

Featured Articles

City Management Platform Using Big Data from People and Traffic Flows

Michio Morioka, Ph.D.
 Kyoji Kuramochi
 Yusuke Mishina
 Takayuki Akiyama
 Naoyuki Taniguchi

OVERVIEW: In cities in Japan and elsewhere, progress is being made toward the creation of smart cities, with demands for the optimization and efficient operation of social systems that include more sophisticated transportation systems, reductions in CO₂ emissions, and the upgrading of aging infrastructure. The widespread adoption in recent years of technologies such as smartphones, smartcards, and various sensors has made it possible to collect, store, and visualize information on urban activities such as people and traffic flows. As part of its Intelligent Operations, Hitachi is developing city management platform solutions that support the efficient operation of cities by collecting and analyzing this big data from people and traffic flows.

INTRODUCTION

IN cities in Japan and elsewhere, there are demands for the optimization and efficient operation of social systems that include more sophisticated transportation systems, reductions in carbon dioxide (CO₂) emissions, and the upgrading of aging infrastructure. Hitachi operates its Social Innovation Business that seeks to create sustainable smart cities, seeing it as one response to these diverse requirements of cities.

The widespread adoption in recent years of technologies such as smartphones, smartcards, and various sensors has made it possible to collect, store, and visualize information on urban activities such as people and traffic flows. While information on these flows has in the past only been provided in the form of public statistics released once every few years, it is anticipated that providing 365-day availability will expand those sectors that use this information. For example, in addition to administrative areas like urban planning and tourism, it will enable operators of public transportation such as trains and buses to make traffic management more efficient. As part of its Intelligent Operations, Hitachi is developing city management platform solutions that support the efficient operation of cities based around the use of big data from people and traffic flows.

This article describes the concepts behind city management platforms, examples from Japan and overseas, and the prospects for the future.

CONCEPTS BEHIND CITY MANAGEMENT PLATFORMS

Fig. 1 shows the concepts behind city management platform solutions. People and traffic flow data is collected from a variety of social infrastructure operators using technologies such as smartphones, smartcards, and sensors. Similarly, statistical information such as facility data, traffic census data, and population statistics is sourced from national and local governments. This collected data is stored and analyzed on a city management platform database. While the platform is based on geospatial information system technology, it needs to be able to conduct a variety of analyses in terms of time and spatial parameters. Another feature of the platform is that it can model the collected data and use various types of simulation for its visualization.

The benefits provided by the city management platform consist of: (1) convenience and efficiency, (2) profitability and economics, and (3) safety and security. Specific examples of potential applications in the public transportation sector, which includes trains and buses, include the optimization of public transportation and integrated navigation to support smooth multi-modal travel. Possible examples in the tourism and retail sectors, meanwhile, include the analysis of business regions, and effective ways of presenting information based on the analysis of people's patterns of movement. Other possibilities include urban and residential applications for

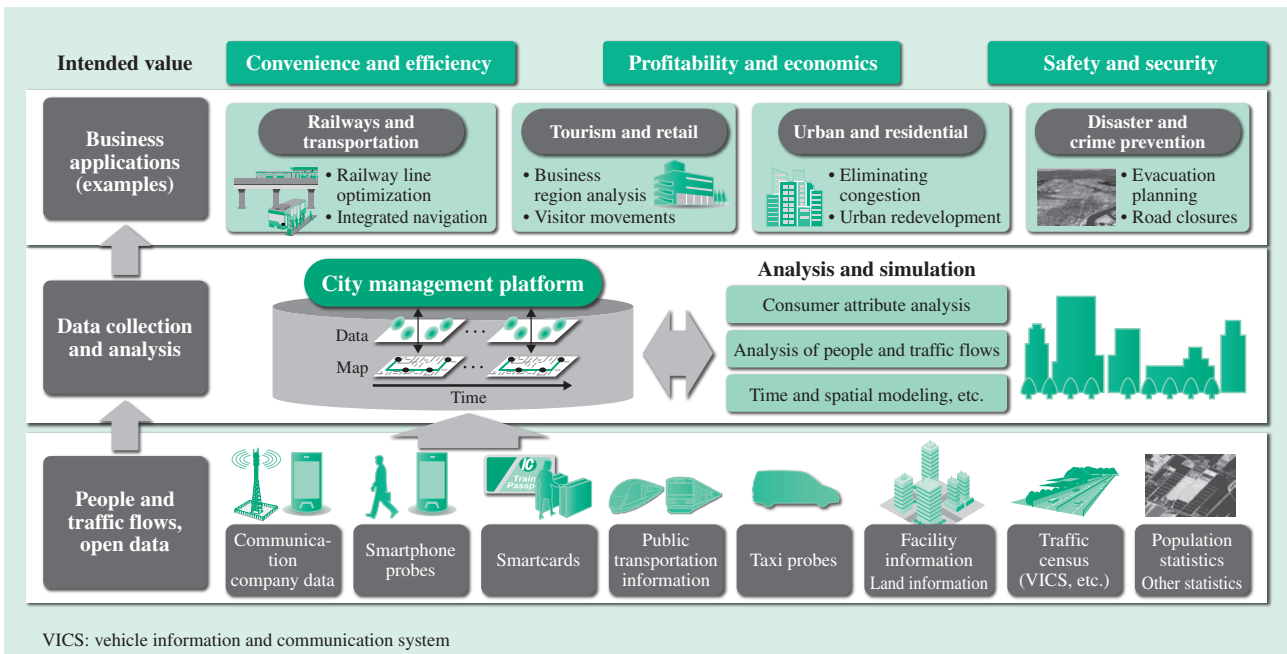


Fig. 1—City Management Platform Solution Concept. The solution uses smartphones, smartcards, and sensors to collect real-world big data from people and traffic flows. City management platforms based on data collection and analysis are equipped with geospatial information system technology and support the operation of cities using modeling and visualization.

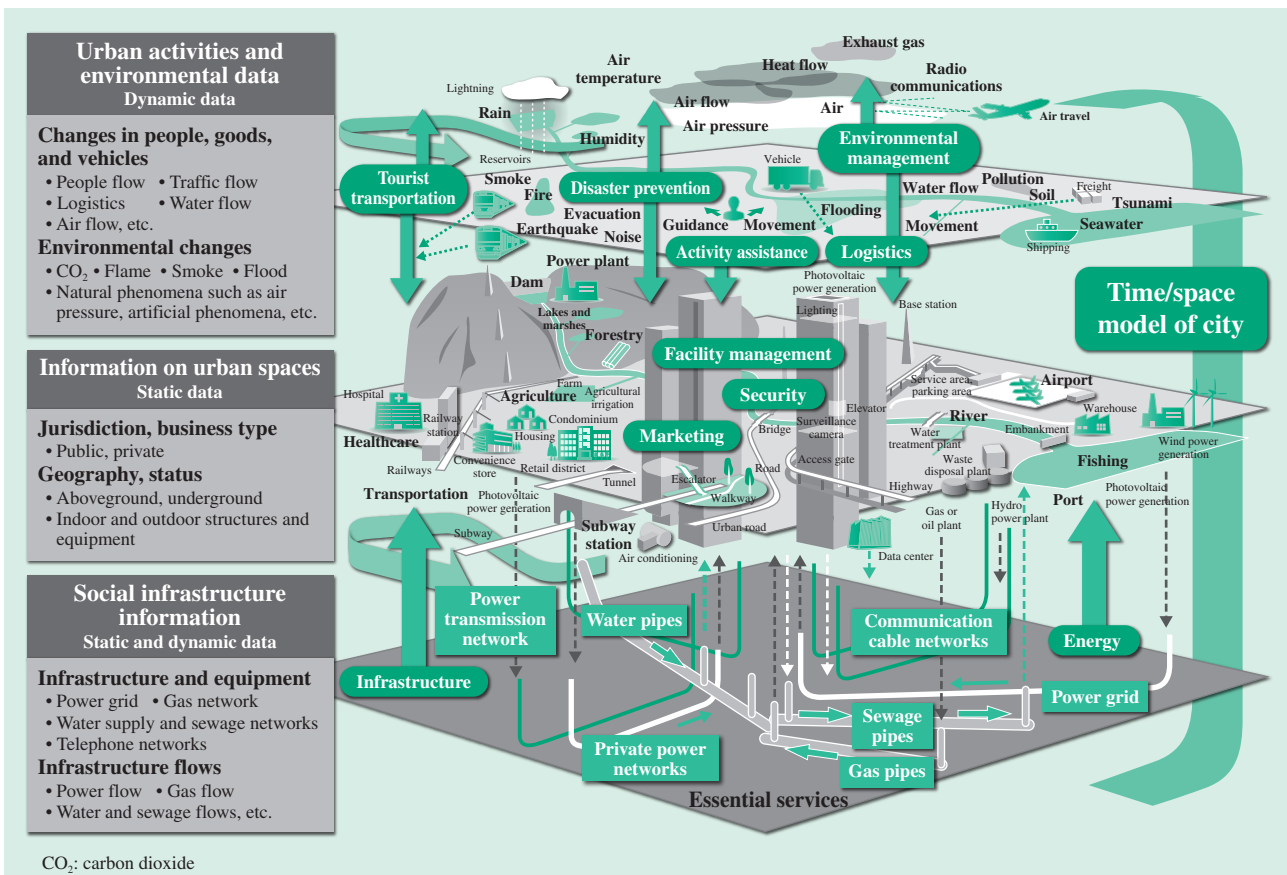


Fig. 2—Three-tier Model of Urban Big Data. A data model for urban big data. The lowest tier consists of the platforms that support social infrastructure, and the middle tier consists of the urban spaces that are built on this infrastructure, such as buildings, roads, and dams. The top tier consists of dynamic data that is used in urban spaces, such as people and traffic flows.

overcoming traffic congestion or assisting with urban planning, and disaster and crime prevention applications that support evacuation planning or determine road closure information.

A three-tier model can be used for databases that collect and analyze a variety of different forms of big data from cities (see Fig. 2). At the lowest tier are those platforms that support social infrastructure such as the electric power grid or gas, water, and sewage networks. The middle tier contains urban spaces, particularly buildings, roads, dams, and other facilities that are built on this infrastructure. The top tier consists of dynamic data that is used in urban spaces, and it is to this tier that people and traffic flows belong.

EXAMPLE USES OF CITY MANAGEMENT PLATFORMS

Smartphone Probe Demonstration Project in Fukuoka

In 2011, Fukuoka City established the Fukuoka Directive Council, a partnership between industry, academia, government, and the private sector, to formulate a growth strategy for the Fukuoka City region and to investigate smart city policies. The council is made up of five working groups (tourism, environment, food, human resources, and urban development), with Hitachi being mainly involved with the environment working group, including

participation in vision-building and demonstration projects aimed at making the Fukuoka City region a leader in smart mobility.

In FY2013, the environment working group undertook a demonstration project for using smartphone probes to obtain information on “people flow.” Fig. 3 shows an overview of the project. Project participants who had consented to the collection of their personal data (200 people associated with the Fukuoka Directive Council) were given smartphones and the Hayakaken smartcards issued by the Fukuoka City Transportation Bureau and had their movements recorded for a one-week period in late January 2014. The smartphones were pre-installed with an application that collected global positioning system (GPS) and accelerometer data. With the cooperation of the Fukuoka City Transportation Bureau, the project also collected data from the smartcards on where users got on and off the subway. This data was obtained after the trial period had finished. To visualize information on people’s movements, the route traveled and means of transportation were determined automatically from the smartphone GPS and accelerometer data. In the case of subway rides where GPS signals cannot be received, the information was obtained from the smartcard trip records. The demonstration project automatically classified trips into four categories (walking, bus, subway, or other means of transportation).

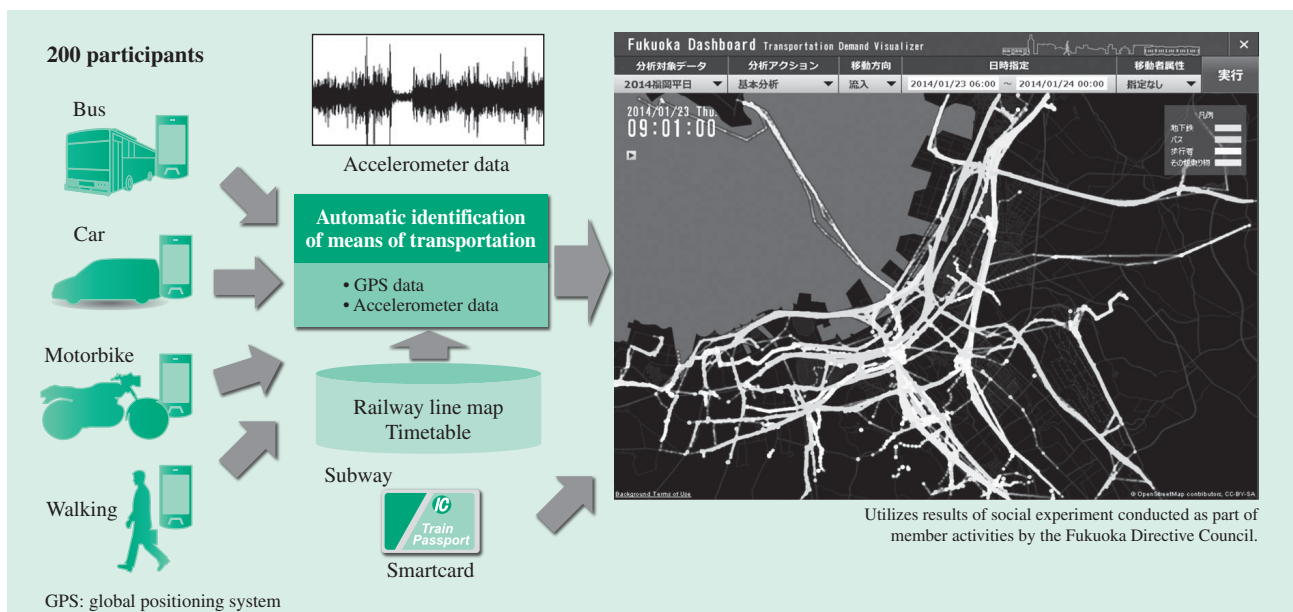


Fig. 3—Overview of Smartphone Probe Demonstration Project in Fukuoka. The diagram shows an overview of a demonstration project conducted in January 2014. Smartphones and public transportation smartcards were issued to 200 people who acted as monitors and their movements were analyzed over the period of a week.



Fig. 4—Dashboard Screen for People Flow Analysis. The screen shows a people flow analysis conducted using smartphone probe data. The screen can be used to analyze the numbers of people gathering in particular areas and the means of transportation they used to get there.

The right of Fig. 3 shows a dashboard screen that can be used to present and analyze the demonstration project results. It is designed so that it can be used by the government, infrastructure operators, and others to conduct basic analyses such as showing people's movements, means of transportation, and other information for each time period, or showing the differences between weekdays and holidays.

Fig. 4 shows a dashboard analysis screen. The screen is intended to provide information that is easy to understand and visualize, and can be used by government administrators and others, with the main analysis items being the distribution in the numbers of people gathering in a particular area at different times of the day from morning to evening, their length of stay, and the means of transportation they use to reach the area. The Fukuoka Directive Council showed the dashboard screens produced by the demonstration project to various departments at the Fukuoka municipal government. City officials identified a wide variety of fields with potential applications. These included providing additional data for person-trip studies; use in assessing the current status of vehicle transportation and associated policy-making; and use in meeting, incentive travel, convention, and exhibition (MICE) promotional work to identify what people do when they visit Fukuoka, and to study ways of providing information. Possible uses in the private sector include both use by public transportation operators to make timetables more convenient, review lines and stops, or optimize the locations of station and other staff, and also use by distribution businesses to

analyze business regions or customers who are likely to make purchases.

Taxi Probe Demonstration Project in Bali

The province of Bali in the Republic of Indonesia is experiencing worsening traffic congestion, a common problem among members of the Association of Southeast Asian Nations (ASEAN). This is due to economic development triggering a rapid increase in vehicle use by the local population, and chronic traffic congestion in the vicinity of the Denpasar International Airport transportation hub. This was the background to a joint-venture (JV) demonstration project conducted by Japanese companies as part of an FY2012 project funded by the Ministry of Economy, Trade and Industry to promote and study infrastructure system exports. The project aimed to deploy Japanese smart community technologies that use intelligent transport systems (ITSs) to relieve congestion in Bali and to promote its tourist industry by making it easier to travel between tourist sites. Hitachi participated in the system implementation, primarily through the generation of congestion information.

The demonstration project obtained GPS data from 300 vehicles operated by a local taxi company. The data was analyzed to calculate parameters such as travel times and speeds for each section of road and the required time for a particular choice of route. Fig. 5 shows an example of the travel times for each section of road displayed on a map. Techniques for



Fig. 5—Results of Traffic Information Generation Trial during Bali Demonstration Project.

GPS data from a local taxi company was analyzed off-line to calculate parameters such as travel times and speeds for each section of road and the required time for a particular choice of route.

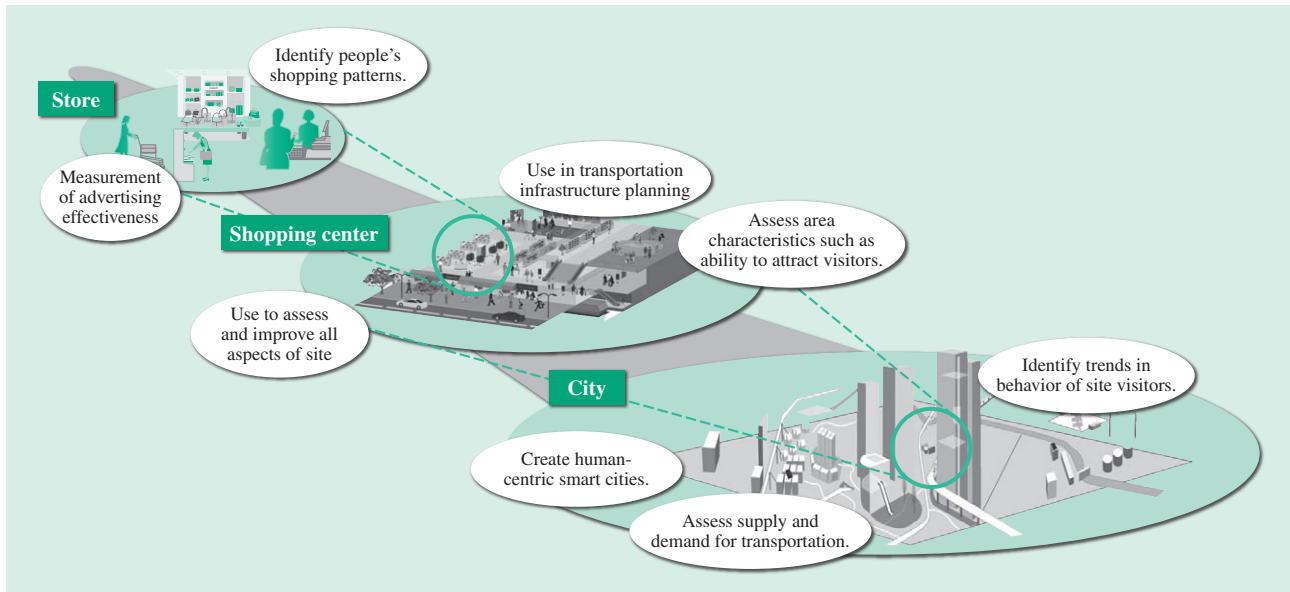


Fig. 6—Seamless Analysis of People Flow, from City to Indoor Level.

There are growing expectations for the use of big data on people and traffic flows on a range of different scales, from localized indoor spaces to large areas of a city.

map-matching the GPS data to the road network and calculating the speeds were used to present the speed on each section of road in color-coded format (green for moving freely, yellow for congested, and red for stationary). The project also selected routes between major tourist sites and compared mean travel times that took account of congestion information at key times such as in the morning, midday, or evening. When approximately 200 local users were surveyed about the idea of providing this information by smartphone or other means, 45% responded that they would use such a service even if they had to pay for it. This demonstrated the demand for this traffic information.

FUTURE PROSPECTS

This section describes where Hitachi intends to go next with its city management platforms based around big data from people and traffic flows.

(1) Extending use of personal data

It is anticipated that society's systems will be capable of generating and storing ever larger quantities of data in the future. It is also anticipated that policies for the use of personal data by business will be clarified in the near future along with amendments to personal information protection laws in Japan.

Given these circumstances, Hitachi is working to improve analysis techniques and the speed of analysis, and to develop methods for analyzing large amounts of collected information to generate new value by

identifying hidden relationships. In the future, Hitachi will seek to develop the systems that underpin the social system, including through the integration of big data analytics with the systems that control social infrastructure to assist people's activities, automate driving, and manage the supply and demand for transportation.

(2) Seamless people flow analysis, from city to indoor level

There are growing expectations for the application in a variety of fields of the ability of city management platforms to analyze the flow of people at various different levels, from indoor spaces to city-wide areas (see Fig. 6). People flow analysis can be used at retailers for purposes such as identifying people's shopping patterns or measuring advertising effectiveness. At venues or other facilities, it can be used to assess and improve all aspects of the facility, or to assess different areas for their ability to attract visitors, for example. Across an entire city, meanwhile, it has applications in urban development, such as determining the supply and demand for transportation or identifying trends in the behavior of people visiting particular facilities. Accordingly, Hitachi is seeking to develop the use of its city management platforms, not just by government but also in a variety of business and other fields, by providing seamless analysis of people and traffic flows across large areas of a city and also down to the level of facilities and indoor areas.

CONCLUSIONS

This article has described the concepts behind city management platforms, examples from Japan and overseas, as well as the prospects for the future.

Hitachi operates its Social Innovation Business for solving the problems faced by society with the aim of creating sustainable smart cities. In addition to the further development of city management platform solutions, Hitachi intends to work in collaboration with a wide range of users from both the public and private sectors to implement these in actual society.

ACKNOWLEDGEMENTS

The Fukuoka smartphone probe demonstration project described in this article received considerable assistance from the people involved at the Fukuoka Directive Council and Fukuoka municipal government.

Similarly, the taxi probe demonstration project in Bali was conducted under an FY2012 project funded by the Ministry of Economy, Trade and Industry to promote and study infrastructure system exports. The authors would like to take this opportunity to express their sincere thanks.

REFERENCES

- (1) S. Sugawara et al., "Geospatial Information Platform for Sustainable Society," Hitachi Hyoron **94**, pp. 276–281 (Mar. 2012) in Japanese.
- (2) T. Okubo et al., "Realizing Smart Mobility Using Probe Data," Hitachi Review **63**, pp. 359–363 (Aug. 2014).
- (3) H. Ohashi et al., "Modality Classification Method Based on the Model of Vibration Generation while Vehicles are Running," Pro. of the Sixth ACM SIGSPATIAL Int. Workshop on Computational Transportation Science (2013).

ABOUT THE AUTHORS



Michio Morioka, Ph.D.
Social Innovation Business Office, Information & Telecommunication Systems Group, Hitachi, Ltd. He is currently engaged in smart city business planning and sales in Japan and overseas, primarily city management platform solutions. Dr. Morioka is a member of the Information Processing Society of Japan (IPSI).



Kyoji Kuramochi
Social Innovation Business Office, Information & Telecommunication Systems Group, Hitachi, Ltd. He is currently engaged in smart city business planning and sales in Japan and overseas, primarily city management platform solutions.



Yusuke Mishina
Social Innovation Business Office, Information & Telecommunication Systems Group, Hitachi, Ltd. He is currently engaged in smart city business planning and sales in Japan and overseas, primarily city management platform solutions.



Takayuki Akiyama
Intelligent Media Systems Research Department, Central Research Laboratory, Hitachi, Ltd. He is currently engaged in research into the analysis and simulation of people and traffic flows using sensor data. Mr. Akiyama is a member of the IPSJ.



Naoyuki Taniguchi
Social Business Solutions Division, Social Innovation Business Project Division, Hitachi, Ltd. He is currently engaged in solution engineering for urban transportation.