ETSI TS 135 201 V9.0.0 (2010-02)

Technical Specification

Universal Mobile Telecommunications System (UMTS); LTE; Specification of the 3GPP confidentiality and integrity algorithms; Document 1: f8 and f9 specification (3GPP TS 35.201 version 9.0.0 Release 9)

Reference

RTS/TSGS-0335201v900

Keywords

LTE, SECURITY, UMTS

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Important notice

Individual copies of the present document can be downloaded from:
http://www.etsi.org

The present document may be made available in more than one electronic version or in print. In any case of existing or perceived difference in contents between such versions, the reference version is the Portable Document Format (PDF). In case of dispute, the reference shall be the printing on ETSI printers of the PDF version kept on a specific network drive within ETSI Secretariat.

Users of the present document should be aware that the document may be subject to revision or change of status. Information on the current status of this and other ETSI documents is available at
http://portal.etsi.org/tb/status/status.asp

If you find errors in the present document, please send your comment to one of the following services:
http://portal.etsi.org/chaircor/ETSI_support.asp

Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (http://webapp.etsi.org/IPR/home.asp).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Foreword

This Technical Report (TR) has been produced by ETSI 3rd Generation Partnership Project (3GPP).

The present document may refer to technical specifications or reports using their 3GPP identities, UMTS identities or GSM identities. These should be interpreted as being references to the corresponding ETSI deliverables.

The cross reference between GSM, UMTS, 3GPP and ETSI identities can be found under http://webapp.etsi.org/key/queryform.asp.

Contents

Foreword

This Technical Specification (TS) has been produced by ETSI 3rd Generation Partnership Project (3GPP).

The present document may refer to technical specifications or reports using their 3GPP identities, UMTS identities or GSM identities. These should be interpreted as being references to the corresponding ETSI deliverables.

The cross reference between GSM, UMTS, 3GPP and ETSI identities can be found under http://webapp.etsi.org/key/queryform.asp.

The 3GPP Confidentiality and Integrity Algorithms f8 & f9 have been developed through the collaborative efforts of the European Telecommunications Standards Institute (ETSI), the Association of Radio Industries and Businesses (ARIB), the Telecommunications Technology Association (TTA), the T1 Committee.

The f8 & f9 Algorithms Specifications may be used only for the development and operation of 3G Mobile Communications and services. Every Beneficiary must sign a Restricted Usage Undertaking with the Custodian and demonstrate that he fulfills the approval criteria specified in the Restricted Usage Undertaking.

Furthermore, Mitsubishi Electric Corporation holds essential patents on the Algorithms. The Beneficiary must get a separate IPR License Agreement from Mitsubishi Electronic Corporation Japan.

For details of licensing procedures, contact ETSI, ARIB, TTA or T1.

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

Introduction

This specification has been prepared by the 3GPP Task Force, and gives a detailed specification of the 3GPP confidentiality algorithm ***f8***, and the 3GPP integrity algorithm ***f9***.

This document is the first of four, which between them form the entire specification of the 3GPP Confidentiality and Integrity Algorithms:

- **3GPP TS 35.201: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3G Security; Specification of the 3GPP Confidentiality and Integrity Algorithms; Document 1: *f8* and *f9* Specification".**
- 3GPP TS 35.202: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3G Security; Specification of the 3GPP Confidentiality and Integrity Algorithms; Document 2: KASUMI Specification".

- 3GPP TS 35.203: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3G Security; Specification of the 3GPP Confidentiality and Integrity Algorithms; Document 3: Implementors" Test Data".

- 3GPP TS 35.204: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3G Security; Specification of the 3GPP Confidentiality and Integrity Algorithms; Document 4: Design Conformance Test Data".

The normative part of the specification of the ***f8*** (confidentiality) and ***f9*** (integrity) algorithms is in the main body of this document. The annexes to this document are purely informative. Annex 1 contains illustrations of functional elements of the algorithm, while Annex 2 contains an implementation program listing of the cryptographic algorithm specified in the main body of this document, written in the programming language C.

The normative part of the specification of the block cipher (**KASUMI)** on which they are based is in the main body of Document 2. The annexes of that document, and Documents 3 and 4 above, are purely informative.

0 Scope

This specification gives a detailed specification of the 3GPP confidentiality algorithm ***f8***, and the 3GPP integrity algorithm ***f9***.

NORMATIVE SECTION

This part of the document contains the normative specification of the Confidentiality and Integrity algorithms.

1 Outline of the normative part

Section 1 introduces the algorithms and describes the notation used in the subsequent sections.

Section 3 specifies the confidentiality algorithm ***f8***.

Section 4 specifies the integrity algorithm ***f9***.

1.1 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TS 33.102 version 3.2.0: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3G Security; Security Architecture".

[2] 3GPP TS 33.105 version 3.1.0: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3G Security; Cryptographic Algorithm Requirements".

[3] 3GPP TS 35.201: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3G Security; Specification of the 3GPP Confidentiality and Integrity Algorithms; Document 1: f8 and f9 Specification".

[4] 3GPP TS 35.202: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3G Security; Specification of the 3GPP Confidentiality and Integrity Algorithms; Document 2: KASUMI Specification".

[5] 3GPP TS 35.203: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3G Security; Specification of the 3GPP Confidentiality and Integrity Algorithms; Document 3: Implementors" Test Data".

[6] 3GPP TS 35.204: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3G Security; Specification of the 3GPP Confidentiality and Integrity Algorithms; Document 4: Design Conformance Test Data".

[7] ISO/IEC 9797-1:1999: "Information technology – Security techniques – Message Authentication Codes (MACs)".

2 Introductory information

2.1 Introduction

Within the security architecture of the 3GPP system there are two standardised algorithms: A confidentiality algorithm ***f8***, and an integrity algorithm ***f9***. These algorithms are fully specified here. Each of these algorithms is based on the **KASUMI** algorithm that is specified in a companion document[4]. **KASUMI** is a block cipher that produces a 64-bit output from a 64-bit input under the control of a 128-bit key.

The confidentiality algorithm ***f8*** is a stream cipher that is used to encrypt/decrypt blocks of data under a confidentiality key **CK**. The block of data may be between 1 and 20000 bits long. The algorithm uses **KASUMI** in a form of output-feedback mode as a keystream generator.

The integrity algorithm ***f9*** computes a 32-bit MAC (Message Authentication Code) of a given input message using an integrity key **IK.** The approach adopted uses **KASUMI** in a form of CBC-MAC mode.

2.2 Notation

2.2.1 Radix

We use the prefix **0x** to indicate **hexadecimal** numbers.

2.2.2 Conventions

We use the assignment operator "=", as used in several programming languages. When we write

<variable> = <expression>

we mean that <*variable*> assumes the value that <*expression*> had before the assignment took place. For instance,

$$x = x + y + 3$$

means

(new value of x) becomes (old value of x) + (old value of y) + 3.

2.2.3 Bit/Byte ordering

All data variables in this specification are presented with the most significant bit (or byte) on the left hand side and the least significant bit (or byte) on the right hand side. Where a variable is broken down into a number of sub-strings, the left most (most significant) sub-string is numbered 0, the next most significant is numbered 1 and so on through to the least significant.

For example an n-bit **MESSAGE** is subdivided into 64-bit substrings $\mathbf{MB_0, MB_1 \ldots MB_i}$ so if we have a message:

0x0123456789ABCDEFFEDCBA987654321086545381AB594FC28786404C50A37…

we have:

$\mathbf{MB_0}$ = 0x0123456789ABCDEF
$\mathbf{MB_1}$ = 0xFEDCBA9876543210
$\mathbf{MB_2}$ = 0x86545381AB594FC2
$\mathbf{MB_3}$ = 0x8786404C50A37…