INTERNATIONAL STANDARD

ISO/IEC 11770-2

Third edition
2018-10

IT Security techniques — Key management —

Part 2: Mechanisms using symmetric techniques

Techniques de sécurité IT — Gestion de clés —

Partie 2: Mécanismes utilisant des techniques symétriques

Reference number
ISO/IEC 11770-2:2018(E)

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Published in Switzerland

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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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC 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).

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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/IEC JTC 1, *Information technology*, Subcommittee SC 27, *Security techniques*.

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.

This third edition cancels and replaces the second edition (ISO/IEC 11770-2:2008), which has been technically revised. It also incorporates ISO/IEC 11770-2:2008/Cor 1:2009.

The main changes compared to the previous edition are as follows:

— the list of requirements in Clause 5 has been updated;

— an optional message and mechanism identifier to the encrypted strings sent within each of the mechanisms has been added;

— the set of inputs for calculation of the key in Mechanism 5 has been expanded;

— minor changes have been made to the fourth message in Mechanism 8 and the second message in Mechanism 10.

A list of all parts in the ISO/IEC 11770 series can be found on the ISO website.

Introduction

The purpose of key management is to provide procedures for handling cryptographic keying material to be used in symmetric or asymmetric cryptographic algorithms according to the security policy in force.

Key establishment mechanisms using symmetric cryptographic techniques can be derived from the entity authentication mechanisms of ISO/IEC 9798-2 and ISO/IEC 9798-4 by specifying the use of text fields available in those mechanisms. Other key establishment mechanisms exist for specific environments. Besides key establishment, the goals of such a mechanism can include unilateral or mutual authentication of the communicating entities. Further goals can be the verification of the integrity of the established key, or key confirmation.

IT Security techniques — Key management —

Part 2:
Mechanisms using symmetric techniques

1 Scope

This document defines key establishment mechanisms using symmetric cryptographic techniques.

This document addresses three environments for the establishment of keys: Point-to-Point, Key Distribution Centre (KDC), and Key Translation Centre (KTC). It describes the required content of messages which carry keying material or are necessary to set up the conditions under which the keying material can be established.

This document does not indicate other information which can be contained in the messages or specify other messages such as error messages. The explicit format of messages is not within the scope of this document.

This document does not specify the means to be used to establish initial secret keys; that is, all the mechanisms specified in this document require an entity to share a secret key with at least one other entity (e.g. a TTP). For general guidance on the key lifecycle, see ISO/IEC 11770-1. This document does not explicitly address the issue of inter-domain key management. This document also does not define the implementation of key management mechanisms; products complying with this document are not necessarily compatible.

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 11770-1, *Information technology — Security techniques — Key management — Part 1: Framework*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 11770-1 and the following 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
distinguishing identifier
information which unambiguously distinguishes an entity

3.2
entity authentication
corroboration that an entity is the one claimed

[SOURCE: ISO/IEC 9798-1:2010]

3.3
explicit key authentication from *A* to *B*
assurance for entity *B* that entity *A* (and possibly additional identified trusted parties) is the only other entity that is in possession of the correct key

Note 1 to entry: Implicit key authentication from *A* to *B* is assurance for entity *B* that entity *A* (and possibly additional identified trusted parties) is the only other entity that can possibly be in possession of the correct key.

Note 2 to entry: Implicit key authentication from *A* to *B* and key confirmation from *A* to *B* together imply explicit key authentication from *A* to *B*.

Note 3 to entry: Where a mechanism is claimed to provide explicit key authentication, this assumes that the mechanism has completed successfully, i.e. both parties send and receive all messages correctly and succeed in processing them correctly. In any protocol, it is not possible from within the protocol itself for the sender of the final message to know whether this message has been received correctly by the intended recipient. If assurance is required that this has occurred, then this can typically be obtained from the context of use of the mechanism, e.g. if a message is received from the recipient making use of an established key.

[SOURCE: ISO/IEC 11770-3:2015]

3.4
key confirmation
key confirmation from *A* to *B*
assurance for entity *B* that entity *A* is in possession of the correct key

Note 1 to entry: Where a mechanism is claimed to provide key confirmation, this assumes that the mechanism has completed successfully, i.e. both parties send and receive all messages correctly and succeed in processing them correctly. In any protocol, it is not possible from within the protocol itself for the sender of the final message to know whether this message has been received correctly by the intended recipient. If assurance is required that this has occurred, then this can typically be obtained from the context of use of the mechanism, e.g. if a message is received from the recipient making use of an established key.

[SOURCE: ISO/IEC 11770-3:2015]

3.5
key control
ability to choose the key, or the parameters used in the key computation

3.6
key derivation function
KDF
function which takes as input a number of parameters, at least one of which is secret, and which gives as output keys appropriate for the intended algorithm(s) and applications

Note 1 to entry: In ISO/IEC 11770-2:2008, such a function was referred to as a key generating function.

[SOURCE: ISO/IEC 11770-6:2016, 3.3 — modified, Note 1 to entry has been changed and Note 2 to entry has been removed.]

3.7
point-to-point key establishment
direct establishment of keys between entities, without involving a third party

3.8
random number
time variant parameter (3.11) whose value is unpredictable

3.9
redundancy
information that is known and can be checked

3.10
sequence number
time variant parameter (3.11) whose value is taken from a specified sequence which is non-repeating within a certain time period

3.11
time variant parameter
data item used to verify that a message is not a replay, such as a *random number* (3.8), *sequence number* (3.10), or a time stamp

3.12
unknown key share attack
attack in which all the entities involved in the mechanism complete the mechanism successfully to establish a shared secret key K, but do not agree on the identity of the entity with which they share the key.

4 Symbols and abbreviated terms

A, B	entities between which a key is established
$e_K(Z)$	result of encrypting data Z with a symmetric encryption algorithm using the secret key K
f	key derivation function
F	keying material
F_X	keying material originated by entity X
I_X	the distinguishing identifier of entity X
K	secret key that is established between entities A and B as a result of the use of one of the mechanisms specified in this document; K can be part of F or computed from F using a key derivation function NOTE K is not to be confused with K_{AB}, the long-term secret key shared by A and B.
KDC	Key Distribution Centre
KTC	Key Translation Centre
K_{XY}	secret key associated with entities X and Y
MAC	Message Authentication Code
$\text{MAC}_K(Z)$	result of applying a MAC function to data Z using the secret key K
P	Key Distribution Centre or Key Translation Centre
R	random number
R_X	random number issued by entity X
SID^i_m	constant uniquely identifying the mechanism (m) and the instance of encryption (i) within the mechanism
T/N	time stamp or sequence number

$Text_1$, $Text_2$, ..., fields that can contain optional data for use in applications outside the scope of this document (they can be empty). Their relationship and contents depend upon the specific application. One such possible application is message authentication (see Annex C for an example). Likewise, optional plaintext text fields may be included as a prefix, or appended, to any of the messages. They have no security implications and are not explicitly included in the mechanisms specified in this document.

TVP Time Variant Parameter

TVP_X Time Variant Parameter issued by entity X

T_X/N_X time stamp or sequence number issued by entity X

$X||Y$ The result of the concatenation of data items X and Y in the order specified. In cases where the result of concatenating two or more data items is encrypted as part of one of the mechanisms specified in this document, this result shall be composed so that it can be uniquely resolved into its constituent data strings, i.e. so that there is no possibility of ambiguity in interpretation. This latter property can be achieved in a variety of different ways, depending on the application. For example, it can be achieved by (a) fixing the length of each of the strings throughout the domain of use of the mechanism, or (b) encoding the sequence of concatenated strings using a method that guarantees unique decoding, e.g. using the distinguished encoding rules defined in ISO/IEC 8825-1[1].

[...] Data items that are optional in the mechanisms are shown in square brackets, [thus].

5 Requirements

The key establishment mechanisms specified in this document make use of symmetric cryptographic techniques, more specifically, symmetric encryption algorithms, MACs, and/or key derivation functions. The cryptographic algorithms and their key life-times shall be chosen such that it is computationally infeasible for a key to be deduced during its lifetime. If the following additional requirements are not met, the key establishment process can be compromised.

a) For those mechanisms making use of a symmetric encryption algorithm, either assumption 1) or assumption 2) is required.

   1) The encryption algorithm, its mode of operation, and the redundancy in the plaintext shall provide the recipient with the means to detect forged or manipulated data.

   2) The integrity of the encrypted data shall be ensured by a MAC.

   In order to achieve 1) or 2), it is recommended that choices for encryption and integrity algorithms be in accordance with the following.

      i) Assumption 1) above is guaranteed if an authenticated encryption technique is used; use of one of the techniques standardized in ISO/IEC 19772[10] is recommended.

      ii) The choice for a symmetric encryption algorithm should be chosen from amongst those standardized in ISO/IEC 18033-3, ISO/IEC 18033-4, ISO/IEC 29192-2 and ISO/IEC 29192-3.

      iii) If a block cipher encryption algorithm is used, then the mode of operation employed should be one of those standardized in ISO/IEC 10116[4].

      iv) If a MAC is used, then the techniques should be chosen from amongst those standardized in ISO/IEC 9797 (all parts)[2] and ISO/IEC 29192-6.

      NOTE 1 When a KDC or KTC is involved, assumptions 1) and 2) are not always equivalent in terms of the ability to unambiguously detect on which link an active attack is being performed. See Annex C for examples.

b) In each exchange specified in the mechanisms of 6, 7 and 8, the recipient of a message shall know the claimed identity of the originator. If this is not the case, i.e. if the context of use of the mechanism does not establish the claimed identity, then this can, for example, be achieved by the inclusion of identifiers in additional plaintext text fields of one or more of the messages.

The specifications of many of the mechanisms in this document require the correctness of an identifier included in a message to be checked. This should be done by comparing the received identifier with the expected identifier (as specified in the mechanism concerned). If the identifier in question is that of the originator of the message, then the recipient should know the value of the expected identifier because of requirement b).

c) Keying material can be established using either secure or insecure communication channels. When using only symmetric cryptographic techniques, at least the long-term key(s) K_{AB} (and K_{AP}, K_{BP}, where relevant) shall be exchanged between two entities using a secure channel in order to allow secure communications.

d) The key establishment mechanisms in this document require the use of time variant parameters, such as time stamps, sequence numbers, or random numbers. In this context, the use of the term random number also includes unpredictable pseudo-random numbers. The properties of these parameters, in particular that they are non-repeating, are important for the security of these mechanisms. For additional information on time variant parameters, see ISO/IEC 9798-1:2010, Annex B[3]. For means of generating random numbers, see ISO/IEC 18031 [8].

e) The secret key(s) used in implementations of any of the mechanisms specified in this document shall be distinct from keys used for any other purposes.

f) The data strings encrypted at various points in a key establishment mechanism shall not be composed so that they can be interchanged.

NOTE 2 This can be enforced by including the following elements in each encrypted data string, e.g. within a text field.

— The object identifier as specified in Annex A, in particular identifying the ISO/IEC standard number (11770), the part number (2), and the authentication mechanism.

— A constant that uniquely identifies the encrypted string within the mechanism. This constant may be omitted in the mechanisms that involve only one encrypted string. A specific proposal for including this information in the form of a special identifier is provided in ISO/IEC 9798-2[3], and is included as an optional element in the mechanism specifications in this document.

If any additional element is included in an encrypted string, then its presence shall be checked by the recipient after decryption, and the mechanism shall fail if any such check fails.

g) In the mechanisms involving a KDC or a KTC, the holder of a key K_{AP} (or K_{BP}) shall always use it in the same way, i.e. acting either as the KDC or KTC P or the entity A (or B). That is, no entity shall act as the KDC or KTC in one instance of a mechanism and act as A or B in another instance of the mechanism, and use the same key in both cases. That is, if a single entity uses a mechanism acting as P in one instance and as A (or B) in the other, then the keys it uses in the two instances shall be distinct.

The mechanisms specified in this document are believed to offer protection against unknown key share attacks. However, additional protection against such attacks can be provided if a key K established using one of the mechanisms specified in this document is subject to further processing before use by applying one of the key derivation functions (KDFs) specified in ISO/IEC 11770-6[7]. The inputs to the KDF, which should be agreed in advance by the relevant parties, should include the key K and the identifiers of the parties who will share the secret key. The output of the KDF can then be used as an operational key.

Annex A defines object identifiers that shall be used to identify the mechanisms specified in this document.