

# American National Standard

INCITS/ISO/IEC 19772:2009[R2014]

(ISO/IEC 19772:2009, IDT)

*Information technology - Security techniques -  
Authenticated encryption*

**Developed by**



*Where IT all begins*



## INCITS/ISO/IEC 19772:2009[R2014]

### PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

**Adopted by INCITS (InterNational Committee for Information Technology Standards) as an American National Standard.**

Date of ANSI Approval: 12/5/2014

Published by American National Standards Institute,  
25 West 43rd Street, New York, New York 10036

Copyright 2014 by Information Technology Industry Council  
(ITI). All rights reserved.

These materials are subject to copyright claims of International Standardization Organization (ISO), International Electrotechnical Commission (IEC), American National Standards Institute (ANSI), and Information Technology Industry Council (ITI). Not for resale. No part of this publication may be reproduced in any form, including an electronic retrieval system, without the prior written permission of ITI. All requests pertaining to this standard should be submitted to ITI, 1101 K Street NW, Suite 610, Washington DC 20005.  
Printed in the United States of America

This is a preview of "INCITS/ISO/IEC 19772...". [Click here to purchase the full version from the ANSI store.](#)

First edition  
2009-02-15

---

---

## Information technology — Security techniques — Authenticated encryption

*Technologies de l'information — Techniques de sécurité — Chiffrement authentifié*

---

---

Reference number  
ISO/IEC 19772:2009(E)



© ISO/IEC 2009

This is a preview of "INCITS/ISO/IEC 19772...". [Click here to purchase the full version from the ANSI store.](#)

**PDF disclaimer**

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.



**COPYRIGHT PROTECTED DOCUMENT**

© ISO/IEC 2009

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
Case postale 56 • CH-1211 Geneva 20  
Tel. + 41 22 749 01 11  
Fax + 41 22 749 09 47  
E-mail [copyright@iso.org](mailto:copyright@iso.org)  
Web [www.iso.org](http://www.iso.org)

Published in Switzerland

This is a preview of "INCITS/ISO/IEC 19772...". Click here to purchase the full version from the ANSI store.

## Contents

Page

Foreword .....	v
Introduction.....	vi
1 Scope .....	1
2 Normative references .....	1
3 Terms and definitions .....	1
4 Symbols (and abbreviated terms).....	3
5 Requirements.....	4
6 Authenticated encryption mechanism 1 (OCB 2.0).....	4
6.1 Introduction.....	4
6.2 Specific notation.....	4
6.3 Specific requirements .....	5
6.4 Definition of function $M_2$ .....	5
6.5 Definition of function $M_3$ .....	5
6.6 Definition of function $J$ .....	6
6.7 Encryption procedure .....	6
6.8 Decryption procedure .....	7
7 Authenticated encryption mechanism 2 (Key Wrap) .....	7
7.1 Introduction.....	7
7.2 Specific notation.....	8
7.3 Specific requirements .....	8
7.4 Encryption procedure .....	8
7.5 Decryption procedure .....	9
8 Authenticated encryption mechanism 3 (CCM) .....	9
8.1 Introduction.....	9
8.2 Specific notation.....	9
8.3 Specific requirements .....	10
8.4 Encryption procedure .....	10
8.5 Decryption procedure .....	12
9 Authenticated encryption mechanism 4 (EAX) .....	13
9.1 Introduction.....	13
9.2 Specific notation.....	13
9.3 Specific requirements .....	13
9.4 Definition of function $M$ .....	13
9.5 Encryption procedure .....	14
9.6 Decryption procedure .....	14
10 Authenticated encryption mechanism 5 (Encrypt-then-MAC) .....	15
10.1 Introduction.....	15
10.2 Specific notation.....	15
10.3 Specific requirements .....	15
10.4 Encryption procedure .....	16
10.5 Decryption procedure .....	16
11 Authenticated encryption mechanism 6 (GCM) .....	16
11.1 Introduction.....	16
11.2 Specific notation.....	17
11.3 Specific requirements .....	17
11.4 Definition of multiplication operation .....	18

This is a preview of "INCITS/ISO/IEC 19772...". [Click here to purchase the full version from the ANSI store.](#)

11.5	Definition of function G .....	18
11.6	Encryption procedure .....	18
11.7	Decryption procedure .....	19
<b>Annex A</b>	<b>(informative) Guidance on use of the mechanisms .....</b>	<b>20</b>
<b>A.1</b>	<b>Introduction .....</b>	<b>20</b>
<b>A.2</b>	<b>Selection of mechanism .....</b>	<b>20</b>
<b>A.3</b>	<b>Mechanism 1 (OCB 2.0) .....</b>	<b>21</b>
<b>A.4</b>	<b>Mechanism 2 (Key Wrap) .....</b>	<b>21</b>
<b>A.5</b>	<b>Mechanism 3 (CCM) .....</b>	<b>21</b>
<b>A.6</b>	<b>Mechanism 4 (EAX) .....</b>	<b>21</b>
<b>A.7</b>	<b>Mechanism 5 (Encrypt-then-MAC) .....</b>	<b>22</b>
<b>A.8</b>	<b>Mechanism 6 (GCM) .....</b>	<b>22</b>
<b>Annex B</b>	<b>(informative) Examples .....</b>	<b>23</b>
<b>B.1</b>	<b>Introduction .....</b>	<b>23</b>
<b>B.2</b>	<b>Mechanism 1 (OCB 2.0) .....</b>	<b>23</b>
<b>B.3</b>	<b>Mechanism 2 (Key Wrap) .....</b>	<b>24</b>
<b>B.4</b>	<b>Mechanism 3 (CCM) .....</b>	<b>24</b>
<b>B.5</b>	<b>Mechanism 4 (EAX) .....</b>	<b>25</b>
<b>B.6</b>	<b>Mechanism 5 (Encrypt-then-MAC) .....</b>	<b>26</b>
<b>B.7</b>	<b>Mechanism 6 (GCM) .....</b>	<b>26</b>
<b>Annex C</b>	<b>(normative) ASN.1 module .....</b>	<b>28</b>
<b>C.1</b>	<b>Formal definition .....</b>	<b>28</b>
<b>C.2</b>	<b>Use of subsequent object identifiers .....</b>	<b>28</b>
	<b>Bibliography .....</b>	<b>29</b>

This is a preview of "INCITS/ISO/IEC 19772...". [Click here to purchase the full version from the ANSI store.](#)

## Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

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.

ISO/IEC 19772 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 27, *IT Security techniques*.

## Introduction

When data is sent from one place to another, it is often necessary to protect it in some way whilst it is in transit, e.g. against eavesdropping or unauthorised modification. Similarly, when data is stored in an environment to which unauthorized parties may have access, it may be necessary to protect it.

If the confidentiality of the data needs to be protected, e.g. against eavesdropping, then one solution is to use encryption, as specified in ISO/IEC 18033 and ISO/IEC 10116. Alternatively, if it is necessary to protect the data against modification, i.e. integrity protection, then Message Authentication Codes (MACs), as specified in ISO/IEC 9797, or digital signatures, as specified in ISO/IEC 9796 and ISO/IEC 14888, can be used. If both confidentiality and integrity protection are required, then one possibility is to use both encryption and a MAC or signature. Whilst these operations can be combined in many ways, not all combinations of such mechanisms provide the same security guarantees. As a result it is desirable to define in detail exactly how integrity and confidentiality mechanisms should be combined to provide the optimum level of security. Moreover, in some cases significant efficiency gains can be obtained by defining a single method of processing the data with the objective of providing both confidentiality and integrity protection.

In this standard, *authenticated encryption mechanisms* are defined. These are methods for processing data to provide both integrity and confidentiality protection. They typically involve either a specified combination of a MAC computation and data encryption, or the use of an encryption algorithm in a special way such that both integrity and confidentiality protection are provided.

The methods specified in this standard have been designed to maximise the level of security and provide efficient processing of data. Some of the techniques defined here have mathematical 'proofs of security', i.e. rigorous arguments supporting their soundness.