

# Smart Mobility for Smart Cities

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*OVERVIEW: Hitachi sees a need for smart mobility that can achieve a harmonious balance taking account of the sustainability of society while providing the means for the smooth transportation of people and goods. The concept of smart mobility seeks to achieve a smooth and sustainable society by “optimizing transportation services” for the people who use them through “optimization of coordination between transportation companies” and “intra-company optimization,” with these being considered in terms of a mobility architecture comprising five layers of transportation functions. To achieve this, Hitachi is using three types of control, namely “control of demand,” “control of supply,” and “control of actions,” to contribute to innovation in both public and private transportation infrastructures by supplying urban management infrastructure, information and control platforms, and transportation applications.*

## INTRODUCTION

GIVEN the urbanization of the population, particularly in emerging economies, and the consequent problems including traffic congestion and the impact on the environment, attention has been directed in recent years toward the concept of “modal shifts,” which means using modes of transportation such as railways and coastal shipping that place less of an impact on the environment. In developed economies, meanwhile, there is growing concern about how to maintain transportation and other services as the existing infrastructure ages.

In terms of mobility, while people place a priority on comfort and want their transportation to run smoothly, there is also the perspective of society as a whole, which needs transportation to operate sustainably for reasons of safety, practicality, and continuity. Unfortunately, these objectives often conflict, creating situations in which a means of transportation chosen by someone for their own reasons is not necessarily the best choice for society. What is desired for the smart cities of the future is the ability to take full account of both of these points of view and create a balanced transportation infrastructure. The divisions of Hitachi that deal with transportation have experience in transportation infrastructure that goes back many years. Solving this problem of balance represents a major challenge for them and is part of what defines their identity.

This article describes Hitachi’s concept of mobility in smart cities along with a mobility architecture for translating this concept into reality and example solutions.

## MOBILITY CONCEPT AND ARCHITECTURE

### Mobility Concept

The negative implications of our modern car-centric world include environmental problems and the congestion that results when large numbers of people give priority to their own comfort when getting from place to place.

On the other hand, placing too much importance on the environment would impose excessive restrictions on mobility. For example, placing simplistic restrictions

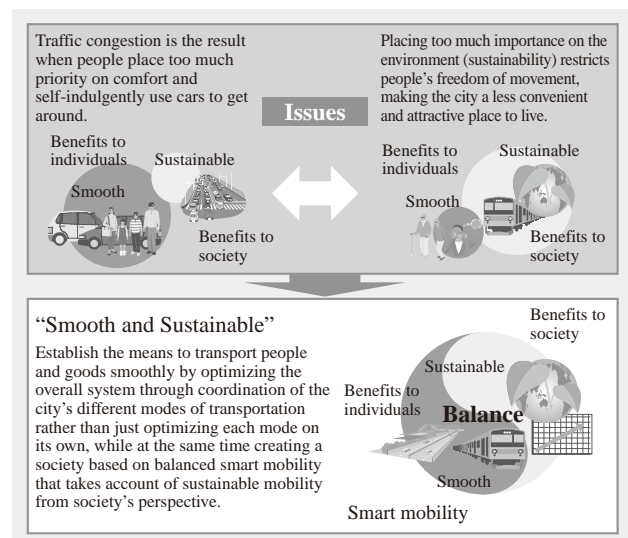


Fig. 1—Overview of Mobility Concept.

Transportation problems cannot be solved by solutions that merely deliver smoothness on its own or sustainability on its own. Rather than optimizing the various different modes of transportation independently, a balanced smooth and sustainable approach is possible by optimizing the overall system.

on entry by vehicles into a city would likely restrict its growth prospects by being a hindrance to motorists and making it a less convenient and attractive place to live.

To solve this dilemma, Hitachi is not only seeking to optimize specific forms of transportation such as trains and cars, it is also working toward a society based on smart mobility, which optimizes all transportation services by coordinating the different means of transportation within the city.

This will eliminate frustrations related to traffic and smooth the process of getting from place to place while helping create harmony in the form of a sustainable society with a reduced impact on the planet.

Hitachi uses the concepts of “smooth and sustainable” to represent this idea of aiming for a win-win society that balances benefits to individuals (providing the comfort sought by people) with benefits to society (providing the practicality, safety, and continuity sought by government) (see Fig. 1).

### Mobility Architecture for Realizing Smart Mobility Concept

Currently, each transportation company provides its own services. The provision of transportation in a way that realizes the smart mobility concept requires building a network for the coordination of transportation companies, which collects and analyzes information from the various companies that operate in the city and supplies each company with information they can use to optimize the overall system.

Hitachi believes that building such a network will require an architecture that allows three specific types of optimization to be performed and that spans the five layers of transportation functions that make up a city.

#### Five layers of transportation functions

Hitachi’s approach is to consider the elements that make up a society based on smart mobility in terms of the five separate layers listed below, which it calls the “five layers of transportation functions” (see Fig. 2).

(1) Transportation user experience layer (domain of transportation service users): Layer in which users receive transportation, information, and other services from transportation companies as they travel from place to place

(2) Transportation services layer (domain of transportation companies): Layer in which transportation companies supply services to users

(3) Information collection layer (domain of transportation companies): Layer in which usage information is collected, such as on how users use the services supplied by transportation companies

(4) Information management and control layer (domain of transportation companies): Layer in which information management and control is performed to ensure that transportation companies supply their services smoothly

(5) Transportation company coordination layer (domain of transportation companies): Layer in which information from all the transportation companies is collected and analyzed, and information is provided to

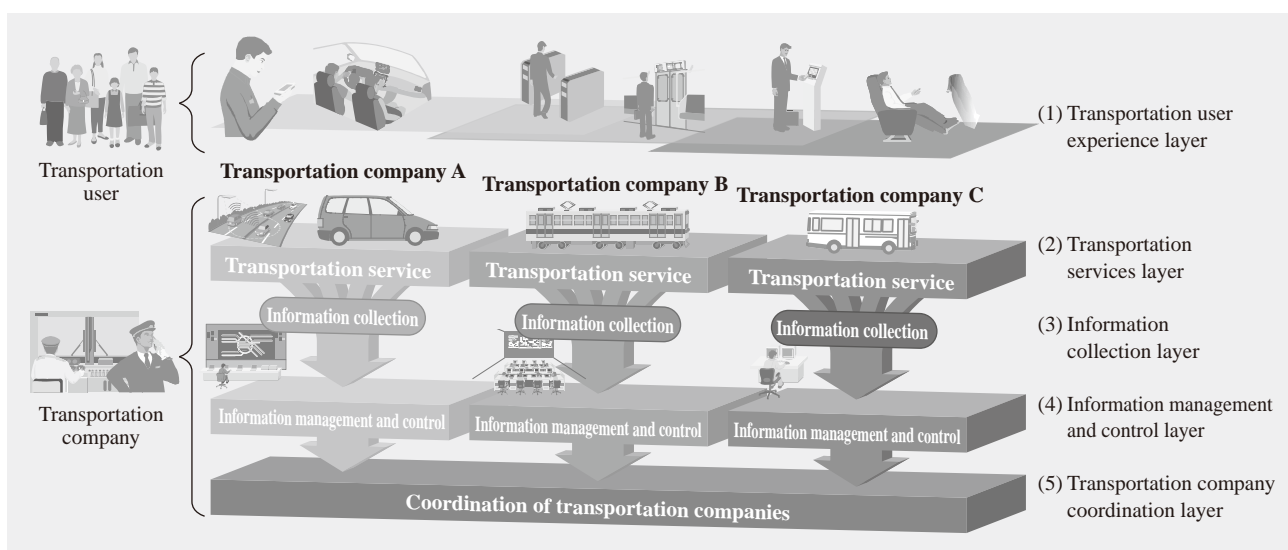


Fig. 2—Five Layers of Transportation Functions.

The five elements involved in creating a society based on smart mobility are the transportation user experience layer, transportation services layer, information collection layer, information management and control layer, and transportation company coordination layer. Hitachi calls these the five layers of transportation functions.

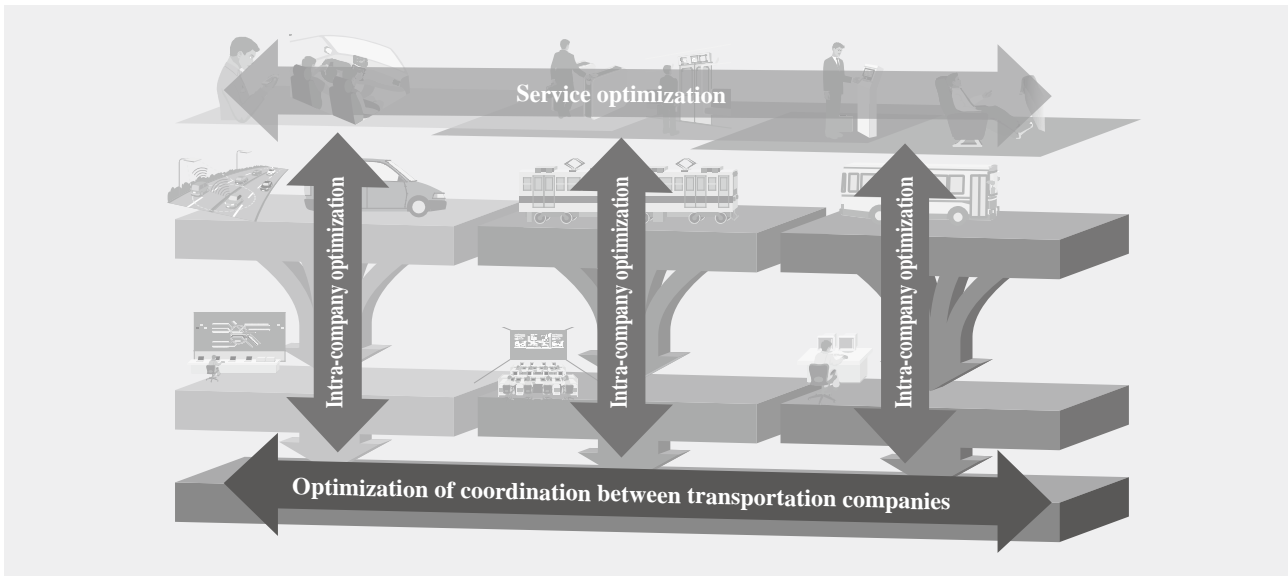


Fig. 3—Three Types of Optimization.

Three different types of optimization are needed to realize the smart mobility concept, namely “optimization of coordination between transportation companies,” “intra-company optimization,” and “service optimization.

guide the operation, control, and other functions of the transportation companies with the aim of optimizing the city’s overall transportation system.

### Three types of optimization

The three types of optimization are “optimization of coordination between transportation companies,” “intra-company optimization,” and “service optimization.” Fig. 3 shows the relationships among these.

To realize the smart mobility concept, “optimization of coordination between transportation companies” and “intra-company optimization” (which means optimizing the respective transportation companies’ services) are performed by using the urban management infrastructure described in the section “Solutions” to collect and analyze actual operational data and provide guidance on what is best for the overall system.

In this way, “service optimization” (which means optimizing the services supplied to users) is achieved along with seamless interoperation between the services supplied by the transportation companies. This allows transportation users to move about in a smooth and sustainable way without being conscious of the boundaries between transportation companies.

### Relationship between “service optimization” and five transportation function layers

“Service optimization” consists of the following processes. First, “intra-company optimization” is performed for the services within the domain

of a particular company’s business via the transportation company coordination layer and through the information management and control layer. Furthermore, “optimization of coordination between transportation companies” provides smooth and sustainable trips in which the continuity of all travel through the transportation system is guaranteed up until the users reach their destination, without their having to pay undue attention to junctions in the transportation system, such as locations where users can transfer from one company’s service to another (through the transportation services layer to the transportation user experience layer).

In practice, “service optimization” for users involves the three types of control: (1) “Control of demand,” meaning the control of the total volume of the flow of people and goods from point of departure to destination, (2) “Control of supply,” meaning control of transportation capacity provided by transportation companies from point of departure to destination, and (3) “Control of actions,” meaning guiding people’s actions by supplying information at the point of departure and up until the destination (see Fig. 4).

In this way, the smart mobility concept means approaching “service optimization” in terms of a mobility architecture consisting of five layers of transportation functions and seeking to create a smooth and sustainable society achieved through three different types of control.

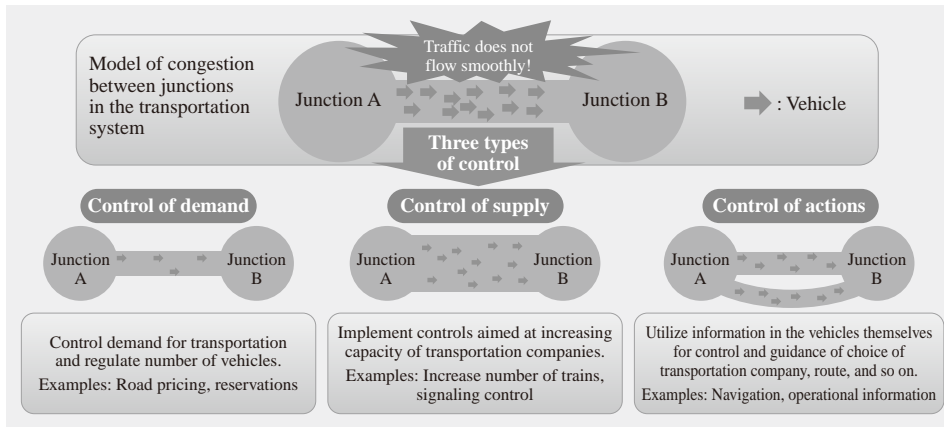


Fig. 4—Three Types of Control. For travel from A to B, optimization of transportation services is performed using three types of control, namely “control of demand,” “control of supply,” and “control of actions.”

## EXAMPLE SOLUTION BASED ON TRANSPORTATION SCENARIO

### Transportation Service

This section considers a specific scenario to give a more detailed image of the smart mobility architecture and describe the sorts of transportation services that will be offered to users and the solutions available for use by those services.

A key feature of the scenario is that, by having different transportation companies work together through the urban management infrastructure, multi-dimensional services can be provided of a nature that could not be achieved in the past by transportation companies acting independently.

Fig. 5 shows a scenario in which a company employee is able to commute from home to work in an energy efficient (sustainable) way and arrive on time (smooth) without any sense of having wasted time and effort on changing between different transportation services, nor any economic cost.

The following describes the commuter’s experience and the operation of the systems run by the transportation companies, which are invisible to the commuter. This scenario includes products that are not currently supplied by Hitachi.

#### (1) Multi-modal navigation service

In response to the user entering his desired destination and indicating that his priority is to travel cheaply and quickly, his mobile handset displays a route comprising the optimum mix of transportation companies that will deliver him there quickly and cheaply, and in an energy-efficient way. Meanwhile, smooth optimization of the city is performed by the analysis functions of the urban management infrastructure, which distribute information such as congestion forecasts to guide people and spread them out to avoid congestion or crowding.

#### (2) Integrated fare collection service

If getting the commuter to his destination involves travel by different bus and train companies, this service allows him to use a smartcard to pay a single fare calculated based on departure and destination instead of paying each company separately at each change of vehicle. This makes commuting cheaper and makes use of public transportation more convenient. Smooth optimization of the city, such as handling changes in fares or regulation of traffic inflows, is performed through control of things like fares, toll roads, car parking, area entry fees, road pricing, eco-points, and local money.

#### (3) Service to smooth transfers between bus and train

This service coordinates the arrival times of buses at the railway station to connect with the train schedule. This eliminates waiting time when changing from bus to train. Having used multi-modal navigation to find the route, the commuter uses his smartcard to confirm his seat on the bus and the service coordinates the timing of traffic signal green lights to get the bus to the station in the time estimated by simulation. In this process, the bus operation management system invokes the bus priority signal system from the ITS (intelligent transportation system) management system via the analysis functions of the urban management infrastructure. This results ultimately in the smooth optimization of the city, which is achieved by controlling infrastructure such as the traffic signals and the trains or buses that provide (supply) the transportation service.

#### (4) EV bus charging management system

In this system, the EV (electric vehicle) bus power management system provides information to the bus operation management system via the analysis functions of the urban management infrastructure indicating where, on what route, and when it

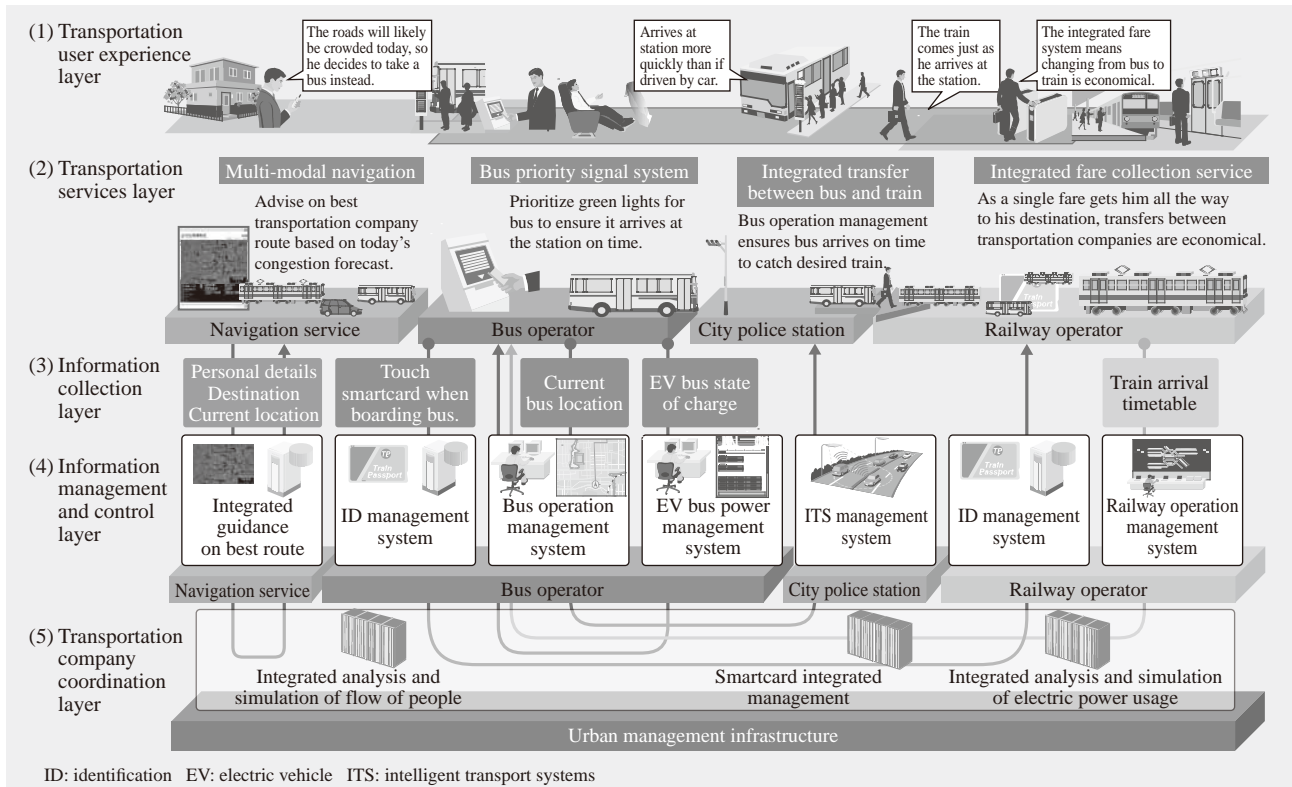


Fig. 5—Relationship between Commuting Scenario and Solution. Having different transportation companies work together through the urban management infrastructure allows for the provision of multi-dimensional services that could not have been achieved in the past by the companies acting independently.

should be recharged based on its current state of charge. As a result, the solution contributes to sustainability (another of the values of smart mobility) by encouraging efficient use of the EV buses and helping reduce CO<sub>2</sub> (carbon dioxide) emissions.

Based on this management and control, Hitachi, through the supply of this solution, is providing users with smooth and comfortable trips and supporting innovation in transportation infrastructure by transportation companies and government agencies so as to provide users with comfortable trips while ensuring that transportation companies, government, and other agencies can achieve safety, practicality, and continuity in a sustainable way.

**Solutions**

Hitachi has formed a consortium of companies from inside and outside the Hitachi group to supply the solutions described below (see Fig. 6).

**(1) Supply of urban management infrastructure**

This performs system-wide optimization by linking transportation companies together and analyzing actual operational data in order to “optimize coordination between transportation companies.” The solution is supplied through the information collection, analysis,

and distribution functions of the urban management infrastructure. The urban management infrastructure achieves an optimum overall result by supplying timely information to transportation companies to guide their operations. This urban management infrastructure is intended to exchange information between transportation companies about their services so that users can experience smooth trips that have the appearance of a single service; it does not act as an impediment to each transportation company’s independent operations.

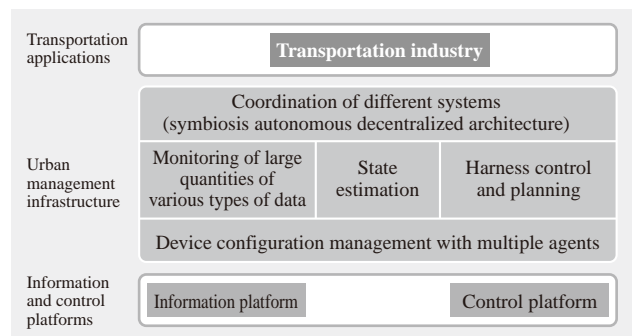


Fig. 6—Hitachi’s Solutions. Hitachi has formed a consortium to supply three solutions: transportation applications, urban management infrastructure, and information and control platforms.

(2) Supply of information and control platforms for transportation companies

The efficient operation of control and services is important for performing “intra-company optimization.” To achieve this, what is needed first of all is to put in place the control and information platforms that act as the foundations. A control platform comprises products such as a transportation company’s operation management system and an information platform makes particular use of cloud services and virtualization.

(3) Supply of transportation applications

The following three services (which embody user needs while also providing the infrastructure and platforms referred to above) are supplied in order to “optimize transportation services.” The general name for these services is “transportation applications.”

(a) Vehicle services: The actual operational services that provide the transportation, consisting of services for vehicles such as rolling stock management

(b) Junction services: Services for junctions in the transportation network such as park-and-ride or ticket gates including smartcard functionality

(c) Information services: Information services such as digital signage or navigation systems

These solutions correspond to elements in the commuting scenario (Fig. 5). The integrated analysis and simulation system for the flow of people and goods, integrated analysis and simulation system for electric power usage, and smartcard integrated management system are examples of urban management infrastructure (1). The bus operation management system, EV bus power management system, ITS management system, and railway operation management system are examples of information and control platforms (2). The multi-modal navigation system is an example of supply of a transportation application (3).

## CONCLUSIONS

This article has described Hitachi’s concept of mobility in smart cities along with a mobility architecture for translating this concept into reality and example solutions.

For transportation in the future, Hitachi believes that the seamless coordination of different transportation companies has an important role to play in balancing people’s desire to be able to move about smoothly with an emphasis on comfort against the desire of society as a whole for transportation to operate sustainably for reasons of safety, practicality, and continuity.

Hitachi is not taking up this challenge on its own.

Instead, it sees this task as one to be confronted jointly with partners from around the world.

Hitachi intends to contribute to the progress of society by deploying this smart mobility globally and by realizing the smooth and sustainable approach through win-win collaborations with partners throughout the world who share a belief in this concept.

## REFERENCE

- (1) Ministry of Land, Infrastructure, Transport and Tourism, General Policy, “Promotion of Modal Shifts and Similar;” <http://www.mlit.go.jp/seisakutokatsu/freight/butsuryu03350.html> in Japanese.

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