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Intelligent transport systems — Interoperability between interoperable fare management (IFM) systems and near field communication (NFC) mobile devices

Systèmes de transport intelligents — Interopérabilité entre les systèmes de gestion tarifaire interopérables (IFM) et les dispositifs mobiles à communication en champ proche (NFC)

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Foreword

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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).

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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.

This document was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

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.

Introduction

Globally, the increasing use of mobile devices and mobile services is one of the most visible trends. Public transport can benefit from this development since new products and services, such as multi-modal travel and traveller information, can be addressed more easily if the customer uses his or her mobile device as the interface to his or her service provider.

In order to take advantage of these new opportunities, the public transport industry can integrate customers' mobile devices with existing public transport fare management systems and ensure technical interoperability with the existing public transport infrastructure of contactless readers and media.

Today, the vast majority of mobile devices are equipped with a near field communication (NFC) interface and can in principle communicate with contactless public transport readers and media. However, globally there are several specifications for contactless interfaces in the industry which can deviate in some details from those for mobile devices. If no precautions are in place, such deviations have the potential to lead to interoperability issues.

A joint working group with participants from the global public transport sector, ISO, the NFC Forum, GSMA and CEN has started to address this issue over the past few years. As a result, there are now specifications and certification schemes in place that will make sure that mobile devices which follow the newly developed specifications for the NFC interface will support technical interoperability with the globally relevant standards for contactless interfaces of public transport devices.

This document presents the results of this work and can provide guidance to owners of interoperable fare management systems [interoperable fare management system suppliers, public transport (PT) operators, PT authorities] on how technical interoperability with NFC mobile devices can be achieved.

Intelligent transport systems — Interoperability between interoperable fare management (IFM) systems and near field communication (NFC) mobile devices

1 Scope

This document presents methods to establish technical interoperability between the contactless interfaces of NFC mobile devices and those of public transport readers and customer media. It provides information on how to apply these for public transport fare management systems which are using ISO/IEC 14443 and/or ISO/IEC 18092 and/or EMV® Contactless Interface Specification[1)] [9] as a basis for contactless communication.

This document deals with the application of standards, specifications and certification schemes from other organizations and standards bodies. These organizations and standards bodies are solely responsible for the content and the maintenance of these standards, specifications and certification schemes.

This document focuses on the technical interoperability of the contactless interfaces of NFC mobile devices and public transport devices. The goal is to reliably support communication and the exchange of data. Syntactic and semantic interoperability, i.e. the support for a particular public transport fare management application, is not covered by this document. However, practical experience shows that if technical interoperability is established successfully, the adoption of a specific public transport application can typically be achieved by loading the fare management system's particular application software onto the NFC mobile device.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 10373-6, *Cards and security devices for personal identification — Test methods — Part 6: Contactless proximity objects*

ISO/IEC 14443 (all parts), *Cards and security devices for personal identification — Contactless proximity objects*

ISO/IEC 18092, *Information technology — Telecommunications and information exchange between systems — Near Field Communication — Interface and Protocol (NFCIP-1)*

ISO/IEC 22536, *Information technology — Telecommunications and information exchange between systems — Near Field Communication Interface and Protocol (NFCIP-1) — RF interface test methods*

ISO/IEC 23917, *Information technology — Telecommunications and information exchange between systems — NFCIP-1 — Protocol Test Methods*

ISO 24014-1, *Public transport — Interoperable fare management system — Part 1: Architecture*

ISO/IEC/TS 24192-1, *Cards and security devices for personal identification — Communication between contactless readers and fare media used in public transport — Part 1: Implementation requirements for ISO/IEC 14443 (all parts)*

1) This trade name is provided for reasons of public interest or public safety. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO.

ISO/IEC/TS 24192-2, *Cards and security devices for personal identification — Communication between contactless readers and fare media used in public transport — Part 2: Test plan for ISO/IEC 14443 (all parts)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 10373-6, the ISO/IEC 14443 series, ISO/IEC 18092, ISO/IEC 22536, ISO/IEC 23917, ISO 24014-1, ISO/IEC TS 24192-1 and ISO/IEC TS 24192-2 and the following apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
Type F
communication signal interface

Note 1 to entry: Conforms with the requirements for bit rates of *fc*/64 and *fc*/32 in ISO/IEC 18092.

3.2
technical interoperability
ability to establish communication between devices and support data exchange

4 Abbreviated terms

GCF	Global Certification Forum
GSMA	GSM Association
IFM	interoperable fare management
JRE	East Japan Railway Company
NFC	near field communication
PT	public transport

5 General considerations

5.1 Interoperability across different specifications

Globally, four different standards or specifications for the contactless interface cover most of the deployed public transport fare management systems:

a) ISO/IEC 14443 series;

b) ISO/IEC 18092;

c) EMV Contactless Interface Specification[9];

d) NFC Forum specifications (Analog, Digital, Activity)[2]–[6].

NFC mobile devices are designed for the global market. Adaptations for single markets or technologies are typically not supported by the mobile industry. In order to take advantage of the existing global public transport fare management infrastructures, the NFC interface of mobile devices supports interoperability with all the previously mentioned contactless specifications.

5.2 Need for continuous, synchronized maintenance

The standards or specifications mentioned in 5.1 are owned and maintained by individual bodies and working parties. In order to guarantee interoperability for current and future versions, the responsible bodies establish continuous working relationships that support alignment and synchronization before any changes are released.

Liaisons which established harmonization of contactless specification releases are in place between the bodies that maintain the NFC Forum specifications, the ISO/IEC TS 24192 series, ISO/IEC 18092 and the EMV Contactless Interface Specification, as well as the related communication signal interfaces.

The continuous working relationships between these specification bodies ensures future-proofed interoperability between PT devices and NFC mobile devices.

5.3 Relevance of certification

Public transport fare management systems which employ a variety of devices from different suppliers use specific measures to ensure technical interoperability of the contactless interfaces. This applies all the more if NFC mobile devices, which are external to the interoperable fare management system manager, will be used as a customer medium or as access devices to customer media:

a) To achieve technical interoperability, the contactless interfaces of the relevant devices conform with the same specifications or alternatively with specifications which are harmonized.

b) Practical experience shows that conformity to the necessary specifications can be reliably achieved if the devices pass specific testing. In that situation, test cases for these specifications and a neutral, trustworthy body that monitors testing and certifies the conformity to the requested specification can be used as a basis to establish conformity successfully.

6 Description of the solution for interoperability

6.1 Approach

The market-relevant standards and specifications for contactless proximity interfaces are implementing requirements from different markets or applications and are maintained by dedicated standardization or industry bodies. Deviations between particular parameters of these standards or different concepts for testing are justified by different device or application requirements. Current standards and specifications and the responsible bodies will keep their role in their markets.

Therefore, it was recognized that a complete harmonization of these standards would not be practical. Instead, the approach focused on establishing technical interoperability between the relevant standards and specifications by harmonization of just those parameters that are necessary for technical interoperability. The specifications and test concepts for the contactless proximity presented in Table 1 were included in this process.

Table 1 — Specifications and responsible bodies

Body	Specifications	Communication signal interface	Target devices
NFC Forum	NFC Forum specifications	Type F and ISO/IEC 14443	NFC mobile devices
ISO/IEC JTC1/SC17	ISO/IEC TS 24192-1 ISO/IEC TS 24192-2[a]	ISO/IEC 14443	ISO/IEC 14443-conformant PT readers and PT objects
ISO/IEC JTC1/SC6	ISO/IEC 18092	Type F and ISO/IEC 14443 Type A	Type F PT readers and PT objects
[a] Provides guidance to enable PT readers to achieve both the ISO/IEC TS 24192 series and EMVCo L1 certifications.			

Table 1 *(continued)*

Body	Specifications	Communication signal interface	Target devices
EMVCo	EMV Contactless Interface Specification	ISO/IEC 14443	PT readers accepting EMV contactless payment applications on smart cards or mobile devices

[a] Provides guidance to enable PT readers to achieve both the ISO/IEC TS 24192 series and EMVCo L1 certifications.

An important goal of the concept is that NFC mobile devices support all contactless interface specifications which are relevant in public transport.

6.2 Partners, roles and responsibilities

In order to implement the approach in 6.1, the following activities were implemented:

a) The NFC Forum used its liaison relationships with ISO/IEC JTC1/SC17, which is responsible for ISO/IEC 14443, and EMVCo for harmonization of critical parameters of the NFC Forum's NFC Analog Specification with ISO/IEC 14443 and EMV Contactless Interface Specification.

b) GSMA and the NFC Forum established a joint PT working group which involved PT stakeholders from Japan, Europe, the US and CEN's activity for ISO/IEC TS 24192. This group identified the PT-specific requirements to the contactless proximity interfaces of mobile and PT devices and introduced these into the technical harmonization work.

c) ISO/IEC JTC1/SC17 generated the first edition of ISO/IEC TS 24192-1 and ISO/IEC TS 24192-2 which support implementation and testing of ISO/IEC 14443-conformant PT devices and are synchronized with the NFC Forum's Analog Specification.

d) JRE reviewed ISO/IEC 18092 in order to make sure that the requirements of Type F PT devices were fully covered.

e) Certification processes for NFC mobile devices and PT devices were established.

f) GSMA transferred all requirements for interoperability of NFC mobile devices into certification by the GCF.

As result, the following work split was defined:

— The contactless interface of NFC mobile devices was implemented and tested according to the NFC Forum's NFC Analog and Digital Specifications and Test Cases for Analog and Digital.

— The NFC Forum's specifications for the contactless interface and all other requirements to NFC mobile devices which apply to operate mobile services for PT are referenced by GSMA in TS.26[7].

— ISO/IEC TS 24192-1 and ISO/IEC TS 24192-2 apply to establish interoperability for ISO/IEC 14443-conformant PT devices.

NOTE Interoperability for ISO/IEC 14443-conformant PT devices was initially developed and based on CEN/TS 16794-1 and CEN/TS 16794-2. While these documents remain applicable, interoperability for ISO/IEC 14443-conformant PT devices is now being based on ISO/IEC TS 24192-1 and ISO/IEC TS 24192-2.

6.3 Implementation of interoperability of the contactless interface

6.3.1 Concept for NFC mobile devices

As stated in 5.1, NFC mobile devices support interoperability with the globally relevant contactless specifications for PT devices.

This interoperability is established for reader/writer and card emulation modes of NFC mobile devices so that they can be used in the following modes of operation:

a) medium access device (reader) for PT objects;

b) PT objects that react to PT readers.

The NFC Forum's NFC Analog and Digital Specifications and Test Cases for Analog and Digital support interoperability of NFC mobile devices with ISO/IEC 14443-conformant PT devices as well as Type F PT devices. They apply to NFC mobile devices which are used for NFC-enabled mobile services in PT. The NFC Forum's specifications also support co-existence with EMVCo L1 certification for NFC mobile devices.

Important aspects to interoperability are the very different innovation frequencies in the mobile and PT markets. Mobile device manufacturers release annual updates to their products while PT readers are typically deployed for 10 or more years of lifetime. Changes to PT infrastructures can be implemented only in the long term. In order to minimize the need for changes to existing PT infrastructures, the NFC Forum's specifications for NFC mobile devices have been changed to support PT devices which conform to the current editions of ISO/IEC 14443 and ISO/IEC 18092.

The NFC Forum's certification scheme offers certifications for contactless frontend chips and NFC mobile devices. It covers analogue and digital testing. In addition, certification of NFC mobile devices for compliance with the NFC Forum's Test Cases for Analog was implemented by the GCF as part of the standard certification process for mobile devices.

6.3.2 Concept for ISO/IEC 14443-conformant PT devices

The NFC Forum's and EMVCo's specifications, which are both applied to NFC mobile devices, use a very different principle for testing and for the definition of some parameters than ISO/IEC 14443. A direct comparison of these parameters and specific values is not possible. In order to be able to judge if interoperability is supported, the NFC Forum developed a concept[1] that allows the translation of parameter values between ISO/IEC 14443 and the NFC Forum's NFC Analog specification. In this way the harmonization or the relevant parameters became practical.

Also, a systemic deviation between the NFC Forum's NFC Analog Specification and ISO/IEC 14443 had to be addressed. ISO/IEC 14443 mandates PT media access devices to support customer media with antennas down to sizes of Class 3 only. In practice, antennas in NFC mobile devices can be much smaller than Class 3. The NFC Forum's NFC Analog Specification compensates for this deviation by making sure that an NFC mobile device always behaves as if it would have at least a Class 3 antenna. This way, changes to existing PT media access devices can be avoided.

ISO/IEC 14443 is a standard that targets a variety of applications. Some requirements from PT are not specified in ISO/IEC 14443 or are more demanding than the specified limits in ISO/IEC 14443. One example is the minimum operating distance which is important in PT for usability and minimization of transaction times. In order to address the specific demands of PT devices, ISO/IEC JTC1/SC17 developed ISO/IEC TS 24192-1 for the implementation of PT devices and ISO/IEC TS 24192-2 for their testing. These specifications guarantee full ISO/IEC 14443 conformity of PT devices and also apply the details which are necessary for operating PT fare management services. A minimum operating distance of 4 cm is supported when implementing an "IFM reader" as defined in ISO/IEC TS 24192 and 0,5 cm when implementing a "Common Reader".

ISO/IEC TS 24192-1 and ISO/IEC TS 24192-2 are synchronized with the NFC Forum's NFC Analog 2.0 specification and NFC Digital 1.1 (or later) specification, thereby supporting the interoperability of the contactless interfaces of PT and NFC mobile devices.

6.3.3 Concept for ISO/IEC 18092-conformant Type F PT devices

Basically, conformity with ISO/IEC 18092 is an integral part of the NFC Forum's NFC Analog Specification for the contactless interface of NFC mobile devices. Also, the NFC Forum's Digital and Activity specifications are defined based on ISO/IEC 18092 and ISO/IEC 14443. Results from the NFC

Forum's Test Cases for Analog and Digital can be directly compared with the results from testing of Type F Public Transport devices according to ISO/IEC 18092. NFC Forum certification also provides ensuring interoperability on the digital part between Type F PT devices and NFC mobile devices.

In addition, there are some cases where PT operators adopt only Type F PT devices for their PT services. In these cases, media access devices conformant to Type F and Customer Media conformant to Type F are certified in accordance with the parts of Type F in test and certification specifications including ISO/IEC 22536, ISO/IEC 23917 and relevant documents of NFC Forum.

6.3.4 Concept for EMV Contactless Interface Specification-conformant PT devices

At this point in time, NFC mobile devices normally pass EMVCo L1 certification, in addition to NFC Forum certification. In this case, interoperability with EMV Contactless Interface Specification-conformant PT devices is ensured through conformance to EMV Contactless Interface Specification for both PT readers and NFC mobile devices.

Only PT readers conforming with both EMV Contactless Interface Specification and ISO/IEC TS 24192 requirements accept both EMV contactless objects and PT objects.

Since some EMVCo requirements are more demanding than the specified limits in ISO/IEC TS 24192, some restrictions can apply. For instance, the anti-collision feature, which enables a customer to present multiple contactless objects to a PT reader and enables the PT reader to pick up the right PT object, is not allowed for PT readers when both EMV Contactless Interface Specification and ISO/IEC TS 24192 specifications are to be met.

6.4 Levels of interoperability

Three levels of interoperability can be achieved between PT devices and NFC mobile devices:

a) Conformity: when both reader and object are tested against the same set of specifications.

b) Interoperability: when readers and objects are tested against different sets of specifications that demonstrate technical interoperability.

c) No ensured interoperability: when readers and objects are tested against different sets of specifications that are not necessarily harmonized, which can lead to communication issues.

Table 2 summarizes the level of interoperability that can be achieved according to the types of contactless objects and contactless readers.

NOTE 1 Table 2 does not imply interoperability of PT applications between different interoperable fare management systems.

Table 2 — Concepts of interoperability between contactless objects and readers

		Contactless objects, specified and tested in accordance with:			
		NFC Forum specifications	ISO/IEC 14443	ISO/ IEC 18092-conformant Type F	EMVCo specifications
Contactless readers, specified and tested in accordance with:	NFC Forum specifications	Conformity based on NFC Forum specifications	Interoperability (see 7.2)	Interoperability (see 7.3)	No ensured interoperability
	ISO/IEC 14443	Interoperability (see 7.2)	Conformity based on ISO/ IEC TS 24192 (previously CEN/ TS 16794)	No ensured interoperability	No ensured interoperability
	ISO/ IEC 18092-conformant Type F	Interoperability (see 7.3)	No ensured interoperability	Conformity based on ISO/IEC 18092 (see 7.3)	No ensured interoperability
	EMVCo specifications	No ensured interoperability	No ensured interoperability	No ensured interoperability	Conformity based on EMV Contactless Interface Specification (see 7.4)

In order to provide a larger acceptance of object types, some PT readers can be specified and tested against several sets of specifications. For instance:

— ISO/IEC TS 24192 and EMVCo L1 certifications for PT readers willing to accept both ISO/IEC 14443 PT objects, NFC mobile devices and EMV contactless objects;

— ISO/IEC TS 24192 and ISO/IEC 18092 certifications for PT readers willing to accept both PT objects conformant to any of Type A, Type B or Type F and NFC mobile devices.

NOTE 2 All these contactless interface certifications are addressed independently of the PT ticketing applications hosted (or downloaded) in the PT objects and/or PT readers.

7 Some statements with regard to establishing interoperability in public transport infrastructures

7.1 General

Owners of public transport fare management systems who want to introduce NFC-enabled mobile services can allow only NFC mobile devices which have been certified by the NFC Forum according to Certification Release 10 (or later) or by the GCF according to Certification Release DCC V3.65 incl. NFC (or later).

The measures for interoperability of PT devices depend on the contactless standard which is used in the particular fare management system.

7.2 Ensuring interoperability for ISO/IEC 14443 PT devices

In order to ensure interoperability for public transport readers and contactless objects conformant to ISO/IEC 14443:

— the specification ISO/IEC TS 24192-1 applies;

— testing is carried out according to the ISO/IEC TS 24192-2 test specification.

The structure of standards and specifications is shown in Figure 1.

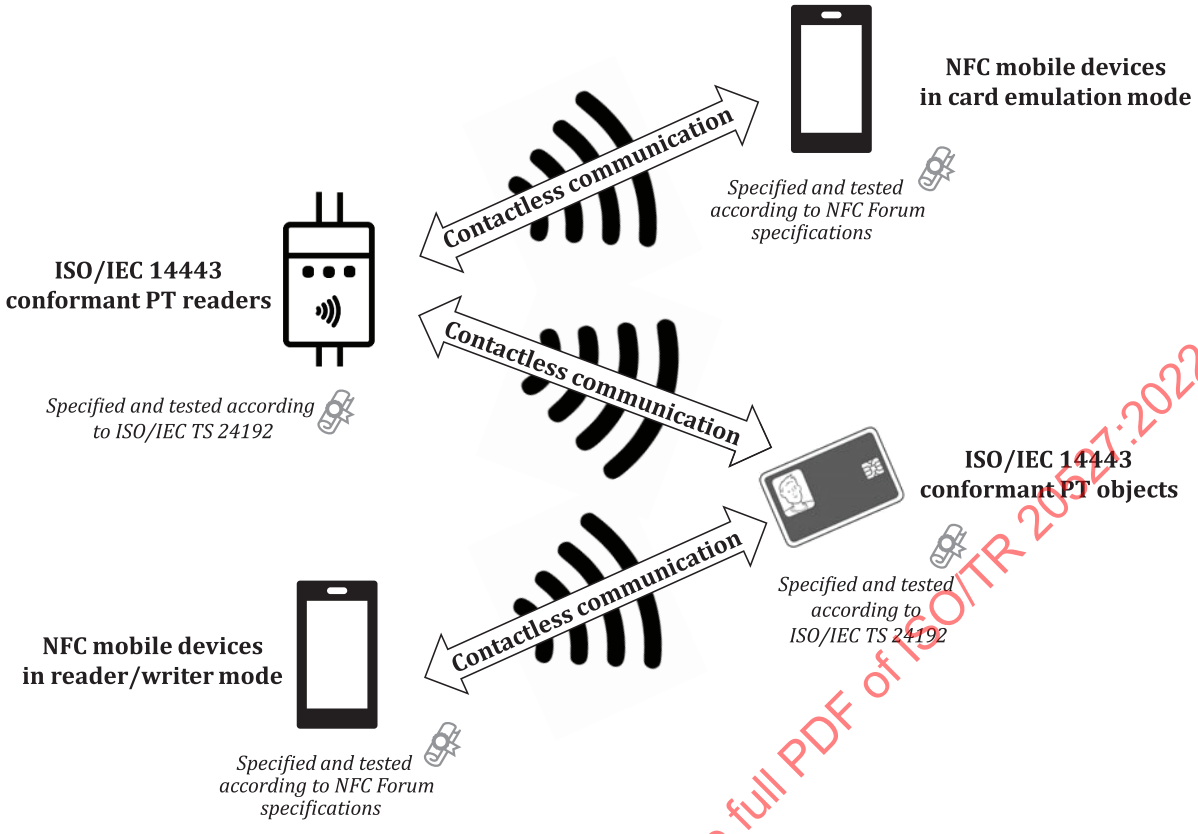

Figure 1 — Structure of standards and specifications for ISO/IEC 14443-conformant PT devices

Certification of public transport devices can be provided by the Smart Ticketing Alliance (https://www.smart-ticketing.org/).

7.3 Ensuring interoperability for ISO/IEC 18092-conformant Type F PT devices

For ensuring international interoperability, Type F PT devices conform with ISO/IEC 18092.

In addition, Type F PT devices meet national standards conforming with the definition of type F devices in ISO/IEC 18092, when it is in force. Also, PT devices meet local industrial standards and specifications, which are harmonized with global industrial specifications such as the NFC Forum's specifications.

Testing and certification are carried out according to national standards or local industrial specifications.

For Japan's use cases, Type F PT devices need to meet the national standard JIS X 6319-4[8] and local industrial standards or specifications in order to keep interoperability.

For local industrial standards and specifications, Type F PT devices currently conform with PT industrial standards, industrial specifications for e-money devices (for non-PT proprietary devices) and industrial specifications for mobile media.

The structure of standards and specifications is shown in Figure 2.