uses no greenhouse gases. A CBM* function enables abnormalities to be detected at an early stage.

*Condition Based Maintenance



Rising to the challenge of new forms of transportation in the ICT era.

Ensuring safe and stable transportation through the optimization of trainset operation and operation control. In addition, precise train control realized via cooperation between onboard and wayside equipment optimizes energy consumption throughout the entire transportation system.

Automatic Train Supervision (ATS)

These systems enable centralized monitoring and control of train operation. User interfaces that offer superior visibility and operability enable accurate understanding of the status of train operation and rapid and precise command decisions. Diverse functions also assist in the formulation of operation plans.



Passenger Information Control (PIC)

LCD panels display train departure and arrival information, line information, advertisements, etc. Videos, still images and information in letters and characters can be freely combined.



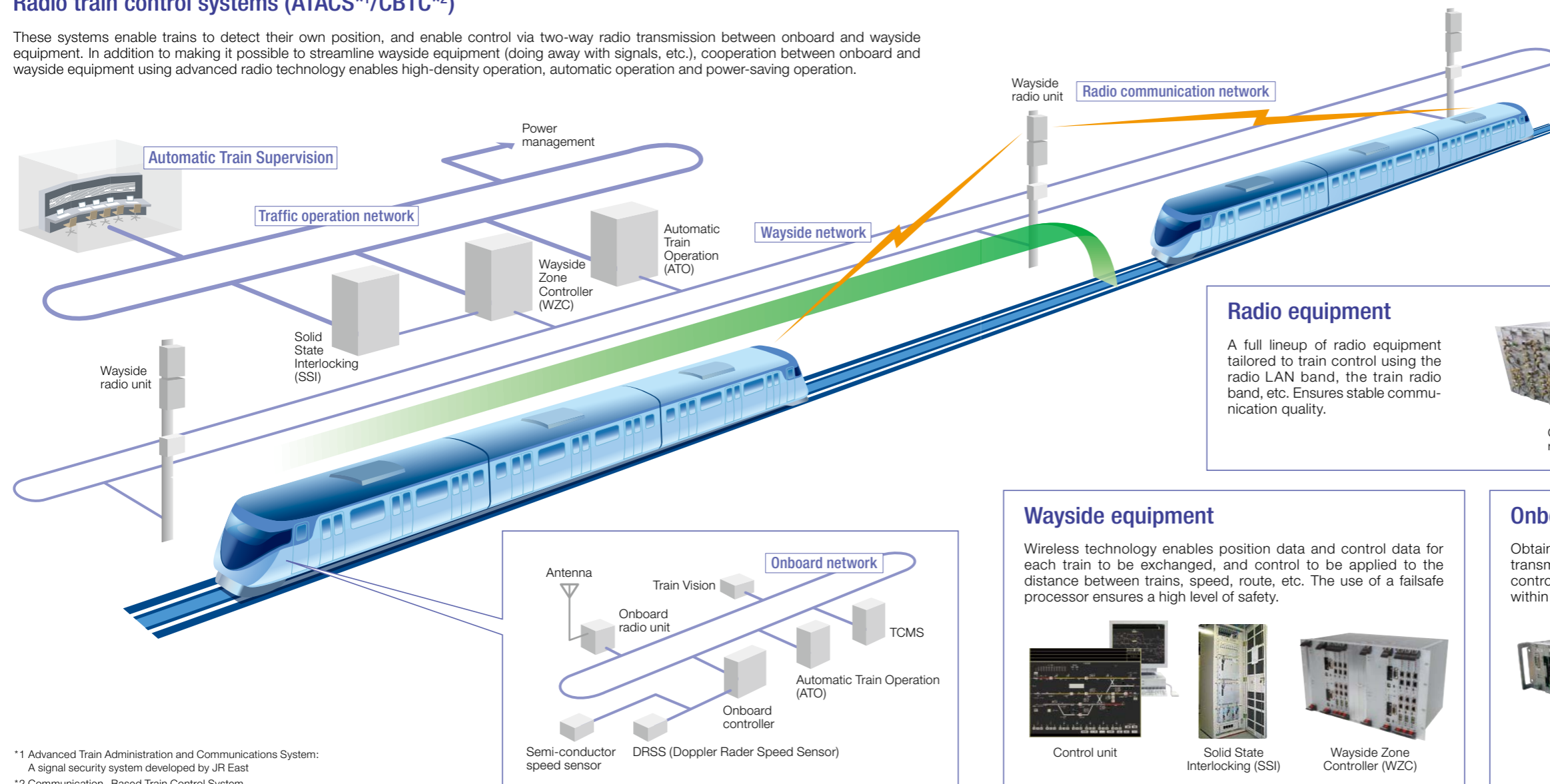
Passenger information display (LCD)



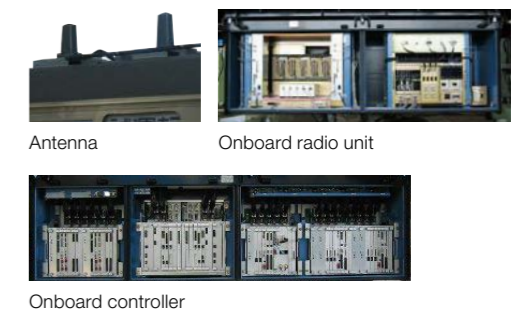
Passenger information display (Full-color LCD)

Radio train control systems (ATACS^{*1}/CBTC^{*2})

These systems enable trains to detect their own position, and enable control via two-way radio transmission between onboard and wayside equipment. In addition to making it possible to streamline wayside equipment (doing away with signals, etc.), cooperation between onboard and wayside equipment using advanced radio technology enables high-density operation, automatic operation and power-saving operation.



The first operation of ATACS (JR East Senseki Line)



Radio equipment

A full lineup of radio equipment tailored to train control using the radio LAN band, the train radio band, etc. Ensures stable communication quality.



Onboard radio unit



Wayside radio unit

Wayside equipment

Wireless technology enables position data and control data for each train to be exchanged, and control to be applied to the distance between trains, speed, route, etc. The use of a failsafe processor ensures a high level of safety.



Control unit

Solid State Interlocking (SSI)

Wayside Zone Controller (WZC)

Onboard equipment

Obtains control data related to the interval between trains while transmitting position data for the subject train to wayside zone controller via radio communications, enabling ATO to be applied within a restricted speed.



Onboard controller

Automatic Train Operation (ATO)

^{*1} Advanced Train Administration and Communications System:
A signal security system developed by JR East
^{*2} Communication-Based Train Control System

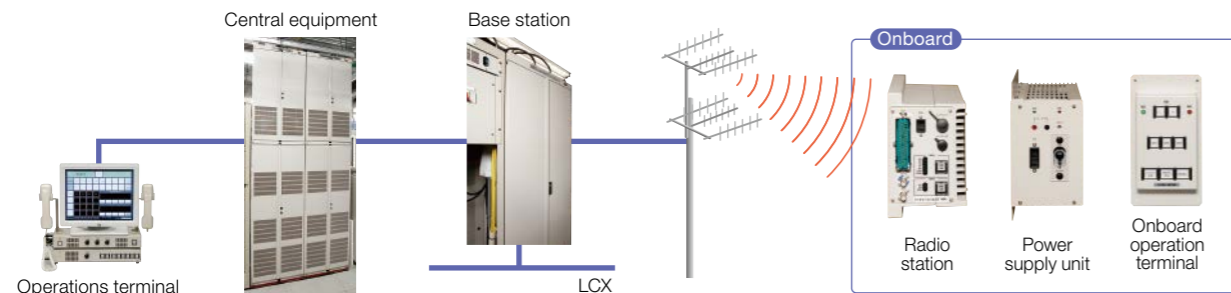
Creating next-generation information infrastructure by offering various products.

Voice communication between wayside systems and onboard systems and the deployment of communications systems in areas including signals and power are essential to train operations. Leveraging the technologies that we have cultivated over many years, we are able to supply systems of the highest reliability.

Radio systems

Train radio systems

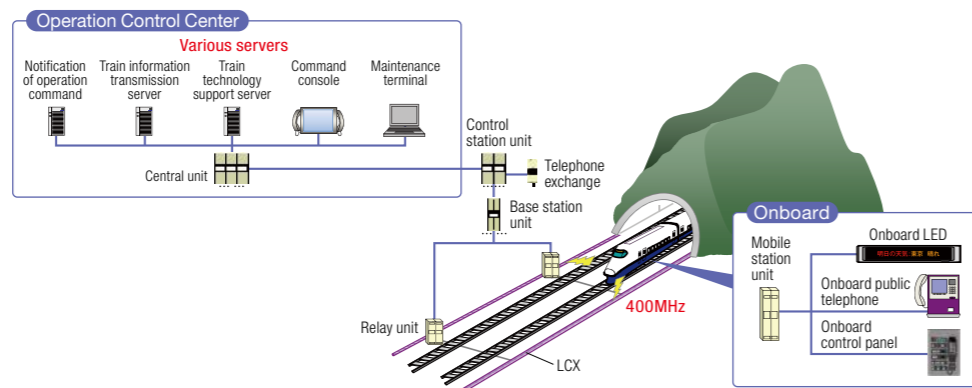
Employing the latest digital radio technologies, we realize high-quality two-way information and communication infrastructure between wayside equipment and onboard equipment, supporting train traffic management procedures and enabling fast and accurate provision of information to users.



Onboard LCX digital wireless systems for high-speed trains

The use of LCX laid along the tracks and technologies to boost radio quality enables the realization of stable radio communications across all lines, even at 360km/h.

LCX: Leaky Coaxial Cable



Making stations even more comfortable with facilities offering absolute safety and security and abundant information services.

Today, in the ongoing diversification of the services provided by rail operators, stations are no longer place simply to take a train; they form part of our living space in which people come together. Mitsubishi Electric supplies a range of products and systems that assist in making stations safe and comfortable spaces that respond to the needs of their diverse users.

Safety and security

Elevators and escalators

Seeking to realize shared spaces that everyone can use together, we provide elevators and escalators for platforms and concourses that are both easy to use and welcoming to all users.



Increasing the efficiency of maintenance via a sufficient support system and unique technologies.

Contributing to reducing lifecycle costs by providing support for CBM. A full range of maintenance services also offer rapid response to malfunctions and increase the efficiency of inspection procedures.

Train lifecycle management solutions.

Creating platforms for systems that collect and utilize train monitoring data by integrating the Train Control and Management System (TCMS) with wayside equipment. The sharing and use of monitoring data and related data enables rapid response to malfunctions (breakdown maintenance) and increased efficiency in inspection procedures (time-based maintenance). It also allows monitoring data analysis techniques to be honed and knowhow obtained towards the realization of condition-based maintenance (CBM).



Maintenance services

Mitsubishi Electric provides comprehensive maintenance services that respond to our customers' needs, from onsite responses to handover-related services. We always respond with honest maintenance services that consider the customer.



Electrical equipment for rail use



Train air conditioning system

Train depot systems

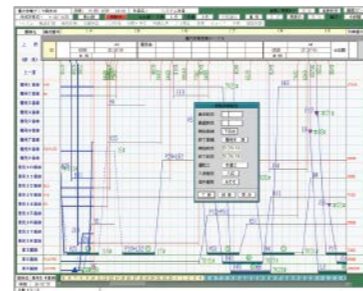
Maintenance information management system (MIMS)

Centralized management of train equipment logs and train data, including maintenance data and malfunction data, in a database. Supports expansion to use in malfunction prediction and improvement of maintenance procedures.



Depot information management system (DIMS)

Formulates train operation (allocation) plans based on main line timetables and train maintenance plans. Can also be used in the formulation of depot work plans and route control.



Measurement and analysis of wayside equipment.

Mitsubishi's MMSD™* infrastructure monitoring system enables measurement and analysis of wayside equipment using measurement cars

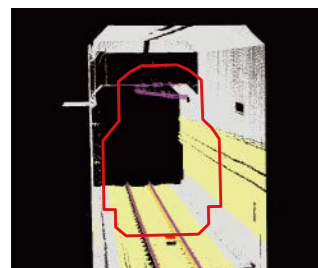
Using high-precision 3D measurement and a range of sensing technologies, we are able to automate social infrastructure inspections and equipment measurements, reducing the expenditure of manpower and increasing precision. Conducting measurements in motion using road-rail vehicles and similar equipment makes it possible to conduct precise 3D measurements in a short period. Analysis and processing of 3D shape data enables its use in a variety of fields and applications.

*Mitsubishi MMS for Diagnosis (MMSD™) is a registered trademark of Mitsubishi Electric Corporation.



Measurement car

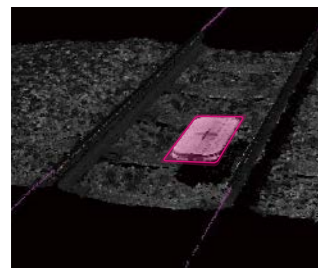
Examples of analysis



① Measurement of structure gauge
Enables measurement of structure gauge for tunnels, etc.



② Tunnel wall status analysis
Internal changes in tunnels are displayed as differently-colored areas.



③ Beacon and signal location measurement
Enables measurement of absolute position of beacon, equipment management based on absolute position.



④ Measurement of deviation of contact wires
Enables measurement of distance from central position of catenaries.



⑤ Formulation of 3D CAD data
Enables 3D CAD data to be formulated from 3D shape data.

Reinforcing relationships with local railway operators and car builders by expanding global manufacturing and services.

New rail projects are getting underway one after another throughout the world. Attention is being focused on rail as an environmentally-friendly form of mobility. Mitsubishi Electric works with joint ventures and add to its range of local manufacturing and servicing bases. Integrating with local communities and contributing to local regions, we advance our activities every day with the goal of forming close local partnerships.



Overseas bases

- Sales and maintenance bases: New York, Mexico City, São Paulo, Sydney, Singapore, Hong Kong, London, Shanghai, Gurgaon, Düsseldorf, and Madrid
- Manufacturing bases: Pittsburgh, San Juan del Rio, Sydney, Zhuzhou, Bengaluru, and Padua
- Research bases: Boston, Rennes, and Livingston
- Capital alliance: Warsaw, Espoo



Padua, Italy
Mitsubishi Electric Klimat Transportation Systems S.P.A.
● Design, manufacture and maintenance of train air conditioning equipment
● Local sales and maintenance system



Bengaluru, India
Mitsubishi Electric India Pvt. Ltd.
● Manufacturing base for domestic projects
Traction motor, control unit, auxiliary power supply, etc.
● Sales base for India
● Engineering functions
● After-sales service for India



Zhuzhou, China
Zhuzhou Shiling Transportation Equipment Company Limited
● Manufacturing base for domestic projects
● Control unit, auxiliary power supply, etc.
● Engineering and design functions
● After-sales service for China



Sydney, Australia
Mitsubishi Electric Australia Pty. Ltd.
● Manufacturing base for domestic projects
● Control unit, auxiliary power supply, etc.
● Sales base for Australia
● Engineering functions
● After-sales service for Australia



Pittsburgh, US
Mitsubishi Electric Power Products, Inc.
● Manufacturing base for domestic projects
Control unit, auxiliary power supply, etc.
● Sales base for North America
● Engineering functions
● After-sales service for North America



San Juan del Rio, Mexico
Mitsubishi Electric de Mexico S.A. de C.V.
● Global manufacturing base
Traction motor, control unit, auxiliary power supply, etc.
● Manufacturing base for domestic projects
● Sales base for Mexico
● Engineering functions
● After-sales service for Central and South America



MERL
The R&D base in Boston conducts basic research and R&D of advanced technologies with a view to practical application in the areas of electronics, communications, media signal processing, data analysis, spatial information processing, mechatronics, and optimization technologies.



Warsaw, Poland
MEDCOM Sp. z o.o. (Capital alliance)
Design, manufacture, sales and after-sales service of solutions with the full-SiC technology, dedicated to public transportation vehicles as rail vehicles, trolleybuses, eBuses, including comprehensive propulsion systems, auxiliary power supplies, Train Control and Management Systems and battery chargers.

MERCE
The research centers in both Britain and France conduct advanced R&D projects and are also actively engaged in international standardization activities, with the focus in Britain on technologies related to air conditioning and cooling equipment, and in France on power electronics and communications technologies.

Espoo, Finland
EKE-Electronics Ltd. (Capital alliance)
Design, manufacture, sales and after-sales services of train information systems (TCMS and peripheral equipment) and remote train condition monitoring systems which utilize TCMS

Meeting the needs of the present age with uncompromising high-quality manufacturing and cutting-edge technologies.

With an absolute commitment to quality, we adopt a total approach to manufacturing in order to enable us to offer products of ever-higher quality. We are working to strengthen cooperation between our manufacturing bases and research centers, always striving to resolve a range of difficult issues with a view towards the future of the rail industry.



Itami Works

- Rolling stock systems
- Signal control systems

Transmission & Distribution Systems Center

- Switchgear
- Lightning arresters



Transmission & Distribution Systems Center Ako Plant

- Traction Transformer



Kobe Works

- Automatic Train Supervision
- Transportation power supply system
- Optical network systems
- Disaster prevention systems, etc.



Communication Networks Center

- Train radio system
- On board crime prevention system



Nagasaki Works

- Train air conditioning
- Platform screen doors
- Passenger information display (Full-color LED)
- Onboard display (Full-color LED)



Power Device Works (Fukuoka, Kumamoto Prefecture)

- Power devices (IGBT modules, IPM, SiC power modules, etc.)



Nakatsugawa Works

- Linear fan (Lindelier)
- Solar systems



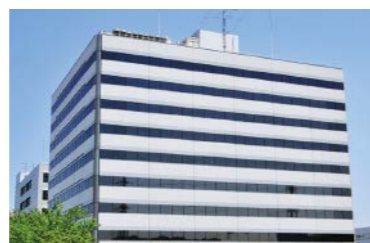
Advanced Technology R&D Center

- SiC power modules
- Computer platforms for traffic data control (traffic management, transportation planning, support for commands) systems



Power Distribution Systems Center

- Power distribution system



Information Technology R&D Center

- Train radio system (LCX, millimeter-wave)
- Train dynamics monitoring systems



Mitsubishi Electric Building Solutions Corporation Inazawa Building Systems Works

- Elevators and escalators



Integrated Design Center

- Passenger information system (Concept/Screen)
- Screens for train information systems
- Screens for automatic train supervision (Including Operation Control Center design)

Design Systems Engineering Center

Manufacturing Engineering Center

Component Manufacturing Technology Center

1950

1960

- ▶ First advance into overseas markets: Delivery of electrical components to Indian Railways
- ▶ Advance into European market: Delivery of electrical components for the Spanish National Railway Network
- ▶ Completion of traction motors for Shinkansen production cars
- ▶ Marketing of Japan's first* Automatic Train Control (ATC) and Automatic Train Operation (ATO) equipment



Traction motor for Shinkansen production cars

1970

- ▶ World's first* mass production and delivery of chopper control system



Chopper control system



CFC evaporative cooling rectifier



Regenerative inverter

1980

- ▶ Japan's first delivery of Unattended Train Operation (UTO) system
- ▶ Delivery of Japan's first* VVVF inverter for 1500V catenary



VVVF inverter for 1500V catenary



Flywheel-type train line power storage equipment

1990

- ▶ Delivery of converter-inverter applying IPM semiconductors (First for Shinkansen*)



Converter-inverter applying IPM semiconductors

2000

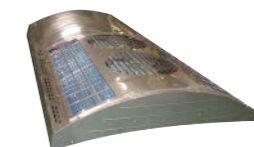
- ▶ Delivery of Japan's first* Train Integrated Management System (TIMS)
- ▶ Delivery of Japan's* first passenger information system (Train Vision)
- ▶ Delivery of totally enclosed induction motor
- ▶ Marketing of air conditioning using substitute refrigerant



Train Vision



Totally enclosed induction motor



AU726A-G4 air conditioning

2010

- ▶ Marketing of world's first* VVVF inverter using SiC
- ▶ Delivery of world's first* auxiliary power supply using SiC
- ▶ Marketing of Station Energy Saving Inverter (S-EIV)



VVVF inverter using SiC



Auxiliary power supply using SiC



Station Energy Saving Inverter (S-EIV)

*According to in-house survey conducted in March 2017