

Title: LS on GUP Security and the Proposed Changes to TS 23.240
Response to: LS (S2-043841) Response LS on GUP Security Recommendations
Release: Rel-6
Work Item: GUP Security

Source: SA2
To: SA2
Cc: CN4

Contact Person:

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Attachments: S3-041035 (= S2-043841)

1. Overall Description:

SA3 thanks SA2 for the response liaison on GUP Security Recommendations (S2-043841).

SA3 has reviewed the proposed changes to TS 23.240 related to the support of the Discovery Service as a Trusted Authority, and confirms that the proposed changes satisfy the SA3 concerns.

2. Actions:

To SA2 group.

ACTION: SA3 kindly asks SA2 to implement the changes proposed in S2-043841 to TS 23.240.

3. Date of Next TSG-SA3 Meetings:

SA3#37	21-25 February 2005	Sophia Antipolis
SA3#38	25 - 29 April 2005	Switzerland (TBC)

CR-Form-v7.1

CHANGE REQUEST

33.220 CR 020 rev **2** Current version: **6.2.0**

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Proposed change affects: UICC apps ME Radio Access Network Core Network

Title:	GBA User Security Settings (GUSS) usage in GAA and Introduction of NAF groups		
Source:	SA WG3		
Work item code:	SEC1-SC	Date:	12/11/2004
Category:	C	Release:	Rel-6
	Use <u>one</u> of the following categories: F (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 <u>one</u> of the following releases: Ph2 (GSM Phase 2) R96 (Release 1996) R97 (Release 1997) R98 (Release 1998) R99 (Release 1999) Rel-4 (Release 4) Rel-5 (Release 5) Rel-6 (Release 6) Rel-7 (Release 7)

Reason for change: The details of GBA user security settings (GUSS) are used is missing.
 - The MNO may have a need to supply different USSs to NAFs for the same service, dependent on particular NAF, e.g. if located in home or visited network. For this purpose NAF groups are introduced.

Summary of change:

- The BSF may require that one or more USSs shall be present in subscriber's GUSS for a particular NAF. If one or more of these required USSs are missing from the GUSS, the BSF will not provide bootstrapping information to the NAF. (This method is used for the home operator control on whether the subscriber may use service in the visited network, i.e. visited NAF.)
- If a NAF requests USSs from the BSF and they are not present in user GBA user security settings, it will not cause an error, provided the conditions of the local policy of the BSF are fulfilled. The BSF will then send only the requested and found USSs to the NAF.
- GUSS may be used to transfer subscriber specific parameters intended for the BSF only (i.e., the type of subscriber's UICC and subscriber specific key lifetime).
- The complete set of application-specific user security settings are named GUSS and application-specific user security setting are named USS in the specification for clarity reasons.
- NAF grouping for better controllability of GBA usage is introduced.

Consequences if not approved: The details of how GBA user security settings (GUSS) are used are missing. Difficult handling of varying access controls on GBA usage.

Clauses affected: 3.1, 3.2, 4.2.1, 4.2.2, 4.2.3, 4.4.3, 4.4.6, 4.5.3, 5.3.3

Other specs affected:	Y	N					
	X					Other core specifications	TS 29.109
		X				Test specifications	
		X	O&M Specifications				

Other comments:

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3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

Application: In all places in this document where the term application is used to refer to a service offered by the MNO or a third party to the mobile subscriber, then it always denotes the type of application and not the actual instance of an application installed on an application server.

Bootstrapping Server Function: BSF is hosted in a network element under the control of an MNO.

Editor's note: Definition to be completed.

ME-based GBA: in GBA_ME, all GBA-specific functions are carried out in the ME. The UICC is GBA-unaware. If the term GBA is used in this document without any further qualification then always GBA_ME is meant, see clause 4 of this specification.

UICC-based GBA: this is a GBA with UICC-based enhancement. In GBA_U, the GBA-specific functions are split between ME and UICC, see clause 5 of this specification.

Network Application Function: NAF is hosted in a network element under the control of an MNO.

Editor's note: Definition to be completed.

Bootstrapping Transaction Identifier: the bootstrapping transaction identifier (B-TID) is used to bind the subscriber identity to the keying material in reference points Ua, Ub and Zn.

~~**GBA User Security Setting:** An application specific parameter set describing the security related usage of bootstrapping function by the BSF and, optionally, some types of NAFs in the context of an application and in relation to a subscriber. A user security setting~~ **A USS is an application and subscriber specific parameter set that defines** ~~has~~ two parts, an authentication part, which contains the list of identities of the user needed for the application (e.g. IMPI, IMPUs, MSISDN, pseudonyms), and an authorisation part, which contains the user permission flags (e.g. access to application allowed, type of certificates which may be issued). Sometimes also called application-specific user security setting. The USS is delivered to the BSF as a part of GUSS from the HSS, and from the BSF to the NAF if requested by the NAF.

GBA User Security Settings: GUSS contains the BSF specific information element and the set of all application-specific ~~user security settings~~ USSs.

NAF Group: A grouping of NAFs to allow assignment of different USSs to NAFs representing the same application. This grouping is done in each home network separately, i.e. one NAF contacting BSFs in different home networks belongs to different groups in every home network.

3.2 Abbreviations

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

AK	Anonymity Key
AKA	Authentication and Key Agreement
B-TID	Bootstrapping Transaction Identifier
BSF	Bootstrapping Server Function
CA	Certificate Authority
FQDN	Fully Qualified Domain Name
GAA	Generic Authentication Architecture
GBA	Generic Bootstrapping Architecture
GBA_ME	ME-based GBA
GBA_U	GBA with UICC-based enhancements
GUSS	GBA User Security Settings
HSS	Home Subscriber System
IK	Integrity Key
KDF	Key Derivation Function
Ks_int	Derived key in GBA_U which remains on UICC
Ks_ext	Derived key in GBA_U
MNO	Mobile Network Operator
NAF	Network Application Function
PKI	Public Key Infrastructure
USS	GBA -User Security Setting

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4.2.1 Bootstrapping server function (BSF)

A generic Bootstrapping Server Function (BSF) and the UE shall mutually authenticate using the AKA protocol, and agree on session keys that are afterwards applied between UE and an ~~operator-controlled~~ Network Application Function (NAF). The BSF shall restrict the applicability of the key material to a specific NAF by using a suitable key derivation procedure. The key derivation procedure may be used with multiple NAFs during the lifetime of the key material. The lifetime of the key material is set according to the local policy of the BSF. The generation of key material is specified in clause 4.5.2.

The BSF shall be able to acquire the GBA user security settings ([GUSS](#)) from the HSS.

The BSF shall be able to keep a list, which assigns NAFs to NAF Groups. This list is used to select if any and which application-specific USS within GUSS is valid for a certain NAF.

NOTE 1: The operator does the assignment of NAFs to NAF Groups. NAF Group definitions in HSS and all connected BSFs belonging to the same operator's network shall be equal (cf., clause 4.2.3). As these network elements belong to the same operator's network, standardisation of the NAF Group definitions themselves is not necessary in 3GPP.

NOTE 2: The NAF grouping may be e.g. "home" and "visited". It allows the BSF to send USSs for the same application with e.g. different authorization flags to different NAFs, e.g., in home network and visited networks. The NAF e.g. in visited network indicates only the requested application, but it is unaware of the grouping in home network of the subscriber.

4.2.2 Network application function (NAF)

After the bootstrapping has been completed, the UE and an ~~an operator controlled~~ NAF can run some application specific protocol where the authentication of messages will be based on those session keys generated during the mutual authentication between UE and BSF.

General assumptions for the functionality of an ~~an operator controlled~~ NAF are:

- there is no previous security association between the UE and the NAF;
- NAF shall be able to locate and communicate securely with the subscriber's BSF;
- NAF shall be able to acquire a shared key material established between UE and the BSF during the run of the application-specific protocol;
- NAF shall be able to acquire ~~an~~zero or more (application-specific) ~~user security setting~~ USSs from the HSS via the BSF;
- NAF shall be able to check lifetime of the shared key material.

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4.2.3 HSS

The set of all user security settings (USSs), i.e. GUSS, is stored in the HSS. ~~There shall be at most one USS per application stored in the HSS.~~ In the case where the subscriber has multiple subscriptions, i.e. multiple ISIM or USIM applications on the UICC, the HSS shall contain one or more ~~subscriber profiles~~ GUSSs that can be mapped to one or more private identities, i.e. IMPIs and IMSIs.

~~Editor's note: Needed new subscriber profile parameters, i.e. GBA user security settings, are FFS.~~

The requirements on the HSS are:

- HSS shall provide the only persistent storage for ~~GBA~~-USSs;
- ~~GBA~~-USS shall be defined in such a way that interworking of different operators for standardised application profiles is possible;
- ~~GBA~~-USS shall be defined in such a way that profiles for operator specific applications and extensions to existing application profiles are supported without need for standardisation of these elements.
- GUSS shall be able to contain application-specific USSs that contain parameters that are related to identification or authorization information of one or more applications hosted by one ore more NAFs. Any other types of parameters are not allowed in the application-specific USS.

NOTE 1: The necessary subscriber profile data may be fetched by the NAF directly from HSS or from its local database using identity information provided by the application-specific USS.

NOTE 2: The HSS may temporarily remove an application-specific USS from the GUSS if the service is temporarily revoked from the subscriber.

- GUSS shall be able to contain parameters intended for the BSF usage:
 - the type of the UICC the subscriber is issued (i.e., is it GBA_U aware or not, cf. subclause 5);
 - subscriber specific key lifetime.

NOTE 3: These parameters are optional and if they are missing from subscriber's GUSS or subscriber does not have GUSS then the BSF will use the default values in the BSF local policy defined by the particular MNO.

- HSS shall be able to assign application-specific USSs to a NAF Group. This shall be defined in such a way that different USSs for the same application, but for different groups of NAFs, are possible. The restrictions on the number of USSs per GUSS are dependent on the usage of NAF Groups by the operator:
 - if no NAF Groups are defined for this application then at most one USS per application is stored in GUSS;

- if NAF Groups are defined for this application then at most one USS per application and NAF Group is stored in GUSS.
- NAF Group definitions in the HSS and all connected BSFs belonging to the same operator's network shall be equal.

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4.4.3 Roaming

The requirements on roaming are:

- The roaming subscriber shall be able to utilize the bootstrapping function in the home network. The subscriber shall be able to utilize network application function that is in a visited network.
- The home network shall be able to control whether its subscriber is authorized to use the service in the visited network.

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4.4.6 Requirements on reference point Zn

The requirements for reference point Zn are:

- mutual authentication, confidentiality and integrity shall be provided;
- If the BSF and the NAF are located within the same operator's network, the Zn reference point shall be secured according to NDS/IP [13];
- If the BSF and the NAF are located in different operators' networks, the Zn' reference point between the D-Proxy and the BSF shall be secured using TLS as specified in RFC 2246 [6];

Editor's Note: The TLS Certificate profiling needs to be completed and will be added into an Annex.

- The BSF shall verify that the requesting NAF is authorised;
- The NAF shall be able to send a key material request to the BSF, containing NAF's public hostname used by the UE's corresponding request. The BSF shall be able to verify that a NAF is authorized to use this hostname, i.e. the FQDN used by UE when it contacts the NAF;
- The BSF shall be able to send the requested key material to the NAF;
- The NAF shall be able to get a selected set of application-specific ~~user security settings~~USSs from the BSF, depending on the policy of the BSF and the application indicated in the request from the NAF over Zn;
- The NAF shall be able to indicate to the BSF the single application or several applications it requires ~~user security settings~~USS for;

NOTE 1: If some application needs only a subset of an application-specific ~~user security setting~~USS, e.g. only one IMPU, the NAF selects this subset from the complete set of ~~user security settings~~USSs sent from BSF.

- If a NAF requests USSs from the BSF and they are not present in subscriber's GUSS, it shall not cause an error, provided the conditions of the local policy of the BSF are fulfilled. The BSF shall then send only the requested and found USSs to the NAF;
- The BSF shall be able to be configured on a per NAF or per application basis if private subscriber identity and which ~~user security settings~~application-specific USSs may be sent to a NAF;
- The BSF shall be able to be configured locally by the MNO in such a way that the BSF is able to decide on a per NAF basis if one or more application-specific USSs shall be present in subscriber's GUSS, and to reject the request from the NAF in case the conditions are not fulfilled;
- The BSF shall be able to indicate to the NAF the lifetime of the key material. The key lifetime sent by the BSF over Zn shall indicate the expiry time of the key, and shall be identical to the key lifetime sent by the BSF to the UE over Ub.

NOTE 2: This does not preclude a NAF to refresh the key before the expiry time according to the NAF's local policy.

Editor's note: It is ffs which actions are to be taken over Zn when the BSF receives a user security settings update from the HSS over Zh.

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4.5.3 Procedures using bootstrapped Security Association

Before communication between the UE and the NAF can start, the UE and the NAF first have to agree whether to use shared keys obtained by means of the GBA. If the UE does not know whether to use GBA with this NAF, it uses the Initiation of Bootstrapping procedure described in clause 4.5.1.

Once the UE and the NAF have established that they want to use GBA then every time the UE wants to interact with an NAF the following steps are executed as depicted in figure 4.4.

UE starts communication over reference point Ua with the NAF:

- in general, UE and NAF will not yet share the key(s) required to protect the reference point Ua. If they already do (i.e. if a key Ks_NAF for the corresponding key derivation parameter NAF_Id is already available), the UE and the NAF can start to securely communicate right away. If the UE and the NAF do not yet share a key, the UE proceeds as follows:
 - if a key Ks for the selected UICC application is available in the UE, the UE derives the key Ks_NAF from Ks, as specified in clause 4.5.2;
 - if no key Ks for the selected UICC application is available in the UE, the UE first agrees on a new key Ks with the BSF over the reference point Ub, and then proceeds to derive Ks_NAF;

NOTE 1: If it is not desired by the UE to use the same Ks for the selected UICC application to derive more than one Ks_NAF then the UE should agree on a new key Ks with the BSF over the reference point Ub, and then proceed to derive Ks_NAF;

- if the NAF shares a key with the UE, but the NAF requires an update of that key, e.g. because the key's lifetime has expired, it shall send a suitable bootstrapping renegotiation request to the UE and terminates the protocol used over reference point Ua, see figure 4.5. The form of this indication depends on the particular protocol used over reference point Ua. If the UE receives a bootstrapping renegotiation request, it starts a run of the protocol over reference point Ub, as specified in clause 4.5.2, in order to obtain a new key Ks.

NOTE 2: To allow for consistent key derivation in BSF and UE, both have to use the same FQDN for derivation (see NOTE 2 of clause 4.5.2). For each protocol used over Ua it shall be specified if only cases (1) and (2) of NOTE 2 of clause 4.5.2 are allowed for the NAF or if the protocol used over Ua shall transfer also the FQDN used for key derivation by UE to NAF.

NOTE 3: If the shared key between UE and NAF is invalid, the NAF can set deletion conditions to the corresponding security association for subsequent removal.

- the UE supplies the B-TID to the NAF, in the form as specified in clause 4.3.2, to allow the NAF to retrieve the corresponding keys from the BSF;

NOTE 4: The UE may adapt the key material Ks_NAF to the specific needs of the reference point Ua. This adaptation is outside the scope of this specification.

- when the UE is powered down, or when the UICC is removed, any keys Ks and Ks_NAF shall be deleted from storage;
- when a new Ks is agreed over the reference point Ub and a key Ks_NAF, derived from one NAF_Id, is updated, the other keys Ks_NAF, derived from different values NAF_Id, stored on the UE shall not be affected;

NAF starts communication over reference point Zn with BSF

- The NAF requests key material corresponding to the B-TID supplied by the UE to the NAF over reference point Ua. If the NAF has several FQDNs, which may be used in conjunction with this specification, then the NAF

shall transfer in the request over Zn the same FQDN, which was used over Ua (see NOTE 2 on key derivation in this clause);

- The NAF may also request [one or more](#) application-specific ~~user security settings~~USSs for the applications, which the request received over Ua from UE may access;
- With the key material request, the NAF shall supply NAF’s public hostname that UE has used to access NAF to BSF, and BSF shall be able verify that NAF is authorized to use that hostname;
- The BSF derives the keys required to protect the protocol used over reference point Ua from the key Ks and the key derivation parameters, as specified in clause 4.5.2, and supplies to NAF the requested key Ks_NAF, as well as the lifetime of that key, [and the requested application-specific and potentially NAF group specific USSs if they are available in subscriber's GUSS and if the NAF is authorized to receive the requested USSs](#). If the key identified by the B-TID supplied by the NAF is not available at the BSF, the BSF shall indicate this in the reply to the NAF. The NAF then indicates a bootstrapping renegotiation request to the UE.

NOTE 5: The NAF shall adapt the key material Ks_NAF to the specific needs of the reference point Ua in the same way as the UE did. This adaptation is outside the scope of this specification.

[- The BSF may require that one or more application-specific and potentially NAF group specific USSs shall be present in subscriber's GUSS for the NAF \(cf. subclause 4.4.6\). If one or more of these required settings are missing from the GUSS, the BSF shall indicate this in the reply to the NAF.](#)

- The BSF may also send the private user identity (IMPI) and requested ~~user security settings~~USSs to NAF according to the BSF's policy;

NAF continues with the protocol used over the reference point Ua with the UE.

Once the run of the protocol used over reference point Ua is completed the purpose of bootstrapping is fulfilled as it enabled UE and NAF to use reference point Ua in a secure way.

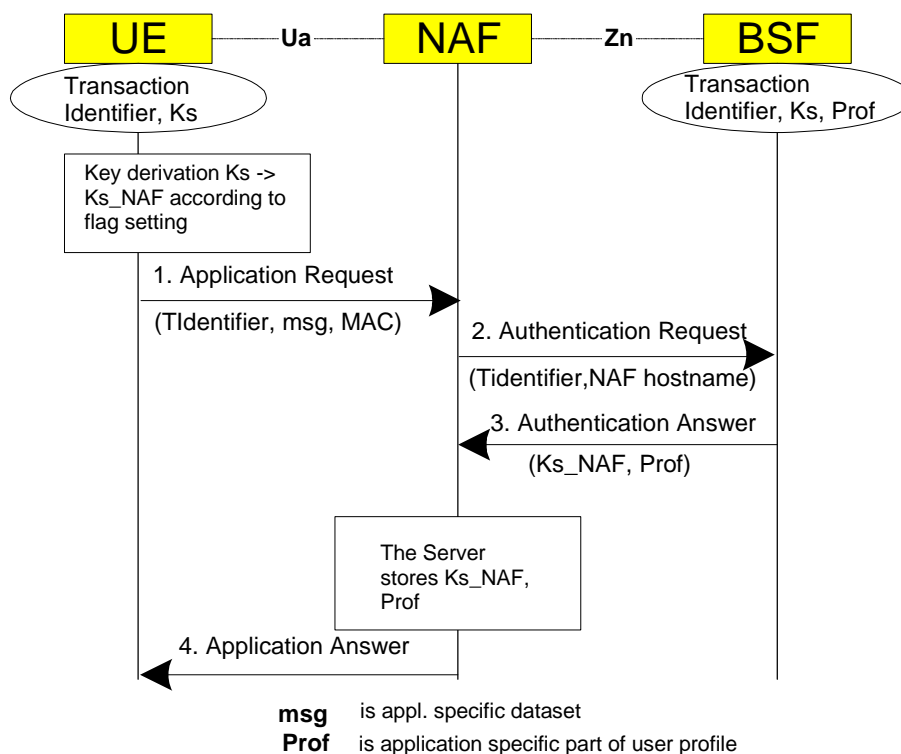


Figure 4.4: The bootstrapping usage procedure

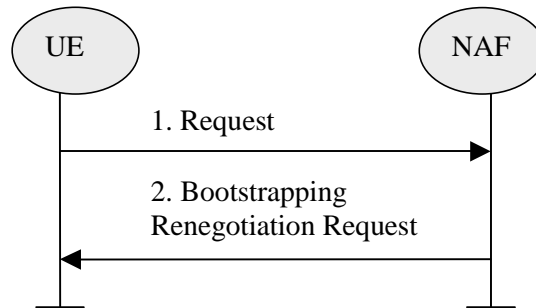


Figure 4.5: Bootstrapping renegotiation request

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5.3.3 Procedures using bootstrapped Security Association

Before communication between the UE and the NAF can start, the UE and the NAF first have to agree whether to use shared keys obtained by means of the GBA. If the UE does not know whether to use GBA with this NAF, it uses the Initiation of Bootstrapping procedure described in clause 5.3.1.

Once the UE and the NAF have established that they want to use GBA then every time the UE wants to interact with a NAF the following steps are executed as depicted in figure 5.3.

Next, the UE and the NAF have to agree, which type of keys to use, Ks_{ext_NAF} or Ks_{int_NAF} , or both. The default is the use of Ks_{ext_NAF} only. This use is also supported by MEs and NAFs, which are GBA_U unaware. If Ks_{int_NAF} , or both Ks_{ext} and Ks_{int} are to be used, this use has to be agreed between UE and NAF prior to the execution of the procedure described in the remainder of this clause 5.3.3. Any such agreement overrides the default use of the keys. How this agreement is reached is application-specific and is not within the scope of this document.

NOTE 1: This agreement may be mandated by the specification, which defines the U_a reference point between UE and NAF, e.g. TS 33.246 for the use of GBA in MBMS, or negotiated by the NAF and the UE over the U_a reference point, or reached by configuration.

Editors' Note: The support of unaware GBA_U MEs, which are GBA_{ME} aware only is FFS.

In general, UE and NAF will not yet share the key(s) required to protect the U_a reference point. If they do not, the UE proceeds as follows:

- if Ks_{ext_NAF} is required and a key Ks_{ext} for the selected UICC application is available in the UE, the UE derives the key Ks_{ext_NAF} from Ks_{ext} , as specified in clause 5.3.2;
- if Ks_{int_NAF} is required and a key Ks_{int} for the selected UICC application is available in the UICC, the ME requests the UICC to derive the key Ks_{int_NAF} from Ks_{int} , as specified in clause 5.3.2;

NOTE 2: If it is not desired by the UE to use the same $Ks_{ext/int}$ for the selected UICC application to derive more than one Ks_{ext/int_NAF} then the UE should first agree on new keys Ks_{ext} and Ks_{int} with the BSF over the U_b reference point, as specified in clause 5.3.2, and then proceeds to derive Ks_{ext_NAF} or Ks_{int_NAF} , or both, as required.

- if Ks_{ext} and Ks_{int} for the selected UICC application are not available in the UE, the UE first agrees on new keys Ks_{ext} and Ks_{int} with the BSF over the U_b reference point, as specified in clause 5.3.2, and then proceeds to derive Ks_{ext_NAF} or Ks_{int_NAF} , or both, as required;
- if the NAF shares a key with the UE, but the NAF requires an update of that key, it shall send a suitable bootstrapping renegotiation request to the UE and terminate the protocol used over U_a reference point. The form of this indication depends on the particular protocol used over U_a reference point. If the UE receives a bootstrapping renegotiation request, it starts a run of the protocol over U_b , as specified in clause 5.3.2, in order to obtain new keys.

NOTE 3: If the shared keys between UE and NAF become invalid, the NAF can set deletion conditions to the corresponding security association for subsequent removal.

NOTE 4: If it is not desired by the NAF to use the same Ks to derive more than one Ks_int/ext_NAF then the NAF should always reply to the first request sent by a UE by sending a key update request to the UE.

UE and NAF can now start the communication over Ua reference point using the keys Ks_ext_NAF or Ks_int_NAF, or both, as required. They proceed as follows:

- The UE supplies the B-TID to the NAF, as specified in clause 5.3.2, to allow the NAF to retrieve the corresponding keys from the BSF

NOTE 5: To allow for consistent key derivation in BSF and UE, both have to use the same FQDN for derivation (cf. NOTE 2 of clause 4.5.2). For each protocol used over Ua it shall be specified if only cases (1) and (2) of NOTE 2 of clause 4.5.2 are allowed for the NAF or if the protocol used over Ua shall transfer also the FQDN used for key derivation by UE to NAF.

NOTE 6: The UE may adapt the keys Ks_ext_NAF or Ks_int_NAF to the specific needs of the Ua reference point. This adaptation is outside the scope of this specification.

- when the UE is powered down, or when the UICC is removed, any GBA_U keys shall be deleted from storage in the ME. There is no need to delete keys Ks_int and Ks_int_NAF from storage in the UICC;

NOTE 7: After each run of the protocol over the Ub reference point, new keys Ks_ext and Ks_int, associated with a new B-TID, are derived in the UE according to clause 5.3.2, so that it can never happen, that keys Ks_ext and Ks_int with different B-TIDs simultaneously exist in the UE.

- When new keys Ks_ext and Ks_int are agreed over the Ub reference point and new NAF-specific keys need to be derived for one NAF_Id, then both, Ks_ext_NAF and Ks_int_NAF (if present), shall be updated for this NAF_Id, but further keys Ks_ext_NAF or Ks_int_NAF relating to other NAF_Ids, which may be stored on the UE, shall not be affected;

NOTE 8: This rule ensures that the keys Ks_ext_NAF and Ks_int_NAF are always in synch at the UE and the NAF.

NAF now starts communication over the Zn reference point with the BSF.

- The NAF requests from the BSF the keys corresponding to the B-TID, which was supplied by the UE to the NAF over the Ua reference point. If the NAF is GBA_U aware it indicates this by including a corresponding flag in the request. If the NAF has several FQDNs, which may be used in conjunction with this specification, then the NAF shall transfer in the request over Zn the same FQDN, which was used over Ua (see note above on key derivation in this clause).
- The NAF may also request [one or more](#) application-specific ~~user security settings~~USSs for the applications, which the request received over Ua from UE may access;
- With the keys request over the Zn reference point, the NAF shall supply NAF's public hostname that UE has used to access NAF to BSF, and BSF shall be able to verify that NAF is authorized to use that hostname.
- The BSF derives the keys Ks_ext_NAF, and Ks_int_NAF (if additionally required), as specified in clause 5.3.2. If the NAF indicated in its request that it is GBA_U aware, the BSF supplies to NAF both keys, Ks_ext_NAF, and Ks_int_NAF, otherwise the BSF supplies only Ks_ext_NAF. In addition, the BSF supplies the lifetime time of these keys, [and the requested application-specific and potentially NAF group specific USSs if they are available in subscriber's GUSS and if the NAF is authorized to receive the requested USSs](#). If the key identified by the B-TID supplied by the NAF is not available at the BSF, the BSF shall indicate this in the reply to the NAF. The NAF then indicates a bootstrapping renegotiation request (See figure 4.5) to the UE;

NOTE 9: The NAF may adapt the keys Ks_ext_NAF and Ks_int_NAF to the specific needs of the Ua reference point in the same way as the UE did. This adaptation is outside the scope of this specification.

- [The BSF may require that one or more application-specific and potentially NAF group specific USSs shall be present in subscriber's GUSS for the NAF \(cf. subclause 4.4.6\). If one or more of these required settings are missing from the GUSS, the BSF shall indicate this in the reply to the NAF.](#)
- The BSF may also send the private user identity (IMPI) and requested ~~user security settings~~USSs to NAF according to the BSF's policy.

The NAF now continues with the protocol used over the Ua reference point with the UE.

Once the run of the protocol used over Ua reference point is completed the purpose of bootstrapping is fulfilled as it enabled the UE and NAF to use Ua reference point in a secure way.

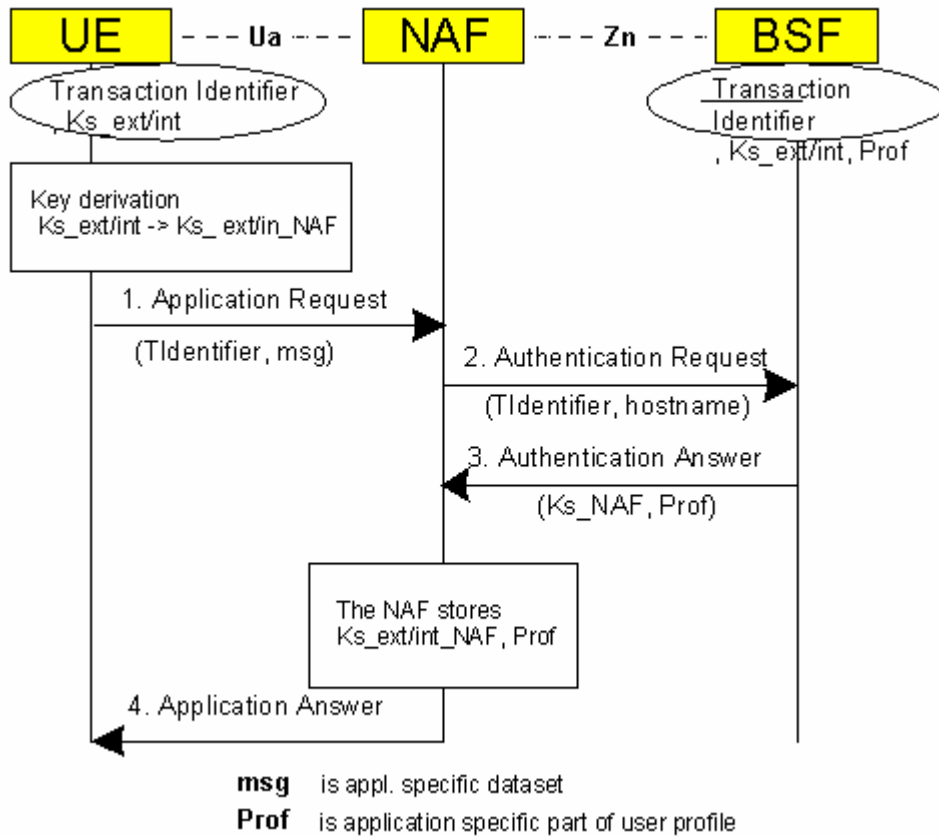


Figure 5.3: The bootstrapping usage procedure with UICC-based enhancements

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