Technical Specification Group Services and System Aspects **TSGS#11(01)0131**
Meeting #11, Palm Springs, CA, USA, 19-22 March 2001

Source: **SA WG3**

Title: **7 Corrective CRs to 33.102 version 3.7.0**

Document for: **Approval**

Agenda Item: **7.3.3**

The following CRs were agreed at SA WG3 meeting #17 and are presented to TSG SA #11 for approval.

Spec	CR	Rev	Phase	Subject	Cat	Ver	WG	Meeting	S3 doc
33.102	135		R99	RES has to be a multiple of 8 bits	F	3.7.0	S3	S3-17	S3-010006
33.102	136		R99	Add bit ordering convention	F	3.7.0	S3	S3-17	S3-010064
33.102	137		R99	Timing of security mode procedure	F	3.7.0	S3	S3-17	S3-010094
33.102	140		R99	Correction to the handling of re-transmitted authentication request messages on the ME	F	3.7.0	S3	S3-17	S3-010124
33.102	141		R99	Optional Support for USIM-ME interface for GSM-Only ME	F	3.7.0	S3	S3-17	S3-010126
33.102	142	1	R99	Definition corrections	F	3.7.0	S3	S3-17	S3-010138
33.102	143		R99	GSM ciphering capability Handling in Security Mode set up procedure	F	3.7.0	S3	S3-17	S3-010117

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CHANGE REQUEST

⌘	**33.102**	**CR**	**135**	⌘ rev	**-**	⌘ Current version:	**3.7.0** ⌘

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Proposed change affects: ⌘ (U)SIM [ ] ME/UE [ ] Radio Access Network [ ] Core Network [x]

Title:	⌘	RES has to be a multiple of 8 bits		
Source:	⌘	SA WG3		
Work item code:	⌘	Security	***Date:*** ⌘	19/2/2001
Category:	⌘	**F**	***Release:*** ⌘	R99
		Use one of the following categories: ***F*** *(essential correction)* ***A*** *(corresponds to a correction in an earlier release)* ***B*** *(Addition of feature),* ***C*** *(Functional modification of feature)* ***D*** *(Editorial modification)* Detailed explanations of the above categories can be found in 3GPP TR 21.900.		*Use one of the following releases:* *2 (GSM Phase 2)* *R96 (Release 1996)* *R97 (Release 1997)* *R98 (Release 1998)* *R99 (Release 1999)* *REL-4 (Release 4)* *REL-5 (Release 5)*

Reason for change:	⌘	-Other specifications have no protocol-provisions to handle bits for XRES A) TS 29.002 (MAP) specify XRES as OCTET STRING. "XRES **::= OCTET STRING (SIZE (4..16))"** B) TS 24.008 (Mobile Radio layer 3 Specification) specify RES as number of octets. "The Authentication Response parameter (extension) IE is a type 4 information element with a minimum length of 3 octets and a maximum length of 14 octets" - All other Authentication Parameters are specified as bits, but match a multiple of 8 bits.
Summary of change:	⌘	RES definition is aligned to a multiple of 8 bits (octet) too.
Consequences if not approved:	⌘	TS 29.002 and TS 24.008 have to be adapted to handle bit-variable RES.

Clauses affected:	⌘	6.3.7 6.8.1.2		
Other specs affected:	⌘	[ ] Other core specifications [ ] Test specifications [ ] O&M Specifications	⌘	
Other comments:	⌘			

6.3.7 Length of authentication parameters

The authentication key (K) shall have a length of 128 bits.

The random challenge (RAND) shall have a length of 128 bits.

Sequence numbers (SQN) shall have a length of 48 bits.

The anonymity key (AK) shall have a length of 48 bits.

The authentication management field (AMF) shall have a length of 16 bits.

The message authentication codes MAC in AUTN and MAC-S in AUTS shall have a length of 64 bits.

The cipher key (CK) shall have a length of 128 bits.

The integrity key (IK) shall have a length of 128 bits.

The authentication response (RES) shall have a variable length of 4-16 octets~~32-128 bits~~.

6.8.1.2 R99+ HLR/AuC

Upon receipt of an *authentication data request* from a R99+ VLR/SGSN for a UMTS subscriber, a R99+ HLR/AuC shall send quintets, generated as specified in 6.3.

Upon receipt of an *authentication data request* from a R98- VLR/SGSN for a UMTS subscriber, a R99+ HLR/AuC shall send triplets, derived from quintets using the following conversion functions:

a) c1: $RAND_{[GSM]} = RAND$

b) c2: $SRES_{[GSM]} = XRES^*_1 \text{ xor } XRES^*_2 \text{ xor } XRES^*_3 \text{ xor } XRES^*_4$

c) c3: $Kc_{[GSM]} = CK_1 \text{ xor } CK_2 \text{ xor } IK_1 \text{ xor } IK_2$

whereby XRES* is 16 octet~~128 bits~~ long and XRES* = XRES if XRES is 16 octet~~128 bits~~ long and XRES* = XRES || 0...0 if XRES is shorter than 16 octet~~128 bits~~, $XRES^*_i$ are all 4 octet~~32 bit~~ long and $XRES^* = XRES^*_1 \| XRES^*_2 \| XRES^*_3 \| XRES^*_4$, CK_i and IK_i are both 64 bits long and $CK = CK_1 \| CK_2$ and $IK = IK_1 \| IK_2$.

3GPP TSG SA WG3 Security — S3#17 **S3-010064**

27 February – 2 March, 2001

Gothenburg, Sweden

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CHANGE REQUEST

⌘	**33.102**	**CR**	**136**	⌘	rev	**-**	⌘	Current version:	**3.7.0**	⌘

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

Proposed change affects: ⌘ (U)SIM [X] ME/UE [X] Radio Access Network [X] Core Network [X]

Title:	⌘	Add bit ordering convention		
Source:	⌘	SA WG3		
Work item code:	⌘	Security	***Date:*** ⌘	2001-02-15
Category:	⌘	**F**	***Release:*** ⌘	REL-99
		Use one of the following categories: ***F*** *(essential correction)* ***A*** *(corresponds to a correction in an earlier release)* ***B*** *(Addition of feature),* ***C*** *(Functional modification of feature)* ***D*** *(Editorial modification)* Detailed explanations of the above categories can be found in 3GPP TR 21.900.		*Use one of the following releases:* *2 (GSM Phase 2)* *R96 (Release 1996)* *R97 (Release 1997)* *R98 (Release 1998)* *R99 (Release 1999)* *REL-4 (Release 4)* *REL-5 (Release 5)*

Reason for change:	⌘	The bit ordering of parameters is ambiguous. Some examples: 1) SQN is defined as a 48-bit string SQN[0]..SQN[47]. In the scheme in section C.1.1.1, SQN = SEQ||IND, and in normal operation the AuC may set SEQhe = SEQ+1. This is ambiguous unless we know which numbered bit is the msb. 2) AUTN = SQN [(+)AK] || AMF || MAC-A, where the component parts are formally defined as arrays of bits numbered from 0. This is ambiguous unless we know whether bit 0 of each array is the leftmost or rightmost bit. 3) COUNT-I is defined as a 32-bit counter COUNT-I[0]..COUNT-I[31] that increments by one for each integrity protected message. That is ambiguous unless we know whether COUNT-I[0] or COUNT-I[31] is the msb.
Summary of change:	⌘	A new section is added to specify the bit ordering convention.
Consequences if not approved:	⌘	Serious risk of protocol breakdown if different manufacturers make different bit ordering assumptions.

Clauses affected:	⌘	3		
Other specs affected:	⌘	[X] Other core specifications [ ] Test specifications [ ] O&M Specifications	⌘	33.103-CR 013, 33.105-CR 016
Other comments:	⌘	The most important thing is to establish a consistent bit ordering; exactly which ordering is chosen is a secondary issue. However, the proposed convention is the one that will allow for the most efficient implementations of the security algorithms designed by ETSI SAGE.		

3 Definitions, symbols, ~~and~~ abbreviations and conventions

3.1 Definitions

In addition to the definitions included in TR 21.905 [3], for the purposes of the present document, the following definitions apply:

Confidentiality: The property that information is not made available or disclosed to unauthorised individuals, entities or processes.

Data integrity: The property that data has not been altered in an unauthorised manner.

Data origin authentication: The corroboration that the source of data received is as claimed.

Entity authentication: The provision of assurance of the claimed identity of an entity.

Key freshness: A key is fresh if it can be guaranteed to be new, as opposed to an old key being reused through actions of either an adversary or authorised party.

USIM – User Services Identity Module. In a security context, this module is responsible for performing UMTS subscriber and network authentication and key agreement. It should also be capable of performing GSM authentication and key agreement to enable the subscriber to roam easily into a GSM Radio Access Network.

SIM – GSM Subscriber Identity Module. In a security context, this module is responsible for performing GSM subscriber authentication and key agreement. This module is **not** capable of handling UMTS authentication nor storing UMTS style keys.

UMTS Entity authentication and key agreement: Entity authentication according to this specification.

GSM Entity authentication and key agreement: Entity authentication according to TS ETSI GSM 03.20

User access module: either a USIM or a SIM

Mobile station, user: the combination of user equipment and a user access module.

UMTS subscriber: a mobile station that consists of user equipment with a USIM inserted.

GSM subscriber: a mobile station that consists of user equipment with a SIM inserted.

UMTS security context: a state that is established between a user and a serving network domain as a result of the execution of UMTS AKA. At both ends "UMTS security context data" is stored, that consists at least of the UMTS cipher/integrity keys CK and IK and the key set identifier KSI.

GSM security context: a state that is established between a user and a serving network domain usually as a result of the execution of GSM AKA. At both ends "GSM security context data" is stored, that consists at least of the GSM cipher key Kc and the cipher key sequence number CKSN.

Quintet, UMTS authentication vector: temporary authentication data that enables an VLR/SGSN to engage in UMTS AKA with a particular user. A quintet consists of five elements: a) a network challenge RAND, b) an expected user response XRES, c) a cipher key CK, d) an integrity key IK and e) a network authentication token AUTN.

Triplet, GSM authentication vector: temporary authentication data that enables an VLR/SGSN to engage in GSM AKA with a particular user. A triplet consists of three elements: a) a network challenge RAND, b) an expected user response SRES and c) a cipher key Kc.

Authentication vector: either a quintet or a triplet.

Temporary authentication data: either UMTS or GSM security context data or UMTS or GSM authentication vectors.

3.2 Symbols

For the purposes of the present document, the following symbols apply:

||	Concatenation
⊕	Exclusive or
f1	Message authentication function used to compute MAC
f1*	Message authentication function used to compute MAC-S
f2	Message authentication function used to compute RES and XRES
f3	Key generating function used to compute CK
f4	Key generating function used to compute IK
f5	Key generating function used to compute AK in normal procedures
f5*	Key generating function used to compute AK in re-synchronisation procedures
K	Long-term secret key shared between the USIM and the AuC

3.3 Abbreviations

In addition to (and partly in overlap to) the abbreviations included in TR 21.905 [3], for the purposes of the present document, the following abbreviations apply:

AK	Anonymity Key
AKA	Authentication and key agreement
AMF	Authentication management field
AUTN	Authentication Token
AV	Authentication Vector
CK	Cipher Key
CKSN	Cipher key sequence number
CS	Circuit Switched
HE	Home Environment
HLR	Home Location Register
IK	Integrity Key
IMSI	International Mobile Subscriber Identity
KSI	Key Set Identifier
KSS	Key Stream Segment
LAI	Location Area Identity
MAC	The message authentication code included in AUTN, computed using f1
MAC	The message authentication code included in AUTN, computed using f1*
ME	Mobile Equipment
MS	Mobile Station
MSC	Mobile Services Switching Centre
PS	Packet Switched
P-TMSI	Packet-TMSI
Q	Quintet, UMTS authentication vector
RAI	Routing Area Identifier
RAND	Random challenge
SQN	Sequence number
SQN_{HE}	Individual sequence number for each user maintained in the HLR/AuC
SQN_{MS}	The highest sequence number the USIM has accepted
SGSN	Serving GPRS Support Node
SIM	(GSM) Subscriber Identity Module
SN	Serving Network
T	Triplet, GSM authentication vector
TMSI	Temporary Mobile Subscriber Identity
UEA	UMTS Encryption Algorithm
UIA	UMTS Integrity Algorithm
UICC	UMTS IC Card
USIM	User Services Identity Module
VLR	Visitor Location Register
XRES	Expected Response

3.4 Conventions

All data variables in this specification are presented with the most significant substring on the left hand side and the least significant substring on the right hand side. A substring may be a bit, byte or other arbitrary length bitstring. Where a variable is broken down into a number of substrings, the leftmost (most significant) substring is numbered 0, the next most significant is numbered 1, and so on through to the least significant.

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Gothenburg, 27 Feb – 2 Mar, 2001

Document S3-010094
e.g. for 3GPP use the format TP-99xxx
or for SMG, use the format P-99-xxx

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CHANGE REQUEST

⌘	**33.102**	**CR**	**137**	⌘ rev	**-**	⌘ Current version:	**3.7.0** ⌘

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

Proposed change affects: ⌘ (U)SIM [ ] ME/UE [X] Radio Access Network [X] Core Network [X]

Title:	⌘	Timing of security mode procedure	
Source:	⌘	SA WG3	
Work item code:	⌘	Security	***Date:*** ⌘ 2001-02-26
Category:	⌘	**F**	***Release:*** ⌘ R99

Use one of the following categories:
F *(essential correction)*
A *(corresponds to a correction in an earlier release)*
B *(Addition of feature),*
C *(Functional modification of feature)*
D *(Editorial modification)*
Detailed explanations of the above categories can be found in 3GPP TR 21.900.

Use one of the following releases:
2 (GSM Phase 2)
R96 (Release 1996)
R97 (Release 1997)
R98 (Release 1998)
R99 (Release 1999)
REL-4 (Release 4)
REL-5 (Release 5)

Reason for change:	⌘	Sections 6.5.5 and 6.6.5 contain a sentence which gives a time limit for a change of the ciphering and integrity keys to be completed. This time limit is meant to apply to the RNC only. This is clarified as it has created confusion.
Summary of change:	⌘	Clarification of keys time limit scope
Consequences if not approved:	⌘	Confusion and inconsistency in key management

Clauses affected:	⌘	6.5.5 and 6.6.5
Other specs affected:	⌘	[X] Other core specifications ⌘ [ ] Test specifications [ ] O&M Specifications
Other comments:	⌘	

6.5.5 Integrity key selection

There may be one IK for CS connections (IK_{CS}), established between the CS service domain and the user and one IK for PS connections (IK_{PS}) established between the PS service domain and the user.

The data integrity of radio bearers for user data is not protected.

The signalling radio bearers are used for transfer of signalling data for services delivered by both CS and PS service domains. These signalling radio bearers are data integrity protected by the IK of the service domain for which the most recent security mode negotiation took place. This may require that the integrity key of an (already integrity protected) ongoing signalling connection has to be changed, when a new connection is established with another service domain, or when a security mode negotiation follow a re-authentication during an ongoing connection. This change should be completed by the RNC within five seconds after receiving the security mode ~~negotiation~~command from the VLR/SGSN.

Note: For the behaviour of the terminal regarding key changes see section 6.4.5.

6.6.5 Cipher key selection

There is one CK for CS connections (CK_{CS}), established between the CS service domain and the user and one CK for PS connections (CK_{PS}) established between the PS service domain and the user.

The radio bearers for CS user data are ciphered with CK_{CS}.

The radio bearers for PS user data are ciphered with CK_{PS}.

The signalling radio bearers are used for transfer of signalling data for services delivered by both CS and PS service domains. These signalling radio bearers are ciphered by the CK of the service domain for which the most recent security mode negotiation took place. This may require that the cipher key of an (already ciphered) ongoing signalling connection has to be changed, when a new connection is established with another service domain, or when a security mode negotiation follows a re-authentication during an ongoing connection. This change should be completed by the RNC within five seconds after receiving the security mode ~~negotiation~~ command from the VLR/SGSN.

Note: For the behaviour of the terminal regarding key changes see section 6.4.5.

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CHANGE REQUEST

⌘ **33.102**	**CR 143**	⌘ rev	**-**	⌘ Current version:	**3.7.0**	⌘

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

Proposed change affects: ⌘ (U)SIM [ ] ME/UE [ ] Radio Access Network [X] Core Network [X]

Title:	⌘	GSM ciphering capability Handling in Security Mode set up procedure		
Source:	⌘	SA WG3		
Work item code:	⌘	Security	***Date:*** ⌘	1/3/2001
Category:	⌘	F	***Release:*** ⌘	R99
		Use one of the following categories: ***F*** *(essential correction)* ***A*** *(corresponds to a correction in an earlier release)* ***B*** *(Addition of feature),* ***C*** *(Functional modification of feature)* ***D*** *(Editorial modification)* Detailed explanations of the above categories can be found in 3GPP TR 21.900.		*Use one of the following releases:* *2 (GSM Phase 2)* *R96 (Release 1996)* *R97 (Release 1997)* *R98 (Release 1998)* *R99 (Release 1999)* *REL-4 (Release 4)* *REL-5 (Release 5)*

Reason for change:	⌘	Technical Background: In 24.008 there are 3 different information elements "MS Classmark" specified: MS Classmark 1, 2 and 3. - MS Classmark 2 contains all the information needed by a UMTS core network. - MS Classmark 1 is a short form of MS Classmark 2 and is used only for the Location Update procedure. - MS Classmark 3 contains information needed by the GSM BSS. The MS Classmark 3 is *not* included in the initiating messages like CM Service Request or Location Update Request, but only in RRC messages. For historical reasons the fields indicating the mobile's ciphering capabilities are distributed between the different MS Classmarks: support of A5/1, A5/2 and A5/3 can be indicated with MS Classmark 2, but support of additional ciphering algorithms (A5/4, ..., A5/7) can only be indicated with MS Classmark 3. TS 33.102: Within TS 33.102 it is needed to specify the mechanism how ciphering capability information in Classmarks 2 and 3 are handled in UTRAN.
Summary of change:	⌘	Correct mechanism is described how UTRAN handles GSM ciphering capability
Consequences if not approved:	⌘	These are described in a separate liaison statement to RAN (S3-010118).
Clauses affected:	⌘	6.4.5; 6.8.4
Other specs affected:	⌘	[X] Other core specifications ⌘ 25.331 [ ] Test specifications [ ] O&M Specifications
Other comments:	⌘	

6.4.5 Security mode set-up procedure

This section describes one common procedure for both ciphering and integrity protection set-up. It is mandatory to start integrity protection of signalling messages by use of this procedure at each new signalling connection establishment between MS and VLR/SGSN. The four exceptions when it is not mandatory to start integrity protection are:

- If the only purpose with the signalling connection establishment and the only result is periodic location registration, i.e. no change of any registration information.
- If there is no MS-VLR/SGSNsignalling after the initial L3 signalling message sent from MS to VLR/SGSN, i.e. in the case of deactivation indication sent from the MS followed by connection release.
- If the only MS-VLR/SGSN signalling after the initial L3 signalling message sent from MS to VLR/SGSN, and possible user identity request and authentication (see below), is a reject signalling message followed by a connection release.
- If the call is an emergency call teleservice as defined in TS 22.003, see section 6.4.9.2 below

When the integrity protection shall be started, the only procedures between MS and VLR/SGSN that are allowed after the initial connection request (i.e. the initial Layer 3 message sent to VLR/SGSN) and before the security mode set-up procedure are the following:

- Identification by a permanent identity (i.e. request for IMSI), and
- Authentication and key agreement

The message sequence flow below describes the information transfer at initial connection establishment, possible authentication and start of integrity protection and possible ciphering.

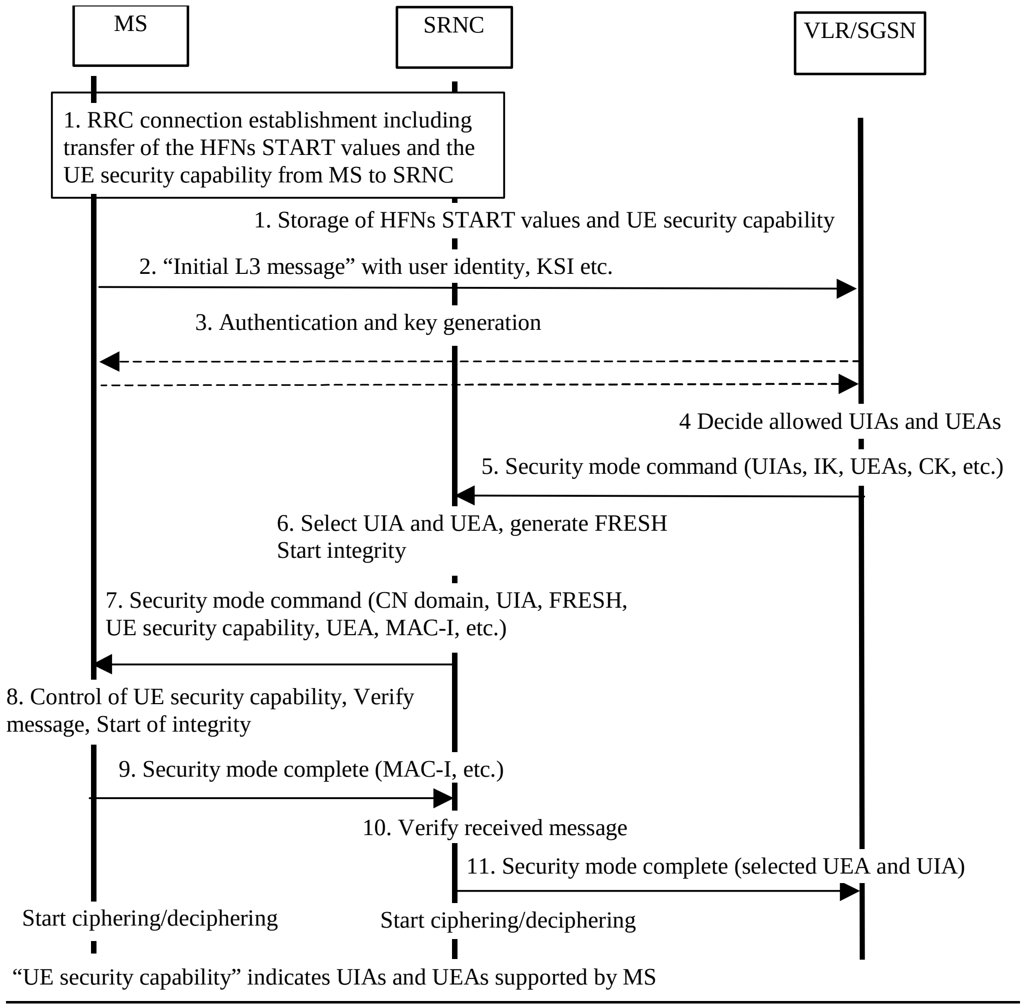

Figure 14: Local authentication and connection set-up

NOTE 1: The network must have the "U~~M~~E security capability" information before the integrity protection can start, i.e. the "U~~M~~E security capability" must be sent to the network in an unprotected message. Returning the "U~~M~~E security capability" later on to the U~~M~~E in a protected message will give U~~M~~E the possibility to verify that it was the correct "U~~M~~E security capability" that reached the network.

Detailed description of the flow above:

1. RRC connection establishment includes the transfer from MS to RNC of the U~~M~~E security capability and optionally the GSM -Classmark 2~~M2~~ and~~-~~ ~~CM~~3 and the START values for the CS service domain respective the PS service domain. The UE security capability information includes the ciphering capabilities (UEAs) and the integrity capabilities (UIAs) of the MS. The START values and the UE security capability information are stored in the SRNC. If the GSM -Classmark~~M~~ 2 and ~~CM~~3 are transmitted during the RRC Connection establishment, the RNC must store the GSM ciphering capability of the UE (see also message 7)

2. The MS sends the Initial L3 message (Location update request, CM service request, Routing area update request, attach request, paging response etc.) to the VLR/SGSN. This message contains e.g. the user identity and the KSI. The included KSI (Key Set Identifier) is the KSI allocated by the CS service domain or PS service domain at the last authentication for this CN domain.

3. User identity request may be performed (see 6.2). Authentication of the user and generation of new security keys (IK and CK) may be performed (see 6.3.3). A new KSI will then also be allocated.

4. The VLR/SGSN determines which UIAs and UEAs that are allowed to be used.

5. The VLR/SGSN initiates integrity and ciphering by sending the RANAP message Security Mode Command to SRNC. This message contains a list of allowed UIAs and the IK to be used. If ciphering shall be started, it contains the allowed UEAs and the CK to be used. It also contains the UE's capability information about GSM ciphering algorithms A5/1, A5/2, A5/3 in the form of GSM MS classmark 2. If a new authentication and security key generation has been performed (see 3 above), this shall be indicated in the message sent to the SRNC. The indication of new generated keys implies that the START value to be used shall be reset (i.e. set to zero) at start use of the new keys. Otherwise, it is the START value already available in the SRNC that shall be used (see 1. above).

6. The SRNC decides which algorithms to use by selecting from the list of allowed algorithms, and the list of algorithms supported by the MS (see 6.4.2). The SRNC generates a random value FRESH and initiates the downlink integrity protection. If the requirements received in the Security mode command can not be fulfilled, the SRNC sends a SECURITY MODE REJECT message to the requesting VLR/SGSN. The further actions are described in 6.4.2.

7. The SRNC generates the RRC message Security mode command. The message includes the ME security capability, optionally the GSM ciphering capability (if received during RRC Connection establishment), the UIA and FRESH to be used and if ciphering shall be started also the UEA to be used. Additional information (start of ciphering) may also be included. Because of that the MS can have two ciphering and integrity key sets, the network must indicate which key set to use. This is obtained by including a CN type indicator information in the Security mode command message. If the GSM MS classmark 2 exists, then the message shall also contain it. Before sending this message to the MS, the SRNC generates the MAC-I (Message Authentication Code for Integrity) and attaches this information to the message.

8. At reception of the Security mode command message, the MS controls that the "UEME security capability" received is equal to the "UEME security capability" sent in the initial message. The same applies to the GSM ciphering capability if it was included in the RRC Connection Establishment.MS classmark 2. The MS computes XMAC-I on the message received by using the indicated UIA, the stored COUNT-I and the received FRESH parameter. The MS verifies the integrity of the message by comparing the received MAC-I with the generated XMAC-I.

9. If all controls are successful, the MS compiles the RRC message Security mode complete and generates the MAC-I for this message. If any control is not successful, the procedure ends in the MS.

10. At reception of the response message, the SRNC computes the XMAC-I on the message. The SRNC verifies the data integrity of the message by comparing the received MAC-I with the generated XMAC-I.

11. The transfer of the RANAP message Security Mode Complete response, including the selected algorithms, from SRNC to the VLR/SGSN ends the procedure.

The Security mode command to MS starts the downlink integrity protection, i.e. this and all following downlink messages sent to the MS are integrity protected using the new integrity configuration. The Security mode complete from MS starts the uplink integrity protection, i.e. this and all following messages sent from the MS are integrity protected using the new integrity configuration. When ciphering shall be started, the Ciphering Activation time information that is exchanged between SRNC and MS during the Security mode set-up procedure sets the RLC Sequence Number/Connection Frame Number when to start ciphering in Downlink respective Uplink using the new ciphering configuration.

6.8.4 Intersystem handover for CS Services – from UTRAN to GSM BSS

If ciphering has been started when an intersystem handover occurs from UTRAN to GSM BSS, the necessary information (e.g. Kc, supported/allowed GSM ciphering algorithms) is transmitted within the system infrastructure before the actual handover is executed to enable the communication to proceed from the old RNC to the new GSM BSS, and to continue the communication in ciphered mode. The RNC may request the MS to send the MS Classmarks 2 and 3 which include information on the GSM ciphering algorithm capabilities of the MS. This is necessary only if the MS Classmarks 2 and 3 were not transmitted from UE to UTRAN during the RRC Connection Establishment.The intersystem handover will imply a change of ciphering algorithm from a UEA to a GSM A5. The GSM BSS includes the selected GSM ciphering mode in the handover command message sent to the MS via the RNC.

The integrity protection of signalling messages is stopped at handover to GSM BSS.

The START values (see subclause 6.4.8) shall be stored in the ME/USIM at handover to GSM BSS.

3GPP TSG SA WG3 Security — S3#17 **S3-000124**
27 February – 2 March, 2001
Göteborg, Sweden

CR-Form-v3

CHANGE REQUEST

⌘ **33.102 CR 140** ⌘ rev **-** ⌘ Current version: **3.7.0** ⌘

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Proposed change affects: ⌘ (U)SIM [ ] ME/UE [X] Radio Access Network [ ] Core Network [ ]

Title: ⌘	Correction to the handling of re-transmitted authentication request messages on the ME
Source: ⌘	SA WG3
Work item code: ⌘	Security
Date: ⌘	2001-03-01
Category: ⌘	F
Release: ⌘	REL-99

Use one of the following categories:
F *(essential correction)*
A *(corresponds to a correction in an earlier release)*
B *(Addition of feature),*
C *(Functional modification of feature)*
D *(Editorial modification)*
Detailed explanations of the above categories can be found in 3GPP TR 21.900.

Use one of the following releases:
2 (GSM Phase 2)
R96 (Release 1996)
R97 (Release 1997)
R98 (Release 1998)
R99 (Release 1999)
REL-4 (Release 4)
REL-5 (Release 5)

Reason for change: ⌘	N1 have stated that the most critical procedure for which re-transmission is expected to occur with the highest probability is the UMTS Authentication procedure via the Gb interface. Therefore it is specified that the mechanism shall be implemented for PS and may be implemented for CS. In addition, it has been identified that the ME is required to delete the stored RAND and RES when the GSM cipher mode command is received.
Summary of change: ⌘	It is specified that the mechanism shall be implemented for PS and may be implemented for CS. In addition, it is added that the ME deletes the stored RAND and RES when the GSM cipher mode command is received.
Consequences if not approved: ⌘	Specification that the mechanism shall be implemented in PS and may be implemented in CS was a compromise position reached in N1 and it provides the basis for N1 stage 3 CRs to be presented at CN#10. If this corresponding stage 2 CR is not approved then completion of the stage 3 specifications may be further delayed. In addition, if the stored RAND and RES are not deleted when the GSM cipher mode command is received then a 3G authentication request could be successfully replayed during a GSM BSS connection.
Clauses affected: ⌘	6.3
Other specs affected: ⌘	[X] Other core specifications ⌘ 24.008-CR-xxx [ ] Test specifications [ ] O&M Specifications
Other comments: ⌘	

6.3.3 Authentication and key agreement

The purpose of this procedure is to authenticate the user and establish a new pair of cipher and integrity keys between the VLR/SGSN and the USIM. During the authentication, the USIM verifies the freshness of the authentication vector that is used.

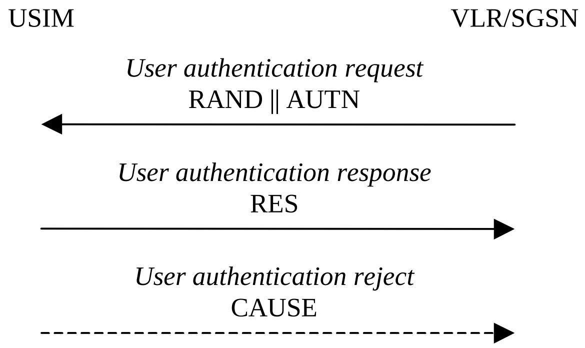


Figure 8: Authentication and key establishment

The VLR/SGSN invokes the procedure by selecting the next unused authentication vector from the ordered array of authentication vectors in the VLR/SGSN database. Authentication vectors in a particular node are used on a first-in / first-out basis. The VLR/SGSN sends to the USIM the random challenge RAND and an authentication token for network authentication AUTN from the selected authentication vector.

Upon receipt the user proceeds as shown in Figure 9.

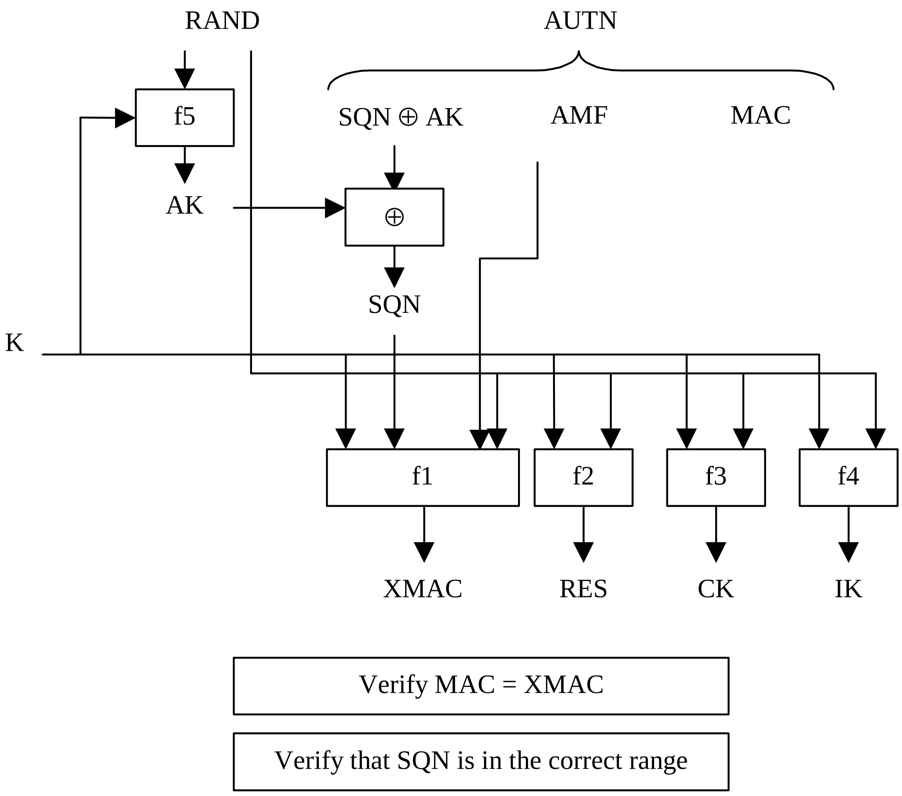


Figure 9: User authentication function in the USIM

Upon receipt of RAND and AUTN the USIM first computes the anonymity key AK = $f5_K$ (RAND) and retrieves the sequence number SQN = (SQN ⊕ AK) ⊕ AK.

Next the USIM computes XMAC = $f1_K$ (SQN || RAND || AMF) and compares this with MAC which is included in AUTN. If they are different, the user sends *user authentication reject* back to the VLR/SGSN with an indication of the cause and the user abandons the procedure. In this case, VLR/SGSN shall initiate an Authentication Failure Report procedure towards the HLR as specified in section 6.3.6. VLR/SGSN may also decide to initiate a new identification and authentication procedure towards the user.

Next the USIM verifies that the received sequence number SQN is in the correct range.

If the USIM considers the sequence number to be not in the correct range, it sends *synchronisation failure* back to the VLR/SGSN including an appropriate parameter, and abandons the procedure.

The synchronisation failure message contains the parameter AUTS. It is AUTS = Conc(SQN_{MS}) || MAC-S. Conc(SQN_{MS}) = $SQN_{MS} \oplus f5^*_K$(RAND) is the concealed value of the counter SQN_{MS} in the MS, and MAC-S = $f1^*_K$(SQN_{MS} || RAND || AMF) where RAND is the random value received in the current user authentication request. f1* is a message authentication code (MAC) function with the property that no valuable information can be inferred from the function values of f1* about those of f1, ... , f5, f5* and vice versa. f5* is the key generating function used to compute AK in re-synchronisation procedures with the property that no valuable information can be inferred from the function values of f5* about those of f1, f1*, f2, ... , f5 and vice versa.

The AMF used to calculate MAC-S assumes a dummy value of all zeros so that it does not need to be transmitted in the clear in the re-synch message.

The construction of the parameter AUTS in shown in the following Figure 10:

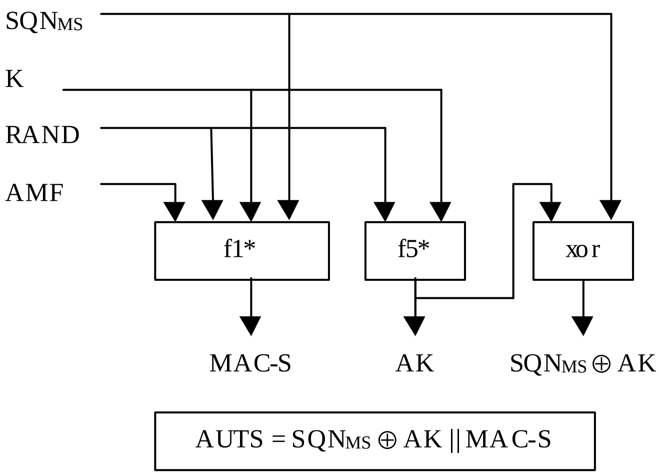


Figure 10: Construction of the parameter AUTS

If the sequence number is considered to be in the correct range however, the USIM computes RES = $f2_K$ (RAND) and includes this parameter in a *user authentication response* back to the VLR/SGSN. Finally the USIM computes the cipher key CK = $f3_K$ (RAND) and the integrity key IK = $f4_K$ (RAND). Note that if this is more efficient, RES, CK and IK could also be computed earlier at any time after receiving RAND. If the USIM also supports conversion function c3, it shall derive the GSM cipher key Kc from the UMTS cipher/integrity keys CK and IK. UMTS keys are sent to the MS along with the derived GSM key for UMTS-GSM interoperability purposes. USIM shall store original CK, IK until the next successful execution of AKA.

Upon receipt of *user authentication response* the VLR/SGSN compares RES with the expected response XRES from the selected authentication vector. If XRES equals RES then the authentication of the user has passed. The VLR/SGSN also selects the appropriate cipher key CK and integrity key IK from the selected authentication vector. If XRES and RES are different, VLR/SGSN shall initiate an Authentication Failure Report procedure towards the HLR as specified in section 6.3.6. VLR/SGSN may also decide to initiate a new identification and authentication procedure towards the user.

Re-use and re-transmission of (RAND, AUTN)

The verification of the SQN by the USIM will cause the MS to reject an attempt by the VLR/SGSN to re-use a quintet to establish a particular UMTS security context more than once. In general therefore the VLR/SGSN shall use a quintet only once.

There is one exception however: in the event that the VLR/SGSN has sent out an *authentication request* using a particular quintet and does not receive a response message (*authentication response* or *authentication reject*) from the MS, it may re-transmit the *authentication request* using the same quintet. However, as soon as a response message arrives no further re-transmissions are allowed. If after the initial transmission or after a series of re-transmissions no response arrives, retransmissions may be abandoned. If retransmissions are abandoned then the VLR/SGSN shall delete the quintet. At the MS side, in order to allow this re-transmission without causing additional re-synchronisation procedures, the ME shall store for the PS domain (and optionally the CS domain) the last received RAND as well as the corresponding RES, CK and IK. If the USIM returned SRES and Kc (for GSM access), the ME shall store these values. When the ME receives an *authentication request* and discovers that a RAND is repeated, it shall re-transmit the response. The ME shall delete the stored values RAND, RES and SRES (if they existed) as soon as the 3G security mode command or the GSM cipher mode command is received by the ME or the connection is aborted. If the ME can handle the retransmission mechanism for CS domain then The MEit shall be able to handle the retransmission for both PS and CS domain simultaneously.

3GPP TSG SA WG3 — SA 3 #17 **S3-010126**
Göteborg, Sweden. 27 February-2 March 2001.

CR-Form-v3

CHANGE REQUEST

⌘ **33.102**	**CR 141**	⌘	rev	**-**	⌘	Current version: **3.7.0**	⌘

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

Proposed change affects: ⌘ (U)SIM [ ] ME/UE [X] Radio Access Network [ ] Core Network [x]

Title:	⌘	Optional Support for USIM-ME interface for GSM-Only ME		
Source:	⌘	SA WG3		
Work item code:	⌘	Security	***Date:*** ⌘	2/3/2001
Category:	⌘	**F**	***Release:*** ⌘	R99
		Use one of the following categories: ***F*** *(essential correction)* ***A*** *(corresponds to a correction in an earlier release)* ***B*** *(Addition of feature),* ***C*** *(Functional modification of feature)* ***D*** *(Editorial modification)* Detailed explanations of the above categories can be found in 3GPP TR 21.900.		*Use one of the following releases:* *2 (GSM Phase 2)* *R96 (Release 1996)* *R97 (Release 1997)* *R98 (Release 1998)* *R99 (Release 1999)* *REL-4 (Release 4)* *REL-5 (Release 5)*

Reason for change:	⌘	Alignment with T3-view
Summary of change:	⌘	Include that GSM-Only ME may optionally support the USIM-ME interface Adaptations to interworking sections necessary.
Consequences if not approved:	⌘	Inconsistent Specification

Clauses affected:	⌘	2; 3.1; 6.8	
Other specs affected:	⌘	[ ] Other core specifications [ ] Test specifications [ ] O&M Specifications	⌘
Other comments:	⌘	2 explicit requirement have been introduced for the R99+ VLR/SGSN (for UMTS subscriber handling a R99+ ME) as a consequence of R99+ GSM only ME that may support USIM-ME interface. 1) The R99+ VLR/SGSN shall reject authentication if SRES is received in response of a UMTS challenge (RAND, AUTN) over an Iu-Interface. 2) The R99+ VLR/SGSN shall accept authentication if a valid SRES is received in response of a UMTS challenge (RAND, AUTN) over A or Gb-Interface. This will happen in case a UICC is inserted in a ME that is not capable of UMTS AKA and is attached to a GSM BSS. In this case the R99+ VLR/SGSN uses function c2 to convert RES (from the quintet) to SRES to verify the received SRES.	

****** First modified section *****

2 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 21.133: "3rd Generation Partnership Project (3GPP); Technical Specification Group (TSG) SA; 3G Security; Security Threats and Requirements".

[2] 3GPP TS 33.120: "3rd Generation Partnership Project (3GPP); Technical Specification Group (TSG) SA; 3G Security; Security Principles and Objectives".

[3] 3GPP TR 21.905: "3rd Generation Partnership Project (3GPP); Technical Specification Group Services and System Aspects; Vocabulary for 3GPP Specifications (Release 1999)".

[4] 3GPP TS 23.121: "3rd Generation Partnership Project (3GPP); Technical Specification Group Services and System Aspects; Architecture Requirements for Release 99".

[5] 3GPP TS 31.101: "3rd Generation Partnership Project (3GPP); Technical Specification Group Terminals; UICC-terminal interface; Physical and logical characteristics".

[6] 3GPP TS 22.022: "3rd Generation Partnership Project (3GPP); Technical Specification Group Services and System Aspects; Personalisation of UMTS Mobile Equipment (ME); Mobile functionality specification".

[7] 3GPP TS 23.048: "3rd Generation Partnership Project (3GPP); Technical Specification Group Services and System Aspects; Security Mechanisms for the USIM application toolkit; Stage 2".

[8] ETSI GSM 03.20: "Digital cellular telecommunications system (Phase 2+); Security related network functions".

[9] 3GPP TS 23.060: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Digital cellular telecommunications system (Phase 2+); General Packet Radio Service (GPRS); Service description; Stage 2".

[10] ISO/IEC 9798-4: "Information technology - Security techniques - Entity authentication - Part 4: Mechanisms using a cryptographic check function".

[11] 3GPP TS 35.201: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Specification of the 3GPP confidentiality and integrity algorithms; Document 1: f8 and f9 specifications".

[12] 3GPP TS 35.202: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Specification of the 3GPP confidentiality and integrity algorithms; Document 2: Kasumi algorithm specification".

[13] 3GPP TS 35.203: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Specification of the 3GPP confidentiality and integrity algorithms; Document 3: Implementers' test data".

[14] 3GPP TS 35.204: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Specification of the 3GPP confidentiality and integrity algorithms; Document 4: Design conformance test data".

[15] 3GPP TS 31.111: "3rd Generation Partnership Project; Technical Specification Group Terminals; USIM Application Toolkit (USAT)".

[16] 3GPP TS 02.48: "Security Mechanisms for the SIM Application Toolkit; Stage 1".

[17] 3GPP TS 25.331: "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; RRC Protocol Specification".

[18] 3GPP TS 25.321: "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; MAC protocol specification".

[19] 3GPP TS 25.322: "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; RLC Protocol Specification".

[20] 3GPP TS 31.102: "3rd Generation Partnership Project (3GPP); Technical Specification Group Terminals; Characteristics of the USIM Application

3 Definitions, symbols and abbreviations

3.1 Definitions

In addition to the definitions included in TR 21.905 [3], for the purposes of the present document, the following definitions apply:

Confidentiality: The property that information is not made available or disclosed to unauthorised individuals, entities or processes.

Data integrity: The property that data has not been altered in an unauthorised manner.

Data origin authentication: The corroboration that the source of data received is as claimed.

Entity authentication: The provision of assurance of the claimed identity of an entity.

Key freshness: A key is fresh if it can be guaranteed to be new, as opposed to an old key being reused through actions of either an adversary or authorised party.

USIM – User Services Identity Module. In a security context, this module is responsible for performing UMTS subscriber and network authentication and key agreement. It should also be capable of performing GSM authentication and key agreement to enable the subscriber to roam easily into a GSM Radio Access Network.

SIM – GSM Subscriber Identity Module. In a security context, this module is responsible for performing GSM subscriber authentication and key agreement. This module is **not** capable of handling UMTS authentication nor storing UMTS style keys.

UMTS Entity authentication and key agreement: Entity authentication according to this specification.

GSM Entity authentication and key agreement: Entity authentication according to TS ETSI GSM 03.20

User access module: either a USIM or a SIM

Mobile station, user: the combination of user equipment and a user access module.

UMTS subscriber: a mobile station that consists of user equipment with a USIM inserted.

GSM subscriber: a mobile station that consists of user equipment with a SIM inserted.

UMTS security context: a state that is established between a user and a serving network domain as a result of the execution of UMTS AKA. At both ends "UMTS security context data" is stored, that consists at least of the UMTS cipher/integrity keys CK and IK and the key set identifier KSI.

GSM security context: a state that is established between a user and a serving network domain usually as a result of the execution of GSM AKA. At both ends "GSM security context data" is stored, that consists at least of the GSM cipher key Kc and the cipher key sequence number CKSN.

Quintet, UMTS authentication vector: temporary authentication data that enables an VLR/SGSN to engage in UMTS AKA with a particular user. A quintet consists of five elements: a) a network challenge RAND, b) an expected user response XRES, c) a cipher key CK, d) an integrity key IK and e) a network authentication token AUTN.

Triplet, GSM authentication vector: temporary authentication data that enables an VLR/SGSN to engage in GSM AKA with a particular user. A triplet consists of three elements: a) a network challenge RAND, b) an expected user response SRES and c) a cipher key Kc.

Authentication vector: either a quintet or a triplet.

Temporary authentication data: either UMTS or GSM security context data or UMTS or GSM authentication vectors.

R99+ ME capable of UMTS AKA: either a R99+ UMTS only ME, a R99+ GSM/UMTS ME, or a R99+ GSM only ME that does support USIM-ME interface.

R99+ ME not capable of UMTS AKA: a R99+ GSM only ME that does not support USIM-ME interface

****** next modified section *****

6.8 Interoperation and handover between UMTS and GSM

6.8.1 Authentication and key agreement of UMTS subscribers

6.8.1.1 General

For UMTS subscribers, authentication and key agreement will be performed as follows:

- UMTS AKA shall be applied when the user is attached to a UTRAN.

- UMTS AKA shall be applied when the user is attached to a GSM BSS, in case the user has R99+ ME capable of UMTS AKAR99+ ME and also the VLR/SGSN is R99+. In this case, the GSM cipher key Kc is derived from the UMTS cipher/integrity keys CK and IK, by the VLR/SGSN on the network side and by the USIM on the user side.

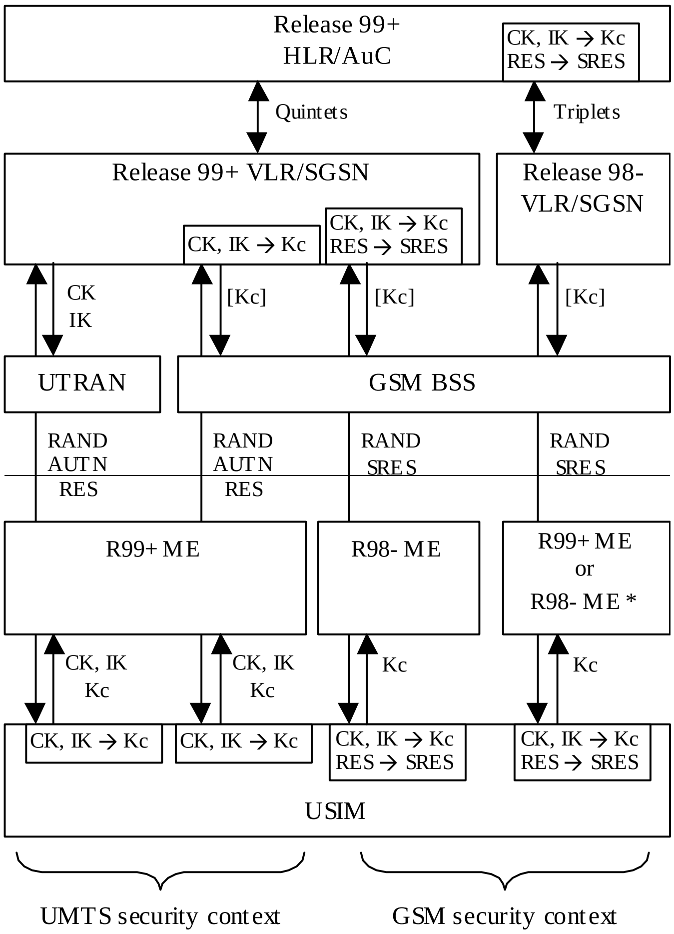
- GSM AKA shall be applied when the user is attached to a GSM BSS, in case the user has R98- MER99+ ME not capable of UMTS AKA or R98- ME. In this case, the GSM user response SRES and the GSM cipher key Kc are derived from the UMTS user response RES and the UMTS cipher/integrity keys CK and IK. A R98- VLR/SGSN uses the stored Kc and RES and a R99+ VLR/SGSN derives the SRES from RES and Kc from CK, IK.

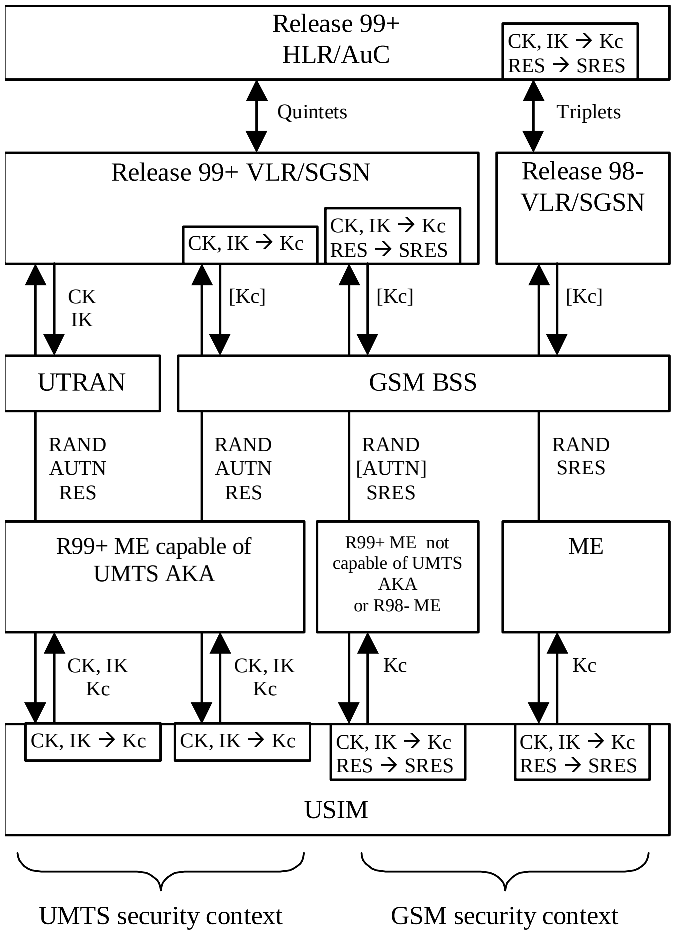
NOTE: To operate within a R99+ ME not capable of UMTS AKA or R98- ME, the USIM may support the SIM-ME interface as defined in GSM 11.11, and support GSM AKA which provides the corresponding GSM functionality for calculating SRES and Kc based on the 3G authentication key K and the 3G authentication algorithm implemented in the USIM. Due to the fact that the UMTS3G authentication algorithm only computes CK/IK and RES, conversion of CK/IK to Kc shall be achieved by using the conversion function c3, and conversion of RES to SRES by c2.

- GSM AKA shall be applied when the user is attached to a GSM BSS, in case the VLR/SGSN is R98-. In this case, the USIM derives the GSM user response SRES and the GSM cipher key Kc from the UMTS user response RES and the UMTS cipher/integrity keys CK, IK.

The execution of the UMTS (resp. GSM) AKA results in the establishment of a UMTS (resp. GSM) security context between the user and the serving network domain to which the VLR/SGSN belongs. The user needs to separately establish a security context with each serving network domain.

Figure 18 shows the different scenarios that can occur with UMTS subscribers using either R98- or R99+ ME in a mixed network architecture.


Release 99+
HLR/AuC
CK, IK → Kc
RES → SRES
Quintets
Triplets
Release 99+ VLR/SGSN
CK, IK → Kc
CK, IK → Kc
RES → SRES
Release 98-
VLR/SGSN
CK
IK
[Kc]
[Kc]
[Kc]
UTRAN
GSM BSS
RAND
AUTN
RES
RAND
AUTN
RES
RAND
SRES
RAND
SRES
R99+ ME
R98- ME
R99+ ME
or
R98- ME *
CK, IK
Kc
CK, IK
Kc
Kc
Kc
CK, IK → Kc
CK, IK → Kc
CK, IK → Kc
RES → SRES
CK, IK → Kc
RES → SRES
USIM
UMTS security context
GSM security context



~~(See the note above for further explanation on * in figure 18).~~

Figure 18: Authentication and key agreement of UMTS subscribers

Note that the UMTS parameters RAND, AUTN and RES are sent transparently through the UTRAN or GSM BSS and that the GSM parameters RAND and SRES are sent transparently through the GSM BSS.

In case of a GSM BSS, ciphering is applied in the GSM BSS for services delivered via the MSC/VLR, and by the SGSN for services delivered via the SGSN. In the latter case the GSM cipher key Kc is not sent to the GSM BSS.

In case of a UTRAN, ciphering and integrity are always applied in the RNC, and the UMTS cipher/integrity keys CK an IK are always sent to the RNC.

6.8.1.2 R99+ HLR/AuC

Upon receipt of an *authentication data request* from a R99+ VLR/SGSN for a UMTS subscriber, a R99+ HLR/AuC shall send quintets, generated as specified in 6.3.

Upon receipt of an *authentication data request* from a R98- VLR/SGSN for a UMTS subscriber, a R99+ HLR/AuC shall send triplets, derived from quintets using the following conversion functions:

a) c1: $RAND_{[GSM]}$ = RAND

b) c2: $SRES_{[GSM]} = XRES^*_1$ xor $XRES^*_2$ xor $XRES^*_3$ xor $XRES^*_4$

c) c3: $Kc_{[GSM]} = CK_1$ xor CK_2 xor IK_1 xor IK_2

whereby XRES* is 128 bits long and XRES* = XRES if XRES is 128 bits long and XRES* = XRES || 0...0 if XRES is shorter than 128 bits, $XRES^*_i$ are all 32 bit long and $XRES^* = XRES^*_1 \| XRES^*_2 \| XRES^*_3 \| XRES^*_4$, CK_i and IK_i are both 64 bits long and $CK = CK_1 \| CK_2$ and $IK = IK_1 \| IK_2$.

6.8.1.3 R99+ VLR/SGSN

The AKA procedure will depend on the terminal capabilities, as follows:

- **UMTS subscriber with R99+ ME**

When the user has R99+ ME, the VLR/SGSN shall send the ME a UMTS authentication challenge (i.e. RAND and AUTN)~~UMTS AKA shall be performed~~ using a quintet that is either:

a) retrieved from the local database,

b) provided by the HLR/AuC, or

c) provided by the previously visited R99+ VLR/SGSN.

Note: Originally all quintets are provided by the HLR/AuC.

When the R99+ ME is capable of the USIM-ME interface UMTS AKA is performed and the VLR/SGSNreceives the UMTS response RES.

UMTS AKA results in the establishment of a UMTS security context; the UMTS cipher/integrity keys CK and IK and the key set identifier KSI are stored in theVLR/SGSN.

When the user is attached to a UTRAN, the UMTS cipher/integrity keys are sent to the RNC, where the cipher/integrity algorithms are allocated.

When the user is attached to a GSM BSS, UMTS AKA is followed by the derivation of the GSM cipher key from the UMTS cipher/integrity keys. When the user receives service from an MSC/VLR, the derived cipher key Kc is then sent to the BSC (and forwarded to the BTS). When the user receives service from an SGSN, the derived cipher key Kc is applied in the SGSN itself.

UMTS authentication and key freshness is always provided to UMTS subscribers with R99+ ME independently of the radio access network.

When the R99+ ME is not capable of the USIM-ME interface GSM AKA is performed and the VLR/SGSN receives the GSM response SRES.

GSM AKA results in the establishment of a GSM security context; the GSM cipher key Kc and the cipher key sequence number CKSN are stored in the VLR/SGSN.

The R99+ VLR/SGSN shall reject authentication if SRES is received in response of a UMTS challenge (RAND, AUTN) over an Iu-Interface.

The R99+ VLR/SGSN shall accept authentication if a valid SRES is received in response of a UMTS challenge (RAND, AUTN) over A or Gb-Interface. This will happen in case a UICC is inserted in a R99+ ME that is not capable of UMTS AKA and is attached to a GSM BSS. In this case the R99+ VLR/SGSN uses function c2 to convert RES (from the quintet) to SRES to verify the received SRES.

- UMTS subscriber with R98- ME

When the user has R98- ME, the R99+ VLR/SGSN send the ME a GSM authentication challenge ~~shall perform GSM AKA~~ using a triplet that is either

a) derived by means of the conversion functions c2 and c3 in the R99+ VLR/SGSN from a quintet that is:

   i) retrieved from the local database,

   ii) provided by the HLR/AuC, or

   iii) provided by the previously visited R99+ VLR/SGSN, or

b) provided as a triplet by the previously visited VLR/SGSN.

NOTE: R99+ VLR/SGSN will always provide quintets for UMTS subscribers.

NOTE: For a UMTS subscriber, all triplets are derived from quintets, be it in the HLR/AuC or in an VLR/SGSN.

GSM AKA results in the establishment of a GSM security context; the GSM cipher key Kc and the cipher key sequence number CKSN are stored in the VLR/SGSN.

In this case the user is attached to a GSM BSS. When the user receives service from an MSC/VLR, the GSM cipher key is sent to the BSC (and forwarded to the BTS). When the user receives service from an SGSN, the derived cipher key Kc is applied in the SGSN itself.

UMTS authentication and key freshness cannot be provided to UMTS subscriber with R98- ME.

6.8.1.4 R99+ ME

Release 99+ ME that has UTRAN radio capability shall support the USIM-ME interface as specified in TS 31.102 [20].

Release 99+ ME that has no UTRAN radio capabilities may support the USIM-ME interface as specified in TS 31.102 [20].

R99+ ME capable of UMTS AKA with a USIM inserted and attached to a UTRAN shall only participate in UMTS AKA and shall not participate in GSM AKA.

R99+ ME capable of UMTS AKA with a USIM inserted and attached to a GSM BSS shall participate in UMTS AKA and may participate in GSM AKA. Participation in GSM AKA is required to allow registration in a R98- VLR/SGSN.

A R99+ ME that does not support the USIM-ME interface (not capable of UMTS AKA) with a USIM inserted can only participate in GSM AKA.

The execution of UMTS AKA results in the establishment of a UMTS security context; the UMTS cipher/integrity keys CK and IK and the key set identifier KSI are passed to the ME. If the USIM supports conversion function c3 and/or GSM AKA, the ME shall also receive a GSM cipher key Kc derived at the USIM.

The execution of GSM AKA results in the establishment of a GSM security context; the GSM cipher key Kc and the cipher key sequence number CKSN are stored in the ME.

6.8.1.5 USIM

The USIM shall support UMTS AKA and may support backwards compatibility with the GSM system, which consists of:

Feature 1: GSM cipher key derivation (conversion function c3) to access GSM BSS attached to a R99+ VLR/SGSN using a dual-mode R99+ ME;

Feature 2: GSM AKA to access the GSM BSS attached to a R98- VLR/SGSN or when using R99+ ME not capable of UMTS AKA or R98- ME;

Feature 3: SIM-ME interface (GSM 11.11) to operate within R98- ME or R99+ ME not capable of UMTS AKA.

When the ME provides the USIM with RAND and AUTN, UMTS AKA shall be executed. If the verification of AUTN is successful, the USIM shall respond with the UMTS user response RES and the UMTS cipher/integrity keys CK and IK. The USIM shall store CK and IK as current security context data. If the USIM supports access to GSM cipher key derivation (feature 1), the USIM shall also derive the GSM cipher key Kc from the UMTS cipher/integrity keys CK and IK using conversion function c3 and send the derived Kc to the R99+ ME. In case the verification of AUTN is not successful, the USIM shall respond with an appropriate error indication to the R99+ ME.

When the ME provides the USIM with only RAND, and the USIM supports GSM AKA (Feature 2), GSM AKA shall be executed. The USIM first computes the UMTS user response RES and the UMTS cipher/integrity keys CK and IK. The USIM then derives the GSM user response SRES and the GSM cipher key Kc using the conversion functions c2 and c3. The USIM then stores the GSM cipher key Kc as the current security context and sends the GSM user response SRES and the GSM cipher key Kc to the ME.

In case the USIM does not support GSM cipher key derivation (Feature 1) or GSM AKA (Feature 2), the R99+ ME shall be informed. A USIM that does not support GSM cipher key derivation (Feature 1) cannot operate in any GSM BSS. A USIM that does not support GSM AKA (Feature 2) cannot operate under a R98- VLR/SGSN or in both a R99+ ME that is not capable of UMTS AKA.and in R98- ME.

6.8.2 Authentication and key agreement for GSM subscribers

6.8.2.1 General

For GSM subscribers, GSM AKA shall always be used.

The execution of the GSM AKA results in the establishment of a GSM security context between the user and the serving network domain to which the VLR/SGSN belongs. The user needs to separately establish a security context with each serving network domain.

When in a UTRAN, the UMTS cipher/integrity keys CK and IK are derived from the GSM cipher key Kc by the ME and the VLR/SGSN, both R99+ entities.

Figure 19 shows the different scenarios that can occur with GSM subscribers using either R98- or R99+ ME in a mixed network architecture.

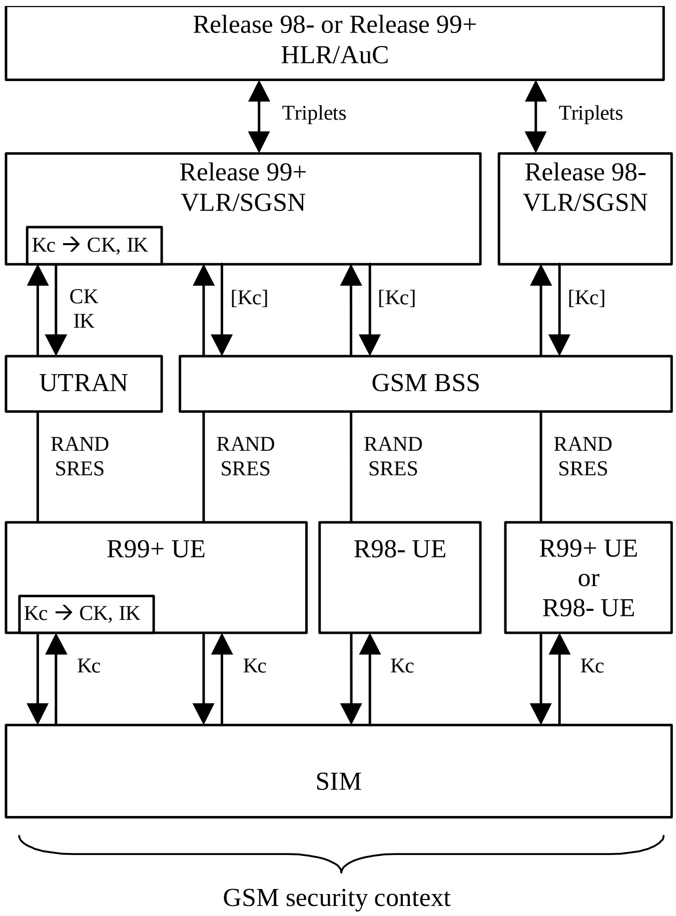


Figure 19: Authentication and key agreement for GSM subscribers

Note that the GSM parameters RAND and RES are sent transparently through the UTRAN or GSM BSS.

In case of a GSM BSS, ciphering is applied in the GSM BSS for services delivered via the MSC/VLR, and by the SGSN for services delivered via the SGSN. In the latter case the GSM cipher key Kc is not sent to the GSM BSS.

In case of a UTRAN, ciphering is always applied in the RNC, and the UMTS cipher/integrity keys CK an IK are always sent to the RNC.

6.8.2.2 R99+ HLR/AuC

Upon receipt of an *authentication data request* for a GSM subscriber, a R99+ HLR/AuC shall send triplets generated as specified in GSM 03.20.

6.8.2.3 VLR/SGSN

The R99+ VLR/SGSN shall perform GSM AKA using a triplet that is either:

a) retrieved from the local database,

b) provided by the HLR/AuC, or

c) provided by the previously visited VLR/SGSN.

NOTE: All triplets are originally provided by the HLR/AuC.

GSM AKA results in the establishment of a GSM security context; the GSM cipher key Kc and the cipher key sequence number CKSN are stored in the VLR/SGSN.

When the user is attached to a UTRAN, the R99+ VLR/SGSN derives the UMTS cipher/integrity keys from the GSM cipher key using the following conversion functions:

a) c4: $CK_{[UMTS]} = Kc \| Kc$;

b) c5: $IK_{[UMTS]} = Kc_1 \text{ xor } Kc_2 \| Kc \| Kc_1 \text{ xor } Kc_2$;

whereby in c5, Kc_i are both 32 bits long and $Kc = Kc_1 \| Kc_2$.

The UMTS cipher/integrity keys are then sent to the RNC where the ciphering and integrity algorithms are allocated.

When the user is attached to a GSM BSS and the user receives service from an MSC/VLR, the cipher key Kc is sent to the BSC (and forwarded to the BTS). When the user receives service from an SGSN, the cipher key Kc is applied in the SGSN itself.

6.8.2.4 R99+ ME

R99+ ME with a SIM inserted, shall participate only in GSM AKA.

GSM AKA results in the establishment of a GSM security context; the GSM cipher key Kc and the cipher key sequence number CKSN are stored in the ME.

When the user is attached to a UTRAN, R99+ ME shall derive the UMTS cipher/integrity keys CK and IK from the GSM cipher key Kc using the conversion functions c4 and c5. The ME shall handle the $START_{CS}$ and $START_{PS}$ as described in section 6.4.8 with the exception that the START values are stored on the ME rather than on the GSM SIM. If the ME looses the current START value for a particular domain (e.g. due to power off) it shall delete the corresponding GSM cipher key (Kc), the derived UMTS cipher/integrity keys (CK and IK), and reset the START value to zero. The ME shall then trigger a new authentication and key agreement at the next connection establishment by indicating to the network that no valid keys are available for use using the procedure described in section 6.4.4.

6.8.3 Distribution and use of authentication data between VLRs/SGSNs

The distribution of authentication data (unused authentication vectors and/or current security context data) between R99+ VLRs/SGSNs of the same service network domain is performed according to chapter 6.3.4. The following four cases are distinguished related to the distribution of authentication data between VLRs/SGSNs (of the same or different releases). Conditions for the distribution of such data and for its use when received at VLRn/SGSNn are indicated for each case:

a) R99+ VLR/SGSN to R99+ VLR/SGSN

   UMTS and GSM authentication vectors can be distributed between R99+ VLRs/SGSNs. Note that originally all authentication vectors (quintets for UMTS subscribers and triplets for GSM subscribers) are provided by the HLR/AuC.

   Current security context data can be distributed between R99+ VLRs/SGSNs. VLRn/SGSNn shall not use current security context data received from VLRo/SGSNo to authenticate the subscriber using local authentication in the following cases:

i) Security context to be established at VLRn/SGSNn requires a different set of keys than the one currently in use at VLRo/SGSNo. This change of security context is caused by a change of ME release (R'99 ME ←→ R'98 ME) when the user registers at VLRn/SGSNn.

ii) Authentication data from VLRo includes Kc+CKSN but no unused AVs and the subscriber has a R'99 ME (under GSM BSS or UTRAN). In this situation, VLRn have no indication of whether the subscriber is GSM or UMTS and it is not able to decide whether Kc received can be used (in case the subscriber were a GSM subscriber).

In these two cases, received current security context data shall be discarded and a new AKA procedure shall be performed.

b) R98- VLR/SGSN to R98- VLR/SGSN

Only triplets can be distributed between R98- VLRs/SGSNs. Note that originally for GSM subscribers, triplets are generated by HLR/AuC and for UMTS subscribers, they are derived from UMTS authentication vectors by R99+ HLR/AuC. UMTS AKA is not supported and only GSM security context can be established by a R98- VLR/SGSN.

R98- VLRs are not prepared to distribute current security context data.

Since only GSM security context can be established under R98- SGSNs, security context data can be distributed and used between R98- SGSNs.

c) R99+ VLR/SGSN to R98- VLR/SGSN

R99+ VLR/SGSN can distribute to a new R98- VLR/SGSN triplets originally provided by HLR/AuC for GSM subscribers or can derive triplets from stored quintets originally provided by R99+ HLR/AuC for UMTS subscribers. Note that R98- VLR/SGSN can only establish GSM security context.

R99+ VLRs shall not distribute current security context data to R98- VLRs.

Since R98- SGSNs are only prepared to handle GSM security context data, R99+ SGSNs shall only distribute GSM security context data (Kc, CKSN) to R98- SGSNs.

d) R98- VLR/SGSN to R99+ VLR/SGSN.

In order to not establish a GSM security context for a UMTS subscriber, triplets provided by a R98- VLR/SGSN can only be used by a R99+ VLR/SGSN to establish a GSM security context under GSM-BSS with a R98- ME.

In all other cases, R99+ VLR/SGSN shall request fresh AVs (either triplets or quintets) to HE. In the event, the R99+ VLR/SGSN receives quintets, it shall discard the triplets provided by the R98- VLR/SGSN.

R98- VLRs are not prepared to distribute current security context data.

R98- SGSNs can distribute GSM security context data only. The use of this information at R99+ SGSNn shall be performed according to the conditions stated in a).

6.8.4 Intersystem handover for CS Services – from UTRAN to GSM BSS

If ciphering has been started when an intersystem handover occurs from UTRAN to GSM BSS, the necessary information (e.g. Kc, supported/allowed GSM ciphering algorithms) is transmitted within the system infrastructure before the actual handover is executed to enable the communication to proceed from the old RNC to the new GSM BSS, and to continue the communication in ciphered mode. The intersystem handover will imply a change of ciphering algorithm from a UEA to a GSM A5. The GSM BSS includes the selected GSM ciphering mode in the handover command message sent to the MS via the RNC.

The integrity protection of signalling messages is stopped at handover to GSM BSS.

The START values (see subclause 6.4.8) shall be stored in the ME/USIM at handover to GSM BSS.

6.8.4.1 UMTS security context

A UMTS security context in UTRAN is only established for a UMTS subscriber with a R99+ -ME that is capable of UMTS AKA. At the network side, three cases are distinguished:

a) In case of a handover to a GSM BSS controlled by the same MSC/VLR, the MSC/VLR derives the GSM cipher key Kc from the stored UMTS cipher/integrity keys CK and IK (using the conversion function c3) and sends Kc to the target BSC (which forwards it to the BTS).

b) In case of a handover to a GSM BSS controlled by other R98- MSC/VLR, the initial MSC/VLR derives the GSM cipher key from the stored UMTS cipher/integrity keys (using the conversion function c3) and sends it to the target BSC via the new MSC/VLR controlling the BSC. The initial MSC/VLR remains the anchor point throughout the service.

c) In case of a handover to a GSM BSS controlled by another R99+ MSC/VLR, the initial MSC/VLR sends the stored UMTS cipher/integrity keys CK and IK to the new MSC/VLR. The initial MSC/VLR also derives Kc and sends it to the new MSC/VLR. The new MSC/VLR store the keys and sends the received GSM cipher key Kc to the target BSC (which forwards it to the BTS). The initial MSC/VLR remains the anchor point throughout the service.

At the user side, in either case, the ME applies the derived GSM cipher key Kc received from the USIM during the last UMTS AKA procedure.

6.8.4.2 GSM security context

A GSM security context in UTRAN is only established for a GSM subscribers with a R99+ ME. At the network side, two cases are distinguished:

a) In case of a handover to a GSM BSS controlled by the same MSC/VLR, the MSC/VLR sends the stored GSM cipher key Kc to the target BSC (which forwards it to the BTS).

b) In case of a handover to a GSM BSS controlled by another MSC/VLR (R99+ or R98-), the initial MSC/VLR sends the stored GSM cipher key Kc to the BSC via the new MSC/VLR controlling the target BSC. The initial MSC/VLR remains the anchor point throughout the service.

   If the non-anchor MSC/VLR is R99+, then the anchor MSC/VLR also derives and sends to the non-anchor MSC/VLR the UMTS cipher/integrity keys CK and IK. The non-anchor MSC/VLR stores all keys. This is done to allow subsequent handovers in a non-anchor R99+ MSC/VLR.

At the user side, in either case, the ME applies the stored GSM cipher key Kc.

6.8.5 Intersystem handover for CS Services – from GSM BSS to UTRAN

If ciphering has been started when an intersystem handover occurs from GSM BSS to UTRAN, the necessary information (e.g. CK, IK, START value information, supported/allowed UMTS algorithms) is transmitted within the system infrastructure before the actual handover is executed to enable the communication to proceed from the old GSM BSS to the new RNC, and to continue the communication in ciphered mode. The GSM BSS requests the MS to send the UMTS capability information, which includes information on the START values and UMTS security capabilities of the MS. The intersystem handover will imply a change of ciphering algorithm from a GSM A5 to a UEA. The target UMTS RNC includes the selected UMTS ciphering mode in the handover to UTRAN command message sent to the MS via the GSM BSS.

The integrity protection of signalling messages shall be started immediately after that the intersystem handover from GSM BSS to UTRAN is completed. The Serving RNC will do this by initiating the RRC security mode control procedure when the first RRC message (i.e. the Handover to UTRAN complete message) has been received from the MS. The UE security capability information, that has been sent from MS to RNC via the GSM radio access and the system infrastructure before the actual handover execution, will then be included in the RRC Security mode command message sent to MS and then verified by the MS (i.e. verified that it is equal to the UE security capability information stored in the MS)

6.8.5.1 UMTS security context

A UMTS security context in GSM BSS is only established for UMTS subscribers with R99+ ME that is capable of UMTS AKA under GSM BSS controlled by a R99+ VLR/SGSN. At the network side, two cases are distinguished:

a) In case of a handover to a UTRAN controlled by the same MSC/VLR, the stored UMTS cipher/integrity keys CK and IK are sent to the target RNC.

b) In case of a handover to a UTRAN controlled by another MSC/VLR, the initial MSC/VLR sends the stored UMTS cipher/integrity keys CK and IK to the new RNC via the new MSC/VLR that controls the target RNC. The initial MSC/VLR remains the anchor point for throughout the service.

   The anchor MSC/VLR also derives and sends to the non-anchor MSC/VLR the GSM cipher key Kc. The non-anchor MSC/VLR stores all keys. This is done to allow subsequent handovers in a non-anchor R99+ MSC/VLR.

At the user side, in either case, the ME applies the stored UMTS cipher/integrity keys CK and IK.

6.8.5.2 GSM security context

Handover from GSM BSS to UTRAN with a GSM security context is possible for a GSM subscriber with a R99+ ME or for a UMTS subscriber with a R99+ ME when the initial MSC/VLR is R98-. At the network side, two cases are distinguished:

a) In case of a handover to a UTRAN controlled by the same MSC/VLR, UMTS cipher/integrity keys CK and IK are derived from the stored GSM cipher key Kc (using the conversion functions c4 and c5) and sent to the target RNC. In case of subsequent handover in a non-anchor R99+ MSC/VLR, a GSM cipher key Kc is received for a UMTS subscriber if the anchor MSC/VLR is R98-.

b) In case of a handover to a UTRAN controlled by another MSC/VLR, the initial MSC/VLR (R99+ or R98-) sends the stored GSM cipher key Kc to the new MSC/VLR controlling the target RNC. That MSC/VLR derives UMTS cipher/integrity keys CK and IK which are then forwarded to the target RNC. The initial MSC/VLR remains the anchor point for throughout the service.

At the user side, in either case, the ME derives the UMTS cipher/integrity keys CK and IK from the stored GSM cipher key Kc (using the conversion functions c4 and c5) and applies them.

6.8.6 Intersystem change for PS Services – from UTRAN to GSM BSS

6.8.6.1 UMTS security context

A UMTS security context in UTRAN is only established for UMTS subscribers. At the network side, three cases are distinguished:

a) In case of an intersystem change to a GSM BSS controlled by the same SGSN, the SGSN derives the GSM cipher key Kc from the stored UMTS cipher/integrity keys CK and IK (using the conversion function c3) and applies it.

b) In case of an intersystem change to a GSM BSS controlled by another R99+ SGSN, the initial SGSN sends the stored UMTS cipher/integrity keys CK and IK to the new SGSN. The new SGSN stores the keys, derives the GSM cipher key Kc and applies the latter. The new SGSN becomes the new anchor point for the service.

c) In case of an intersystem change to a GSM BSS controlled by a R98- SGSN, the initial SGSN derives the GSM cipher key Kc and sends the GSM cipher key Kc to the new SGSN. The new SGSN stores the GSM cipher key Kc and applies it. The new SGSN becomes the new anchor point for the service.

At the user side, in all cases, the ME applies the derived GSM cipher key Kc received from the USIM during the last UMTS AKA procedure.

6.8.6.2 GSM security context

A GSM security context in UTRAN is only established for GSM subscribers. At the network side, two cases are distinguished:

a) In case of an intersystem change to a GSM BSS controlled by the same SGSN, the SGSN starts to apply the stored GSM cipher key Kc.

b) In case of an intersystem change to a GSM BSS controlled by another SGSN, the initial SGSN sends the stored GSM cipher key Kc to the (new) SGSN controlling the BSC. The new SGSN stores the key and applies it. The new SGSN becomes the new anchor point for the service.

At the user side, in both cases, the ME applies the GSM cipher key Kc that is stored.

6.8.7 Intersystem change for PS services – from GSM BSS to UTRAN

6.8.7.1 UMTS security context

A UMTS security context in GSM BSS is only established for UMTS subscribers with R99+ ME that is capable of UMTS AKA and connected to a R99+ VLR/SGSN. At the network side, two cases are distinguished:

a) In case of an intersystem change to a UTRAN controlled by the same SGSN, the stored UMTS cipher/integrity keys CK and IK are sent to the target RNC.

b) In case of an intersystem change to a UTRAN controlled by another SGSN, the initial SGSN sends the stored UMTS cipher/integrity keys CK and IK to the (new) SGSN controlling the target RNC. The new SGSN becomes the new anchor point for the service. The new SGSN then stores the UMTS cipher/integrity keys CK and IK and sends them to the target RNC.

At the user side, in both cases, the ME applies the stored UMTS cipher/integrity keys CK and IK.

6.8.7.2 GSM security context

A GSM security context in GSM BSS can be either:

- **Established for a UMTS subscriber**

  A GSM security context for a UMTS subscriber is established in case the user has a R98- ME or R99+ ME not capable of UMTS AKA, where intersystem change to UTRAN is not possible, or in case the user has a R99+ ME but the SGSN is R98-, where intersystem change to UTRAN implies a change to a R99+ SGSN.

  As result, in case of intersystem change to a UTRAN controlled by another R99+ SGSN, the initial R98- SGSN sends the stored GSM cipher key Kc to the new SGSN controlling the target RNC.

  Since the new R99+ SGSN has no indication of whether the subscriber is GSM or UMTS, a R99+ SGSN shall perform a new UMTS AKA when receiving Kc from a R98- SGSN. A UMTS security context using fresh quintets is then established between the R99+ SGSN and the USIM. The new SGSN becomes the new anchor point for the service.

  At the user side, new keys shall be agreed during the new UMTS AKA initiated by the R99+ SGSN.

- **Established for a GSM subscriber**

  Handover from GSM BSS to UTRAN for GSM subscriber is only possible with R99+ ME. At the network side, three cases are distinguished:

  a) In case of an intersystem change to a UTRAN controlled by the same SGSN, the SGSN derives UMTS cipher/integrity keys CK and IK from the stored GSM cipher key Kc (using the conversion functions c4 and c5) and sends them to the target RNC.

  b) In case of an intersystem change from a R99+ SGSN to a UTRAN controlled by another SGSN, the initial SGSN sends the stored GSM cipher key Kc to the (new) SGSN controlling the target RNC. The new SGSN becomes the new anchor point for the service. The new SGSN stores the GSM cipher key Kc and derives the UMTS cipher/integrity keys CK and IK which are then forwarded to the target RNC.

  c) In case of an intersystem change from an R98-SGSN to a UTRAN controlled by another SGSN, the initial SGSN sends the stored GSM cipher key Kc to the (new) SGSN controlling the target RNC. The new SGSN becomes the new anchor point for the service. To ensure use of UMTS keys for a possible UMTS subscriber (superfluous in this case), a R99+ SGSN will perform a new AKA when a R99+ ME is coming from a R98-SGSN.

  At the user side, in all cases, the ME derives the UMTS cipher/integrity keys CK and IK from the stored GSM cipher key Kc (using the conversion functions c4 and c5) and applies them. In case c) these keys will be over-written with a new CK, IK pair due to the new AKA.

CR-Form-v3

CHANGE REQUEST

⌘ **33.102**	**CR 142**	⌘	rev **1**	⌘	Current version: **3.7.0**	⌘

For ***HELP*** *on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

Proposed change affects: ⌘ (U)SIM [ ] ME/UE [ ] Radio Access Network [ ] Core Network [x]

Title:	⌘	Definition corrections		
Source:	⌘	SA WG3		
Work item code:	⌘	Security	***Date:*** ⌘	21/2/2001
Category:	⌘	**F**	***Release:*** ⌘	R99

Use one of the following categories:
- ***F*** *(essential correction)*
- ***A*** *(corresponds to a correction in an earlier release)*
- ***B*** *(Addition of feature),*
- ***C*** *(Functional modification of feature)*
- ***D*** *(Editorial modification)*

Detailed explanations of the above categories can be found in 3GPP TR 21.900.

Use one of the following releases:
- *2* *(GSM Phase 2)*
- *R96* *(Release 1996)*
- *R97* *(Release 1997)*
- *R98* *(Release 1998)*
- *R99* *(Release 1999)*
- *REL-4* *(Release 4)*
- *REL-5* *(Release 5)*

Reason for change:	⌘	Definitions corrections
Summary of change:	⌘	Only changes to definitions and references sections
Consequences if not approved:	⌘	Possible incorrect interpretation of terms used in TS 33.102. Definition of R98- and R99+ was requested by SA#09.

Clauses affected:	⌘	2; 3.1		
Other specs Affected:	⌘	[ ]	Other core specifications	⌘
		[ ]	Test specifications	
		[ ]	O&M Specifications	
Other comments:	⌘			

****** First modified section *****

2 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 21.133: "3rd Generation Partnership Project (3GPP); Technical Specification Group (TSG) SA; 3G Security; Security Threats and Requirements".

[2] 3GPP TS 33.120: "3rd Generation Partnership Project (3GPP); Technical Specification Group (TSG) SA; 3G Security; Security Principles and Objectives".

[3] 3GPP TR 21.905: "3rd Generation Partnership Project (3GPP); Technical Specification Group Services and System Aspects; Vocabulary for 3GPP Specifications (Release 1999)".

[4] 3GPP TS 23.121: "3rd Generation Partnership Project (3GPP); Technical Specification Group Services and System Aspects; Architecture Requirements for Release 99".

[5] 3GPP TS 31.101: "3rd Generation Partnership Project (3GPP); Technical Specification Group Terminals; UICC-terminal interface; Physical and logical characteristics".

[6] 3GPP TS 22.022: "3rd Generation Partnership Project (3GPP); Technical Specification Group Services and System Aspects; Personalisation of UMTS Mobile Equipment (ME); Mobile functionality specification".

[7] 3GPP TS 23.048: "3rd Generation Partnership Project (3GPP); Technical Specification Group Services and System Aspects; Security Mechanisms for the USIM application toolkit; Stage 2".

[8] ETSI GSM 03.20: "Digital cellular telecommunications system (Phase 2+); Security related network functions".

[9] 3GPP TS 23.060: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Digital cellular telecommunications system (Phase 2+); General Packet Radio Service (GPRS); Service description; Stage 2".

[10] ISO/IEC 9798-4: "Information technology - Security techniques - Entity authentication - Part 4: Mechanisms using a cryptographic check function".

[11] 3GPP TS 35.201: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Specification of the 3GPP confidentiality and integrity algorithms; Document 1: f8 and f9 specifications".

[12] 3GPP TS 35.202: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Specification of the 3GPP confidentiality and integrity algorithms; Document 2: Kasumi algorithm specification".

[13] 3GPP TS 35.203: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Specification of the 3GPP confidentiality and integrity algorithms; Document 3: Implementers' test data".

[14] 3GPP TS 35.204: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Specification of the 3GPP confidentiality and integrity algorithms; Document 4: Design conformance test data".

[15] 3GPP TS 31.111: "3rd Generation Partnership Project; Technical Specification Group Terminals; USIM Application Toolkit (USAT)".

[16] 3GPP TS 02.48: "Security Mechanisms for the SIM Application Toolkit; Stage 1".

[17] 3GPP TS 25.331: "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; RRC Protocol Specification".

[18] 3GPP TS 25.321: "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; MAC protocol specification".

[19] 3GPP TS 25.322: "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; RLC Protocol Specification".

[20] 3GPP TS 22.101: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Service aspects; Service principles".

3 Definitions, symbols and abbreviations

3.1 Definitions

In addition to the definitions included in TR 21.905 [3] and TS 22.101[20], for the purposes of the present document, the following definitions apply:

NOTE: 'User' and 'Subscriber' have been defined in TR 21.905[3]. 'User Equipment', 'USIM', 'SIM' and IC Card' have been defined in TS 22.201[20]

Confidentiality: The property that information is not made available or disclosed to unauthorised individuals, entities or processes.

Data integrity: The property that data has not been altered in an unauthorised manner.

Data origin authentication: The corroboration that the source of data received is as claimed.

Entity authentication: The provision of assurance of the claimed identity of an entity.

Key freshness: A key is fresh if it can be guaranteed to be new, as opposed to an old key being reused through actions of either an adversary or authorised party.

~~**USIM – User Services Identity Module.** In a security context, this module is responsible for performing UMTS subscriber and network authentication and key agreement. It should also be capable of performing GSM authentication and key agreement to enable the subscriber to roam easily into a GSM Radio Access Network.~~

~~**SIM – GSM Subscriber Identity Module.** In a security context, this module is responsible for performing GSM subscriber authentication and key agreement. This module is **not** capable of handling UMTS authentication nor storing UMTS style keys.~~

UMTS Entity authentication and key agreement: Entity authentication according to this specification.

GSM Entity authentication and key agreement: The entity Authentication and Key Agreement procedure to provide authentication of a SIM to a serving network domain and to generate the key Kc in accordance to the mechanisms specified in TS ETSI GSM 03.20.

~~Entity authentication according to TS ETSI GSM 03.20~~

~~**User access module:** either a USIM or a SIM~~

~~**Mobile station, user:** the combination of user equipment and a user access module.~~

User: Within the context of this specification a user is either a UMTS subscriber (Section 6.8.1) or a GSM Subscriber (Section 6.8.2) or a physical person as defined in TR 21.905[3] (Section 5.3 and 5.5)

UMTS subscriber: a Mobile Equipment with a UICC inserted and activated USIM-application.

GSM subscriber: a Mobile Equipment with a SIM inserted or a Mobile Equipment with a UICC inserted and activated SIM-application.

~~**UMTS subscriber:** a mobile station that consists of user equipment with a USIM inserted.~~

~~**GSM subscriber:** a mobile station that consists of user equipment with a SIM inserted.~~

UMTS security context: a state that is established between a user and a serving network domain as a result of the execution of UMTS AKA. At both ends "UMTS security context data" is stored, that consists at least of the UMTS cipher/integrity keys CK and IK and the key set identifier KSI. One is still in a UMTS security context, if the keys CK/IK are converted into Kc to work with a GSM BSS.

GSM security context: a state that is established between a user and a serving network domain usually as a result of the execution of GSM AKA. At both ends "GSM security context data" is stored, that consists at least of the GSM cipher key Kc and the cipher key sequence number CKSN.

Quintet, UMTS authentication vector: temporary authentication and key agreement data that enables an VLR/SGSN to engage in UMTS AKA with a particular user. A quintet consists of five elements: a) a network challenge RAND, b) an expected user response XRES, c) a cipher key CK, d) an integrity key IK and e) a network authentication token AUTN.

Triplet, GSM authentication vector: temporary authentication and key agreement data that enables an VLR/SGSN to engage in GSM AKA with a particular user. A triplet consists of three elements: a) a network challenge RAND, b) an expected user response SRES and c) a cipher key Kc.

Authentication vector: either a quintet or a triplet.

Temporary authentication data: either UMTS or GSM security context data or UMTS or GSM authentication vectors.

R98-: Refers to a network node or ME that conforms to R97 or R98 specifications.

R99+: Refers to a network node or ME that conforms to R99 or later specifications.