Special feature article

Providing High-quality Services for Railways: Efforts Centered on Stations Utilizing ICT

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Stations are JR East's largest operating resource, used by 16 million people a day. They are increasingly characterized as having community aspects where stations provide things such as various information and living services in addition to being a place people pass through when using railways. The Frontier Service Development Laboratory is thus working on R&D for providing high-quality services with railways, with efforts centering on stations utilizing various ICTs.

1 Smart Station Vision

With the rapid aging and declining birthrate in society today and with lifestyles becoming more diverse, a transformation of the railway market from "railways as a means of transport" to "spaces and communities where people come together to enjoy life" is an important issue for management. JR East is thus making efforts in a variety of management measures in terms of both physical and human aspects.

Achieving stations that are convenient to each individual customer and can be used with peace of mind is considered a particularly important issue to handle with recent diversification of customer needs and increased accessibility for the aging society. The Frontier Service Development Laboratory is also making efforts in R&D for creation of efficient and personal services by ICT under the Smart Station Vision as a goal for ideal stations sometime in the 2020s.

Particularly in terms of providing information to customers, deploying personal information guidance services that are becoming the norm on the town proved difficult due to the restrictions of stations and trains as structures and equipment for public transport. However, big data has come to be more readily used thanks to the recent rapid proliferation of smartphones, expansion of high-speed communications networks such as WiMAX and LTE, and advance of sensor technologies and computer systems. Information guidance systems optimized for individual customers even in a railway environment have thus become feasible, and expansion of and removal of barriers to information services in railways spaces has become a priority topic for the Frontier Service Development Laboratory too.

Major themes in our R&D roadmap for the Smart Station Vision are currently "making movement smooth" and "providing information according to individual needs and situations" in the station. We are aiming to achieve in the next five to ten years stations that are easy to use by all customers without being a source of stress and that autonomously provide information on their own. And in line with that, we aim to achieve Smart Stations that anyone can use enjoyably and with convenience by sometime in the 2020s. (Fig. 1)

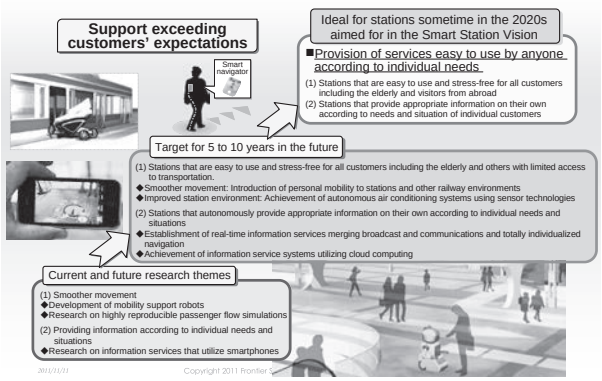

Fig. 1 R&D Roadmap for Fulfilling the Smart Station Vision

2 Use of General-purpose ITC

ITC plays an important role in railway business, being used by railways in a variety of forms. The oldest is the MARS (Multi Access seat Reservation System) system, Japan's largest online real-time system for ticket reservation and sales that came into being in 1960. That was followed by COMTRAC (COMputer-aided TRAffic Control) system for Shinkansen operation control that was introduced to the Tokaido and Sanyo Shinkansen in 1972. Recent years saw the introduction of the Suica IC card system for transport and affiliate commercial facilities, which reached its 10th anniversary in 2011.

Accuracy and stability are very important elements in systems that support railway operations, but robustness of the system is demanded and convenience and speed of the information provided are important when applying those systems to information services. The systems thus are not limited to railway use alone, and we believe that perspectives of so-called open data and mashup where systems interactively link with information on the town, events, and the like demanded by customers are also needed.

"Live train map for the London Underground" (http://traintimes.org.uk/map/tube/) where London subway operation information is shown in the Internet in real time is a well-known example of such efforts. This is not a service by Transport for

London (http://www.tfl.gov.uk) on its own. It is released on the Internet by general users, achieving services combined with online map services based on operation information released by Transport for London and development tools for web delivery (http://www.tfl.gov.uk/businessandpartners/syndication/). (Fig. 2)

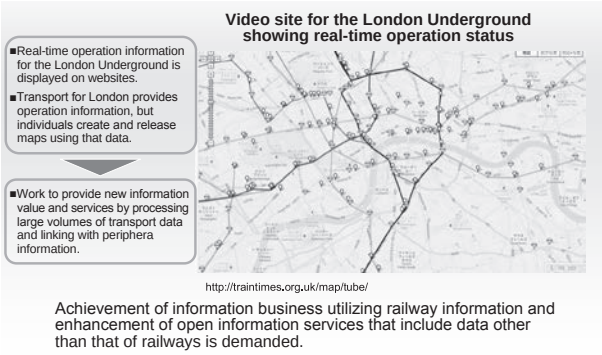

Fig. 2 Trend for Big Data Use and Opening of Data

Even in R&D to achieve Smart Stations, development is done on the assumption of open system design and interactivity of information upon securing security needed for railway information. Independent infrastructure is not built for each service. Rather, efforts are made with importance placed on areas such as general-purpose ICT including public Wi-Fi networks and smartphone apps as well as linkage with online information. Through such a development policy, we believe that we can reduce overall system development costs too.

3 Research on Providing Information

In regards to information services for railways, customers have a strong desire to know the latest up-to-the-minute operation information, especially status and alternative routes when train operation is disrupted. The Frontier Service Development Laboratory too has been working on ways of shifting from conventional voice and text information transmission to pictorial means and on providing information in quick and easy-to-understand manner. That has been done by putting into practical use services such as an "emergency information display" that shows operation information and alternative transportation in emergencies with route maps on large displays at stations in the greater Tokyo area utilizing Autonomous Decentralized Transport Operation Control System (ATOS) information and a "train location system" that utilizes GPS-equipped mobile phones to display at stations train operation information of regional lines. However, passengers further demand better information services helpful in actually making decisions on actions to take in transport disruptions. Accurately and quickly providing information on the situation as it happens will be not enough. We are thus working on development of big data analysis based on transport OD (Origin and Destination) data and the like and an inference engine based on railway operation information. With that, we aim to achieve real-time restoration estimates that change in line with restoration status and prediction and recommendation functions for railway operation such as guidance of alternative routes optimized for the individual customer. (Fig. 3)

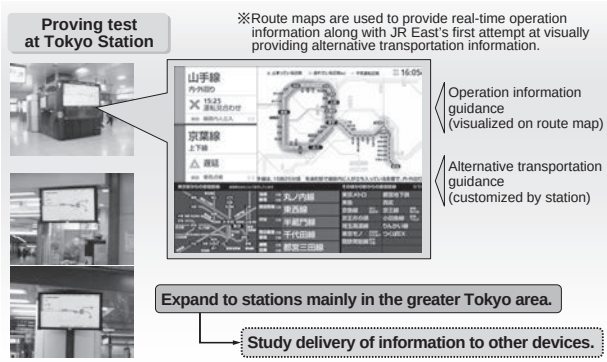

Fig. 3 Emergency Information Display

We have also made efforts in developing "touch panel information terminal" digital signage that combines a 46-inch touch panel and PC to provide information in increasingly complex stations in the greater Tokyo area. Proving tests are underway on that system for easily finding desired information and station maps by touching a large touch screen set up in a station. The system features a wide range of service functions including content automatically displayed in order of frequency used and four-language display (Japanese, English, Chinese, Korean). It also has a function to allow easy content updating on site to quickly deal with facility changes and design allowing it to be used for marketing linked with products of commercial spaces in the station. Though those features, we worked to enable smooth operation on-site and reduced introduction costs. (Fig. 4)

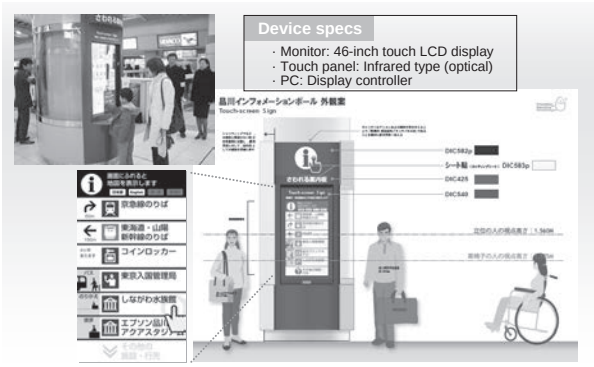

Fig. 4 Touch Panel Information Terminal

Japan's railway system is very complex to visitors from abroad. While ticket purchasing and fare calculation is made easier by transport IC card tickets, changing trains and finding the line that a train departs from or arrives at in the station is no easy task. We thus developed a "route information terminal" featuring a unit design for installation in ticket vending machine spaces, allowing for searching of railway timetables and in-station information in four languages. In addition to allowing searching of timetable information by connecting to timetable websites on the Internet, it provides information such as the line that a train departs from or arrives at and station maps. It also has a feature

for printing out search results, allowing travelers to take the printed receipt to follow directions for moving about the station. Tests in Akihabara station garnered 500 searches per day, and we are considering introducing the terminal to stations heavily used by foreign visitors.

In developing such information delivery systems, we ran into the issue of space intrinsic of stations in the greater Tokyo area. It is difficult to find space to install new devices with stations already having many guidance maps and signs, and people may not recognize them as information providing spots even if they are set up. We thus started R&D on providing information services to overcome these issues and increasing added value by providing the optimal information for each individual.

4 Personalization of Information Provision

Low-cost and high-quality information delivery according to individual needs, a task that was once difficult, became possible with a radical change in the Internet information environment whereby smartphones came into general use starting with the release of the iPhone in 2007 (iPhone 3G in Japan in 2008). We have thus made efforts recently in actively utilizing smartphones for personal information services, conducting a proving test on "Train Net" service on a train set of the Yamanote Line in October 2011.

Train Net is a service to deliver content to passengers via Wi-Fi. With that service, a variety of data related to operation recorded onboard (operation status, cabin congestion information, cabin temperature, etc.) and information content sent from a wayside server (station information, ads, local news, etc.) is stored on an information delivery device set up on the train. Information sources are selected and processed according to where the train is running, and content is delivered to in-cabin displays and passengers' smartphones.

The tests featured a diversion from the traditional model of information delivery where fixed railway information (mass information) is repeatedly delivered, switching to a first attempt by railways at personal information provision. In this, content delivered from the wayside is changed according to the location and direction of the train, and it is delivered to individual smartphones.

Approx. 1,000 accesses per day were recorded in the month-long test, and questionnaire results showed that the service was well received. We thus commenced a second proving test on the Yamanote Line in September 2012, moving basic content delivery from the onboard server to wayside server for more flexible content management, enhancing town information and marketing content, and adding an Internet connection function much requested in questionnaire results. A second train set equipped with the service set was added in November, and operation tests were conducted to January 2013 with an aim of introducing the service to practical use as early as possible. (Fig. 5)

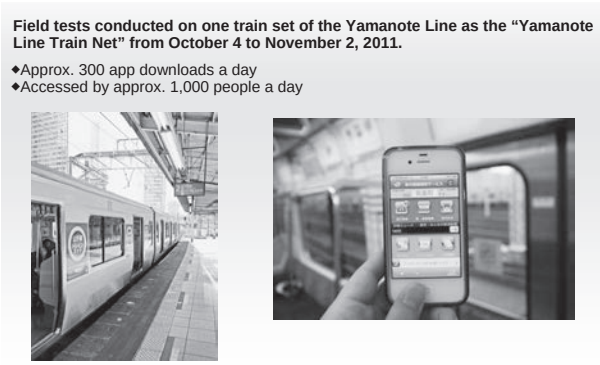

Fig. 5 Yamanote Line Train Net Test (First Phase)

5 Situation-based Guidance

In increasingly complex and multifunctional stations of the greater Tokyo area, it is important to provide information according to the ever-changing situation by identifying the passenger's situation in the station so as deliver the information that the customer needs. We are thus putting efforts into identifying flow of people in the station and providing in an easy-to-understand manner information. To do that, we are testing a system utilizing sensors to visualize passenger flow and augmented reality (AR) technology to display station maps and operation information by reading markers on walls and floors.

A variety of service guidance and ads other than railway information are provided in stations in the form of guide signs and videos, making it difficult for passengers to quickly find the information they are looking for. We thus looked for a way to consolidate in the cloud various information in the station, and then allow individual customers to easily access the information they are looking for by accessing map information by AR markers. "JR × AR" proving tests were conducted in Tokyo Station in June 2012 where AR markers were set up and 3D station maps, allowing information such as railway arrival and departure timetables and in-station commercial information to be provided by reading markers with a smartphone camera. (Fig. 6)

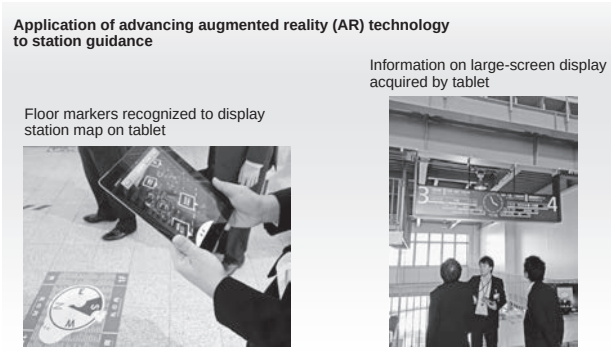

Fig. 6 Test of Station Guidance System Using AR Technology

In these tests, we employed a method whereby information is provided by the action of reading markers with a camera, but it may be difficult to point a camera at markers in a crowded station. We are thus working on development of a service to

allow provision of information and navigation according to the location anywhere in the station as the next step. In that, markerless location detection will be employed using positioning technologies such as area GPS and acceleration sensors as well as 3D image recognition technology.

If such information services are achieved, service information will be provided in the cabin to passengers, and they will be able to follow that information to navigate after arriving at the station. That will eliminate the need for passengers to look for various guide signs on their own, and it will allow for new services linked to day-to-day railway usage situations and lifestyle services to be provided.

6 Stations that Provide Peace of Mind

Alongside enhancing information services in stations, we are working to create station environments where a variety of passengers can freely move on their own with peace of mind. Giving universal design to information services and supporting mobility in particular are major issues in being able to deal with the aging of society.

While information services assuming use of smartphones and the like are coming into general use, many passengers are not used to ICT. We thus believe that providing necessary information to such passengers and giving them peace of mind is another major research theme for us. The Frontier Service Development Laboratory is therefore working on information services with characteristics of the elderly and others with limited access to transportation in mind. That goes beyond direct investigation of signs that are easy for the elderly to read and announcement that are easy for them to hear. We are also working to develop "Kamishirube" (name coined from "paper" and "guidepost" in Japanese) digital signage where pointing at a map in a pamphlet projects information related to places on the map.

Keeping a constant eye on all the changes going on in stations is difficult due to the sheer volume of security cameras to be monitored in each station—hundreds in the case of terminal stations in the greater Tokyo area. We thus developed and introduced at Yokohama Station a system where images from existing cameras are input to an image server for analysis and whereby an alarm automatically sounds in the station office or security monitoring room when movements corresponding to preset warning incidents (person suddenly falling ill, suspicious objects, falls, fights, etc.) are detected. The system handles conditions particular to stations (coming and going of large numbers of people, reflection of lights of trains entering the station, easy connection to existing cameras, etc.), and it is for use in a variety of station environments.

The number of railway passengers moving on their own by wheelchairs is also increasing with further aging of society. We are thus working with experts in robot technologies on basic research for guidance using GPS, RFID tags, and the like so mobility support robots can move about the station smoothly without the help of station staff. This is done on the assumption that, with the advancement in robot technologies, robot use will catch on in general society and the elderly and others with limited access to transportation will use autonomous mobility support robots. While still at the basic research stage, we are making efforts with an aim of creating a station environment that passengers can use with peace of mind even if a society is achieved where humans and robots coexist.

By going forward with such efforts, we believe that guide robots that move autonomously will support passengers in stations. They will be able to do that in the future based on real-time station congestion and train operation information. (Fig. 7)

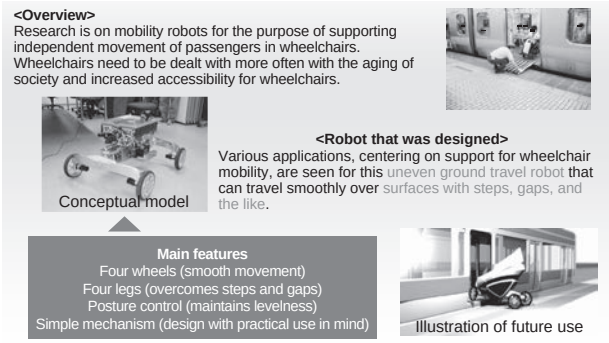

Fig. 7 Research on Robots to Support Mobility of Those with Limited Access to Transportation

7 Fulfilling the Smart Station Vision

Many of the development results introduced in this article are still in the research stage, and issues in terms of operation and cost still need to be overcome before they are put into practical use. We are thus aiming to achieve information systems that can provide necessary information to passengers and station staff and guide them. That will be achieved through situational judgment by a sort of artificial intelligence predicting the changes in the railway environment using general information from the Internet combined in the cloud with railway-specific information such as that from various sensors set up in the railway environment and railway operation databases. (Fig. 8)

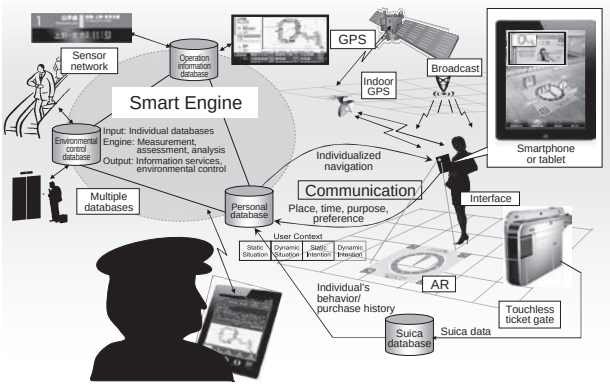

Fig. 8 Station for the 2020s Aimed for in the Smart Station Vision