INTERNATIONAL STANDARD

ISO/IEC 13157-2

Second edition
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Information technology — Telecommunications and information exchange between systems — NFC Security —

Part 2: NFC-SEC cryptography standard using ECDH and AES

Technologies de l'information — Téléinformatique — Sécurité NFC — Partie 2: Norme de cryptographie NFC-SEC utilisant ECDH et AES

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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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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 document 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 on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

ISO/IEC 13157-2 was prepared by Ecma International (as ECMA-386) and was adopted, under a special "fast-track procedure", by Joint Technical Committee ISO/IEC JTC 1, Information technology, in parallel with its approval by national bodies of ISO and IEC.

This second edition cancels and replaces the first edition (ISO/IEC 13157-2:2010) which has been technically revised.

ISO/IEC 13157 consists of the following parts, under the general title *Information technology — Telecommunications and information exchange between systems — NFC Security:*

— Part 1: NFC-SEC NFCIP-1 security services and protocol

— Part 2: NFC-SEC cryptography standard using ECDH and AES

— Part 3: NFC-SEC cryptography standard using ECDH-256 and AES-GCM[1]

— Part 4: NFC-SEC entity authentication and key agreement using asymmetric cryptography[1]

— Part 5: NFC-SEC entity authentication and key agreement using symmetric cryptography[1]

[1] To be published.

Introduction

The NFC Security series of standards comprise a common services and protocol Standard and NFC-SEC cryptography standards.

This NFC-SEC cryptography Standard specifies cryptographic mechanisms that use the Elliptic Curves Diffie-Hellman (ECDH) protocol for key agreement and the AES algorithm for data encryption and integrity.

This International Standard addresses secure communication of two NFC devices that do not share any common secret data ("keys") before they start communicating which each other.

This edition ensures to use the latest references to cryptographic standards.

Information technology — Telecommunications and information exchange between systems — NFC Security —

Part 2: NFC-SEC cryptography standard using ECDH and AES

1 Scope

This International Standard specifies the message contents and the cryptographic methods for PID 01.

This International Standard specifies cryptographic mechanisms that use the Elliptic Curves Diffie-Hellman (ECDH) protocol for key agreement and the AES algorithm for data encryption and integrity.

2 Conformance

Conformant implementations employ the security mechanisms specified in this NFC-SEC cryptography Standard (identified by PID 01) and conform to ISO/IEC 13157-1 (ECMA-385).

The NFC-SEC security services shall be established through the protocol specified in ISO/IEC 13157-1 (ECMA-385) and the mechanisms specified in this International Standard.

3 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 10116, *Information technology -- Security techniques -- Modes of operation for an n-bit block cipher*

ISO/IEC 11770-3, *Information technology -- Security techniques -- Key management -- Part 3: Mechanisms using asymmetric techniques*

ISO/IEC 13157-1, *Information technology -- Telecommunications and information exchange between systems -- NFC Security -- Part 1: NFC-SEC NFCIP-1 security services and protocol* (ECMA-385)

ISO/IEC 15946-1, *Information technology -- Security techniques -- Cryptographic techniques based on elliptic curves -- Part 1: General*

ISO/IEC 18031, *Information technology -- Security techniques -- Random bit generation*

ISO/IEC 18033-3, *Information technology -- Security techniques -- Encryption algorithms -- Part 3: Block ciphers*

ISO/IEC 18092, *Information technology -- Telecommunications and information exchange between systems -- Near Field Communication -- Interface and Protocol (NFCIP-1)* (ECMA-340)

IEEE 1363, *IEEE Standard Specifications for Public-Key Cryptography*

FIPS 186-4, *Digital Signature Standard (DSS)*

4 Terms and definitions

For the purposes of this International Standard, all terms and definitions from ISO/IEC 13157-1 (ECMA-385) apply.

5 Conventions and notations

The conventions and notations of ISO/IEC 13157-1 (ECMA-385) as well as the following apply in this document unless otherwise stated.

5.1 Concatenation

A || B represents the concatenation of the fields A and B: content of A followed by content of B.

5.2 Hexadecimal numbers

(XY) denotes a hexadecimal number XY (i.e. with the Radix of 16) and each pair of characters is encoded in one octet.

6 Acronyms

For the purposes of this International Standard, all acronyms from ISO/IEC 13157-1 (ECMA-385) apply. Additionally, the following acronyms apply.

A	Sender, as specified in ISO/IEC 13157-1 (ECMA-385)
AES	Advanced Encryption Standard
B	Receiver, as specified in ISO/IEC 13157-1 (ECMA-385)
d_A	Sender's private EC key
d_B	Recipient's private EC key
DataLen	Length of the UserData
EC	Elliptic Curve
ECDH	Elliptic Curve Diffie-Hellman
EncData	Encrypted data
G	The base point on EC
ID_A	Sender nfcid3
ID_B	Recipient nfcid3
ID_R	Any Recipient identification number (e.g. ID_B)
ID_S	Any Sender identification number (e.g. ID_A)
IV	Initial Value
K	Key
KDF	Key Derivation Function
KE	Encryption Key
KI	Integrity Key

MAC	Message Authentication Code
Mac_A /Mac_B	Integrity protection value of Sender/ Recipient
$MacTag_A$	Key confirmation tag from Sender
$MacTag_B$	Key confirmation tag from Recipient
MK	Master Key
NA / NB	Nonce generated by Sender/Recipient
NAA / NBB	Nonce generated by the pair of NFC-SEC entities
$Nonce_S$	Sender's nonce
$Nonce_R$	Recipient's nonce
PK	Public Key
PK_R	Recipient's Public Key
PK_S	Sender's Public Key
PRNG	Pseudo Random Number Generator
QA / QB	Compressed EC public key of Sender / Recipient
Q_A / Q_B	Decompressed EC public key of Sender / Recipient
RNG	Random Number Generator
SharedSecret	Shared secret
UserData	NFC-SEC User data
z	Unsigned integer representation of the Shared Secret
Z	Octet string representation of z

The acronyms used in Clauses 9 and 10 not listed above are formal parameters.

7 General

This International Standard specifies mechanisms for the Shared Secret Service (SSE) and the Secure Channel Service (SCH) in ISO/IEC 13157-1 (ECMA-385).

To enable secure communication between NFC devices that do not share any common secret data ("keys") before they start communicating with each other, public key cryptography is used to establish a shared secret between these devices, and more specifically the Elliptic Curve Diffie-Hellman key exchange scheme. This shared secret is used to establish the SSE and the SCH.

8 Protocol Identifier (PID)

This International Standard shall use the one octet protocol identifier PID with value 1.

9 Primitives

This Clause specifies cryptographic primitives. Clauses 11 and 12 specify the actual use of these primitives.

Table 1 summarizes the features.

Table 1 — Summary of features

Supported services	SSE (see ISO/IEC 13157-1 (ECMA-385)) SCH (see ISO/IEC 13157-1 (ECMA-385))
Key agreement	ECDH P-192
KDF	AES-XCBC-PRF-128
Key confirmation	AES-XCBC-MAC-96
Data encryption	AES128-CTR IV Init: AES-XCBC-PRF-128
Data integrity	AES-XCBC-MAC-96
Sequence integrity	SN (see ISO/IEC 13157-1 (ECMA-385))
Encryption order	Encryption (9.5) before MAC calculation (9.6)

9.1 Key agreement

Peer NFC-SEC entities shall agree on a shared secret using Key agreement mechanism 4 from ISO/IEC 11770-3 and the Elliptic Curves Diffie-Hellman primitives from IEEE 1363 as further specified below.

9.1.1 Curve P-192

Curve P-192 as specified in FIPS 186-4 shall be used.

9.1.2 EC Key Pair Generation Primitive

The private key d shall be obtained from a random or pseudo-random process conforming to ISO/IEC 18031.

a) Obtain the private key, d, from a random or pseudo-random process conforming to ISO/IEC 18031.

b) Compute the public key, PK, as a point on EC, PK = dG.

9.1.3 EC Public key validation

The EC public key shall be validated as specified in *Public Key Validation* of ISO/IEC 15946-1.

9.1.4 ECDH secret value derivation Primitive

The ECDH primitive as specified in *7.2.1 ECSVDP-DH* of IEEE 1363 shall output the 'valid' shared secret z and 'invalid' otherwise.

9.1.5 Random nonces

Each peer NFC-SEC entity should send fresh random nonces with the EC public key of the entity.

The nonces are used to provide more entropy to the keys derived from the shared secret (z), and to facilitate the EC key pair management.

The correct generation of these nonces is under the responsibility of the entity.