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LTE;
3G Security;
Specification of the 3GPP confidentiality and
integrity algorithms;
Document 2: Kasumi specification
(3GPP TS 35.202 version 14.0.0 Release 14)**



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Foreword

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

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.

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Introduction

This specification has been prepared by the 3GPP Task Force, and gives a detailed specification of the 3GPP Algorithm KASUMI. KASUMI is a block cipher that forms the heart of the 3GPP confidentiality algorithm *f8*, and the 3GPP integrity algorithm *f9*.

This document is the second 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 **KASUMI** 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.

Similarly the normative part of the specification of the **f8** (confidentiality) and the **f9** (integrity) algorithms is in the main body of Document 1. The annexes of those documents, and Documents 3 and 4 above, are purely informative.

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0 Scope

This specification gives a detailed specification of the 3GPP Algorithm KASUMI. KASUMI is a block cipher that forms the heart of the 3GPP confidentiality algorithm *f8*, and the 3GPP integrity algorithm *f9*.

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NORMATIVE SECTION

This part of the document contains the normative specification of the KASUMI algorithm.

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1 Outline of the normative part

Section 2 introduces the algorithm and describes the notation used in the subsequent sections.

Section 3 defines the algorithm structure and its operation.

Section 4 defines the basic components of the algorithm.

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 in a companion document[3]. Each of these algorithms is based on the **KASUMI** algorithm that is specified here.

KASUMI is a block cipher that produces a 64-bit output from a 64-bit input under the control of a 128-bit key.

2.2 Notation

2.2.1 Radix

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

2.2.2 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 consists of the most significant part of the original string and so on through to the least significant.

For example if a 64-bit value X is subdivided into four 16-bit substrings P , Q , R , S we have:

$$X = 0x0123456789ABCDEF$$

we have:

$$P = 0x0123, Q = 0x4567, R = 0x89AB, S = 0xCDEF.$$

In binary this would be:

$$X = 0000000010010001101000101011001111000100110101011100110111101111011111$$

$$\begin{aligned} \text{with } P &= 00000000100100011 \\ Q &= 0100010101100111 \\ R &= 1000100110101011 \\ S &= 1100110111101111 \end{aligned}$$

2.2.3 Conventions

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

$$\langle \text{variable} \rangle = \langle \text{expression} \rangle$$

we mean that $\langle \text{variable} \rangle$ assumes the value that $\langle \text{expression} \rangle$ had before the assignment took place. For instance,

$$x = x + y + 3$$

means

$$(\text{new value of } x) \text{ becomes } (\text{old value of } x) + (\text{old value of } y) + 3.$$

2.2.4 Subfunctions

KASUMI decomposes into a number of subfunctions (FL , FO , FI) which are used in conjunction with associated sub-keys (KL , KO , KI) in a Feistel structure comprising a number of rounds (and rounds within rounds for some subfunctions). Specific instances of the function and/or keys are represented by $XX_{i,j}$ where i is the outer round number of KASUMI and j is the inner round number.

For example the function FO comprises three rounds of the function FI , so we designate the third round of FI in the fifth round of KASUMI as $FI_{5,3}$.