3GPP TSG SA 3 meeting #11
Mainz, Germany, 22-24 February 2000

***Document* S3-000134**
e.g. for 3GPP use the format TP-99xxx
or for SMG, use the format P-99-xxx

CHANGE REQUEST

Please see embedded help file at the bottom of this page for instructions on how to fill in this form correctly.

33.105	CR	009	Current Version:	3.2.0

GSM (AA.BB) or 3G (AA.BBB) specification number ↑ *↑ CR number as allocated by MCC support team*

For submission to:	SA 7	for approval	X	strategic		(for SMG use only)
list expected approval meeting # here ↑		for information		non-strategic		

Form: CR cover sheet, version 2 for 3GPP and SMG *The latest version of this form is available from: ftp://ftp.3gpp.org/Information/CR-Form-v2.doc*

Proposed change affects: (U)SIM [ ] ME [ ] UTRAN / Radio [ ] Core Network [ ]
(at least one should be marked with an X)

Source: Siemens Atea **Date:**

Subject: Ciphering

Work item: Security

Category: *(only one category shall be marked with an X)*

F	Correction	
A	Corresponds to a correction in an earlier release	
B	Addition of feature	
C	Functional modification of feature	X
D	Editorial modification	

Release:

Phase 2	
Release 96	
Release 97	
Release 98	
Release 99	X
Release 00	

Reason for change: The structure of CK when the effective key length is smaller than 128 bits is changed. In addition, some editorial changes are proposed.

Clauses affected: 5.2

Other specs affected:

Other 3G core specifications	[ ]	→ List of CRs:
Other GSM core specifications	[ ]	→ List of CRs:
MS test specifications	[ ]	→ List of CRs:
BSS test specifications	[ ]	→ List of CRs:
O&M specifications	[ ]	→ List of CRs:

Other comments:

help.doc

<--------- double-click here for help and instructions on how to create a CR.

5.2 Data confidentiality

5.2.1 Overview

The mechanism for data confidentiality of user data and signalling data that is described in 6.6 of [1] requires the following cryptographic function:

f8 UMTS encryption algorithm.

Figure 5.2.1 illustrates the use of f8 to encrypt plaintext by applying a keystream using a bitwise XOR operation. The plaintext may be recovered by generating the same keystream using the same input parameters and applying it to the ciphertext using a bitwise XOR operation.

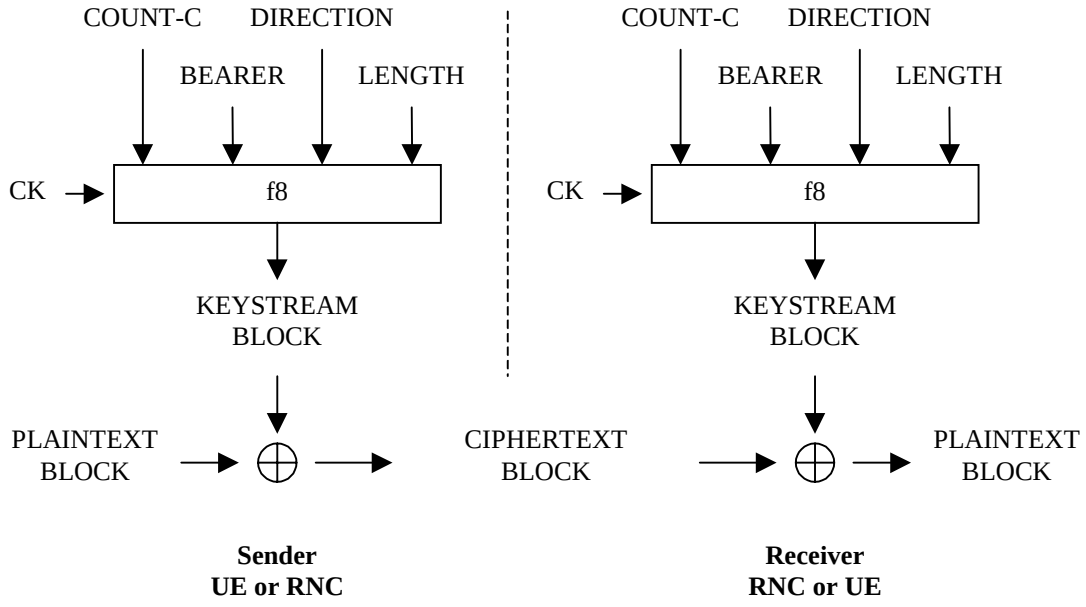

Figure 5.2.1: Ciphering user and signalling data transmitted over the radio access link

The input parameters to the algorithm are the Cipher Key (CK), a time dependent input (COUNT-C), the bearer identity (BEARER), the direction of transmission (DIRECTION) and the length of the keystream required (LENGTH). Based on these input parameters the algorithm generates the output keystream block (KEYSTREAM) which is used to encrypt the input plaintext block (PLAINTEXT) to produce the output ciphertext block (CIPHERTEXT).

The input parameter LENGTH shall affect only the length of the KEYSTREAM BLOCK, not the actual bits in it.

5.2.2 Use

The function f8 shall only be used to protect the confidentiality of user data and signalling data sent over the radio access link between UE and RNC.

5.2.3 Allocation

The function f8 is allocated to the UE and the RNC.

Encryption will be applied in the Medium Access Control (MAC) sublayer and in the Radio Link Control (RLC) sublayer of the data link layer (Layer 2).

5.2.4 Extent of standardisation

The function f8 shall be fully standardized.

5.2.5 Implementation and operational considerations

The algorithm should be designed to accommodate a range of implementation options including hardware and software implementations. For hardware implementations, it should be possible to implement one instance of the algorithm using less than 10,000 gates (working assumption).

A wide range of UE with different bearer capabilities is expected, so the encryption throughput requirements on the algorithm will vary depending on the implementation. However, based on the likely maximum user traffic data rates, it must be possible to implement the algorithm to achieve an encryption speed in the order of 2Mbit/s on the downlink and on the uplink.

1. RLC-transparent mode:
   - New keystream block required every physical layer frame (10ms)
   - Maximum number of bits per physical layer frame of 5114 bits
   - Minimum number of bits per physical layer frame of 1 bit.
   - Granularity of 1 bit on all possible intermediate values
2. For UM RLC mode:
   - New keystream block required every RLC frame (minimum 156μs)
   - Maximum number of bits per UM RLC frame of 1016 bits (ongoing specification work in TSG-R2 could extend this to 5000 bits)
   - Minimum number of bits per UM RLC frame of 16 bit.
   - Granularity of 8 bit on all possible intermediate values
3. For AM RLC mode:
   - New keystream block required every RLC frame (minimum 156μs)
   - Maximum number of bits per AM RLC frame of 1024 bits (ongoing specification work in TSG-R2 could extend this to 5000 bits)
   - Minimum number of bits per AM RLC frame of 24 bit.
   - Granularity of 8 bit on all possible intermediate values

The encryption throughput requirements should be met based on clock speeds upwards of 20MHz (typical clock speeds are expected to be much greater than this).

5.2.6 Type of algorithm

The function f8 should be a symmetric synchronous stream cipher.

5.2.7 Interfaces to the algorithm

5.2.7.1 CK

CK: the cipher key

CK[0], CK[1], …, CK[127]

The length of CK is 128 bits. In case the effective key length k is smaller than 128 bits, the most significant bits of CK shall carry the effective key information, whereas the remaining, least significant bits shall repeat the effective key information:

$CK[n] = CK[n \bmod k]$, for all n, such that $k \leq n < 128$.

5.2.7.2 COUNT-C

COUNT-C: the cipher sequence number.

COUNT-C[0], COUNT-C[1], …, COUNT-C[31]

The length of the COUNT-C parameter is 32 bits.

Synchronisation of the keystream is based on the use of a physical layer (Layer 1) frame counter combined with a hyperframe counter introduced to avoid re-use of the keystream. This allows the keystream to be synchronised every 10ms physical layer frame. The exact structure of the COUNT-C is specified in TS 33.102.

5.2.7.3 BEARER

BEARER: the bearer identifier.

BEARER[0], BEARER[1], …, BEARER[3]

The length of BEARER is 4 bits.

The same cipher key may be used for different bearers simultaneously associated with a single user which are multiplexed onto a single 10ms physical layer frame. To avoid using the same keystream to encrypt more than one bearer, the algorithm shall generate the keystream based on the identity of the bearer.

5.2.7.4 DIRECTION

DIRECTION: the direction of transmission of the bearer to be encrypted.

DIRECTION[0]

The length of DIRECTION is 1 bit.

The same cipher key may be used for uplink and downlink channels simultaneously associated with a UE, which are multiplexed onto a single 10ms physical layer frame. To avoid using the same keystream to encrypt both uplink and downlink transmissions, the algorithm shall generate the keystream based on the direction of transmission.

An explicit direction value is required in preference to splitting the keystream segment into uplink and downlink portions to allow for asymmetric bearer services.

5.2.7.5 LENGTH

LENGTH: the required length of keystream.

LENGTH[0], LENGTH[1], …, LENGTH[15]

The length of LENGTH is 16 bits. For a given bearer and transmission direction the length of the plaintext block that is transmitted during a single physical layer frame may vary. The algorithm shall generate a keystream block of variable length based on the value of the length parameter.

The input parameter LENGTH shall affect only the length of the KEYSTREAM BLOCK, not the actual bits in it.

The format of LENGTH cannot be specified at present since the number and sizes of RLC PDUs / MAC SDUs in each 10ms physical layer frame have not yet been fully specified. However, a maximum RLC PDU / MAC SDU size in the region of 1000 bits has been informally indicated by 3GPP TSG RAN2. The range of values of the length parameter will depend not only on the RLC PDU / MAC SDU size but also the number of RLC PDUs / MAC SDUs which may be sent in a single physical layer 10ms frame for a given bearer and transmission direction.

Not all values between the maximum and minimum values shall be required but it is expected that the ability to produce length values of whole numbers of octets between a minimum and a maximum value will be required.

5.2.7.6 KEYSTREAM

KEYSTREAM: the output keystream.

KS [0], KS [1], …, KS [LENGTH-1]

The length of a keystream block equals the value of the input parameter LENGTH.

5.2.7.7 PLAINTEXT

PLAINTEXT: the plaintext.

PT[0], PT[1], …, PT[LENGTH-1]

The length of a keystream block equals the value of the input parameter LENGTH.

This plaintext block consists of the payload of the particular RLC PDUs / MAC SDUs to be encrypted in a single 10ms physical layer frame for a given bearer and transmission direction. It may consist of user traffic or signalling data. The structure of the plaintext block cannot be specified at present.

5.2.7.8 CIPHERTEXT

CIPHERTEXT: the ciphertext.

CT[0], CT[1], …, CT[LENGTH-1]

The length of a keystream block equals the value of the input parameter LENGTH.