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1 Introduction

This contribution is intended to describe the different phases of handover from GPRS to UMTS in the PS domain. It is mainly based on the contribution WHS002 [7] that was presented at the joint SA2/RAN3 meeting at Sophia Antipolis.
It is based on the principles of the specification TS 23.121 v3.0.0 [4], which has been agreed at TSG SA, and in which:
Section 4.2.2.1 of [4] presents Data Retrieve principles in the PS domain for SRNS relocation, UMTS hard-handover via the CN and GPRS/UMTS handover.
Section 4.3.12.2 of [4] describes flow charts for SRNS relocation. The mechanisms, proposed in these flow charts, are similar to the mechanisms used in GPRS, so they can be extended to UMTS/GPRS handover case.

2 Discussion

2.1 Recall of some principles of inter SGSN RA update

This corresponds to extract of 03.60 V6.4 with some parts having being abstracted.
Note that significant changes have been agreed recently. They consist of replacing LLC Acknowledgement numbers by SNDCP N-PDU numbers. This is more logical since there was some layer mixing. In addition, for a given UE, there is one SNDCP context per PDP context, whereas there was one LLC context for all PDP contexts.
This will ease the similarity with UMTS where there is one RLC context per PDP context.

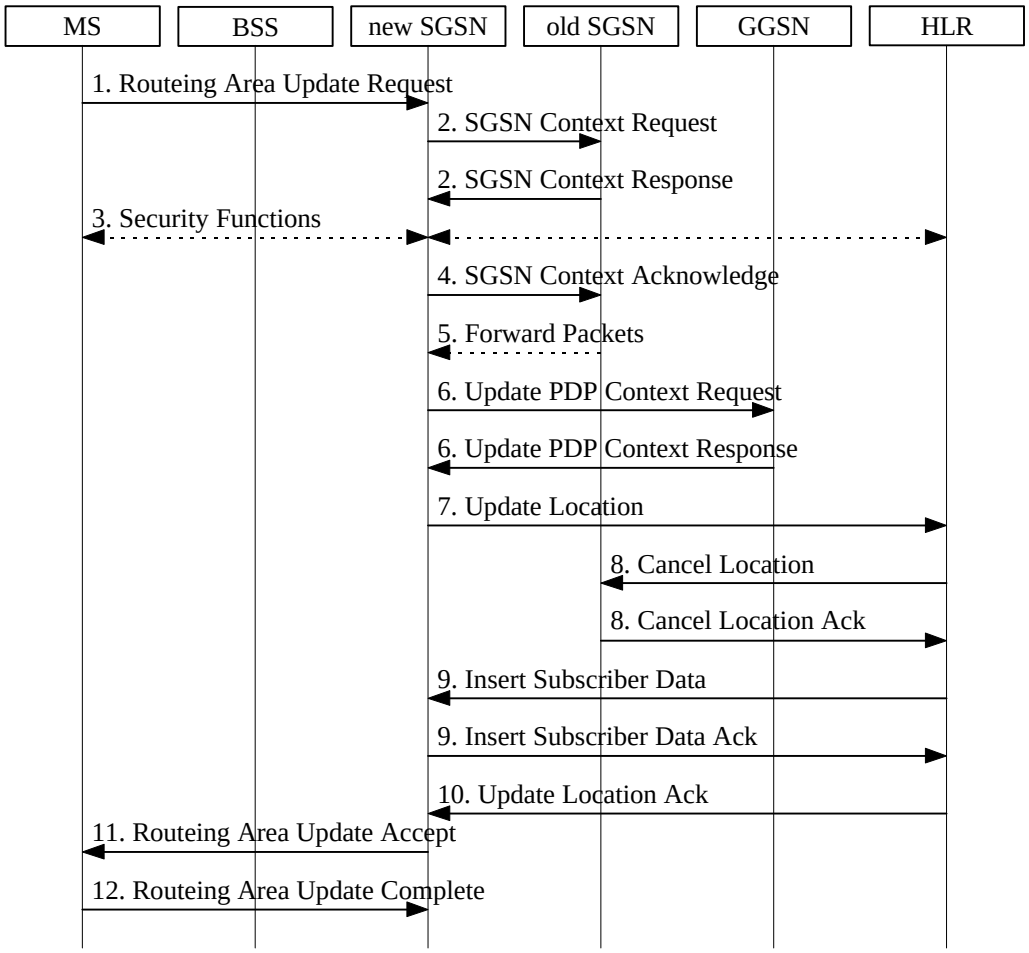

Figure 1: Inter SGSN Routeing Area Update Procedure

1) The MS sends a Routeing Area Update Request (old RAI, old P-TMSI Signature, Update Type) to the new SGSN. Update Type shall indicate RA update or periodic RA update. The BSS shall add the Cell Global Identity including the RAC and LAC of the cell where the message was received before passing the message to the SGSN.

2) **The new SGSN sends SGSN Context Request (old RAI, TLLI, old P-TMSI Signature, New SGSN Address) to the old SGSN to get the MM and PDP contexts for the MS.** The old SGSN validates the old P-TMSI Signature and responds with an appropriate error cause if it does not match the value stored in the old SGSN. This should initiate the security functions in the new SGSN. If the security functions authenticate the MS correctly, the new SGSN shall send an SGSN Context Request (old RAI, TLLI, MS Validated, New SGSN Address) message to the old SGSN. MS Validated indicates that the new SGSN has authenticated the MS. **If the old P-TMSI Signature was valid or if the new SGSN indicates that it has authenticated the MS, the old SGSN stops assigning SNDCP N-PDU numbers to downlink N-PDUs received, and responds with SGSN Context Response (MM Context, PDP Contexts).** If the MS is not known in the old SGSN, the old SGSN responds with an appropriate error cause. The old SGSN stores New SGSN Address, to allow the old SGSN to forward data packets to the new SGSN. **Each PDP Context includes the SNDCP Send N-PDU Number for the next downlink N-PDU to be sent in acknowledged mode to the MS, the SNDCP Receive N-PDU Number for the next uplink N-PDU to be received in acknowledged mode from the MS, the GTP sequence number for the next downlink N-PDU to be sent to the MS and the GTP sequence number for the next uplink N-PDU to be tunnelled to the GGSN. The old SGSN starts a timer and stops the transmission of N-PDUs to the MS.**

3) Security functions may be executed. These procedures are defined in subclause "Security Function". Ciphering mode shall be set if ciphering is supported.

4) **The new SGSN sends an SGSN Context Acknowledge message to the old SGSN. This informs the old SGSN that the new SGSN is ready to receive data packets belonging to the activated PDP contexts.** The old SGSN marks in its context that the MSC/VLR association and the information in the GGSNs and the HLR are invalid. This triggers the MSC/VLR, the GGSNs, and the HLR to be updated if the MS initiates a routeing area update procedure back to the old SGSN before completing the ongoing routeing area update procedure. If the security functions do not authenticate the MS correctly, then the routing area update shall be rejected, and the new SGSN shall send a reject indication to the old SGSN. The old SGSN shall continue as if the SGSN Context Request was never received.

5) **The old SGSN duplicates the buffered N-PDUs and starts tunnelling them to the new SGSN. Additional N-PDUs received from the GGSN before the timer described in step 2 expires are also duplicated and tunnelled to the new SGSN. N-PDUs that were already sent to the MS in acknowledged mode and that are not yet acknowledged by the MS are tunnelled together with the SNDCP N-PDU number. No N-PDUs shall be forwarded to the new SGSN after expiry of the timer described in step 2.**

6) The new SGSN sends Update PDP Context Request (new SGSN Address, TID, QoS Negotiated) to the GGSNs concerned. The GGSNs update their PDP context fields and return Update PDP Context Response (TID).

7) The new SGSN informs the HLR of the change of SGSN by sending Update Location (SGSN Number, SGSN Address, IMSI) to the HLR.

8) The HLR sends Cancel Location (IMSI, Cancellation Type) to the old SGSN with Cancellation Type set to Update Procedure. If the timer described in step 2 is not running, then the old SGSN removes the MM and PDP contexts. Otherwise, the contexts are removed only when the timer expires. This allows the old SGSN to complete the forwarding of N-PDUs. It also ensures that the MM and PDP contexts are kept in the old SGSN in case the MS initiates another inter SGSN routeing area update before completing the ongoing routeing area update to the new SGSN. The old SGSN acknowledges with Cancel Location Ack (IMSI).

9) The HLR sends Insert Subscriber Data (IMSI, GPRS subscription data) to the new SGSN. The new SGSN validates the MS's presence in the (new) RA. If due to regional subscription restrictions the MS is not allowed to be attached in the RA, the SGSN rejects the Routeing Area Update Request with an appropriate cause, and may return an Insert Subscriber Data Ack (IMSI, SGSN Area Restricted) message to the HLR. If all checks are successful then the SGSN constructs an MM context for the MS and returns an Insert Subscriber Data Ack (IMSI) message to the HLR.

10) The HLR acknowledges the Update Location by sending Update Location Ack (IMSI) to the new SGSN.

11) **The new SGSN validates the MS's presence in the new RA.** If due to roaming restrictions the MS is not allowed to be attached in the SGSN, or if subscription checking fails, then the new SGSN rejects the routeing area update with an appropriate cause. If all checks are successful then the new SGSN constructs MM and PDP contexts for the MS. A logical link is established between the new SGSN and the MS. **The new SGSN responds to the MS with Routeing Area Update Accept (P-TMSI, P-TMSI Signature, Receive N-PDU Number). Receive N-PDU Number contains the acknowledgements for each acknowledged-mode NSAPI used by the MS, thereby confirming all mobile-originated N-PDUs successfully transferred before the start of the update procedure.**

12) **The MS acknowledges the new P-TMSI with a Routeing Area Update Complete (P-TMSI, Receive N-PDU Number). Receive N-PDU Number contains the acknowledgements for each acknowledged-mode NSAPI used by the MS, thereby confirming all mobile-terminated N-PDUs successfully transferred before the start of the update procedure.** If Receive N-PDU Number confirms reception of N-PDUs that were forwarded from the old SGSN, then these N-PDUs shall be discarded by the new SGSN.

2.2 Application to handover from GPRS to UMTS

2.2.1 Principles

The main idea of this proposal is to avoid changes in the 2G-SGSN. Therefore, all the procedures used between SGSNs and the associated Gn messages should be reused.
The main difference between 2G-SGSN and 3G-SGSN behaviour is due to the move of L2,

ciphering and compression functions of GPRS (LLC, SNDCP) from SGSN to SRNC (RLC, L3CE). One of the consequences is that the buffering, which was done in the 2G-SGSN, is now done in the SRNC. Therefore, data to be transferred from the old 2G-SGSN have to be sent up to the SRNC, via the 3G-SGSN.
The mechanisms between SGSNs remain unchanged. Furthermore, the transfer of data stored in the old SGSN are transferred to the target SRNC via the same procedures as between two RNCs e.g. in the SRNS relocation procedure and described in TS 23.121 [4] section 4.3.12.2.3.

It should be noted that the proposed procedures do not depend on the type of Transport Channel (DCH, FACH/RACH or DSCH/DCH) used in the UTRAN.

2.2.2 Actions to be performed

In both cases, for a MS/UE that currently has activated a PDP context, the following actions have to be carried out:
a) Establish a RRC connection between UE and SRNC
b) Establish a signaling connection between SRNC and 3G-SGSN
c) Carry out 3G level security checks: if the MS/UE has been the object of 2G security procedures only, going into 3G coverage may mean the need of 3G security procedures. The different way the security works on 2G and on 3G CN as well as the difference in the security parameters (key length, ...) may imply such new security function to be applied to the UE.. This implies the transfer of security parameters (ciphering key, ...) from 3G-SGSN to SRNC.
d) Retrieve the (not yet acknowledged) downstream data that are stored in the 2G-SGSN in order to forward them to the SRNC with the associated sequence numbers.

2.2.3 Flow chart

Note that the BSS and the BTS are not shown since the procedures on the GPRS side are those of GPRS inter-SGSN RA Update.

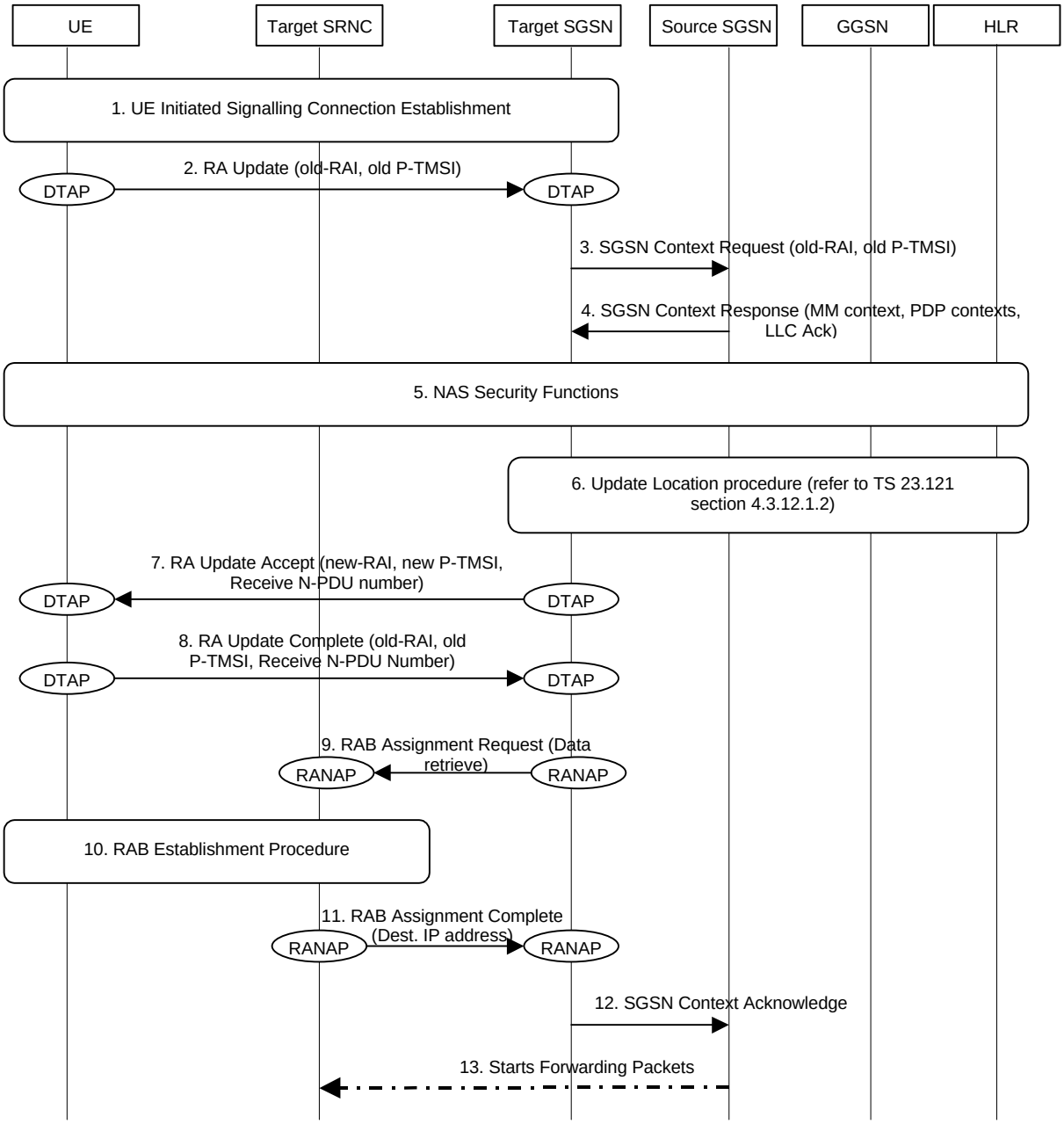

Figure 2: GPRS to UMTS cell reselection (RA Update)

1. The UE selects a UTRAN cell and establishes a NAS signalling connection.
2. The UE sends a ROUTING AREA UPDATE REQUEST (old RAI, old P-TMSI signature, Update type) to the target 3G_SGSN. Update Type shall indicate RA update or periodic RA update. The UE always issues a RA update even between cells of the same RA. The RNC shall add the RAC and LAC of the cell where the message was received before passing the message to the SGSN.
3. The target 3G_SGSN sends SGSN CONTEXT REQUEST (old RAI, old P-TMSI signature, Target SGSN Address) to the source 2G_SGSN to get the MM and PDP contexts for the UE

(The old RAI received from the UE is used to derive the source 2G_SGSN address).

4. **If the old P-TMSI Signature was valid or if the target SGSN indicates that it has authenticated the MS, the source SGSN stops assigning SNDCP N-PDU numbers to downlink N-PDUs received, and responds with SGSN Context Response (MM Context, PDP Contexts). Each PDP Context includes**

- **the SNDCP Send N-PDU Number for the next downlink N-PDU to be sent in acknowledged mode to the MS,**
- **the SNDCP Receive N-PDU Number for the next uplink N-PDU to be received in acknowledged mode from the MS,**
- **the GTP sequence number for the next downlink N-PDU to be sent to the MS, and**
- **the GTP sequence number for the next uplink N-PDU to be tunnelled to the GGSN. The source SGSN starts the timer T3-TUNNEL and stops the transmission of N-PDUs to the UE.**

5. Security functions may be executed.
6. The target 3G_SGSN handles the Update GPRS Location procedure as described in TS 23.121 section 4.3.12.1.2.
7. The target 3G-SGSN validates the UE's presence in the possibly new RA. If all checks are successful, then the target 3G-SGSN constructs MM and PDP contexts for the UE. **The target SGSN responds to the UE with ROUTEING AREA UPDATE ACCEPT (P-TMSI, P-TMSI Signature, Receive N-PDU Number). Receive N-PDU Number contains the acknowledgements for each acknowledged-mode NSAPI used by the UE, thereby confirming all mobile-originated N-PDUs successfully transferred before the start of the update procedure.**
8. **The UE acknowledges the new P-TMSI with a ROUTING AREA UPDATE COMPLETE (P-TMSI, Receive N-PDU Number). Receive N-PDU Number contains the acknowledgements for each acknowledged-mode NSAPI used by the UE, thereby confirming all mobile-terminated N-PDUs successfully transferred before the start of the update procedure. If Receive N-PDU Number confirms reception of N-PDUs that were forwarded from the source SGSN, then these N-PDUs shall be discarded by the target SGSN. LLC and SNDCP in the UE are reset.**
9. The target 3G-SGSN deduces from the PDP contexts that one or several Radio Access Bearers has to be established and sends a RAB ASSIGNMENT REQUEST to the SRNC. RAB ASSIGNMENT REQUEST contains for each radio access bearer the N-PDU number of the first N-PDU to be sent to the UE, and the destination IP address and GTP flow label for the UL N-PDUs to be sent to CN.
10. The SRNC establishes the Radio Access Bearers.
11. When the Radio Access Bearers have been established successfully, the SRNC prepares to receive N-PDUs, and sends a RAB ASSIGNMENT COMPLETE back to the 3G-SGSN with the destination IP address and GTP flow label for the DL N-PDUs.
12. When the 3G-SGSN receives the RAB ASSIGNMENT COMPLETE, it answers to the Source 2G-SGSN by sending it a SGSN CONTEXT ACKNOWLEDGE. This informs the old 2G-SGSN that the target SRNC is ready to receive data packets belonging to the activated PDP contexts.
13. **The source SGSN duplicates the buffered N-PDUs and starts tunnelling them to the target SGSN. Additional N-PDUs received from the GGSN before the timer T3-TUNNEL expires are also duplicated and tunnelled to the target SGSN. N-PDUs that were already sent to the UE in acknowledged mode and that are not yet acknowledged by the UE are tunnelled together with the SNDCP N-PDU number. No N-PDUs shall be forwarded to the target SGSN after expiry of the timer T3-TUNNEL.**

1 Proposal

It is proposed to replace the existing text in section 9.15.3 "GPRS to UTRAN handover" of UMTS 25.931 [1] by the text of section 2.2.3 of the present contribution except the CN to CN messages.

3 References

[1] UMTS 25.931 "UTRAN functions, examples on signalling procedures"
[2] UMTS 25.413 "UTRAN Iu interface, RANAP signalling"
[3] UMTS 25.303 "UE functions and Interlayer procedures in Connected Mode"
[4] UMTS 23.121 v3.0.0 "Architectural Requirements for Release 99"
[5] GSM 03.60 version 6.4.0 Release 1997 "
[6] GPRS 09.60 version 6.3.0 Release 1997 "
[7] WHS 002 Sequence charts for GPRS to UMTS handover, UE initiated, Alcatel