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**Smart community infrastructures —  
Guidance on smart transportation  
with the use of digitally processed  
payment (d-payment)**

*Infrastructures urbaines intelligentes — Recommandations pour le  
transport intelligent utilisant les paiements numériques*

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Published in Switzerland

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 268, *Sustainable cities and communities*, Subcommittee SC 1, *Smart community infrastructures*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

## Introduction

Each day a huge number of city residents and visitors use transportation services by paying fares for every ride in and between cities. Fast ticket processing for these customers is required in order to avoid congestion in ticket offices and at ticket vending machines. In some transportation services, operators do not sell tickets but request that customers pay the exact fare as no change is given. Payment of transportation fares is normally in local currencies, including hard currencies. International travellers have to pay their travel costs in such currencies after having exchanged money in advance. Credit cards are an option for payment but not all cards are accepted in some places, especially when paying small amounts.

Thus, easy procedures for the payment of precise amounts are indispensable in city life and business activities, including transportation rides. In transportation and its related or additional services, customers have to pay many kinds of fees besides transportation fares. They want to pay in their preferred ways, which can include a variety of options. Proper collection of fares or fees in an easy way assists the business of transportation and leads to sustainable local services for citizens, since the business is financially stabilized with reduced handling costs and the avoidance of fee receipt failure.

Digitally processed payment (d-payment) is a method of paying fees using a digital form of an existing and circulated currency, which works like common coins and paper bills. The sums of fares or fees collected in the services are extremely large, even though the amount paid by customers for each transaction is small. Therefore, the payment system requires high security, not necessarily just for the protection of customer payments but also to protect operators from, for example, theft by employees who directly handle and manage cash.

This document describes the concept of d-payment in transportation and its related or additional services, and its safe management and practical application thereof, which will be helpful to citizens and city visitors using such services and beneficial to the service operators.

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# Smart community infrastructures — Guidance on smart transportation with the use of digitally processed payment (d-payment)

## 1 Scope

This document provides guidance on how to organize and implement smart transportation by digitally processed payment (d-payment) in order to provide a safe, convenient payment method for citizens and city visitors in transportation and its related or additional services. This will additionally benefit operators managing fee receipt in transportation services and money transfer or transactions between these business operators and banks or settlement organizations.

Smart transportation by d-payment is not intended to eliminate cash payment from transportation services but is helpful in organizing inter-operator, city, regional and national common ticket networks and providing trading services independent of local currencies.

## 2 Normative references

There are no normative references in this document.

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

### 3.1

#### **smart transportation by d-payment**

transportation and its related or additional services in which payment is digitally processed

### 3.2

#### **digitally processed payment**

#### **d-payment**

currency forms operated, managed and controlled in mathematical algorithms like actual currencies having circulation and trading functions, which are cashable or exchangeable for hard currencies through transactions using digital wallets

### 3.3

#### **d-payment wallet**

digital account managed by using public-key cryptography

## 4 Concept of smart transportation by d-payment

### 4.1 General

Cash payment in transportation causes difficulties for both customers and operators. Operators have to be prepared to receive cash that is not easy to manage, since coins and paper bills are heavy and take up

space. Non-cash payment, typically with credit cards and pre-paid cards, is convenient for both. However, even then customers have to hold these cards and not all card readers work with all types of card.

Thus, fast and simple payment procedures without cash or cards with limited applicability are needed, especially when purchasing tickets at ticket offices and vending machines and when taking bus, tram or ferry rides. In ticketing procedures, payment processes take time. Therefore, some operators do not give change. Easy payment encourages citizens to take casual rides as people hesitate to use transportation services over short distances when they don't have the exact or small change. Pre-paid cards were developed to provide customers with a means of non-cash payment, and the number of passengers using these has increased. If payment can be digitally transacted independently of hard currencies, including such cards, the result is pure non-cash payment.

D-payment is applicable in the transportation services designated in ISO 37154:2017, 5.2.6 and 6.3.4.

## 4.2 Capability of d-payment in transportation

Smart transportation by d-payment for transportation and related or additional services, as designated in this document, where a large number of transactions are carried out by the provider, offers convenience, high security, improved efficiency, low cost, easier settlement and operational traceability aimed at simple and safe payment. It has the following characteristics:

- non-centralized, end-to-end transaction modes;
- public-key cryptography to ensure high efficiency and low-cost transactions;
- convenience and security;
- online or offline payment transactions;
- tamper-free and non-repudiated transactions;
- tractable trading.

These characteristics ensure security in smart transportation and avoid potential forgery.

## 4.3 Satisfaction of SDGs

Smart transportation by d-payment supports the United Nations' Sustainable Development Goals, in particular goal 8, 'Decent work and economic growth', goal 9, 'Industry, innovation and infrastructure', goal 10, 'Reduced inequalities', goal 11, 'Sustainable cities and communities', goal 12, 'Responsible consumption and production' and goal 15, 'Life on land'.

# 5 Expectations for smart transportation by d-payment

## 5.1 Background

### 5.1.1 Local services

D-payment is recommended in any transportation for local commuting within a city, between cities and in large city zones and in transportation-related or additional services. Particularly in the services used by the customers listed in [5.2](#), d-payment should be installed for customer convenience and to reduce the difficulties experienced with conventional payment methods.

### 5.1.2 International services

The adoption of d-payment into the transportation business makes payment procedures easier for foreign travellers. This is especially critical for international services at border crossings and international airports, rail or bus stations and ferry terminals. Even if a city is not internationally accessible, d-payment is preferable and far more convenient for foreign visitors. The availability

of d-payment will attract more visitors to a city, enhancing the city's marketability and resulting in increased local economic activity.

**NOTE** A typical example is Kyoto, Japan. The city has no international airports, rail or bus stations or ferry terminals but is always full of visitors from outside the country. However, there are not many money exchange booths and not every shop or restaurant accepts credit card payment. This results in unnecessary delays for foreign visitors needing transportation services and making business transactions. Furthermore, it impacts local citizens' use of these services.

The simplified procedure of d-payment is a great help to visitors and also to local people, as the former pay for their visit to a city while the latter receive payment from visitors and also pay for anything necessary for their own daily life.

### 5.1.3 Operators' internal management

D-payment can prevent employee fraud when dealing with cash and managing fee payments. In d-payment, no cash is dealt with and every transaction is traceable due to the recording of information, such as what time, by whom, to whom and the number of transactions made. Security algorithm changes are also recorded.

## 5.2 Customers who prefer d-payment

Customers will likely prefer the use of d-payment in transportation services to having to prepare the exact change in advance of a ride. This is of particular benefit to the following types of customers:

- small children;
- people with disabilities;
- elderly citizens;
- those travelling with the elderly, small children or people with disabilities.

## 5.3 D-payment effective business fields

In any service fields, including transportation services, d-payment is effective, especially in the specific transportation and its related or additional services that are designated by ISO 37157, ISO 37158, ISO 37159, ISO 37162 and ISO 37163.

## 5.4 D-payment effective situations

D-payment is effective in the situations listed below, which take place in transportation and its related or additional services:

- when travelling in and shipping delivery items and freight from international cities (e.g. Singapore, Hong Kong and Shenzhen, Macao and Zhuhai, San Diego and Tijuana, El Paso and Ciudad Juárez);
- when travelling in and shipping delivery items and freight from cities close to a border;
- when travelling in and shipping delivery items and freight from cities with international rail or bus stations (e.g. London, Paris), ferry terminals (e.g. Shanghai) and airports;
- when shopping in passport-controlled areas in international rail or bus stations, ferry terminals and airports;

**NOTE** In such areas travellers do not always have local currency to buy articles, since they have not yet exchanged their money to local currency after arriving or have used up their local currency before leaving the country.

- when travelling in and shipping delivery items and freight from cities frequented by overseas travellers (e.g. Kyoto in Japan, Wuxi in China).

## 6 Features of d-payment

D-payment used in smart transportation has specific characteristics and advantages:

- the equivalent in d-payment exchangeable for reserve currencies, such as US dollars, Euros and Chinese Yuan, that are further exchangeable for local currencies;
- quick payment through decentralization or point-to-point direct transactions;
- free exchange of local currencies with the d-payment equivalent of reserve currencies and vice versa;
- no specific machine-required transaction supported with mobile terminals (e.g. mobile phones and smartphones, tablets, PCs) and through telecommunication or internet services.

NOTE Transactions using mobile terminals are known as mobile or air payments.

## 7 Security of smart transportation by d-payment

### 7.1 General

In transportation and related or additional services, quick transactions are required. Transportation services operate on a set schedule, with on-time performance critical. Delays should only be incurred if safety is at issue. Security for smart transportation by d-payment can help to achieve these goals by:

- immediate completion of transaction procedures (e.g. mutual authentication);
- transaction communication protected from risks (e.g. modification, access, blocking, destruction, technological vulnerability);
- low cost to service providers for transactions.

Security is the most important procedure in smart transportation. As a minimum, d-payment security should provide the following for the handling of d-payment:

- fluidity;
- controllable anonymity;
- prevention of forgery;
- avoidance of in-error repeatable transactions;
- non-repudiation;
- avoidance of money laundering.

This security technical framework enables and ensures a successful implementation of d-payment in transportation and related or additional services. D-payment consists mainly of security, transaction, identification and certification processes.

### 7.2 D-payment wallet security

Transactions through d-payment wallets are secured by public-key cryptography using digital signatures and private and public keys.

NOTE In public-key cryptography, all participants in d-payment can obtain any public key, while private keys are hidden by the respective participants. When sending money to a recipient by d-payment, the sender uses a digital signature encoded with their private key that must match their public key. The recipient uses a digital signature encoded with their private key that must match their public key. Eventually, the sender and recipient can recognize each other for the right d-payment process.

To ensure that d-payment is highly secure, temporary public and private keys should be created by a money sender and a recipient. Furthermore, to confirm matching of private and public keys, a temporary matching field should also be created. The sender's private key, created by the sender, and the sender's public key, created by the recipient using a common algorithm, are combined in a temporary matching field also created by the recipient. In the same way, a temporary field is created by the sender in which the recipient's private key, created by the recipient, is combined with the recipient's public key, created by the sender, in the same algorithm. When both combinations in the two fields are successfully matched, they recognize each other with higher accuracy. To obtain the highest security, all personal object data or public and private keys and matching fields should be temporary and used only once. To quickly process the d-payment, an agreement on the procedure to use a common algorithm to create temporary keys and fields should be made between the participants in advance. The procedure can then be completed in about 200 ms.

**NOTE** In transportation services in China, especially bus, subway, ferry and shared bicycles, this procedure must be completed in 350 ms to avoid congestion and service delay caused by slow payment procedures.

To prevent criminal behaviour such as money laundering, any d-payment accounts should be personally owned. A maximum transaction limit for d-payment should be set.

## 8 Operation of smart transportation by d-payment

Smart transportation by d-payment can be operated by both online or offline transactions in order to ensure easy and fast payment in transportation and its related or additional services.

D-payment using smart phones is practically useful, since almost every money sender and recipient has such a device. This payment method is called mobile payment and carried out through common mobile communication networks, payment platforms and connections to other mobile terminals (e.g. PC). Users can complete transactions by combining preferred mobile terminals, for example, from a d-payment wallet to a d-payment wallet, a physical card and a mobile phone having a d-payment wallet.

## 9 Management of smart transportation by d-payment

### 9.1 General

Smart transportation by d-payment should be managed by establishing transaction security-trusted infrastructures, registration centres, payment and transaction communication modules, terminal application modules and other necessary items.

### 9.2 Security-trusted infrastructures for d-payment systems

#### 9.2.1 General

The security and credibility infrastructure of d-payment systems consists primarily of credible service management modules and big data analysis centres.

#### 9.2.2 Credible service management modules

Credible service management modules secure safe d-payment transactions by covering support to access from related business to, application and management of and authentication and authorization for d-payment.

#### 9.2.3 Big data analysis centres

Big data analysis centres ensure the security of d-payment transactions to prevent fraudulent transactions, black money laundering, terrorist financing and other illegal activities through customer transaction analysis using big data and cloud computing technologies. Big data analysis centres provide references for the payment flux and cycle of d-payment in smart transportation.

#### 9.2.4 Registration centres

Registration centres should record the following information:

- corresponding relationships between d-payment and its user identity information;
- transaction flows in d-payment.

Registration centres also complete the registration of transaction processes of d-payment in smart transportation.

#### 9.2.5 Transaction communication modules

Transaction communication modules should support transaction communication both online and offline. Through the internet and offline trading communication (e.g. NFC, bluetooth), d-payment can provide online and offline intelligent terminal services, respectively.

#### 9.2.6 Terminal application modules

Terminal application modules should include mobile terminals that work as modules for client management and terminal security. Mobile terminals are held by d-payment users or consumers and merchants.

### 10 Quality maintenance of smart transportation by d-payment

#### 10.1 General

To maintain smart transportation by d-payment, observe the parameters in [10.2](#) regularly and make corresponding evaluations to improve the quality of the smart transportation services. This will assist with planning and implementation of d-payment in other geographical areas or business fields in the future.

#### 10.2 Parameters to be observed

The following parameters can be used to compare smart transportation performance. Use appropriate units for observation.

- number of times that d-payment is chosen as a payment method when customers order articles or services in transportation and its related or additional services;
- time duration spent by customers for d-payment;
- security verification number taken in d-payment;
- security verification time duration taken in d-payment;
- number of agencies and business activities using d-payment (e.g. per month);
- measures provided by agencies and in business activities using d-payment in order to protect users' privacy from disclosure;
- d-payment introduction or application ratio in target cities or regions where smart transportation is installed;
- economic indicators in target cities or regions where smart transportation is installed;
- number of operational failures in d-payment;
- citizen facilitation indicators specified in ISO 37120 and ISO 37122.