# An Advanced Electronic Payment System to Support Enhanced Service Provision

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## Abstract

Allowing people to make payments electronically has become critical for any business or organization that wishes to offer more advanced and convenient services. Today, electronic payment is widely used in many countries and comes in a variety of forms, primarily prepaid, debit, and credit, depending on the needs of users and services. These payment systems are supported by various underwriters such as the issuing bank or company (issuer), acquiring bank or company (acquirer), and authorized outlets. Moreover, as money is involved in the electronic payment system, an array of powerful security technologies are used. This paper gives an overview of electronic payment services and discusses the features of NEC's electronic payment solutions.

**Keywords**

electronic money, credit card, debit card, e-commerce, remittance, IC card, My Number, FinTech

## 1. Introduction

Nowadays, innovations in electronic technology are driving changes in every industry from automobiles to accounting. One of the most visible changes - one that impacts everyone - is the transition from cash to electronic forms of payment for worldwide exchanges of products and services. As electronic payments reduce the necessity for a physical entity like money and increase payment freedom and flexibility, we can expect an explosion in new services. For example, without electronic payment, e-commerce - one of the fastest growing sectors in the world today, in which products and services are purchased online - would be virtually impossible. Governments also support e-commerce because it makes it easier to track transactions, helps increase tax collection rates, and reduces crimes. One of today's most promising new industries is the financial technology industry - or FinTech - which uses advanced software to offer next-generation technology in electronic payments, financial services, peer-to-peer transactions, alternative lending and crypto-currencies.

In this paper, we will first describe the various services and technologies related to electronic payment and then introduce NEC's electronic payment solutions which integrate electronic money with multi-service readers and writers.

## 2. Overview of the Electronic Payment Service

### 2.1 Classification of Electronic Payment

The term "electronic payment" encompasses a broad range payment methods. In this paper, however, we will define it as a means of payment used at sales points in the value chain. In other words, payment is made using electronic means when a customer purchases a product or service.

Electronic payment services can be classified into several different types.

**(1) Classification according to credit guarantee**

1) Prepaid: The user deposits a certain amount of money into an account, and electronic payment is possible within that range.

2) Debit: The transaction amount of electronic payment is debited from the user's bank account immediately (or within a few days).

3) Credit: The user can make a payment up to a certain limit based on their credit and pays the credit provider after use.

**(2) Classification according to usable locations**

1) Closed type: Electronic payment can only be used at locations owned by the company underwriting the payment - for example, electronic payment cards or mobile payment apps issued by coffee shop chains that can only be used at their stores.

2) Open type: Electronic payment can be widely used for services other than those provided by the company that offers the means of payment - for example, transportation system electronic payment cards.

3) International brand type: This is another form of open-type electronic payment. which has an international network like Visa or MasterCard.

**(3) Classification according to the technology in use (the payment device a user has)**

1) Magnetic stripe card: Cards with bands of magnetic material.

2) Barcode: Cards are affixed with barcodes that can be read by a reader on a POS cash register. Barcodes can also be displayed on mobile device screens.

3) Contact-type IC card: Cards with an IC chip compliant with the ISO7816 standard.

4) Non-contact type card: Non-contact cards with an IC chip compliant with the ISO18092 NFC standard.

5) Mobile device: Smartphones and other mobile devices are used for payment. There are various methods; a barcode is displayed on screen (in the same way as a magnetic stripe card), a built-in NFC function is used (in the same way as a non-contact IC card), a camera is used, and SMS[*1] is used.

6) Biometrics: Users are identified using biometric technology such as fingerprint authentication and face authentication -which is used as an ID for payment.

Means of electronic payment used in retailing are typically classified into one or more of these. For example, Suica -which is transportation system electronic money used in the Kanto District of Japan - is an open-type prepaid card.

### 2.2 Electronic Payment Schema

The players involved in the electronic payment service are shown in **Fig. 1**.

- Brand: An underwriter that plans the schema of electronic payment itself, such as Visa or MasterCard.
- Issuer: An underwriter that issues the right and medium (card, etc.) to use the electronic payment to users.
- Merchant (authorized outlet): An underwriter that offers the services and goods that are the subjects of the payments made by users using the electronic payment service, such as retail shops.
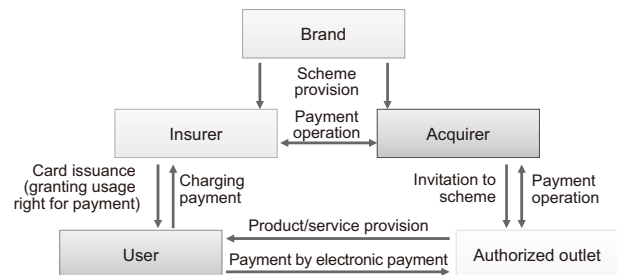


Fig. 1 Electronic payment schema.

- Acquirer (authorized outlet development): Promotes usage of electronic payment services and settles accounts with the authorized outlets.
- Users: The actual people who use electronic payment services.

### 3. System and Technology of Electronic Payment

#### 3.1 Overview

The typical electronic payment process is described below. In this case, a closed type prepaid electronic IC card is used as an example (**Fig. 2**).

A typical electronic payment transaction involves three systems: payment servers, payment terminals, and payment media.

Payment servers manage users of the electronic payment service, prepaid payment balances, and authorized outlets, authorizes and executes payment transactions, calculates and tabulates accounts, and functions as the core of the entire system. The servers are also responsible for the back-end operations including the settlement of accounts between participating players, user support, and the detection of fraudulent transactions.

Payment terminals installed at authorized outlets read and write the electronic payment cards to execute payment.

Payment media are the devices used for payment - in the forms of a card, mobile phone, or smartphone.

#### 3.2 Security

Because monetary value is involved, security is critical to electronic payment systems. The security technology used in the electronic payment system is described below (**Fig. 3**).

**(1) Identity verification**

The identity of the card user needs to be verified to prevent fraudulent use by a third party. Verification methods include credit card signature, PIN code[*2] entry, and fin-

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[*1] Stands for short message service. Using a mobile phone number, this service sends and receives short messages.
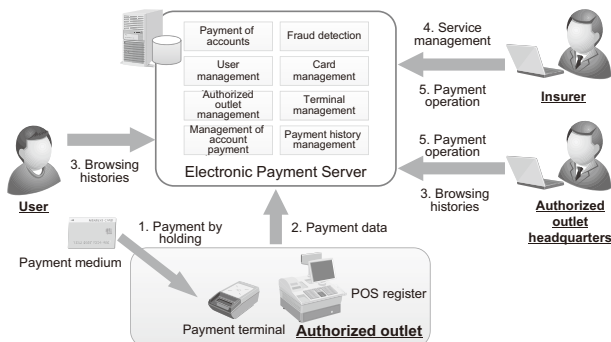
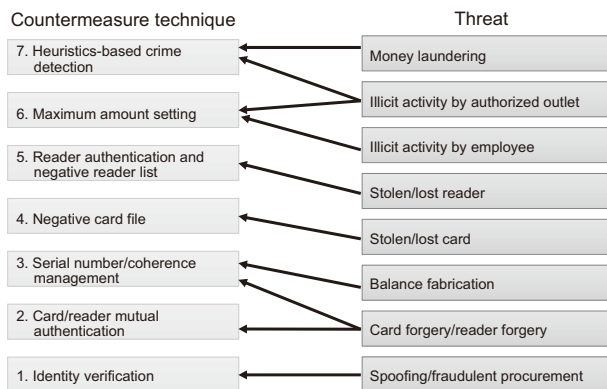Fig. 2 Overview of the electronic payment system.



Fig. 3 Electronic payment security technique map.

gerprint authentication.

**(2) Card/reader mutual authentication**

To prevent forgery and illicit use of payment media, mutual authentication between cards incorporating IC chips and readers is performed to confirm validity.

**(3) Serial number/coherence management**

Serial numbers are issued for all transactions according to cards and readers. Confirmation of missing and redundant numbers helps detect card forgery and illicit manipulation of balances.

**(4) Negative card file**

Card numbers of lost and stolen cards are registered in a usage prohibition list (negative card file). Cards listed in this file are no longer usable. The negative card file is stored either on the electronic money server or the reader.

**(5) Reader authentication and negative reader list**

Readers need to be authenticated when they are first put into service and periodically thereafter. The serial numbers of lost and stolen readers are registered in a negative reader list in the server. This can prevent illicit transactions using stolen readers.

**(6) Maximum amount settings**

Limits are normally set on the maximum amount permitted for a transaction on an electronic payment systems. These include the amount that can be handled by one reader per day and the amount that can be handled by one card per day or month. This helps minimize potential damage when a card or reader is used illicitly.

**(7) Heuristics-based crime detection**

In addition to the measures described in (1) to (6) above, each electronic payment system has a built-in mechanism to detect fraudulent activity based on heuristics. For example, if a user who has only ever made payments in Japan suddenly makes a payment overseas, if a user who has only made small transactions suddenly starts making repeated transactions over a short period of time, or if many people who default on their card loans at a specific store, that user or store can be considered suspicious.

As we have seen, the electronic payment systems adopt various measures against fraud and criminal activity. Security is further enhanced by taking multiple measures against each threat in a multi-layered way.

## 4. NEC's Electronic Payment Solutions

NEC offers a wide range of solutions designed to facilitate the introduction of electronic payment services. This section introduces two solutions suitable for retail organizations.

### 4.1 Integrated Electronic Money Solution

This is a solution ideal for a retail company that wants to implement its own electronic money service.

NEC's integrated electronic money solution combines an electronic money payment server, payment terminal, and payment medium (card) (**Fig. 4**). This eliminates the hassle of integrating different products, allowing retail organizations to quickly launch their own electronic money service.

As for the payment terminal and payment medium, various technologies such as IC cards, barcodes, or magnetic stripe cards can be used. Moreover, the integrated electronic money payment solution also integrates various types of electronic payment, allowing consumers to remit money as well as make payments at retail stores.

### 4.2 Multi-service Reader/Writer

This is a solution that enables handling of multiple electronic money payment services with one payment terminal.

To make it possible to handle multiple electronic payment services using one terminal, the terminal's dataspace is divided

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*2 Stands for personal identification number. Comprised of 4 to 16 alphanumeric characters.
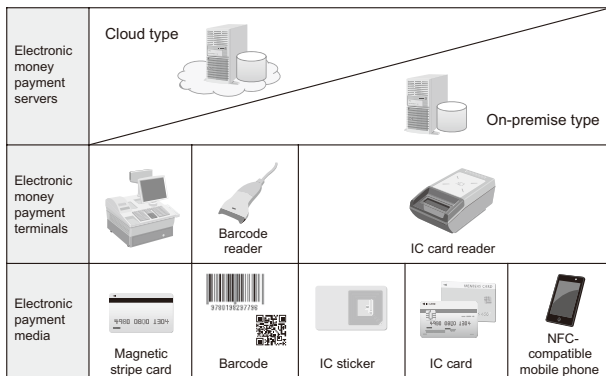
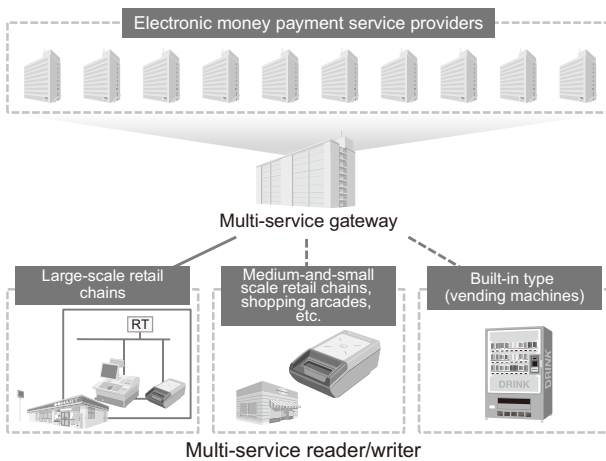Fig. 4 Overview of integrated electronic money payment solution.



Fig. 5 Overview of the multi-service reader/writer.

into multiple security domains. Since the payment program that works in a given domain cannot refer to the data in any other domain, security keys, and programs, multiple electronic money services can coexist safely.

There are also centers called multi-service gateways (MS-GWs) that connect the terminals with multiple electronic money payment service providers. The MSGWs are connected to the servers of about ten electronic payment service providers in Japan and relay the payment history data and negative data (**Fig. 5**).

With these two capabilities, the multi-service reader/writer system makes it possible to offer multiple electronic payment services.

## 5. Future of Electronic Payment Service

As discussed in the introduction, methods of payment are increasingly shifting from cash to electronic payment. Electronic payment services are expected to have a profound impact on the selling of goods and services, potentially creating brand-

new products and services that would not be possible without electronic payment.

For example, a ride sharing service called Uber allows people to book a ride from their smartphones. Instead of paying the driver directly, they make the payment to Uber via electronic payment. This reduces payment-related problems and gives Uber more flexible control over fares. In this way, electronic payment has gone beyond being a mere convenience and has become the very foundation of a business.

Another trend of a different kind is electronic money such as Bitcoin. The forms of electronic payment we have looked at so far are all guaranteed by the trustability of banks and financial networks. In other words, there are enterprises that manage electronic payments, and those enterprises control the information and money flow.

BitCoin, on the other hand, uses a mechanism called P2P, which is a mesh-like interconnection of a vast number of computers, and sophisticated encryption technology that allows the Bitcoin payment system to function without a key entity playing a central role in the operation. Because there is no central entity, it is not easily susceptible to government control, making it usable even in politically unstable countries and regions. However, it has been pointed out that untraceability and lack of government oversight can also make Bitcoin a hotbed of illicit transactions.

In the future, we will need to pay close attention to how new systems of electronic payment like this will affect the world.

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* Uber is a registered trademark of Uber Technologies, Incorporated.

* Other company names and product names are trademarks or registered trademarks of their respective companies.

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