Mobility Solutions that Enrich People's Lives

The automotive industry has seen major changes over recent years, among them demand for technologies that offer safe driving and peace of mind to elderly drivers. The COVID-19 pandemic, meanwhile, has both reduced people's opportunities for going out and increased the delivery volumes handled by delivery and distribution businesses. Through the supply of automated driving control equipment that incorporates mobility know-how data, Hitachi is seeking to improve the precision of autonomous driving by self-driving vehicles while also providing drivers with safety and security and the logistics industry with an efficient workplace environment. This article describes mobility solutions such as connected cars that enrich people's lives as well as technologies for the sharing of mobility know-how data, the objective of which is to improve the efficiency of mobility and the safety of network-connected self-driving vehicles.

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1. Introduction

As lifestyles change, so too do the ways in which people and goods move from place to place. Now more than ever, lifestyle changes prompted by COVID-19 are driving rapid change in the movement of people and goods as people avoid going out and this in turn is increasing demand for distribution services such as package delivery and Uber Eats[*1].

In the automotive industry, the technological and structural changes represented by the acronym CASE (connected, autonomous, shared, and electric) are among the factors driving this change in mobility. CASE refers to the equipping of vehicles with wireless network connections, autonomous driving, the shift away from car ownership and toward shared use, and the electrification of vehicles. These factors are forcing change on an automotive industry that in the past has made its livelihood from the sale of new vehicles, also prompting the exploration of new ways of living. One such new way of living is the idea put forward by Toyota Motor Corporation at the 2020 Consumer Electronics Show (CES)[*2] of a Woven City, meaning an entire city built in a way that encompasses mobility. Another is the announcement of plans for the use of self-driving vehicles and autonomous delivery vehicles capable of driverless product distribution in smart cities like Xiong'an New Area in China.

A common element in all of these is a focus on enriching people's lives and a recognition of the importance of mobility to achieving this goal. This article presents examples of mobility solutions that make people's lives better and what Hitachi is doing to bring these about.

*1 Uber and Uber Eats are registered trademarks of Uber Technologies Inc.
*2 CES is a registered trademark of The Consumer Technology Association.

2. Connected Cars that Enhance QoL

2. 1 Issues with Current Vehicles

With regard to the economic costs of congestion and the associated energy wastage, the Ministry of Land, Infrastructure, Transport and Tourism has estimated the total amount of time lost to congestion in Japan each year at around five billion hours(1), representing a loss of time when workers could have been working. Meanwhile, the aging of developed countries around the world is having a negative impact on vehicle safety. While the number of traffic fatalities continues to decrease due to crashworthy body structures and other technological safety improvements in the vehicles themselves, the proportion of accidents that involve elderly drivers is on the rise.

On top of all this, changes in society brought about by COVID-19 are themselves raising new challenges. According to the Japan Institute of Logistics Systems, the increase in delivery volumes is creating a severe labor shortage, with 60% of companies questioned on the matter reporting that they are experiencing distribution issues as a result of COVID-19(2).

2. 2 Infrastructure-integrated Vehicles

The solutions to the above issues lie not only in functional enhancements to the vehicles themselves, but also through the network-connection of vehicles to enable their organic integration into infrastructural systems. In the case of the economic costs and energy wastage associated with traffic congestion, this can be alleviated by using information on traffic conditions provided by vehicles to select less crowded routes. Similarly, rather than using advanced driver assistance systems (ADAS) or autonomous driving (AD) on their own, there is also potential for improving vehicle safety through the use of vehicle usage data for the continuous improvement of driving. In logistics, the level of skill needed for working as a truck driver can be reduced by sharing the driving habits and other know-how of experienced drivers, such as their knowledge of parking locations, thereby improving working conditions and alleviating labor shortages.

Figure 1 shows this in diagrammatic form. Ways of overcoming the issues described above can be found by linking vehicles into the wider infrastructure to feed driving data back into the public domain, using this as a means of facilitating individual mobility and better social involvement. In other words, by providing the elderly with safe routes to their destination and driving safety support based on current traffic conditions, they can enjoy safe and unhindered mobility. Similarly, goods distribution can be improved by providing delivery drivers with data that is customized to suit their profile, such as efficient routes or suitable parking places. Hitachi intends to provide support for these infrastructure-connected vehicles in the form of an Internet of Vehicles (IoV) platform. The following section describes what this platform is intended to achieve.

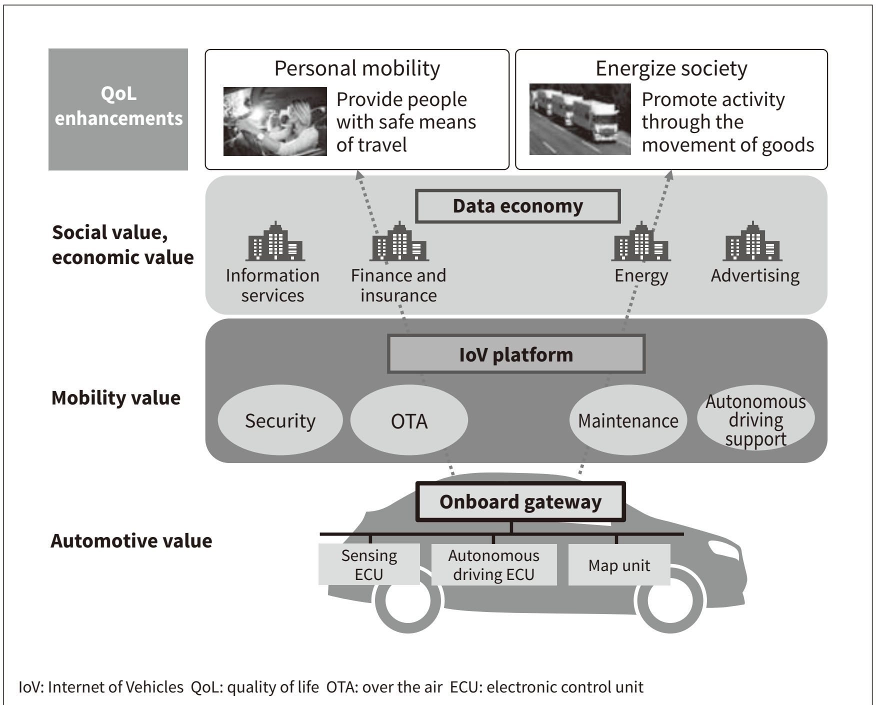


Figure 1 — Infrastructure-integrated Vehicles and IoV Platform
The objective is to link vehicles to the IoV platform so that driving data can be made available to enrich people's lives.

3. IoV Platform for Systemization and Sharing of Experience and Know-how

Through the use of digital technology to systemize tasks that rely on specialist knowledge or years of experience and deliver them as cloud-based applications, it becomes possible for even inexperienced workers to perform specialist work with a degree of competence. One example would be a service that uses cloud-based accounting software to support administrative work that normally requires knowledge and experience of accounting and book-keeping, featuring intuitive operation and the use of artificial intelligence to suggest where account entries should be made. The spread of smartphones is also having a major impact in the field of mobility. Uber, for example, has grown in Europe and America by disrupting traditional taxi operations with services that are cheap and easy to use, bundling together various forms of support that include matching its casual workforce drivers with customers, route search, fare calculation, payment, and customer feedback. This digitalization of know-how, knowledge, and experience is becoming an essential element of corporate activity and daily life.

The origins of the connected car go back to the late 1990s. It initially took the form of emergency assistance, with the collection of vehicle and driving data being limited in both scope and quantity, the emphasis being on services that provided useful driving information about things like weather or traffic conditions. While the scope and quantity of data collection both expanded in the 2010s, the extraction and sharing of know-how from this data didn't go beyond the generation of information about traffic conditions. Another limiting factor was the reluctance of vehicle manufacturers to utilize this data outside their own sphere of operations, a consequence of their seeing it primarily as a means of holding on to customers.

As well as being a way to deliver information to vehicles, Hitachi's IoV platform for connected cars also includes functions for collecting information on driver behavior and from onboard electronic control units (ECUs) and transforming this into know-how that can be shared with drivers. This has been underpinned not only by the spread of 4th generation (4G) telecommunications and the falling cost of cloud resources, but also by the digitalization of vehicles, a consequence of the growing sophistication and wider use of ECUs that has increased the number of components from which data can be collected. It is also an open platform that is not tied to particular vehicle manufacturers or cloud vendors, with service delivery involving collaborative creation with third-party service providers targeted also at working vehicles such as those used for public transportation and distribution. **Figure 2** shows a diagram of this IoV platform that collects mobility know-how and experience from a wide range of sources and shares it by digital means.

The next section describes the particular technologies used on the IoV platform for encapsulating know-how.

4. Technologies for Implementing Connected Car Solutions

4.1 Data Use by Connected Cars

The use of data by connected cars began in 1997 when vehicle manufacturers introduced telematics services featuring

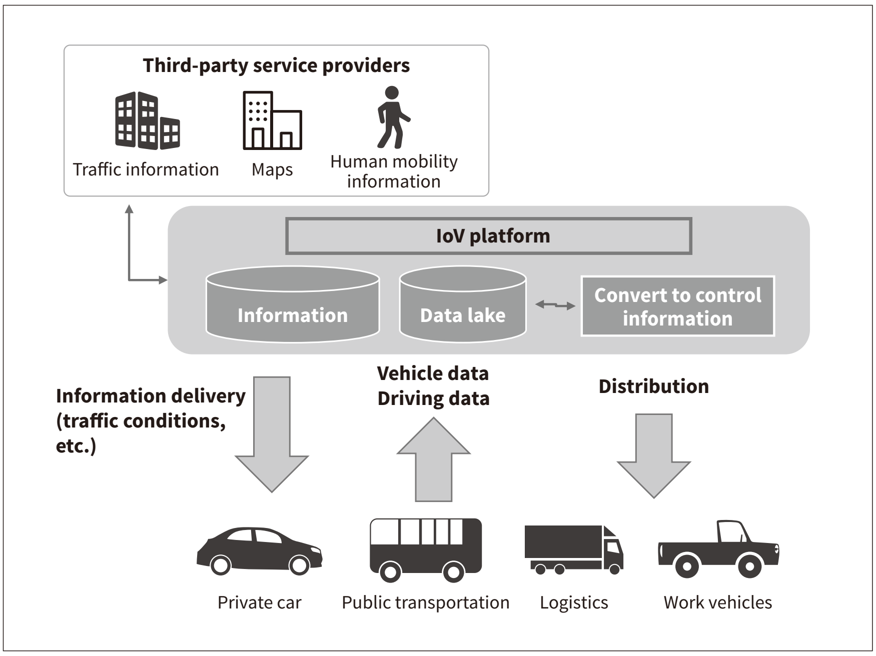
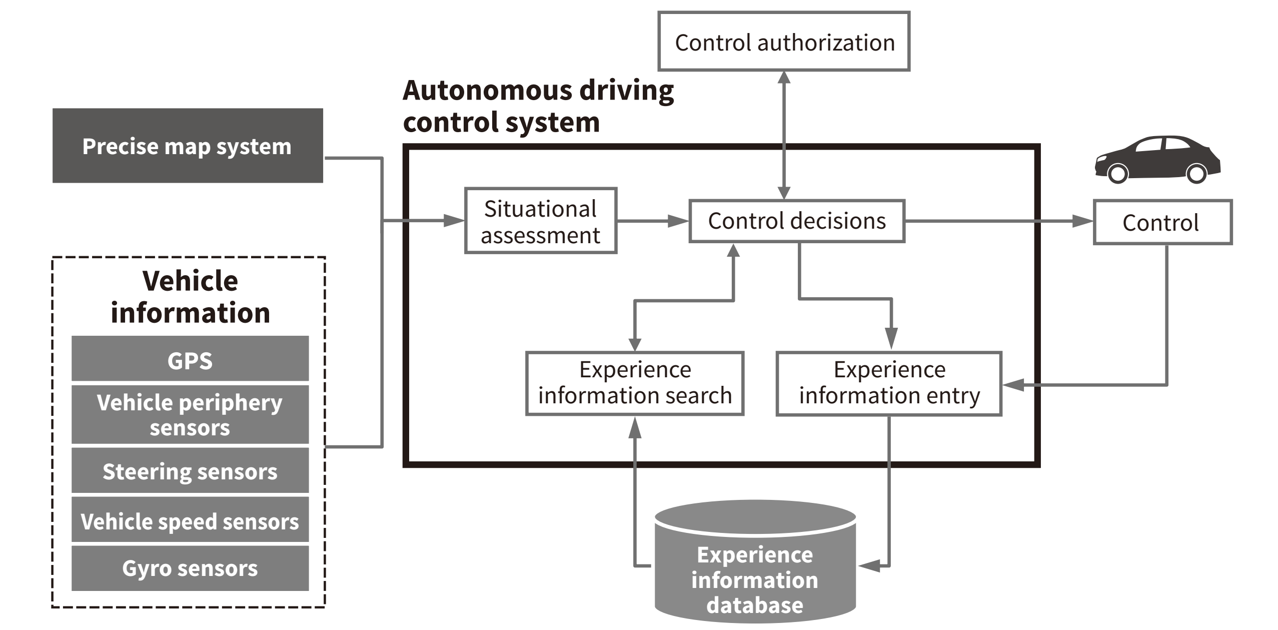


Figure 2 — IoV Platform

Along with information delivery, Hitachi's IoV platform for connected cars also has functions for collecting vehicle and driving data that can be converted into know-how for sharing with drivers. Being an open platform that is not tied to particular vehicle manufacturers or cloud vendors also allows for the widespread deployment of services targeted at working vehicles through collaborative creation with third-party service providers.

Figure 3 — Autonomous Driving Control System Using ADD

The ADD collates information on sensor measurements, situational assessment, control decisions, and control outcomes and provides functions for retrieving information that relates to particular circumstances. The choice of what constitutes experience information is made by analyzing data from timings where operation was different from normal, such as when autonomous driving was disengaged or sudden steering or brake inputs were made. Those instances identified statistically as being useful are saved in the database. This experience information is shared across multiple vehicles by the connected car system.



Source: Figure 1, patent application 2019-133479 Automatic Driving Support Device and Method

ADD: autonomous driving experience database GPS: Global Positioning System

applications that used the voice calling and position information collection capabilities of mobile phones. The third generation of telematics services came in 2002 based on the concept of offering various solutions by extracting meaningful information from the vehicle data passed across the onboard controller area network (CAN)(3). Unfortunately, onboard device performance and communications bandwidth were both still inadequate for this purpose and combined with the fact that the data obtained from a CAN may differ for each car manufacturer and car model, this meant that the use of data was for a long time limited to generic quantities such as distance traveled, vehicle location, and fault codes.

This situation has changed considerably over recent years with the spread of smartphones and cloud services. The distribution of software updates via the network, a practice called over-the-air (OTA) programming, has already become commonplace on smartphones. Use of OTA has also spread to automotive systems by means of telematics control units (TCUs)(4), it being adopted as a way to reduce the cost of recalls and improve maintenance. Meanwhile, the growth of mobility as a service (MaaS) in such forms as car sharing and ride hailing has brought with it greater use of open data and smartphone sensor data as well as vehicle information(5).

Autonomous driving utilizing cameras or radar for peripheral sensing has already been commercialized for highway use(6). Compared to highways, however, local roads are more prone to errors in situational assessment due to the greater diversity of obstructions and prevalence of unclear road markings. This creates a need for more accurate control decision-making based on use of high-performance sensors and precise maps. The commercialization of autonomous driving will also require ways of verifying that the correct control decisions have in fact been made.

4. 2 Autonomous Driving Experience Database for Improving Driving Performance

The autonomous driving experience needed to make the correct control decisions can be accumulated and shared by applying connected car technology to autonomous driving to systematically acquire human know-how about how to drive vehicles safely together with records of autonomous driving. For this purpose, Hitachi has proposed an autonomous driving control system that utilizes an autonomous driving experience database (ADD), as shown in **Figure 3**(7). ADD collates sensor information, situational assessment, control decisions, and control outcomes in a database of experience information and includes functions for retrieving information that relates to particular circumstances. The choice of what constitutes experience information is made by analyzing data from times where operation was different from normal, such as when autonomous driving was disengaged or sudden steering or brake inputs were made. Those instances identified statistically as being useful are saved in the database. This experience information is shared across multiple vehicles by the connected car system.

The ADD provides a way to understand road structures, interconnections, and driving practices that are outside the range of the periphery sensors and can enhance functions for predicting potential events in real time by making use of experience information rather than relying solely on sensors as a basis for the ongoing process of object recognition. Potential benefits of this are shown in **Figure 4** and **Figure 5**. These include eliminating the need to push into a line of waiting cars (case 1), preventing collisions between cars in merging traffic (case 2), identifying when it is safe to change into the appropriate lane based on the intended destination (case 3) (see **Figure 4**), only paying attention to the relevant traffic signal at complex intersections (case 4), and encouraging vehicles to form multiple lines in a single wide lane at intersections that allow for cars waiting to turn right at certain times of the day (case 5) (see **Figure 5**)[8].

Figure 4 — Expected Benefits of ADD (1)

The expected benefits of using ADD in autonomous driving include: eliminating the need to push into a line of waiting cars (case 1), preventing collisions between cars in merging traffic (case 2), and identifying when it is safe to change into the appropriate lane based on the intended destination (case 3).

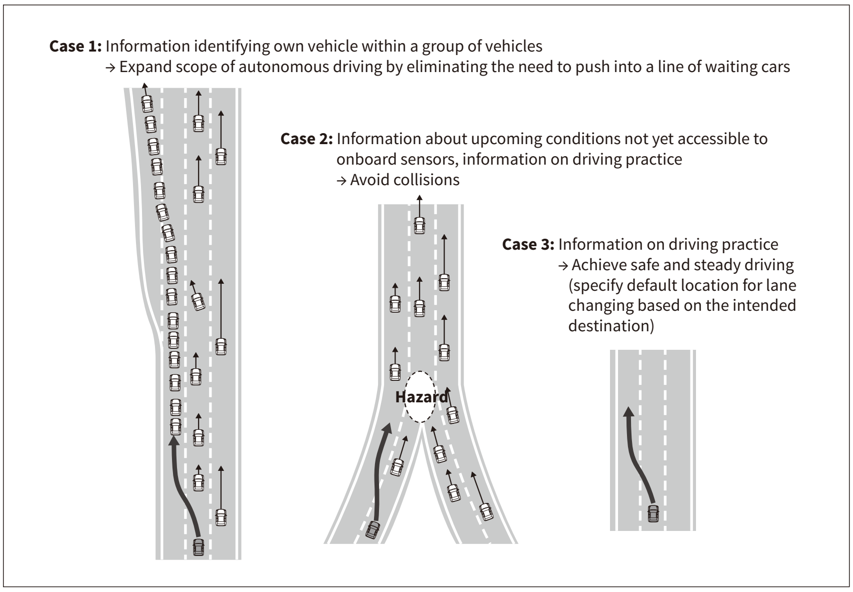
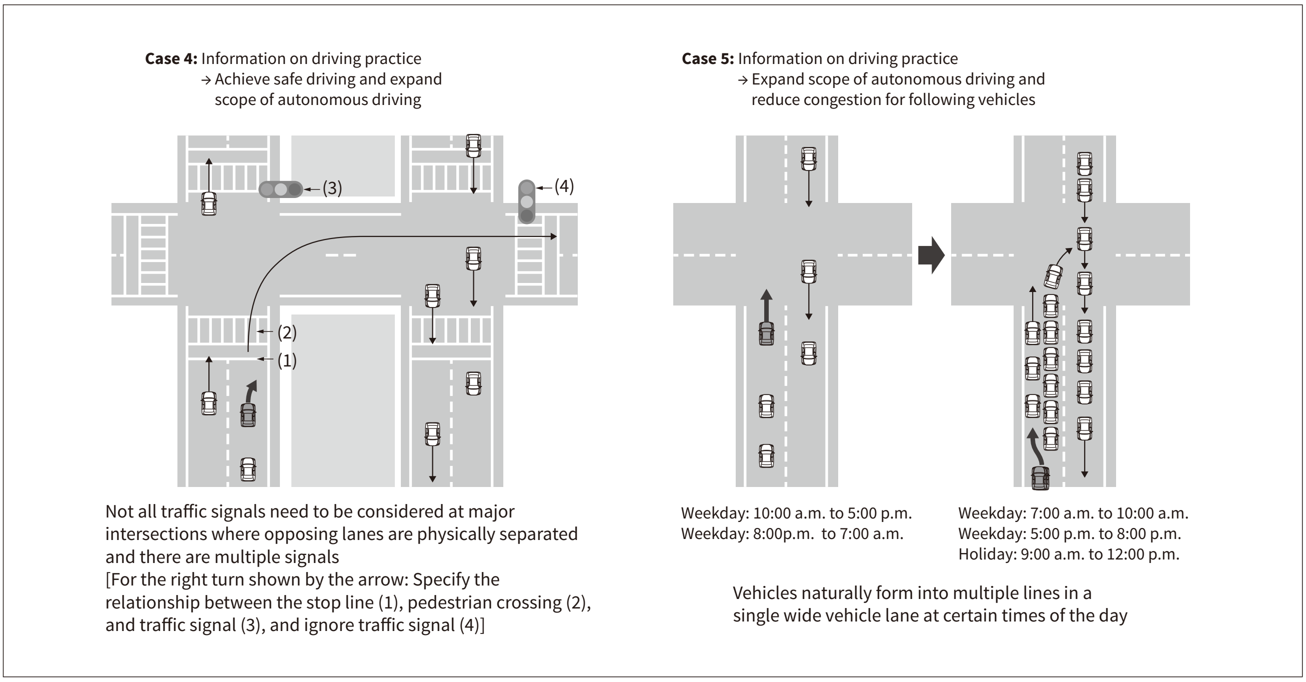


Figure 5 — Expected Benefits of ADD (2)

The expected benefits of using ADD in autonomous driving include: only paying attention to the relevant traffic signal at complex intersections (case 4), and encouraging vehicles to form multiple lines in a single wide lane at intersections that allow for cars waiting to turn right at certain times of the day (case 5).



Together with the autonomous driving control systems that work with it, ADD enables self-driving vehicles to operate in ways that are better suited to the specific circumstances. By augmenting vehicle sensors with the experience information in the ADD to help with obstacles or road conditions that are likely to be missed by older drivers beginning to experience a loss of physical, mental, and decision-making capabilities, driver assistance functions can also provide the elderly with safe and secure driving. In logistics, making deliveries more efficient by optimizing where vehicles wait during idle times or utilizing experience information that is specific to heavy vehicles such as truck maneuvering characteristics can help shorten the time taken for beginners to turn into experienced drivers.

5. Conclusions

This article has explained how mobility solutions can enrich people's lives, describing the ADD data that helps with advances in autonomous driving and how this improves quality of life (QoL).

Hitachi is helping to enrich how people live by supporting progress in autonomous driving through data services and onboard vehicle controllers.

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