

Mobility

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Innovation & R&D, Mobility & Transport

1. Train Positioning Method with High Safety Level Using General-purpose Sensors

To prevent train collisions, train positioning is required to have a high level of safety. Specifically, this means satisfying Safety Integrity Level (SIL) 4, under which the risk of the positioning error exceeding the tolerance must be no more than one in 100,000 years. While common practice for train positioning has been to use dead reckoning based on vehicle speed and augmented by wayside equipment, a desire to reduce running costs has created a need for systems that do not rely on specialized equipment or wayside equipment. Unfortunately, it has been difficult in the past to achieve a high level of safety using general-purpose sensors alone. In response, Hitachi has developed a multi-outlier removal filtering technique that corrects each sensor's error variance to follow a normal distribution. The sensor fusion technique, meanwhile, optimizes the sensor weightings (extent to which the position information from each sensor is included in the final train position result) based on their error distributions. Using these, Hitachi has obtained SIL4 certification from a third-party certification agency, the first time this has ever been granted for train positioning using general-purpose sensors [global navigation satellite system (GNSS), light detection and ranging (LiDAR), and inertial measurement unit (IMU)]*.

In the future, Hitachi intends to utilize this technology to reduce operation costs while also leveraging advanced train control to supply railway systems with high levels of safety and convenience.

* The first for train positioning by means of GNSS, LIDAR, and IMU (based on Hitachi research)



[1] Computing Unit

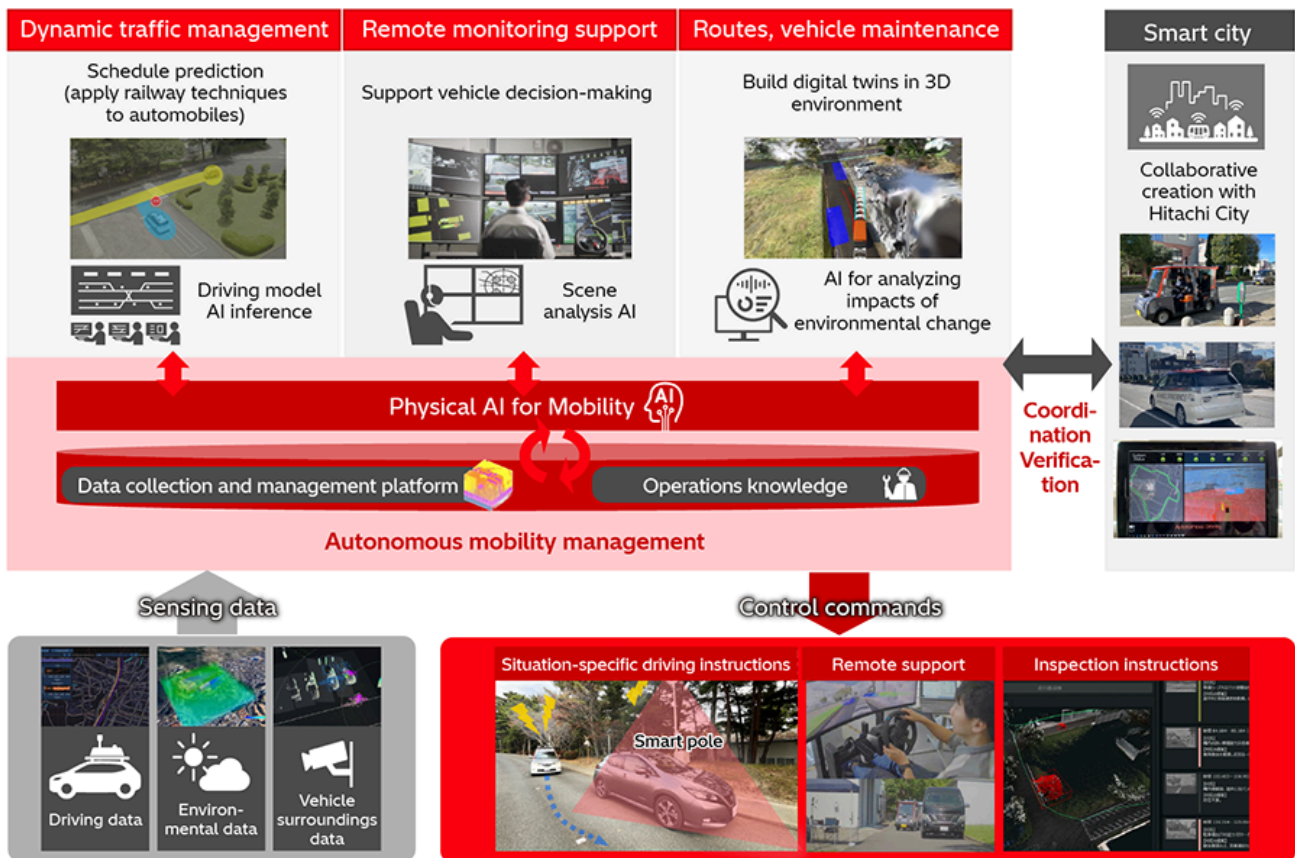
2. Mobility Management System to Support Intra-city Movement of People and Goods

In a society beset by a shrinking workforce and demographic changes driven by an aging population, the goals of improving people's quality-of-life (QoL) and boosting regional economic activity call for sustainable intra-city mobility and transportation systems to help people move around in their communities and to facilitate the distribution of goods. In response, Hitachi has developed an autonomous mobility management system.

The system enables the efficient and safe operation of self-driving vehicles by integrating driving, environmental, and recognition data to generate optimal operating schedules automatically by means of artificial intelligence (AI) and then instructing vehicles accordingly. By doing so, a small number of operators can manage multiple vehicles and meet the demand for mobility and transportation even in a shrinking population. The system features use of digital twins and remote monitoring to keep track

of vehicles and their routes as well as to detect problems and optimize maintenance. It also reduces operational workloads by using AI for prioritized support and the automatic generation of countermeasures.

In the future, Hitachi intends to help overcome societal challenges through next-generation mobility platforms by further enhancing its Integrated World Infrastructure Model (IWIM) to create models for urban infrastructure that combine digital twins with domain knowledge.



[2] Overview of Proposed System Architecture

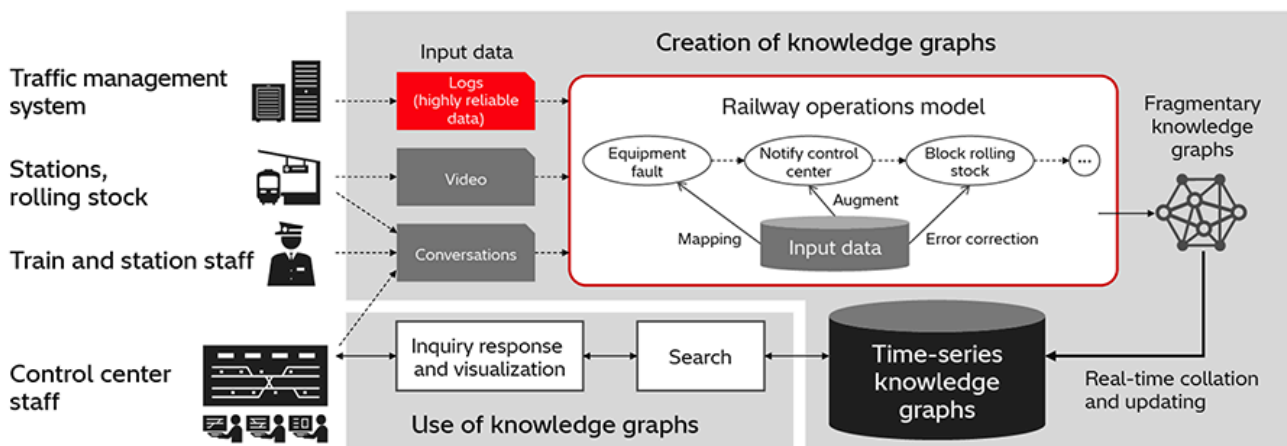
3. Rail Operation Assistant that Supports Control Center Staff

Staff at railway control centers supervise train operations to ensure that they are both safe and punctual. When services are disrupted, they make fast and accurate assessments of the rapidly unfolding situation and then take actions or issue instructions to restore normal operation. Meanwhile, the growth in recent years of automatic driving and through-services that span different railway operators is steadily increasing the volume of information that control center staff need to deal with. If the quality of train

services is to be maintained and improved, this makes it important to take measures to reduce their workloads.

It is against this background that Hitachi is developing a rail operation assistant (ROA) that uses AI to help control center staff undertake situation assessments. To provide the accurate information needed to run the control center, the ROA system draws on a wide range of information, including camera feeds and conversations between control center and field staff, consolidating it into knowledge graphs that are linked to railway operations and augmenting it with highly reliable log information from the traffic management system. In addition to providing this information through an AI chatbot, another system feature is the pre-emptive provision of necessary information based on its assessment of the current operational situation.

In addition to further technical development, Hitachi also intends to provide comprehensive support for train operations by expanding the scope of the system to cover other control center operations beyond the handling of service disruptions, and to provide assistance to field workers and train passengers.



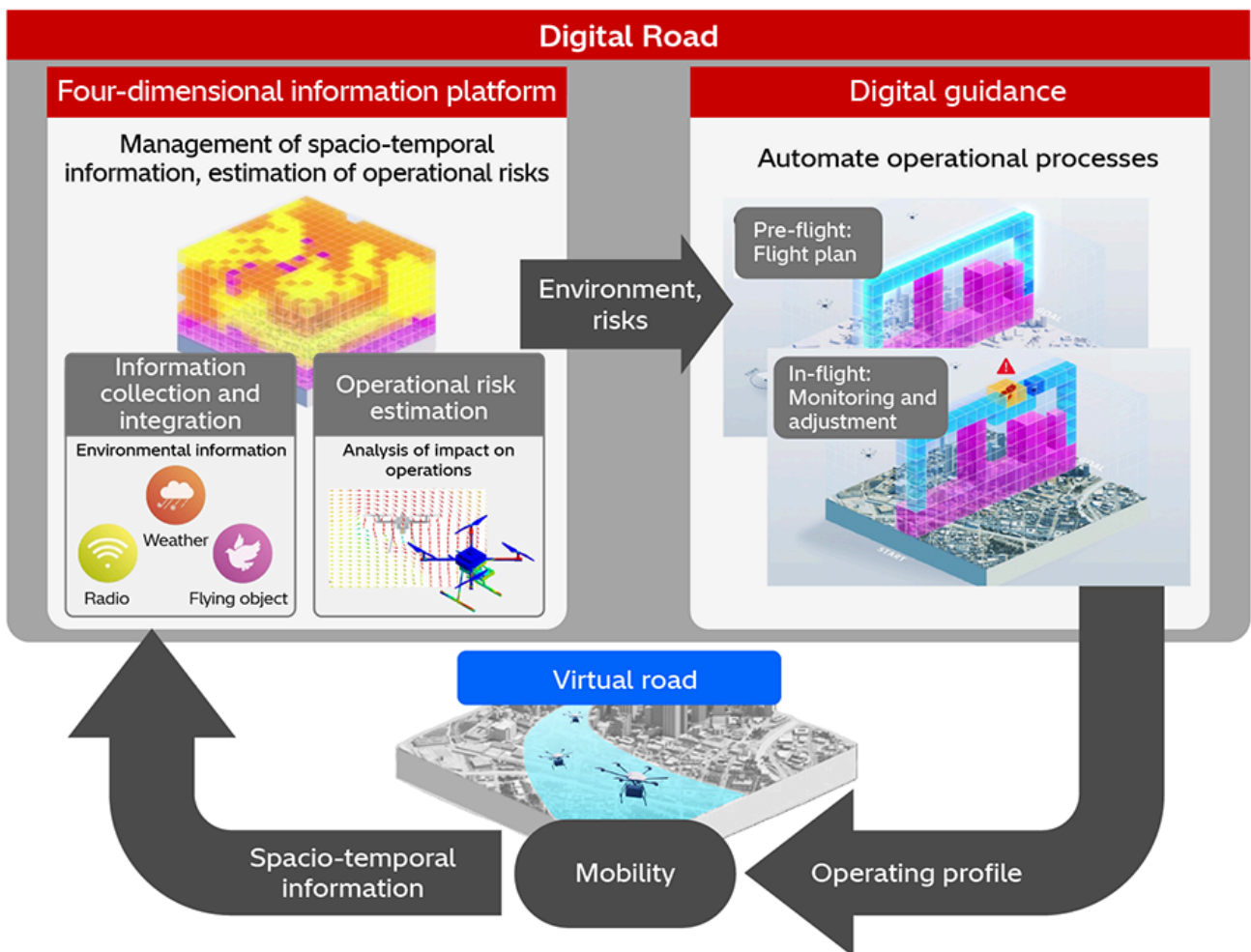
[3] Overview of Rail Operation Assistant

4. Digital Road: Safe and Efficient Virtual Roads for Next-generation Mobility

Services that utilize aerial mobility for things like inspection or delivery are being introduced against the backdrop of a shrinking working population. An obstacle to wider adoption, however, is that their operation consumes human resources and time.

Hitachi has developed Digital Road as a means of using digital technology to build virtual roads for aerial mobility, thereby ensuring safe and efficient operation. Digital

Road is made up of a four-dimensional information platform that manages spacio-temporal information and estimates operational risks, and digital guidance that automates operational processes by generating operating profiles based on the environment and risks. The platform collates ever-changing environmental information on things like the weather, radio, and aircraft and analyzes the impact of changing conditions to identify operational risks. The digital guidance provides virtual roads for mobility operations by generating a plan prior to a flight that takes account of its risks. It then provides monitoring and adjustment during the flight in the form of an operating profile. The technology will contribute to the creation of vibrant future societies through its use for aerial and other forms of next-generation mobility, thereby facilitating the practical realization of new services that can use airspace seamlessly.



[4] Block Diagram of Digital Road

5. Computer Vision Inspection System for Train Exterior Defects and Anomalies

Hitachi has developed a computer vision inspection system that uses AI to identify defects on the outside of trains by analyzing video footage captured by fixed cameras near maintenance depot entrances. Its main advantages include increased inspection frequency, earlier defect identification, and improved data collection – all of which help increase fleet availability and improve maintenance efficiency. The system has the flexibility to support multiple camera positions, without the need for complex recalibration, allowing standard surveillance cameras to be used, minimizing capital costs. The conventional deep learning object detection approach used to identify specific, known defects is being enhanced with Generative AI to identify more general anomalies based on variations from normal images; as well as explaining potential problems and interacting with maintenance staff to help them identify root causes and plan repairs.



Camera installation for roof and side inspection



Inspection result: Detected defects and anomalies are highlighted and explained.

[5] Overview of Computer Vision Inspection System

Note:

This figure is a conceptual diagram for explanatory purposes and was created using generative AI.