Automatic Fare Collection System with Contactless IC (Smart) Card

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Summary

East Japan Railway Company (JR East) will introduce new automatic fare collection (AFC) system with contactless IC card (CIC) as a new generation AFC system by the end of 2001.

We have been investigating AFC system with CIC card from 1987 and as its technology reached a practical usage level, we have been developing and building the new AFC system from 1998.

We have done a monitor test among 10,000 customers from April to July this year. As we received a lot of affirmative opinions from them, we are sure this system will be accepted by our customers and 6 million CIC cards (4 million Suica Passes and 2 million Suica IO cards) will be sold at the official debut.

Thanks to this project, introduction and use of IT and other new technologies, we are moving forward steadily into a new cash less and ticket less era.

Keywords: automatic fare collection system (AFC), contactless IC card (CIC)
1. Introduction

East Japan Railway Company (JR East) is the largest railway company in Japan, which has approximately 7,500 km of railway network in the east part of Honshu island. Approximately 12,000 trains are operated and approximately 16 million customers use our trains every day. And more than 80% of our customers are in the Tokyo metropolitan area, in a radius of about 100 km from Tokyo station. We have introduced an automatic fare collection (AFC) system in the Tokyo metropolitan area from 1990 for the purpose of rationalization of station work and improvement of customer service and have installed the AFC system with magnetic cards/tickets in 350 stations.

Tokyo Metropolitan Area

On the other hand, from 1987 when our railway has been divided and privatized from the old Japanese National Railway, we have been investigating AFC system with contactless IC (CIC) card as a new generation AFC system.
Experiments on CIC Development Chronograph

As its technology has reached a practical usage level after three field-test trials and existing AFC gates have become older and need to be replaced, we decided in 1998 to introduce the new AFC system with CIC card technology and started to develop and build the new AFC system with the aim of introducing in 2001.

2. Requirements of our AFC system

As outlined earlier, a lot of people use our trains in the Tokyo metropolitan area, thus, high performance and high reliability is indispensable for our AFC system. The requirements for our AFC system are as follows:

1. Compatibility with the existing AFC system with magnetic cards
2. No less performance compared with the existing AFC system with magnetic cards: such as throughput of AFC gate.
3. No less reliability compared with the existing AFC system with magnetic cards

Concerning compatibility, as single-use tickets and long trip tickets will still remain even though after the new system will be introduced, existing machines should be adapted to both the CIC and the magnetic card. A simple type AFC machine, adapted only to the CIC card, will be installed at stations where existing AFC gates are not installed yet.

Concerning performance, our AFC gates are designed to deal with 45 persons a minute in the peak time. But in peak time, more than 60 persons go through the gate in a minute. Thus, the new AFC system with CIC card should clear this performance target. To accomplish this target, communication time between the CIC card and reader/writer (R/W) should be less than 100 ms and communication distance should be more than 100 mm. And to accomplish this communication time and the same level reliability with the existing magnetic system, the communication rate should be more than 211 kbps. To select the best CIC card system (CIC card and R/W), we procured them by international tender procedure, and the Sony system was awarded the contract by the overall treatest value methodology. The Sony system has been installed in Hong Kong and performing well.
3. Concept of CIC card AFC system
(1) Service improvement (Improvement of convenience for customer)
  * Going through the AFC gates without taking out cards/tickets from pass case
  * Automatic fare adjustment with AFC gates
  * Reissuing pass when it is lost or stolen
(2) System change (Improvement of station work)
  * Reduction of work with reducing the number of ticket vending machines and fare
    adjustment machines
  * Reduction of machine troubles in the AFC gate machines, such as ticket jam with
    reducing mechanical parts
  * Reduction of maintenance work by station staff
(3) Cost reduction (Reduction of maintenance and initial cost)
  * Reduction of maintenance cost by reducing mechanical parts of AFC gate machines
  * Reduction of fare adjustment machines by automatic fare adjustment
  * Reduction of ticket vending machines by reducing the number of single-use tickets
(4) Security (Improvement of security)
  * Prevention of using counterfeit card or illegal ride
(5) Business Opportunity (New Business)
  * Coupled with View card (credit card issued by JR East)
  * System administration company: settling an account among other railways etc.
  * Data warehouse business
  * Lending part of CIC card capacity to other company

4. Outline of our new AFC system with CIC card
(1) Characteristic of our CIC card and outline of new service
  * Name of CIC card
    We named our CIC card as “Suica” to create a familiar image for the customer. This
    is an acronym from Super Urban Intelligent Card and it has the image of going
    smoothly in Japanese. And as it has the same sounds of Japanese word for watermelon,
    “suika”, we designed a logo and service mark like watermelon. It also looks like the
    earth or railway network consists of IC cards.
Kind of Suica

* Two types of Suica
  One type of Suica is a commuter pass with SF (Stored Fare) function, named as “Suica-teikiken (Suica Pass)”.
  The other type of Suica only has the SF function named as “Suica IO card”: IO means In and Out.

* Touch and go
  As Suica is a contactless IC card, our customer can go through the AFC gates just by touching softly on the R/W with the Suica in a pass case.
  Even though CIC card responds with shaving it near the R/W, as its response range is approximately 100 mm, we recommend our customer to “Touch and Go” for confirming the transaction.

* Recharge function
  When the stored value in the card becomes low, the user can recharge with a ticket vending machine or a card vending machine with cash or a View Card. The upper limit for charge is 20,000 yen (160 US$).

* Rewrite function
  As existing commuter pass has the valid range, valid period and user’s name etc., written on its surface, the Suica Pass can be rewritten more than 60 times. When the Suica Pass is renewed, new valid information is written on the same card. With this rewrite and the charge function, our customer can continue to use the same card and waste of cards can be reduced significantly. Thus, it helps contribute to the protection of environment.

* Automatic fare adjustment function
  When a Suica Pass is used outside of its valid range, additional fare is collected
automatically by the AFC gates, if the Suica is charged enough. Passengers don’t have to buy a ticket from a ticket vending machine or pay additional fare at the adjusting machine any more.

Outline of present service

3 tickets are necessary

Outline of new service

Just one ticket

Automatic Fare Adjustment

(2) Ticket handling equipment

Fig.5 shows an outline of our CIC card automatic fare collection system. Equipment for handling Suica has CIC card R/W and transacts data with Suica by radio communication.

Stations with normal type A.F.C.Gates

Outline of CIC Card A.F.C. System

All AFC gates are adapted to both magnetic tickets and Suica, so passengers can use Suica in any AFC gates. Older gates will be replaced by new type and comparatively
new one will be just modified. At the stations where existing AFC gates are not
installed yet, a cheap and simple type AFC machines only for Suica will be installed so
as to make Suica usable at all stations in Tokyo Metropolitan Area.

Commuter passes will be sold by automatic commuter pass vending machines
(customer handling type) and MARS-terminal (Multi Access Reservation System;
Ticketing and Reservation System for JR trains, station staff handling type). As the
existing MARS-terminals issue only magnetic tickets, CIC card issuing units are
attached to existing terminals. Suica IO cards will be sold by both customer handling
type card vending machines and station staff handling type ticketing terminals.

Passengers can recharge Suica at a ticket vending machine and a card vending
machine outside the gates and at a fare adjustment machine inside the gates. All card
vending machines and some ticket vending machines and fare adjustment machines are
adapted to Suica.

Besides, there are fare adjustment machines for station staff and portable Suica
checkers as for station and train staff handling equipment.

(3) ID management system

Issuing data and usage record data etc. are transmitted on-line to the ID management
system. Thanks to the managing data with the ID management system, we can offer
service as follows:
(a) Offering usage record

Customers can print their usage record of Suica at ticket vending machines and card
vending machines. They can also check their record on screen at ticket vending
machines.
(b) Reissuing service of Suica

For the existing commuter pass, a lost commuter pass will not be reissued, because
we cannot make the lost pass invalid. But for Suica, as customer information is
registered when a card is issued, we can make the card invalid for all the equipment by
inputting the ID data to each terminal if a card is lost. Thus, Suica Pass will be reissued.

Suica IO card is not reissued because personal data is not registered. When Suica is
damaged or become unusable, we reissue Suica based on card data stored in the system.
(c) Prevention of illegal use

As the ID management system checks each cards with collected issuing and usage
data, if someone tampers the card or makes an illegal recharge, we can make the card
invalid by transmitting the ID number of the card to all Suica handling equipment.

5. Monitor Test among 10,000 Customers

For the purpose of verifying the Suica system, collecting opinions from customers
and grasping situation of actual usage, we have done a monitor test trial from April 8th
to July 8th among 10,000 customers. The outline of the monitor test is as follows:
(1) The number of monitors

Suica Pass  8,500 persons
Suica IO card  1,500 persons
(2) Line  Saikyo line (27 stations)
(3) All A.F.C. gates are adapted to CIC cards except A.F.C. gates by other private
companies
(4) Other equipment like ticket vending machines are adapted to CIC cards partially.
During the monitor test, no serious troubles such as flow obstruction of passengers were occurred and the test went smoothly. In this trial, there were 180 thousand transactions other than the usage in the valid range of commuter passes and we could confirm the validity and reliability of the system. Based on this result, we will introduce this Suica system by the end of this year.

We received those opinions as follows:
1. More than 90% customers are affirmative to this system.
2. Many customers are satisfied with the function of contactless, automatic fare adjustment, and reissuing service. As for the reissuing service, approximately 1% customers utilized this service during the monitor test.
3. Multi modal transport service is expected by most customers.

6. Conclusion

As for the beginning of the IT strategy of our company, it is very important to introduce Suica service at the end of this year successfully. We expect that all of existing commuter pass holders, approximately 4 million people, will buy Suica Pass and all of existing IO card holders, approximately 2 million people, will buy Suica IO cards in a short period after the introduction.

After introduction of Suica service, for improvement of customer service, we are now discussing with other transport companies about common use of the CIC card in order to make joint CIC commuter passes and CIC SF cards. And we are studying to extend Suica applications to non-transport use, such as coupling with the View Card or adding electronic money function.

Suica is the most important project for “New Frontier 21”, the medium term business strategy for JR East group. Thanks to Suica project, introduction and use of IT and other new technologies, we are moving forward steadily into a new cash less and ticket less era.