MITSUBISHI ELECTRIC
Changes for the Better

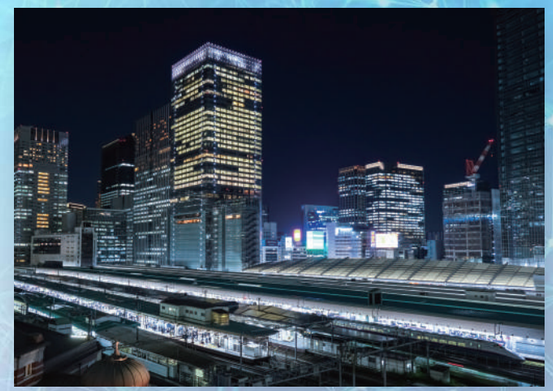
Train Control and Management System

Solution to Bring Out Potential of Railway

MITSUBISHI ELECTRIC CORPORATION

www.MitsubishiElectric.com

Connecting Technologies, Shaping More Vibrant and Sustainable Future Railway.



contents

Train System Integration Solution

**Enhancing Railways Together - Mitsubishi Electric,
Your Train System Integrator for Safety, Comfort, and Efficient Operation.**

Expertise and Synergy in Train System Management

At Mitsubishi Electric, we take pride in our role as a reliable system integrator, focusing on delivering solutions for "safety","comfort" and "efficient operation" in the railway industry.
With our expertise in systems like Brake, Automatic Train Protection, and Communication-Based Train Control, we ensure the highest levels of safety during train operations.
Our offerings also extend to Passenger Information System and Air Conditioning System, providing passengers with a comfortable and enjoyable travel experience.

Additionally, we cover essential aspects like Propulsion System, Automatic Train Operation, and Auxiliary Power Supply, contributing to the efficient operation of trains.

With a deep understanding of these diverse train-systems, we have developed the Train Control and Management System (TCMS), acting as the core of intelligent train management. This integrated approach allows us to achieve optimal performance, ensuring enhanced safety, energy efficiency, and passenger comfort.

Our Vision with Train System Solution

At Mitsubishi Electric, we are driven by three primary objectives:

1) Optimizing Train Performance

With our expertise, we optimize train performance, prioritizing passenger safety and comfort, and ensuring reliable and efficient operation.

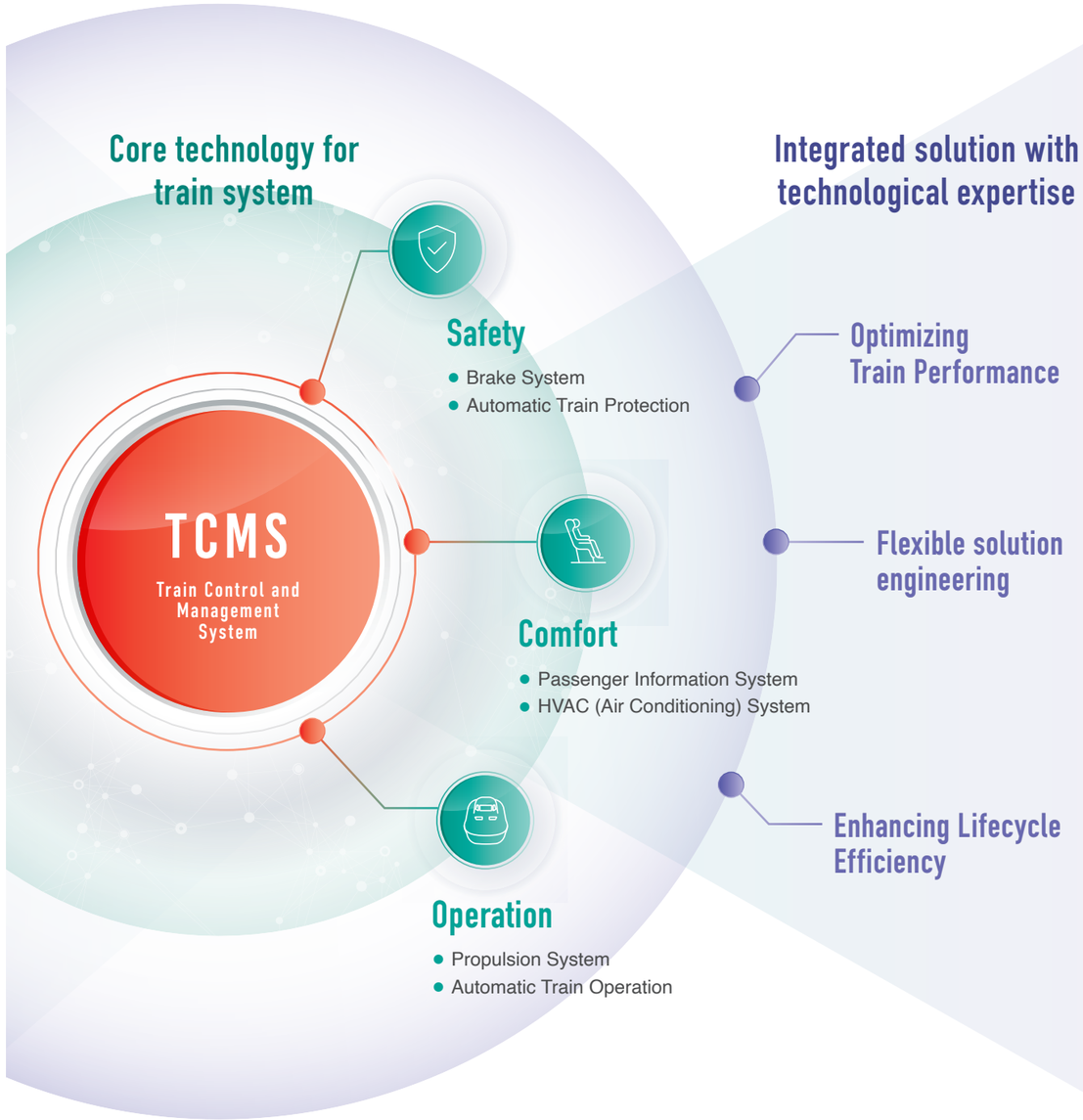
2) Flexible Solution Engineering

We understand the unique requirements of each customer's vehicle systems. Our approach is flexible, allowing us to tailor solutions that precisely match your needs. Through compliance with international standards, we ensure open interfaces, enhancing system compatibility and adaptability.

3) Enhancing Lifecycle Efficiency

We are committed to optimizing overall lifecycle efficiency. Our focus is on enhancing energy efficiency for rolling stock, streamlining vehicle wiring, and implementing maintenance strategies that maximize efficiency while minimizing downtime.

Choosing MELCO as your partner means gaining access to a comprehensive and innovative solution that maximizes the potential of your train operations. Together, let's create a safer, more efficient, and comfortable future for rail transportation.



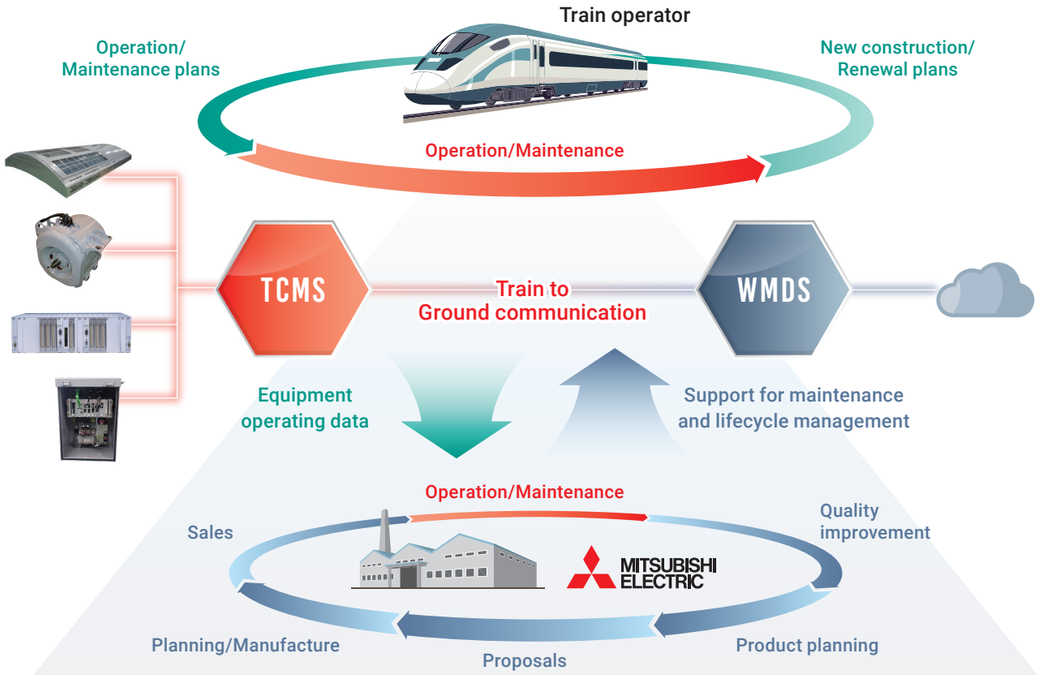
Lifecycle Management Solution
Incorporated with Wayside System

Enhancing Train Lifecycle with Operations and Maintenance through Advanced Data Integration

Concept of Lifecycle Management Solution

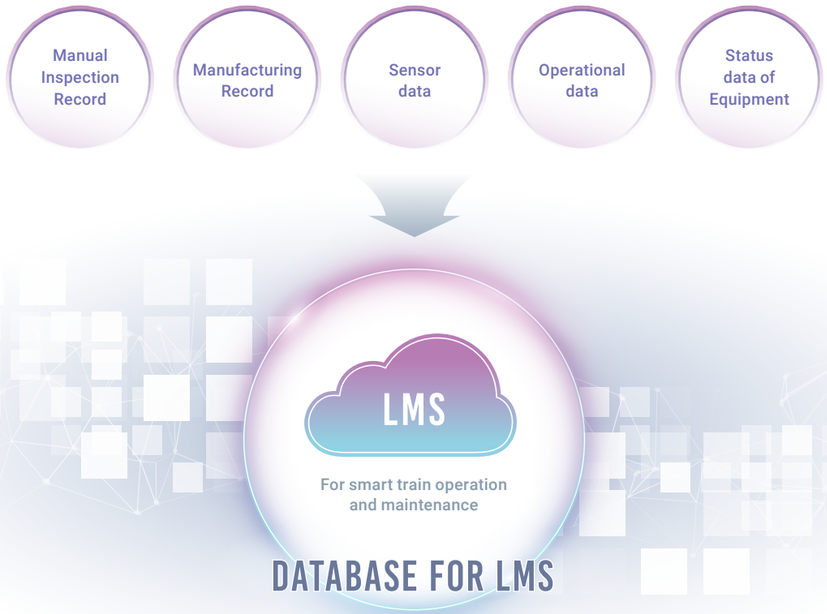
Lifecycle Management Solution (LMS) is a solution to provide improvement in the whole train lifecycle including train operation and maintenance.
Mitsubishi Electric provides the systems that collect and utilize train/equipment data by integrating TCMS and Wayside Monitoring and Diagnostic System (WMDS). The sharing and utilization of data facilitate enhancements in train operation and maintenance such as rapid response to malfunctions, inspection processes. Furthermore, it enables the application of data analysis techniques and expertise in advancing towards condition-based maintenance (CBM).

Train lifecycle management solution



Digitalization for Next Stage

LMS is the digitalization solution to enable train operation and maintenance to next stage. LMS creates the five key values for train lifecyle improvement.



Realtime Monitoring
- Monitor the operational status of fleets and equipment in realtime
- Realtime fault detection and announcement

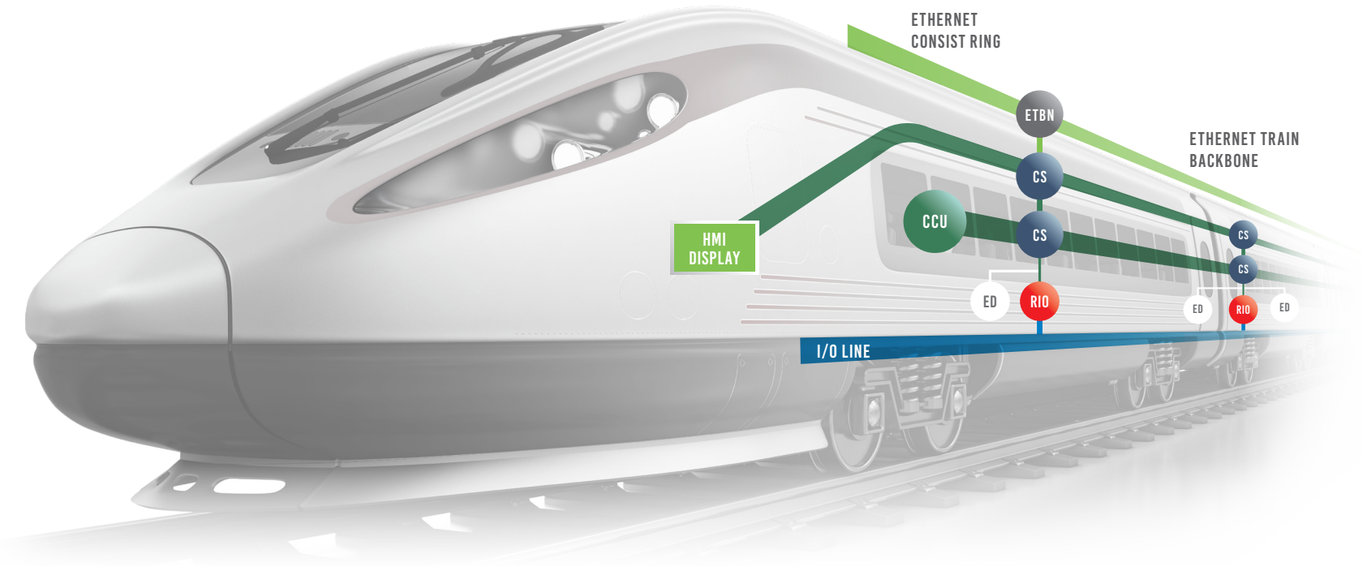
Rapid Recovery
- Track the fleets and equipment status in realtime at operation control center
- Smooth communication between operation control center and driver for failure recovery

Maintenance Optimization
- Improve quality and efficiency of maintenance work with preventive maintenance
- Break away from work reliant on individual ability

Predictive Analytics
- Avoid malfunction leading impacts in availability and safety
- Estimate the remaining lifetime by degradation trend analytics

Energy Saving
- Find areas for energy saving by energy consumption trend visualization
- Evaluate suitable solutions for energy saving and its effectiveness

Mitsubishi Electric TCMS Features

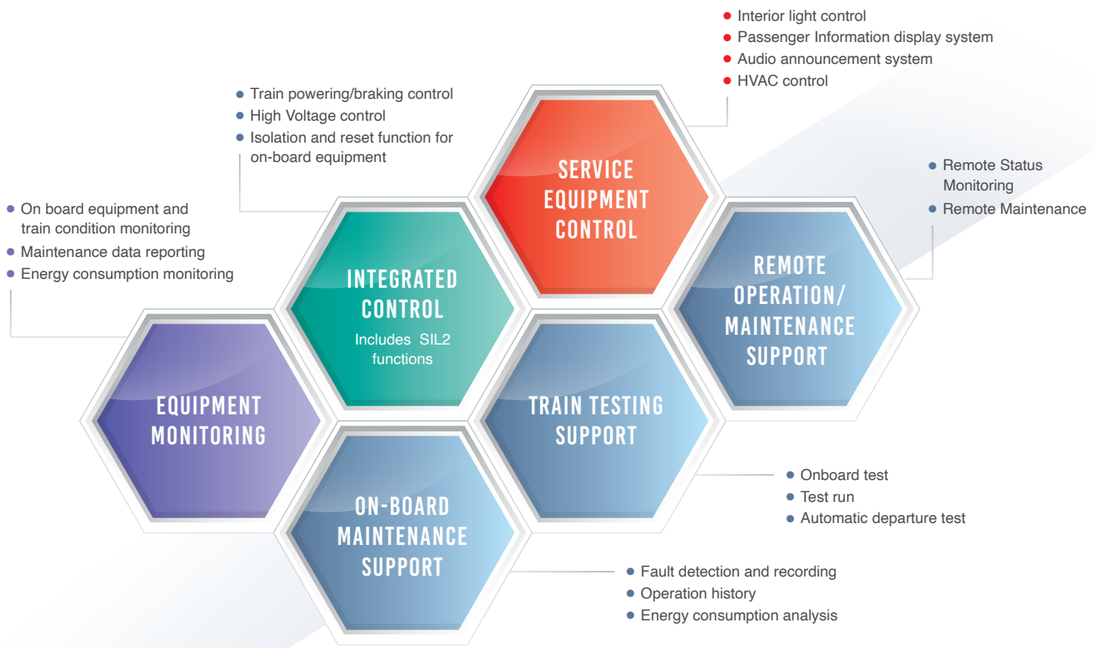


Optimizing Train Operations with Intelligent Control

TCMS serves as the central infrastructure for information exchange throughout the entire train, functioning as the brain of the system.
Enabling automation and leveraging advanced digital technologies, TCMS is a key product of making train systems more intelligent.
Through network connectivity with all train subsystems, TCMS offers a wide range of functionalities, including equipment monitoring, comfort service control, integrated control, train testing support, and maintenance assistance.

Enhancing Efficiency and Safety through TCMS Functions

TCMS provides an optimized train control function, including GoA4 (Grade of Automation Level4) features, ensuring efficient and safe train operations. Its flexible software configuration allows customers to customize monitoring, recording items, fault diagnosis logic, and more for streamlined maintenance support.



Flexible System Architecture for Integrated Solutions

Ethernet Network with Open Interface Compliance:

Mitsubishi Electric TCMS is built on an Ethernet network with interfaces compliant to the IEC 61375 series.
Additionally, the network incorporates necessary cybersecurity measures based on threat analysis. This safe and high-speed data transmission system allows seamless communication between various subsystems, facilitating integration with third-party systems for enhanced services for operators, maintainers, and passengers.

Safety Proven System with SIL2 Certification:

Mitsubishi Electric TCMS is certified with SIL2 (Safety Integrity Level 2) by certification body, guaranteeing a high level of safety.

Enhanced Reliability and Availability:

Integrating train system functions into TCMS reduces cable connections within the train, enabling the utilization of TCMS network redundancy. This leads to improved reliability and availability, contributing to stable train operations. Moreover, TCMS seamlessly coordinates with the Wayside Systems enabling remote condition monitoring and further enhancing transportation stability.

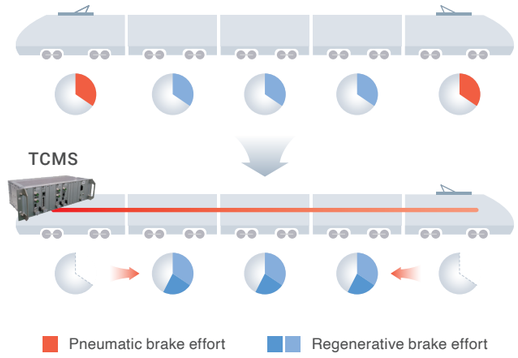
With Mitsubishi Electric TCMS at the heart of your train's intelligence, you can achieve advanced control capabilities, streamlined maintenance, and enhanced passenger experiences, leading the way to a smarter, safer, and more efficient future of rail transportation.

Solution Application

Solution Application of On-board System Integration

Train-wide Integrating Equipment Management for Efficiency

TCMS calculates the brake force at the train level and optimizes regenerative and pneumatic braking to enhance maintenance efficiency and energy savings.
TCMS bridges communication gaps between cars, computes individual brake efficiency, and strategically allocates regenerative and pneumatic brakes to minimize pneumatic brake usage and reduce pad replacements.

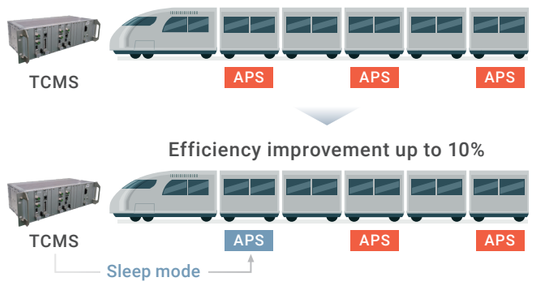


Troubleshooting Guidance for Ease of Maintenance

TCMS provides the troubleshooting guidance to identify the cause of fault and corrective actions. This solution reduces maintenance and handling workload.

Electric-Load-Driven Equipment Control for Energy Saving

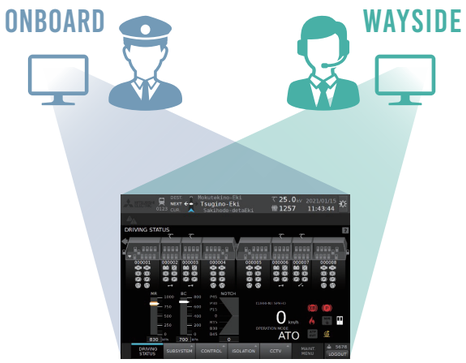
TCMS controls APS operation during the low electric load in train level. It enables high efficiency operation and reduction of the energy consumption during the low electric load.



Solution Application of Wayside System Integration

Virtual Cab Monitor Information for Rapid Recovery

WMDS provides on-board cab monitor information to operation control center. Recovery time can be improved by identifying fault status and recovery guideline. It is possible to confirm necessary screen remotely based on operater control center's needs and support failure recovery.

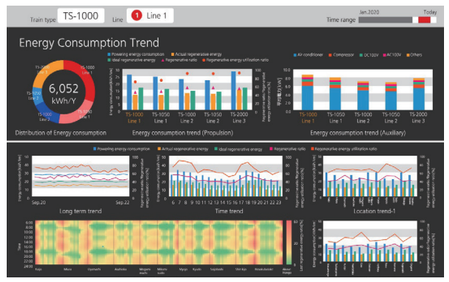


Equipment Health Monitoring and Predictions

By analyzing and monitoring the equipment health based on a cumulative operational load and deterioration trends, it contributes to more efficient preventive maintenance and minimize unexpected mulfunctions.

Energy Consumption Trend Visualization for Energy Saving

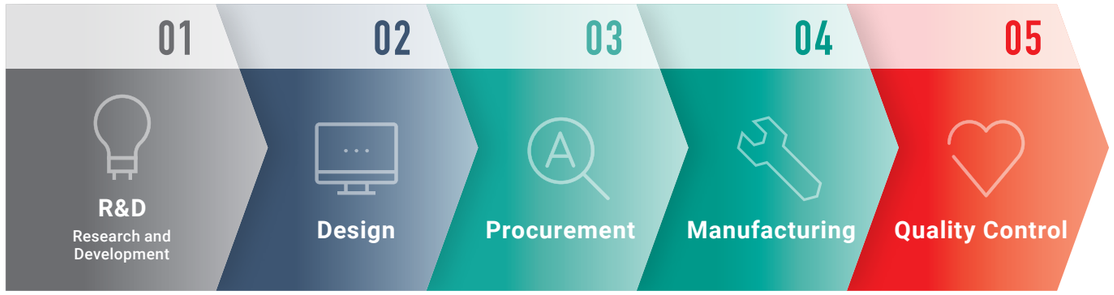
WMDS provides various types of statistical data for energy consumption including lost regenerative energy trends and location trends. By visualization of energy consumption trends, Mitsubishi Electric contribute to train operation improvement for energy saving.

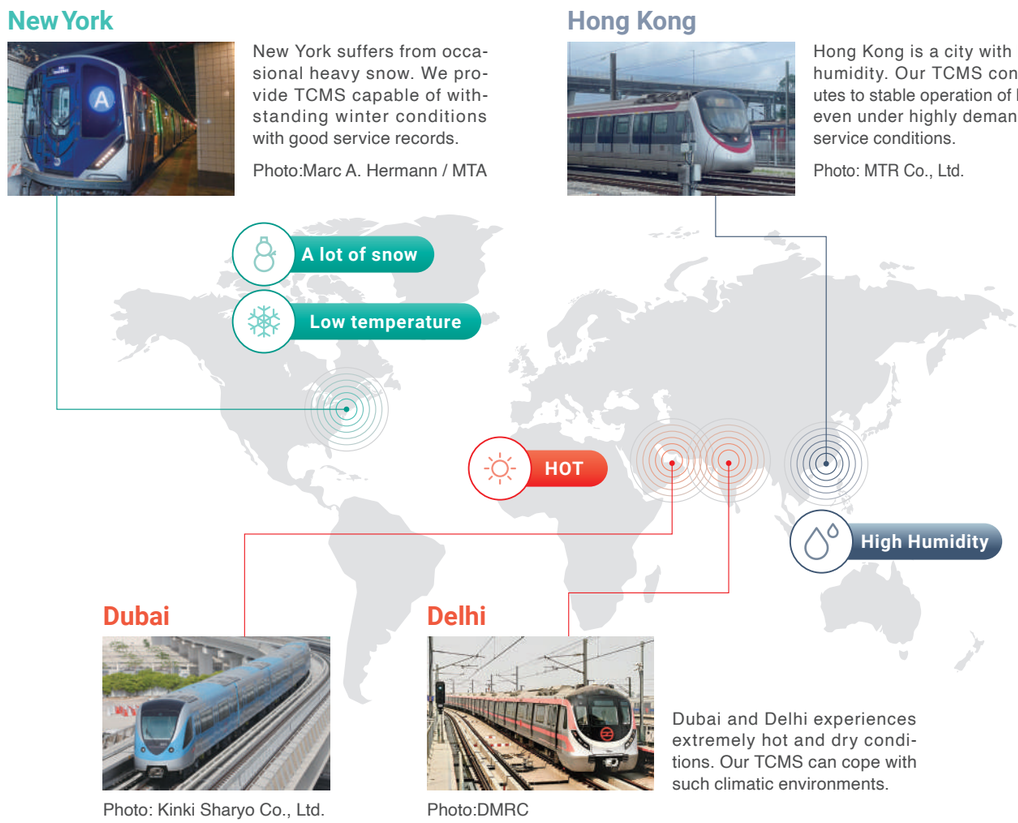


MITSUBISHI ELECTRIC Reliability

Philosophy of Reliability

Reliability is a key element of our purpose, aimed at contributing to the realization of a vibrant and sustainable society.
Since the delivery of our first TCMS in 1979, Mitsubishi Electric has been serving customers around the world. Based on over forty years of experience and solid performance, our TCMS performs reliably and consistently in all operating environment. Based on over forty years of experience and solid performance, we have been serving customers around the world with TCMS.
Research, design, procurement, manufacturing, and quality control are all carried out in Itami works, mother factory in Japan.
With our integrated production management and advanced technology, we provide highly reliable equipment.





Voice of Customer

"Mitsubishi Electric is a valuable partner. We have been collaborating on various projects for a long time," says Mr. Wang of MTR Corporation Limited in Hong Kong. He is the depot manager at MTR Pat Heung Depot and has acquired extensive experience with Mitsubishi Electric through over 20 years of involvement in TMS (*) projects, from LRV Phase 3 to the latest SP and TML C-Train project.
"Mitsubishi Electric TMS (*) demonstrates outstanding reliability. We rarely encounter any issues with TMS," he states. "Furthermore, the quality has consistently improved over the past two decades."
"Additionally, the members of Mitsubishi Electric are exceptionally supportive. Whenever MTR faces any problems or has queries, they strive to provide the quickest response," Mr. Wang explains. A key factor contributing to this prompt response is the on-site support from ME-HK (Mitsubishi Electric (Hong Kong) Limited), the Hong Kong subsidiary. Mr. Wang commends ME-HK for serving as the primary point of contact between MTR and Mitsubishi Electric, coordinating with individuals from various departments in Mitsubishi Electric. "ME-HK acts as a bridge between MTR and Mitsubishi Electric, offering invaluable first-hand support."
The utilization of big data has become a global trend, and MTR is no exception. "Big data technology is rapidly advancing. It can assist us in predictive maintenance," comments Mr. Wang. "By identifying hints and signals before failures occur, it can also provide insights into system performance trends. We aim to utilize this information for planning maintenance works, such as replacements and modifications. We hope that Mitsubishi Electric will continue to improve its service and system to achieve this objective."
(*) TMS: Train Monitoring System, predecessor system of TCMS

Mr. WANG Kwok Kit, Walton

Depot Manager – MTR Pat Heung Depot
MTR Corporation Limited

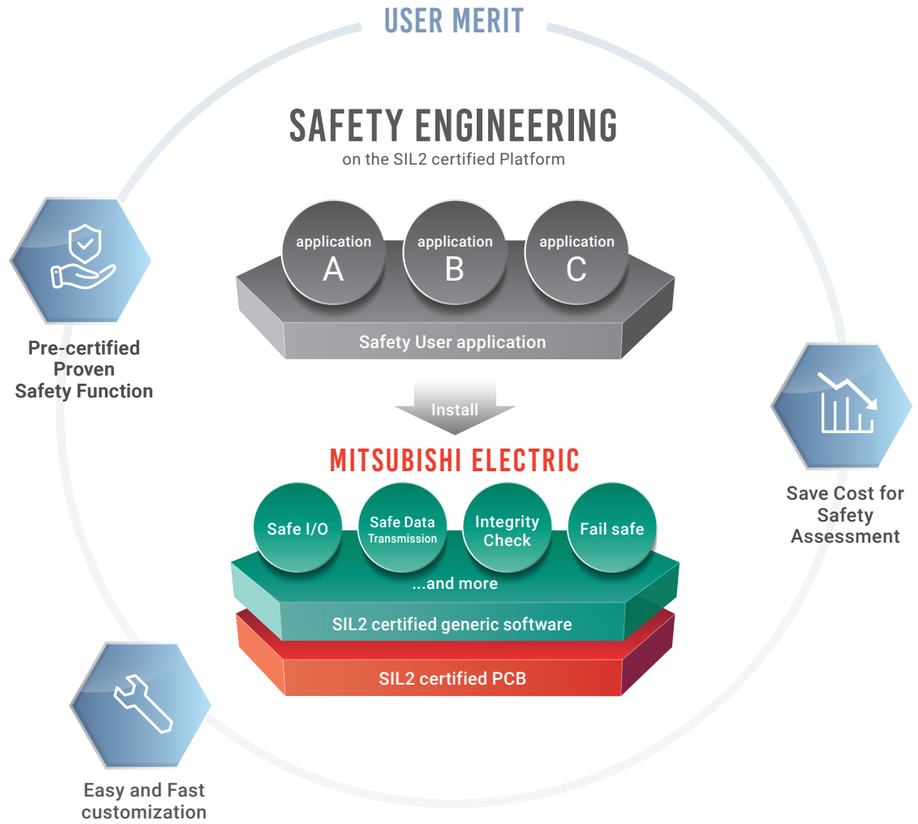
MITSUBISHI ELECTRIC Safety

Philosophy of Safety

Safety is the primary mission in railways, supporting the lives of numerous people. Railways must continuously ensure safety, enabling passengers to travel confidently to their destinations and safeguarding all those involved in train operations.
Mitsubishi Electric TCMS is a system that provides safety as a core of the train system. Mitsubishi Electric continuously seeks the highest standards of safety by considering all possible risks in operations and verifying the safety qualitatively and quantitatively for the entire lifecycle of TCMS during development lifecycle.

Engineering Support for Customized Safety Compliance Certification

As train systems grow in complexity with digitalization, train industry stakeholders face the dual challenge of ensuring safety while reducing costs and timelines. The Mitsubishi Electric TCMS, certified at Safety Integrity Level 2 (SIL2) in accordance with IEC 62425, provides a solid solution. Its platform, which includes both hardware and software, enables the efficient addition of new safety functions, optimizing both cost and integration speed.
Customizing the TCMS on this certified platform allows for the seamless integration of additional features, ensuring safety standards are upheld while reducing both time and expenses related to safety certification processes. By using specialized engineering tools for customization, it meets specific operational requirements of train systems and accelerates the re-certification process for customized components, significantly cutting down on compliance timelines. This integrated approach ensures that our TCMS solution offers both reliability and efficiency, facilitating the development of safe, tailored train systems.



Voice of Expert

We understand the importance of a comprehensive safety approach for Mitsubishi Electric TCMS. It's not just about mechanical and electrical integrity; IT-related functional safety, organizational safety management, staff competency, and product reliability are all crucial.
Our TCMS, enriched by a long history of operational excellence, exemplifies our commitment to safety.

This system has been thoroughly evaluated to meet stringent safety standards, a process that includes assessments by independent safety assessors and third-party organizations. These evaluations, while crucial, are part of a broader strategy that leverages our extensive experience to ensure reliability and operational safety for train operations.

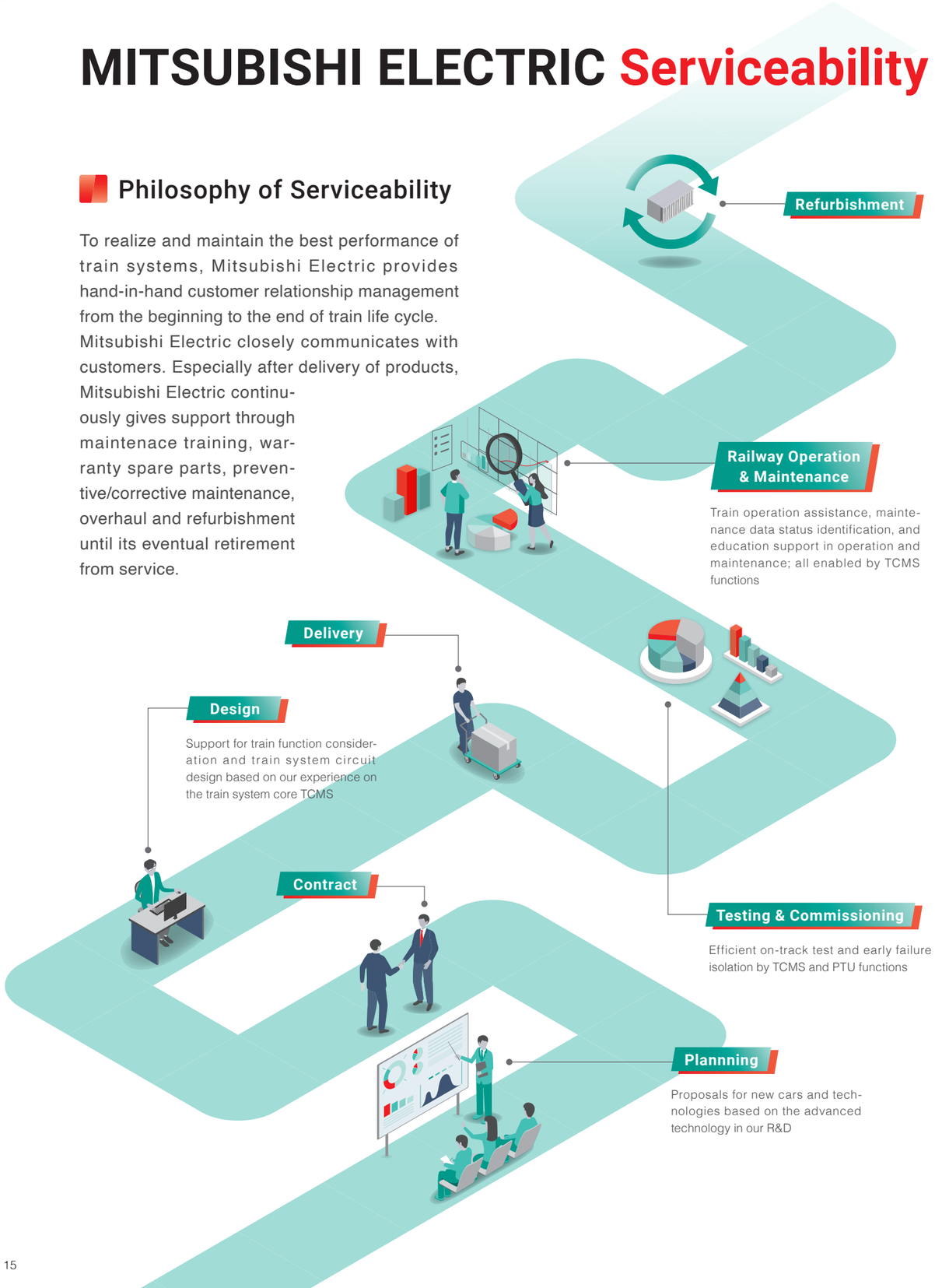
Our TCMS's proven track record and these external assessments serve as a testament to its safety and efficiency in train transport. This balanced approach, combining our history with external reviews, establishes our TCMS as a trusted solution for train operations.

Hiroo Kanamaru
TUV Functional Safety Expert (FSexp)
IP division, Mitsubishi Electric CO.
ID: 171 / 11
HW/SW
Machinery
TÜVRheinland FS Expert

MITSUBISHI ELECTRIC Serviceability

Philosophy of Serviceability

To realize and maintain the best performance of train systems, Mitsubishi Electric provides hand-in-hand customer relationship management from the beginning to the end of train life cycle. Mitsubishi Electric closely communicates with customers. Especially after delivery of products, Mitsubishi Electric continuously gives support through maintenace training, warranty spare parts, preventive/corrective maintenance, overhaul and refurbishment until its eventual retirement from service.



Strong Global Support for Close Local Partnership

ASIA

1 Tokyo, Japan
Mitsubishi Electric Corporation (Head Office)

2 Hyogo, Japan
Mitsubishi Electric Corporation, Itami Works
- Mother factory in Japan
- Railway system and equipment(traction motor, propulsion system,brake system, train control and management system, signal control system, etc.)

3 Hong Kong, China
Mitsubishi Electric Hong Kong Ltd.
- Sales base for Hong Kong
- Engineering functions
- After-sales service for Hong Kong

AUSTRALIA

4 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

EUROPE

5 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

6 Ratingen, Germany
Mitsubishi Electric Europe, B.V.German Branch
- Sales base for Europe
- Engineering function
- After-sales service for Europe

7 Madrid, Spain
Mitsubishi Electric Europe, B.V.Spanish Branch
- Sales base for Europe
- Engineering function
- After-sales service for Europe

NORTH AMERICA

8 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

TCMS Products

Central Control Unit

Central Control Unit (CCU) is involved in control, monitor and diagnostic of train. CCU communicates with subsystems over Ethernet to monitor and control various connected subsystems throughout the train level. CCU can control any train and subsystem from the aspect of safety, operation and comfort. SIL2 certified CPU in CCU which is called CCU-S is a dedicated controller for safety control. As an option, gateway functionality can be added into CCU.

Dimensions(W×H×D)	484.6mm × 132.6mm × 255mm
Weight	5.0kg model
Temperature Range	-40°C to 85°C
Humidity	10% to 95% RH
Power Supply Voltage	DC 77V to DC 137.5V
Energy Consumption	Up to 30 W
Output	5V ± 5%, 10A
Connectors	M12, RJ45, USB Type-A, RITS (3-pin)
Memory	ROM: 128 MB, RAM: 512 KB, SSD: 32 GB

Consist Switch

Consist Switch (CS) is an ethernet switch which is used for Ethernet Consist Network (ECN) with 100Mbps Ethernet. CS is used to connect the TCMS and subsystems with IP based communication. The various types of networks including “Ring Topology with Dual Homing “ to satisfy redundant architecture specification can be constructed with CS. Both Ethernet and RS485 interface are supported.

Dimensions(W×H×D)	484.6mm × 132.6mm × 255mm
Weight	5.0kg model
Temperature Range	-40°C to 85°C
Humidity	10% to 95% RH
Power Supply Voltage	DC 77V to DC 137.5V
Energy Consumption	Up to 55 W
Output	5V ± 5%, 10A
Connectors	M12, RJ45, USB Type-A, RITS (3-pin)
Memory	ROM: 128 MB, RAM: 512 KB

Remote Input/Output

Remote Input/Output (RIO) has the provision to provide the hardwire I/O interface between train and TCMS. The hardwire I/O interfaces is integrated in RIO and it can reduce the train cabling. Digital I/O, Analogue I/O hardwire interface and ethernet communication interface are supported in RIO. RIO provides a flexible combination of digital and analogue I/O, allowing for future expansion and facilitating a wide variety of control and monitoring solutions. RIO is SIL2 certified and can execute safety related I/O function.

Dimensions(W×H×D)	484.6mm × 132.6mm × 255mm
Weight	7.0kg model
Temperature Range	-40°C to 85°C
Humidity	10% to 95% RH
Power Supply Voltage	DC 77V to DC 137.5V
Energy Consumption	Up to 82 W
Output	5V ± 5%, 10A
Connectors	M12, D-sub (9-pin), RITS (3-pin)
Memory	ROM: 32 MB, RAM: 3 MB (1 MB for backup)

※Features such as weight, power supply voltage and energy consumption is subject to change depending on PCB configuration

Ethernet Train Backbone Node

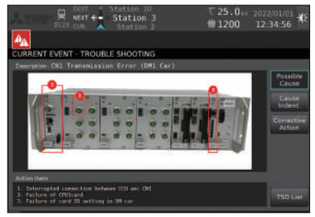
Ethernet Train Backbone Node (ETBN) is the ethernet switch which is used for Ethernet Train Backbone (ETB). ETBN can construct the Backbone Network over the consist considering the interoperability based on IEC 61375-2-5 and enable the routing between ECN and ETB.

Dimensions(W×H×D)	484.6mm × 132.6mm × 255mm
Weight	5.0kg model
Temperature Range	-40°C to 85°C
Humidity	10% to 95% RH
Power Supply Voltage	DC 77V to DC 137.5V
Energy Consumption	Up to 107 W
Output	5V ± 5%, 10A
Connectors	M12, RJ45, USB Type-A, RITS (3-pin)
Memory	ROM: 128 MB, RAM: 512 KB, SSD: 32 GB

TCMS Products

Human Machine Interface

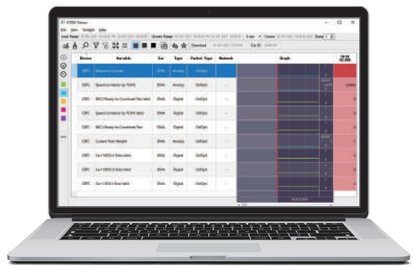
Human Machine Interface (HMI) is the hardware and software tool to provide various display functions such as train speed, train distance, equipment status and faults for supporting the driving and maintenance work. The wiring and equipment information collected by TCMS is displayed on HMI. Operators can operate equipment and Maintainers can carry out equipment tests by touching the HMI. The HMI has different login modes for revenue service operation and maintenance, allowing different functions to be used. Secure access to train functions by HMI is possible by protection against unauthorized person with access control with password in HMI.



Portable Test Unit

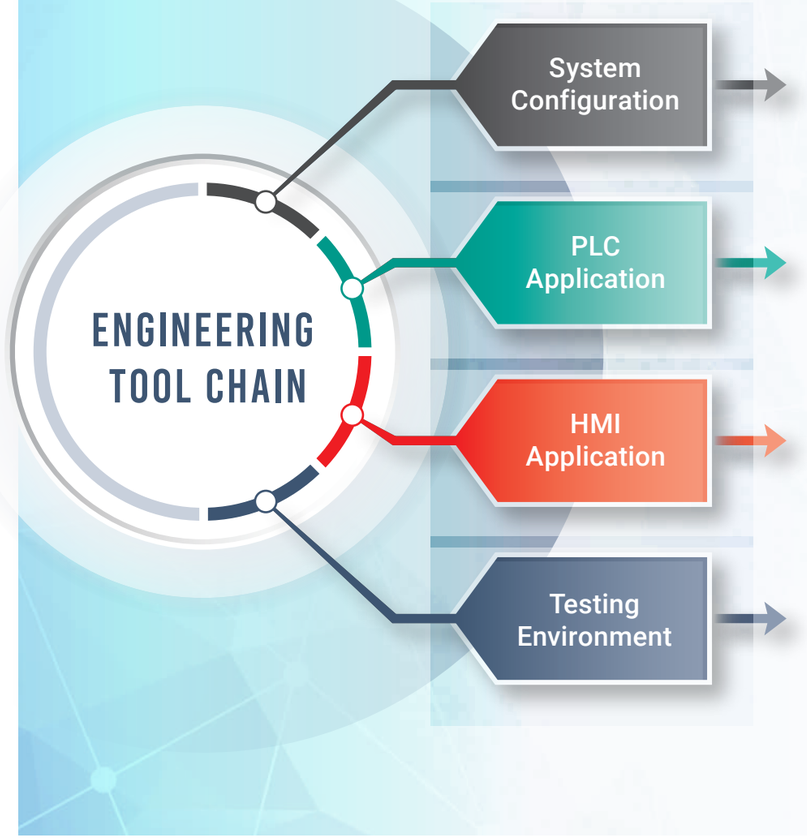
Portable Test Unit (PTU) is the software tool to provide the functions of data/software transfer, data analysis and parameter/data base configuration for supporting the commissioning and maintenance work. Software upload/data download is possible by connecting PTU to the Ethernet consist network.
The various type of data analysis including the event record data and train performance data is supported. Secure access to train functions by PTU is possible by protection provision against unauthorized person with access control with password/username in PTU.

- Software Uploading
- Record Data Downloading
- Record Data Analysis
- Parameter/Data Base Configuration
- Testing Support



Engineering Environment for faster/ flexible customization

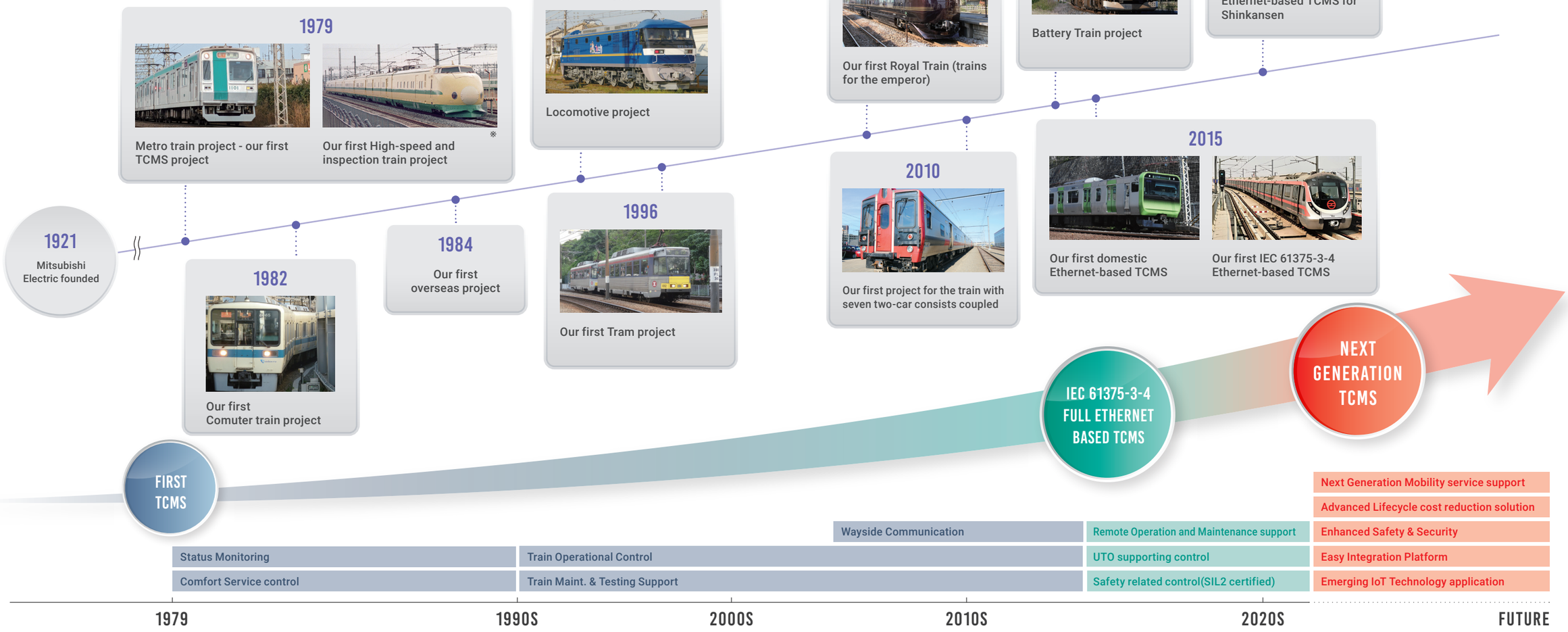
Mitsubishi Electric has an engineering tool chain suitable for TCMS engineering. Using the tool chain facilitates rapid and flexible development of TCMS tailored to suit the train system for each customer. Accordingly, Mitsubishi Electric can flexibly offer upgraded functions or other changes depending on customers' needs at low cost.



MITSUBISHI ELECTRIC History

Innovative technology on TCMS

In 1979, Mitsubishi Electric TCMS began with system information monitoring. Our TCMS has continually developed with our customers' needs and evolution of technology. In 2015, we began offering the Full Ethernet TCMS which meets IEC 61375-3-4 . It serves as the brain of the train and helps to achieve optimal train operations. TCMS is now indispensable not only for integrated management of trains but also for the innovations in our clients' business structures. We are going to continue taking on challenges to realize our customers' ideal train operations.



※OCC/Operation Control Center ※FSK/Frequency Shift Keying ※UTO/Unattended Train Operation ※SIL/Safety Integrity Level

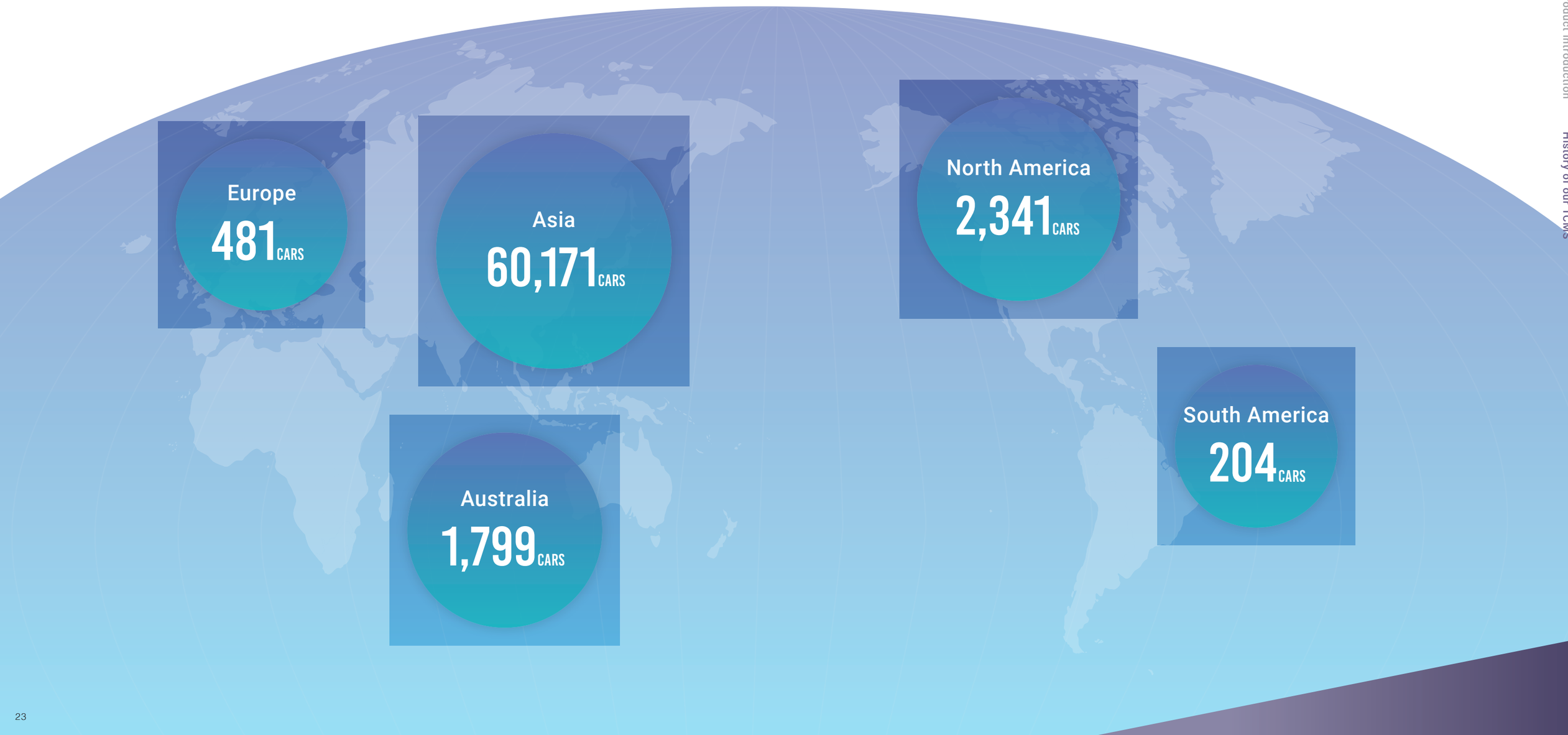
※Our first High-speed and inspection train project: File: 925 sendai untensyo.jpg, spaceaero2, GNU Free Documentation License, Version 1.2”

Delivery Record

As of 2023:

Domestic METRO/Suburban/SHINKANSEN®/Loco 416 Projects Over 43,865 Cars since 1979.

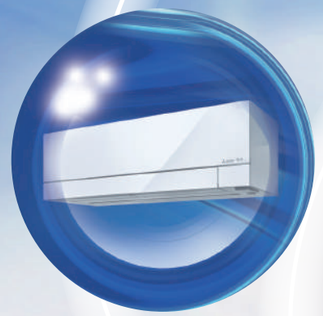
Overseas METRO/Suburban/Loco 106 Projects Over 21,131 Cars since 1984.



What it mean to be a comprehensive Railway solution provider

Mitsubishi Electric conducts business in a wide field, spanning from home electronics to satellites in space. Through co-creation and integration of the expertise and knowledge derived from our diverse fields of business, we will provide evolved integrated solutions for the transportation system business.

By creating synergies between business and achieving technological breakthroughs, we will continue generating new values to solve the difficult challenges present in society today.

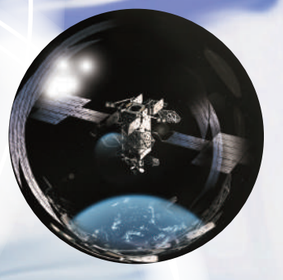


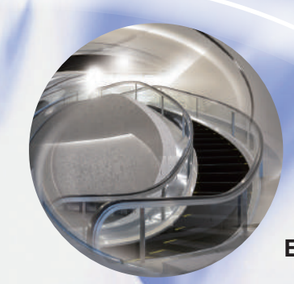
Home Appliances

Semiconductors
&
Devices

Industrial Automation
Systems

Information and
Communication Systems





Building
Systems Group

Energy
&
Electrical Systems

Energy & Industrial Systems
Group

Public Utility Systems Group
Transportation System Business

Others

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