Public Transport Smart Card/Mobile Ticketing Solutions That Support Safe, Reliable Movement of People

NISHI Takahiro, HARADA Tomoyuki, OGURA Shin, KUROSAWA Kazuki, HAMANO Shinichi, IINO Yota

Abstract

The total number of public transport smart cards issued in Japan now exceeds 150 million[1]. With a usage rate of 98 percent in the Tokyo metropolitan area, the public transport smart card is definitely here to stay, an example of social infrastructure that meshes perfectly with people's lifestyles. Turning our gaze overseas, we see opportunities to export Japanese technology are increasing at a rapid pace, spurred by rapid expansion in demand for new and upgraded infrastructure and IT systems in newly emerging economies. Ever since Suica was introduced, NEC has actively helped drive advances in public transport smart cards by adapting its powerful, proprietary ICT to the needs of public transportation. At the same time, we have been exporting our know-how overseas and successfully introduced these systems to many regions. In line with changes in lifestyle that now require contactless, non-face-to-face procedures while still assuring seamless movement of people from place to place, NEC continues to create next-generation solutions that integrate various technologies in mobile, biometrics, and more, to help achieve a world of abundance.

Keywords

public transport smart card, mobile ticketing, cashless, public transport, overseas deployment, smart city, MaaS

1. NEC's Involvement in Development of Public Transport Smart Cards

When the East Japan Railway Company began work on the Suica project which was launched in 2001, NEC participated in its development. Since then, NEC has been involved in the development of eleven public transport smart cards introduced in Japan as of 2020 (**Fig. 1**). NEC's primary role has been to provide the backbone systems for public transport smart cards, including many key components ranging from center servers to station servers. Center servers manage the life cycle of the smart card from the time it is issued until final disposal, while station servers store and forward processed data between the center server and connected equipment. Our stakeholders not only include public transport companies but also financial institutions and government organizations, enabling us to introduce public transport smart cards and to expand their service areas. Working with banks and all levels of government—municipal, prefectural, and national—in addition to public transport companies, we are helping to revitalize communities by introducing technology that facilitates better and more

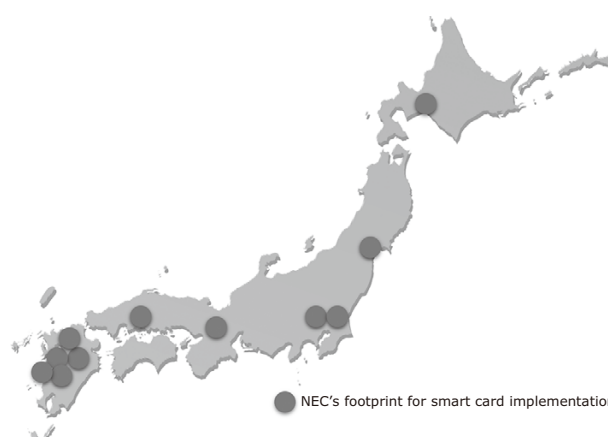● NEC's footprint for smart card implementation

Fig. 1 NEC's track record of public transport smart card project in Japan.

convenient access to public transport.

Beyond this, NEC is also working to expand the utility of smart cards by adding new value and applications. Illustrative of this is the evolution of the smart card into a form of electronic money that can

be used at station kiosks and convenience stores, as well as for mobile ticketing. Now mobile phones and smartphones incorporating the FeliCa chip can be used as mobile tickets and electronic money. Top-up can be done through the mobile phone application anytime, anywhere, offering users maximum mobility and flexibility and thereby helping to further expand usage.

2. Overseas Deployment of Our Solutions

2.1 AFCS and ITMS provide a safe, secure foundation for India's public transport infrastructure

The knowledge and expertise we have gained in the process of developing and advancing smart card technology in Japan is now being deployed effectively overseas with particular focus on India's bus rapid transit (BRT) market.

Selected as one of first 20 candidate cities in the Indian government's smart city project, Ahmedabad in Gujarat State has introduced an automated fare collection system (AFCS) and intelligent transport management system (ITMS)[2)3)] (**Fig. 2**). This helps the city achieve a safe and highly reliable public transport infrastructure that smoothly adjusts to changes in demand by utilizing IoT and big data analysis to facilitate planning, integration, and expansion in accordance with the increase of passengers. The city of Surat in the same state has also introduced the AFCS to make cashless payment possible not only with public transport smart cards but also with QR code tickets[4)].

The public transport smart cards adopted by both cities comply with RuPay, a payment service developed by National Payments Corporation of India (NPCI). In addition to prepaid payment for rides on buses and the BRT system, it can also be used as a debit and credit card

at a multitude of venues, including cafés, restaurants, libraries, and amusement facilities, thus providing citizens with high convenience.

2.2 India's smart city projects

India has made it its mission to create smart cities where use of public transport smart cards and digital ticketing is ubiquitous and automated systems are widely deployed. NEC is an active partner in these endeavors—for example, in October 2019, NEC concluded a system integration contract with the twin cities of Kalyan-Dombivali related to the development of the entire smart city project[5)]. NEC will introduce a wide range of solutions including an advanced traffic control system equipped with image analysis technology performed by AI. These solutions will be linked to IT management service (ITMS) and parking management systems to streamline the movement of people and vehicles throughout the cities.

NEC will also continue efforts to contribute to the achievement of safe, secure, equitable, and efficient smart cities.

2.3 Expanding India's AFCS/ITMS business to other countries

Building on the experience gained in Japan and India, we are now working on a project to introduce the ITMS to bus operators in Mecca, Saudi Arabia[6)].

Welcoming more than two million pilgrims a year, Mecca is very much in need of a safer, more reliable, and more convenient public transport system. To achieve bus services with greater convenience, safety, and efficiency, we are introducing the AFCS which will facilitate cashless payment with more than eight million public transport smart cards. To efficiently manage the movement and scheduling of transport, we are introducing the AVLS which tracks about 400 buses and supports scheduling.

In addition, Japan's Official Development Assistance has initiated several projects to introduce ICT to rail transport in other Asian countries including India's neighbors, Bangladesh and Sri Lanka. Although the introduction of ICT to rail transport is more costly and time-consuming than for buses and BRT, the results in terms of modal shift and traffic congestion alleviation are remarkable.

With this background, NEC will endeavor to deploy AFCS-based public transport ICT solutions in rail transport. By making available public transport smart cards and QR code tickets that can be used by multiple operators as well as for mobile ticketing, we will enable a contactless, cashless payment infrastructure with high safety and convenience. Furthermore, we will leverage our
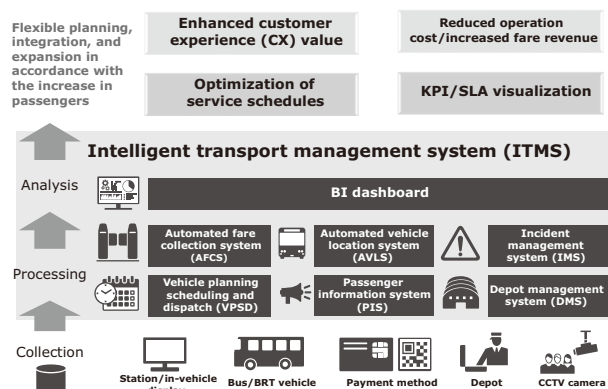

Fig. 2 Intelligent transport management system (ITMS).

know-how in digital transformation (DX) we have gained in the projects for public transport operators in Japan to strengthen our customers' existing services and help them create new services.

3. NEC's New Commitment to the Evolution of Public Transportation

3.1 Trends in the Japanese domestic market

Public transportation has long been dominated by scheduled trains and buses. That has begun to change thanks to the convenience made possible by new technology. Today, a broad range of services, including on-demand buses, bicycle sharing, and car sharing are being rolled out in the market. Users now enjoy much greater choice and flexibility and can freely choose the mode of transport that best suits their needs with respect to route, destination, traveling time, fares, and convenience.

An expanded range of transportation options not only redounds to the benefit of members of the local community, it will also help both domestic and international tourists thanks to improved convenience and flexibility.

3.2 Issues in the Hiroshima area

The number of tourists visiting Hiroshima has been increasing every year. Until 2004, an average of over 9 million people visited every year, but by 2018, the number of visitors reached 13.36 million. Over the same period, the number of foreign tourists increased from about 200 thousand in 2004 to 1.78 million in 2018.

Hiroshima Electric Railway offered tourists a variety of travel passes to choose from, including the Visit Hiroshima Tourist Pass in addition to a regular one-day train pass. Combined sales of these were equivalent to 200 thousand tickets. However, since these passes were paper tickets, tourists could not purchase them in advance; instead, they had to go to the ticket window to buy the passes after arriving in Hiroshima. Clearly this system was not suitable to the city's evolving requirements and needed to be upgraded to provide improved convenience and flexibility.

3.3 How MOBIRY was built

Against this background, NEC consulted with Hiroshima Electric Railway to work out a policy to improve the convenience of tourists and make it easier to get around the city and its environs. After much thoughtful discussion, NEC and Hiroshima Electric Railway entered into an agreement in July 2019 to jointly develop and build a Mobility as a Service (MaaS) system, which was launched in March 2020[7].

Dubbed "MOBIRY," the MaaS system developed for Hiroshima Electric Railway does not have dedicated servers in a data center. Instead, NEC built a backend system in the cloud and developed a web-based application. As a result, we were able to shorten the development period and roll out the MaaS service just nine months after the project was initiated.

3.4 Features of MOBIRY

As of July 2020, MOBIRY offers the following three features:
(1) Advance purchase on the web is possible.
(2) Available in hourly periods, such as 8 hours or 24 hours.
(3) Also available in a package pass combining unlimited local travel and highway bus tickets.

NEC will continue efforts to further improve convenience by linking the MOBIRY with on-demand transport and bicycle sharing services, in addition to trains and buses (**Fig. 3**).

3.5 Expansion into India's multimodal transport services

When we look overseas, especially in newly emerging countries where the economy is fast developing and the population rapidly increasing, we can see that rapid economic development has pushed a number of social issues to the fore. Chronic traffic congestion which comes as a result of an increase in privately owned cars outpaces the construction of new roads and the expansion of public transportation.

This has created an opportunity for the private sector which is currently introducing a variety of innovative new transportation services to get people moving. The primary mode of transportation for the vast bulk of the population, the public system still forms the backbone of the transportation system. Unfortunately, because it is not integrated with modern systems of data provision and payment methods, the system is inconvenient, un-
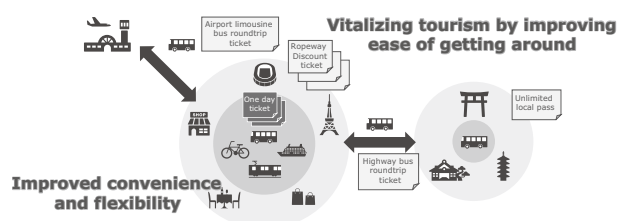

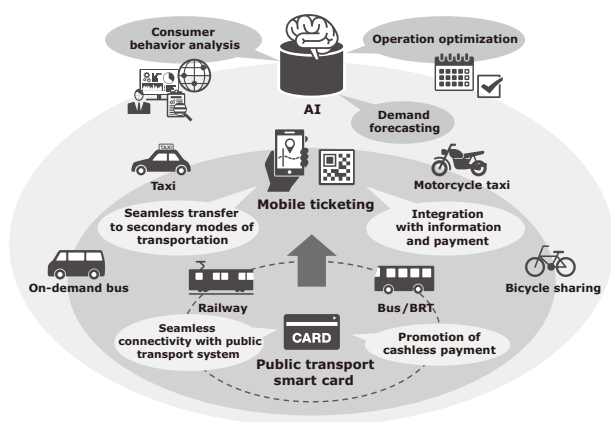Fig. 3 Linking MOBIRY with various services.

Fig. 4 Deployment in multimodal transportation services.

reliable, and difficult to use, consequently increasing the dependence on privately owned cars.

Working together with NEC Laboratories India, which was founded in 2018, we are currently developing a solution that integrates information of both public and private transport services, as well as payment methods. This integrated system will be implemented in mobile apps to provide citizens with a seamless transportation experience. When NEC's leading-edge AI technologies are utilized in this integrated system, it will also be possible to analyze consumer behaviors and perform demand forecasting based on the collected data.

By multiplying what we have learned in the public transportation market with numerous NEC-proprietary technologies, we will continue to develop new solutions going forward (**Fig. 4**).

4. Future Prospects

4.1 Changes in the public transportation environment and the future of public transport smart cards and their prospects

As discussed above, NEC has developed public transport smart card and mobile ticketing solutions to help achieve safe, comfortable transportation. To further improve convenience, these solutions can be used not only to access various modes of transportation, but can also be used for ticketing in a wide range of other applications such as entertainment. At the same time, services can be more finely tuned to meet the more specific characteristics and needs of users. This means that high-spec and numerous servers need to be streamlined and their maintenance and management costs reduced. This can be achieved by transitioning from the current card-based ticketing (CBT) to centralized account-based ticketing (ABT). At NEC, we believe that combining various

solutions while managing the transition between the two systems will help contribute to social value creation.

4.2 Creating new value with the ABT system

Current public transport smart cards generally use the CBT system, which manages stored-fare (SF) balance in each card. This makes it necessary to perform high-speed computation processing at the station service device side, which requires very high specifications. Multiplied by all the stations in the transport system, this is a major factor in driving up costs. With ABT, card balances and personal data are all aggregated at a higher-level data center, reducing the processing demand on station-side equipment and thereby significantly lowering costs. ABT also increases versatility, making it possible to handle various authentication systems, in addition to the smart card authentication. Available options can be increased to include ones that better suit usage scenarios and operator environments, such as QR code payment and contactless biometric payment, which are fast growing in popularity.

A leader in biometrics, NEC has developed a wide range of industry-leading technologies in this field, including face recognition and iris recognition. We have systematized NEC's relevant solutions in the concept of NEC I:Delight, which is a one-stop embodiment of various solutions. We are also focusing on next-generation communication technologies such as 5G to support platforms that require high-speed communications such as ABT.

It is also expected that the linkage of transportation and attribute information on platforms will make it possible to organically connect groupings of information that are conventionally independent of each other. This organic connection will enable this data to be applied to digital marketing. Today, a wide variety of new transportation services—such as car sharing—are on offer, and the modes of transportation are becoming increasingly diversified. To address these needs, we combine our AI and IoT technologies including NEC the WISE—a suite of cutting-edge AI technologies—in order to better use and analyze digital data. We will continue our efforts to address and support the needs of public transportation at every stage of the journey (**Fig. 5**).

4.3 How NEC is reconfiguring to adapt to the changing social environment

As elsewhere in the world, Japan's society and economy were severely disrupted in the spring of 2020 by the impact of the novel coronavirus pandemic (COVID-19), which restricted people's movement and forced many to stay at home as much as possible. Many of these changes
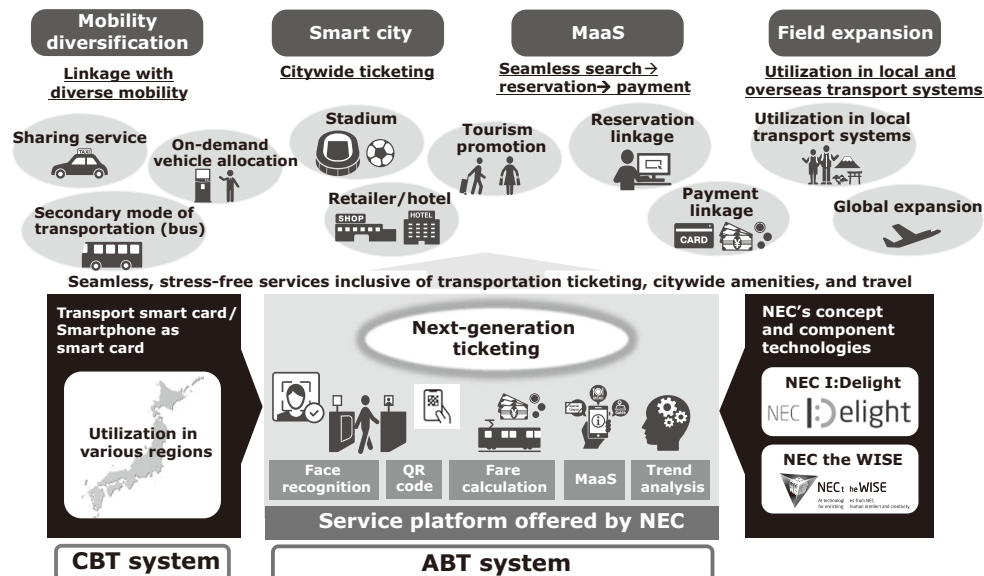
Fig. 5 Next-generation ticketing as envisioned by NEC.

are expected to remain part of everyday life indefinitely and are defining what is commonly called the "new normal," in which our view of what is normal in daily life will be much different than what it was before the pandemic.

The field of transportation is no exception in this respect. New behaviors are being created one after another—such as avoidance of crowded areas and promotion of contactless services. In turn, these are affecting commuting and business travel, with a much greater emphasis on telework. At NEC, our goal is to help redefine public transportation for the age of the "new normal" by offering integrated platforms utilizing the above-mentioned various authentication methods, as well as digital marketing.

5. Conclusion

As discussed above, in addition to mobile ticketing projects in Japan, we have been deploying our solutions to overseas smart cities and BRT projects such as those in India. Drawing on the results and know-how we have gained both in Japan and elsewhere, we will continue to expand and advance these solutions to create new social values and address critical social issues in real time.

* Suica is a registered trademark of East Japan Railway Company.
* FeliCa is a registered trademark of Sony Corporation.
* QR code is a registered trademark of DENSO WAVE INCORPORATED.
* All other company and product names that appear in this paper are trademarks or registered trademarks of their respective companies.

References

1) Kinzai Institute for Financial Affairs, inc.: Gekkan Shouhisha-Sinyou (Consumer Credit Monthly, Japanese), Issue of September, 2019
2) NEC Press Release: NEC expanding delivery of Intelligent Transportation Systems in India, June 2018
   https://www.nec.com/en/press/201806/global_20180613_02.html
3) Smart City Ahmedabad gets IoT-driven buses
   https://www.nec.com/en/case/scadl/index.html
4) NEC Press Release: NEC implements Automatic Bus Fare Collection System for Surat BRT, March 2018
   https://www.nec.com/en/press/201803/global_20180330_05.html
5) NEC Press Release: NEC wins Kalyan-Dombivli smartcity project, October 2019
   https://in.nec.com/en_IN/press/201910/20191015_01.html
6) NEC Press Release: NEC receives order for Intelligent Transportation System in Makkah, Saudi Arabia, August 2019
   https://www.nec.com/en/press/201908/global_20190823_01.html
7) NEC Press Release: NEC and Hiroshima Electric Railway digitize one-day tickets in first phase of Maas implementation in the Hiroshima area (Japanese), December 2019
   https://jpn.nec.com/press/201912/20191225_01.html

Authors' Profiles

NISHI Takahiro
Senior Expert
Transportation and Logistics Solutions Division

HARADA Tomoyuki
Assistant Manager
Transportation and Logistics Solutions Division

OGURA Shin
Assistant Manager
Transportation and Logistics Solutions Division

KUROSAWA Kazuki
Transportation and Logistics Solutions Division

HAMANO Shinichi
Transportation and Logistics Solutions Division

IINO Yota
Transportation and Logistics Solutions Division

Information about the NEC Technical Journal

Thank you for reading the paper.
If you are interested in the NEC Technical Journal, you can also read other papers on our website.

Link to NEC Technical Journal website

Vol.15 No.1 NEC Value Chain Innovation
— Shaping the Future of Organizations and Industries through Digital Transformation

Remarks for Special Issue on NEC Value Chain Innovation
NEC Value Chain Innovation — The Future Created by Digital Technology

Papers for Special Issue

Utilizing digital technologies across organizational and industrial boundaries
The Supply and Demand Optimization Platform: A Co-Creation Project in Value Chains That Reduces Food Losses
Multi-Bank Identity Confirmation Platform — A New Way to Verify User Identity Using Digital Technology
NEC I:Delight — Personalized Adventures Unified by Trust

Connected Manufacturing
Connected Manufacturing — Innovating Manufacturing by Integrating On-site Know-how and Digital Technology
Smart Factory Enabled by Local 5G

Intelligent Logistics & Mobility
Intelligent Logistics and Mobility — Intelligent ICT to Optimize the Movement of People and Goods
Fast Travel: Using Face Recognition to Improve Airport Services with a View towards Wide scale Implementation
Public Transport Smart Card/Mobile Ticketing Solutions That Support Safe, Reliable Movement of People
Reforming Railway Operations
Optimized for the "New Normal," NEC's Intelligent Logistics Supports a Continuous Flow of Goods
Vehicle Interior/Exterior Monitoring Solution for Safe Transportation of People and Goods

Smart Retail CX
NEC's Vision of Retail and Smart Retail CX
A Relaxed and Enjoyable Customer Experience, More Efficient Store Management — The Cashierless Future is Here
OMO Solutions that Provide a Unique Shopping Experience for Only Now, Only Here and Only Me
Digital Store Platform, an Information System Platform for Smart Retail CX

Smart VenueCX
Smart VenueCX — Linking Inspiring Spaces to Deepen Bonds between People, Communities and Societies
Elevating Customer Experience with Comfortable, Touchless Services
NEC's Solutions for Venues in the New Normal Era

Digital Finance
Approach to Digital Finance in DX Era
NEC's Online Personal Identification Service Accelerates Innovations Toward New Normal Era
Measures Required for the Banking System in the Digital Era
AI-Based Fraud and Risk Detection Service Ensures Transparency While Improving Operational Efficiency and Performance

Paving the Way to the Future with Digital Utilization

General Papers

Development of Neoantigen — Targeted Cancer Vaccine Therapy

NEC Information

2019 C&C Prize Ceremony

Vol.15 No.1
January 2021

Special Issue TOP