[iii] Connected Car Technologies and Services to Realize Comfortable Transportation Society

New Mobility Services Made Possible by Digital Technology

The mobility industry is going through a period of major change with the emergence of a wide range of new services. This article describes new mobility services made possible by digital technology and Hitachi's activities in this field. Specifically, it looks at solutions for safe and comfortable mobility that use smartphone apps to encourage behavior change in public transportation users, digital ticketing that can be used seamlessly across both public transportation and tourist sites, and the work being done by Hitachi's European research facilities on mobility solutions for creating a sustainable society.

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1. Introduction

The mobility industry is entering a period of major change. The automotive industry is making solid progress in the key areas that Daimler AG highlighted in its 2016 medium-term strategy, using the terms "connected," "autonomous, "shared & services," and "electric" collectively referred to by the acronym "CASE." More broadly, work on mobility-as-a-service (MaaS) is happening around the world. The MaaS Alliance established at the 2015 ITS World Congress defines this idea of treating mobility as a service as "the integration of various forms of transport services into a single mobility service accessible on demand"[(1)].

These changes in the area of mobility are set to be further accelerated by two factors in particular. The first is COVID-19, which was initially detected in 2019 and subsequently spreading to become a global pandemic in 2020. COVID-19 has had a major impact on both the quality and quantity of people's transportation needs, heightening demand for transport that is safe and comfortable. The second factor is the environment issues. Twenty-twenty (2020) was the year when national governments around the world, including Japan's, stated their intention of achieving carbon neutrality by 2050 or 2060. The transportation sector is responsible for considerable carbon dioxide (CO_2) emissions. In Japan, for example, it is estimated to account for 18.6% of all emissions by industry (in FY2019)[(2)]. This calls for a modal shift to forms of transportation that emit less CO_2.

All of these changes can only be achieved when combined with advances in digital technology. One example is how connectivity makes it possible to collect and store data that can then be analyzed to determine the extent of transportation supply and demand. This supply and demand data can then be made available for sharing with large numbers of transportation service operators and users, enabling the creation of MaaS and other such integrated services. In applications such as tourist services or urban commercial services, the use of digital technology to link

together businesses associated with the mobility sector has the potential to give rise to future mobility services offering a transportation experience that satisfies a wide range of criteria beyond merely meeting demand, including safety and comfort, attractiveness of travel, and consideration for the environment.

This article describes new mobility services like these that are made possible by digital technology, and what Hitachi Group is doing in this field.

2. Safe and Comfortable Transportation under the New Normal

What is important in the new normal brought about by COVID-19 is to help people travel in safety and comfort and to support the business resilience of the transportation operators and the businesses that operate services along their routes. Accordingly, Hitachi has partnered with Nishi-Nippon Railroad Co., Ltd. (NNR) on activities that combine urban economic revitalization with safe and comfortable transportation suited to the new normal. In particular, this has involved initiatives that address both objectives by encouraging behavior change among the users of public transportation. This chapter describes a solution that uses "nudge" technologies developed by Hitachi in the course of these activities to encourage the users of public transportation to change their behavior.

2. 1 Nudge Technologies

To "nudge" means to prod someone lightly with an elbow and the term is used to refer to methods or practices that, rather than forcing people, encourage them to act in a certain way at their own volition[3]. Research in this field has been picking up pace around the world in recent years. However, a single nudge may have little effect on behavior change. Accordingly, Hitachi has developed technologies based on its own concept of using a series of related nudges to prompt significant changes in behavior. Hitachi has also come up with a solution that applies these technologies in the following two use cases, including the development of a prototype web app that public transportation users can access from their smartphones.

(1) To promote destinations and encourage travel, this use case recommends destinations and advises on departure times and routes. Specifically, when users open the web app, it offers them a list of places they might want to go based on their previously entered preferences. If someone cannot think of anywhere to go, for example, the app can offer personalized suggestions based on the level of overcrowding on buses, their preferences, and information about locations. Nudges can also be chained to previous destinations to suggest a convenient place to go next (see **Figure 1**).

(2) To make travel a more pleasant experience, this use case involves providing advice on the most comfortable route and how best to spend the time to avoid overcrowded

Figure 1 — Use Case (1): Destination Recommendation

This application combines parameters such as user preferences and the level of overcrowding on buses and facilities to recommend a destination and advise on the departure time and route.

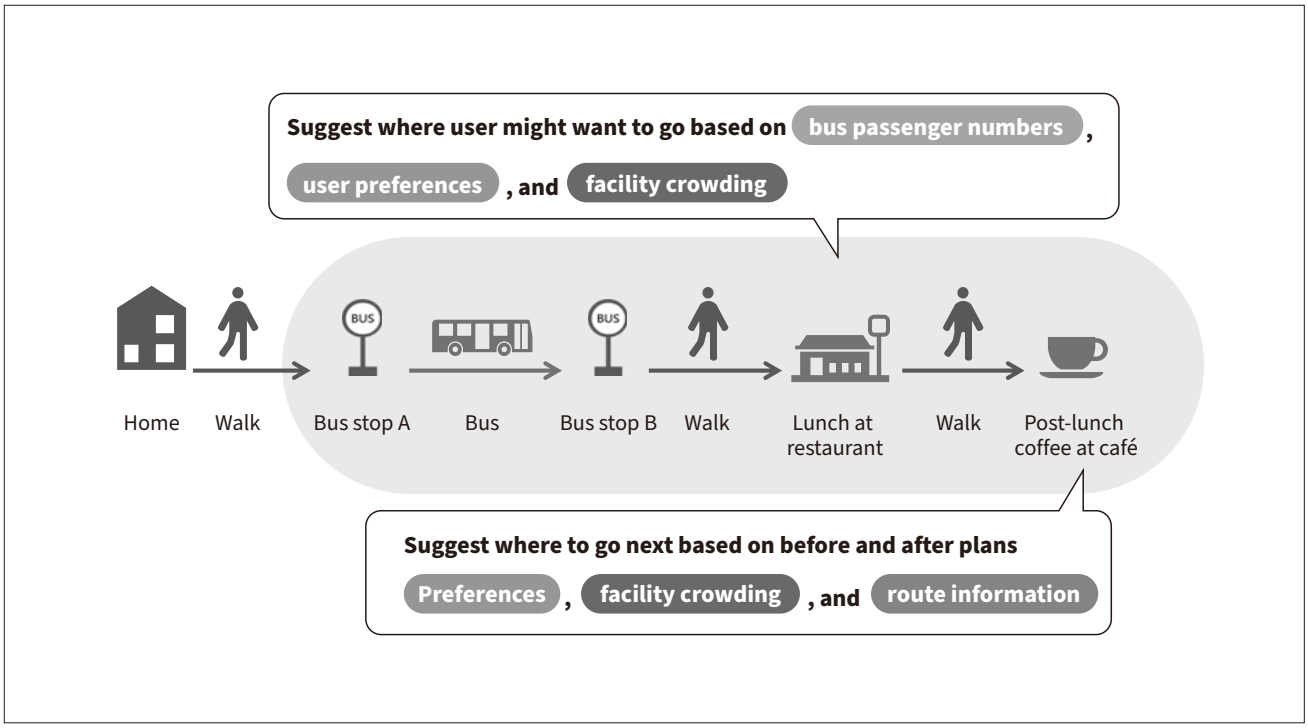


Figure 2 — Use Case (2): Making Travel a Pleasant Experience

This application combines multiple parameters such as user preferences and bus passenger or facility crowding to recommend the most convenient route and how best to spend the time to avoid overcrowded buses or delays along the way.

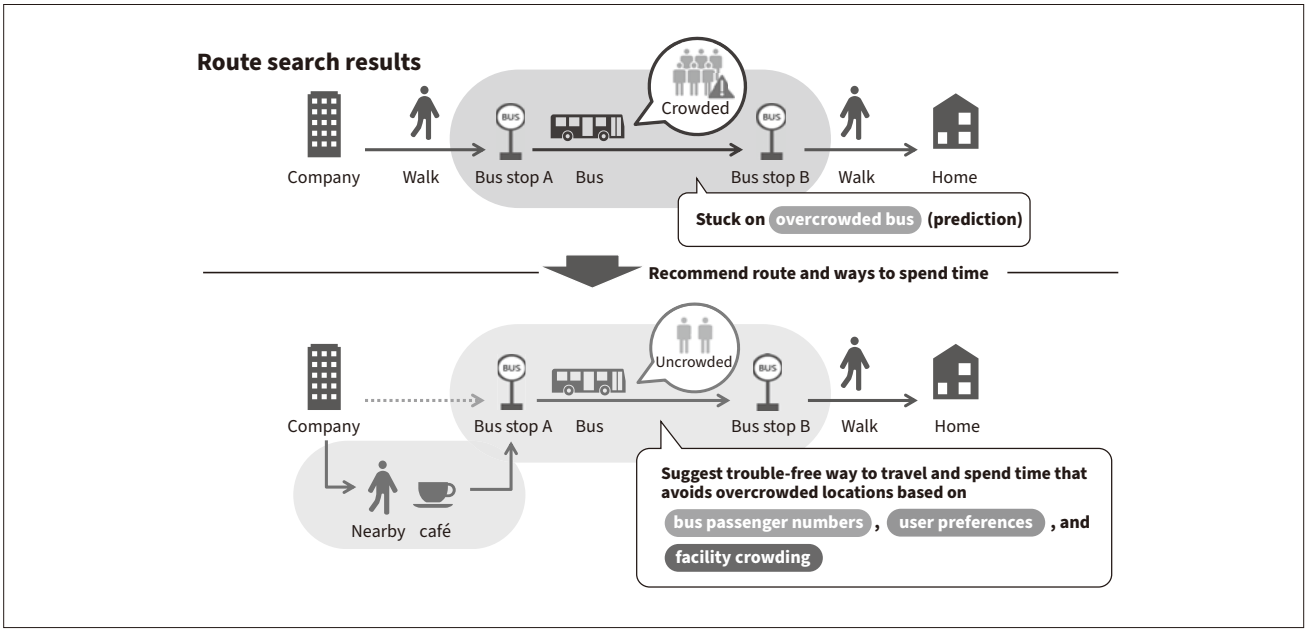
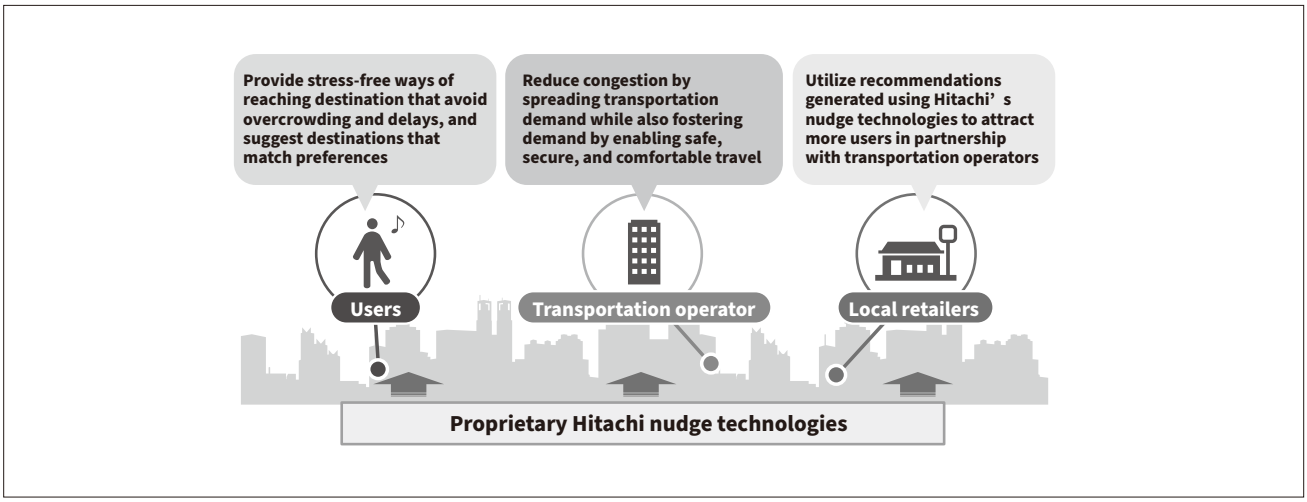


Figure 3 — Value Delivered by Solution

The solution has the potential to deliver benefits to all three parties, including the operators of nearby services as well as the users and operators of public transportation.



buses or delays along the way. Specifically, when someone performs a route search on the web app, it suggests combined travel options including how to spend their time as well as the best route to follow to avoid congestion. This is done by combining route information with traffic congestion forecasts and real-time information about crowding at commercial facilities like cafés and so on, taking account of factors like the person's preferences. One example might be, when buses are busy, to offer the user a coupon for a nearby open café chosen based on their preferences and suggest that they go there to avoid congestion (see **Figure 2**).

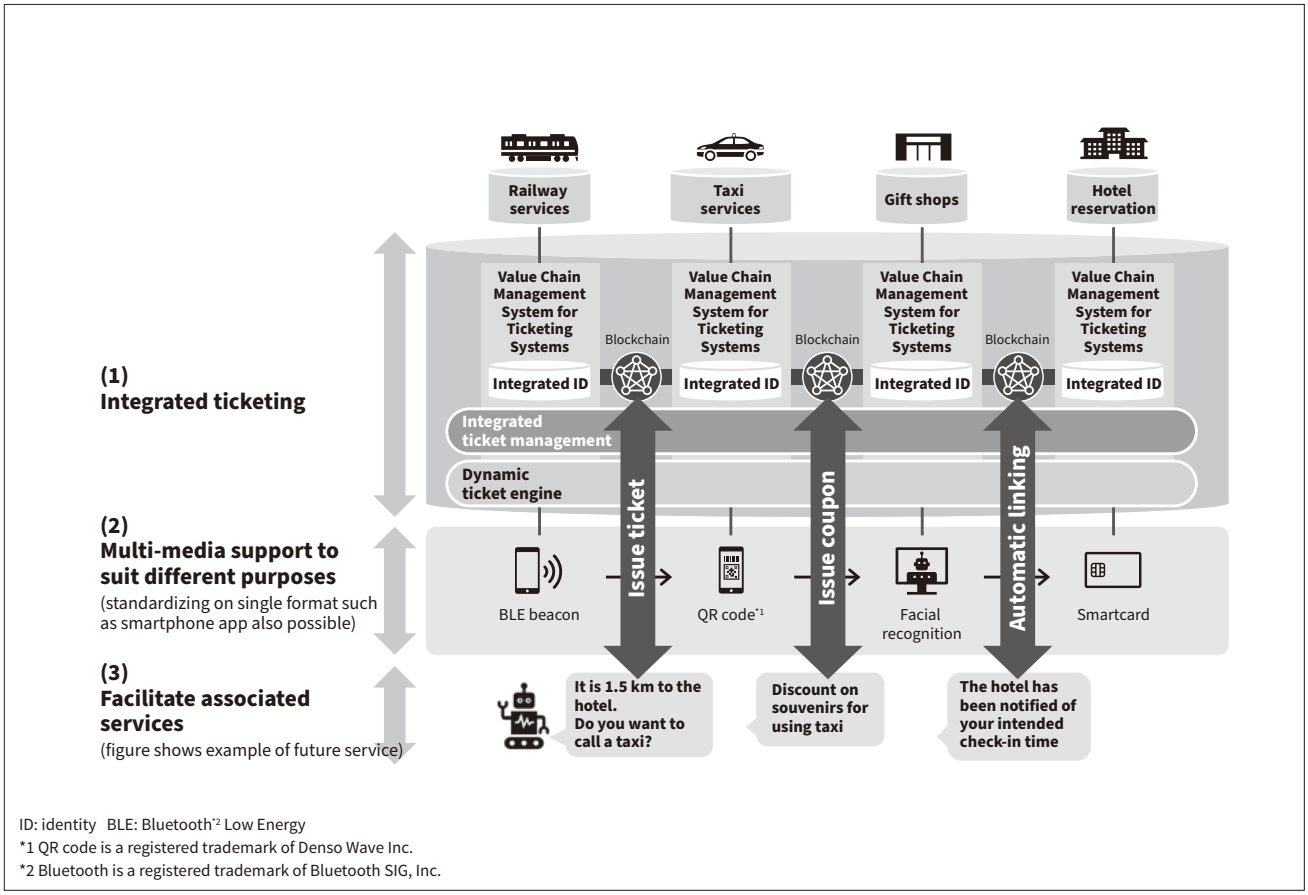
Approaches like these have the potential to deliver benefits to all three parties, including the operators of nearby services as well as the users and operators of public transportation (see **Figure 3**).

2. 2
Future Plans

Through this solution, Hitachi and NNR intend to establish a sustainable model for public transportation and revitalize local economies under the new normal by balancing and spreading demand for transportation and helping commercial services to attract customers and manage peaks while also improving the quality of life (QoL) of public transportation users by providing them with stress-free travel.

Figure 4 — Value Chain Management System for Ticketing Systems

The system provides digital ticketing across multiple operators and with cross-industry integration.



ID: identity BLE: Bluetooth*2 Low Energy
*1 QR code is a registered trademark of Denso Wave Inc.
*2 Bluetooth is a registered trademark of Bluetooth SIG, Inc.

3. Pleasant Travel Experience Achieved by Digital Ticketing

Mobility services such as railways and buses are going through a transition away from the conventional practice of operators running their own exclusive ticketing based on smartcard tickets or paper tickets, shifting instead to digital ticketing based on smartphone apps or biometric authentication. One of the features of digital ticketing is that it separates the ticketing information previously stored on a smartcard or swipe card from the physical ticket and instead manages it on a higher-level system with a link to the user's identity (ID). Managing information in this way allows for flexible service delivery without the inconvenience of physical tickets.

3. 1
Requirements of Cross-industry Integration Ticketing Service

This digital ticketing has the potential to simplify ticketing services developed through cross-industry collaboration and integration by freeing them from relying on physical tickets issued by particular service operators. Unfortunately, current ticketing systems have been established by particular service providers and it would be very costly to develop new systems for industry integration that are separate from these existing systems. Accordingly, one of the requirements for a cross-industry integration ticketing service is that it be able to utilize existing systems (1). Other requirements are to take advantage of digital tickets to provide multi-media support (2) and that the service can be quickly modified or expanded (3).

3. 2
Digital Ticketing through Value Chain Management System for Ticketing Systems

Hitachi has developed the Value Chain Management System for Ticketing Systems as a platform for implementing digital ticketing across multiple service operators and with cross-industry integration (see **Figure 4**). To be able to utilize the existing systems of multiple operators [requirement (1)], the platform creates blockchain nodes for managing each operator and uses these for the coordinated and integrated handling of user identities across different operators. As this integrated ID can be accessed by all operators, it facilitates the management and use of tickets created in a collaborative and coordinated manner by multiple operators. Moreover, the flexibility to change the link between this integrated ID and specific physical tickets means that

different forms of tickets can be used [requirement (2)]. Also, using the ticketing system as a means of enabling flexible service expansion [requirement (3)] provides an engine for implementing dynamic ticketing, whereby it is possible to change ticket details as required in real time.

3. 3
Creating Pleasant Travel Experiences

The Value Chain Management System for Ticketing Systems uses the above practices to help deliver pleasant travel experiences. The system facilitates the rapid deployment of ticketing that combines the different parts that make up a trip, including mobility, tourist (vacation) spots, hospitality and retail, and accommodation. It also promotes the provision of measures that enhance the joy of travel and mobility by adding to or modifying what the ticket gives access to based on how busy sites are or on whatever the user finds interesting along the way, with users able to obtain additional coupons based on real-time ticket usage.

4. Research and Development of Mobility Solutions in Europe

The European Research and Development Centre (ERD) focuses on restoring demand for public transportation, which has fallen during the pandemic, and on creating sustainable mobility services with low CO_2 emissions through optimization of the operation of transportation modes such as railways or buses and by providing services that enable a wide variety of users to travel in comfort.

4. 1
MaaS Simulator

ERD is developing a MaaS simulator based on open-source software that predicts whether or not people will travel as well as where, at what times, and by what means (see **Figure 5**).

These predictions can be used as a basis for simulating demand on the transportation network, vehicle speeds, and the operation of public transportation (such as arrival and departure times). ERD is also developing a smart ticketing solution that is intended to provide people with a higher-quality travel experience. As well as delivering a seamless travel experience without the usual infrastructure of ticketing machines and gates, the solution also feeds the operations data it generates back into the simulator to adjust operations in real time. The plan for the future is to extend its capabilities to include assessing the impact of potential initiatives by transportation operators or local governments to make the transportation services they operate more sustainable with less of a burden on the environment, evaluating these by criteria such as CO_2 emissions and traffic congestion.

Figure 5 — MaaS Simulator
This system shows simulation results for bus and train locations, passenger numbers, and timetables.

4. 2
Tram with Automated Driver Assistance Functions

Trams and other forms of light rail are being developed in Europe to improve convenience and reduce the environmental impact of public transportation. ERD has been drawing on its extensive experience with advanced driver assistance systems (ADAS) to contribute to the development of highly automated trams. Joint research undertaken in 2020 by Hitachi Rail STS S.p.A., the University of Salerno, and Naples, Italy started work on driver assistance as a first step toward the realization of automatic trams (see **Figure 6**). A demonstration project running on an actual tram line will commence in March 2022.

4. 3
Practical Realization of Mobility Services

This research and development of mobility services for sustainable societies is advancing on a variety of fronts. To enable its deployment in practice, ERD is participating in the services for mobility (S4M) collaborative creation scheme in partnership with Hitachi Rail STS and other European business units. The scheme combines technologies and solutions from within Hitachi Group to expand and strengthen proposals for One Hitachi sustainable mobility solutions.

Figure 6 — Tram with Automated Driver Assistance Functions
The assistance functions provide advanced hazard detection for trams or other light rail and generate real-time warnings.

5. Conclusions

This article describes the work Hitachi is doing on new services that utilize digital technology in the mobility sector as it goes through a period of major change. Hitachi intends to continue with this use of digital technology in its work with collaborative creation partners while also helping to deliver travel experiences that satisfy diverse needs, including for safety and comfort, for making transportation attractive, and for considering the impact on the environment.

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