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Source: Alcatel
Title: Sequence charts for Handover from UMTS to GPRS, UE initiated
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1 INTRODUCTION

This contribution is intended to describe the different phases of handover from UMTS in the PS domain to GPRS.
It is based on 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.

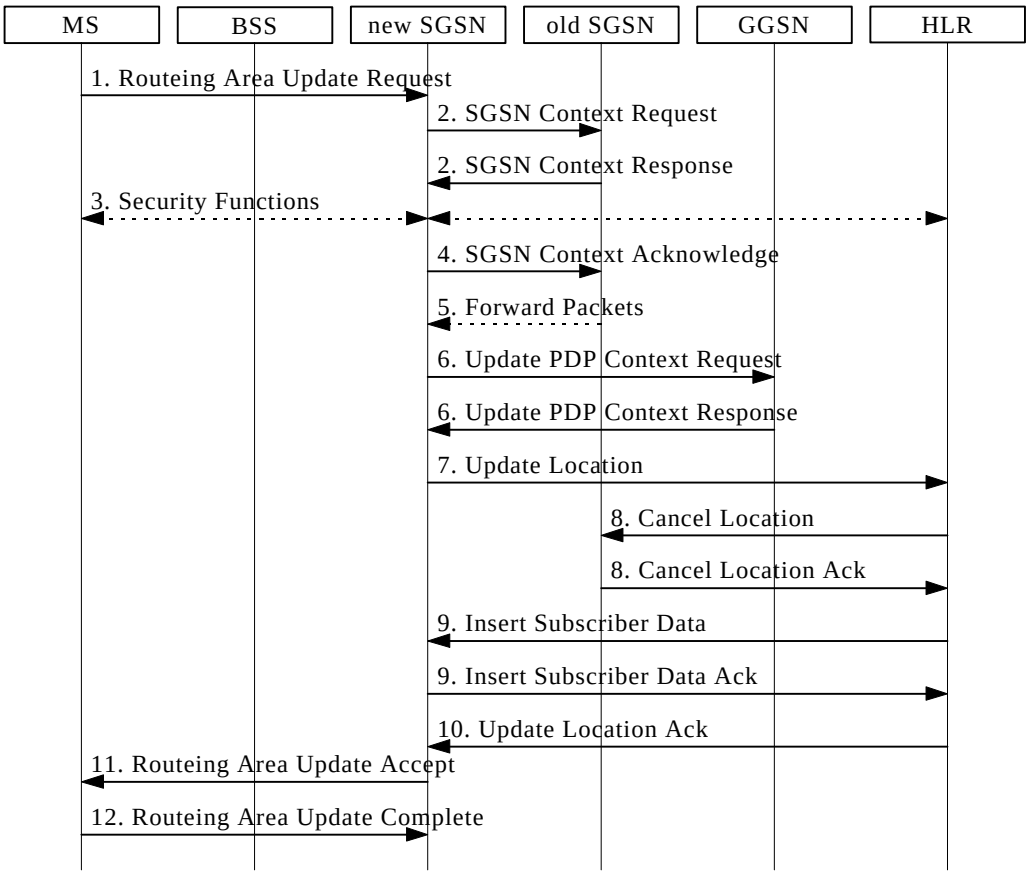

Figure 1: Inter SGSN Routeing Area Update Procedure

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. LLC and SNDCP in the MS are reset.**

2.2 Application to UMTS to GPRS handover

2.2.1 Principles

The main idea of this proposal is to avoid changes in the 2G-SGSN. Therefore, all the procedures used between 2G-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 the 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, user data have to be transferred from the source SRNC to the 2G-SGSN, via the 3G-SGSN. So, the source SRNC has to be informed when it has to transfer the data.

Prior to the transfer of user data, the source 3G-SGSN has to send SGSN CONTEXT RESPONSE to the target 2G-SGSN. This message shall include the L2 acknowledgements for each RLC connection used by the UE (RLC-Ack), in the same way as for Inter-SGSN RA Update (see section 2.1 of this paper). So, the 3G-SGSN has to request RLC-Ack information to the source SRNC. This is achieved by sending a new RANAP message named "SRNS CONTEXT REQUEST".

The source SRNC will answer by sending back SRNS CONTEXT RESPONSE (RLC-Ack) to the 3G-SGSN. At this point, the 3G-SGSN is able to send SGSN CONTEXT RESPONSE to the target 2G-SGSN.

The 2G-SGSN will inform the 3G-SGSN that the user data have to be transferred by sending to it SGSN CONTEXT ACKNOWLEDGE. The 3G-SGSN asks the source SRNC to start the transfer of user data, then to release the resources, by sending to it IU RELEASE COMMAND (see next section). IU RELEASE COMMAND also gives to the source SRNC the IP address to which it will have to transfer the user data. According to Gn protocol, this IP address was transferred from 3G-SGSN to 2G-SGSN in the SGSN CONTEXT ACKNOWLEDGE message.
The effective release of Iu resources will be initiated after the complete transfer of user data, i.e. after the expiry of the time T3-TUNNEL (see section 2.2.3).

2.2.2 UE state

It is assumed that the UE comes from the Cell or URA Connected State under UMTS. According to TS 25.303 [3], the UE goes through the GPRS Packet Idle Mode.
Therefore, when the UE has selected a GPRS cell, it initiates a RA Update procedure as described in GSM 03.60 section "Inter-SGSN RA Update".
The MS / UE always issues a RA update even in case of UMTS to GSM HO between cells of the same RA. This allows establishing the MS - 2G-SGSN relationship exactly the same way as in GPRS and having the same data retrieve trigger in the 2G-SGSN as in the pure 2G case of inter 2G-SGSN RA update.

2.2.3 Flow sequence chart

The flow sequence chart in the GPRS part and between 2G-SGSN and 3G-SGSN is unchanged and as described in GSM 03.60 [5].
Here after is described the procedure in the UMTS part.

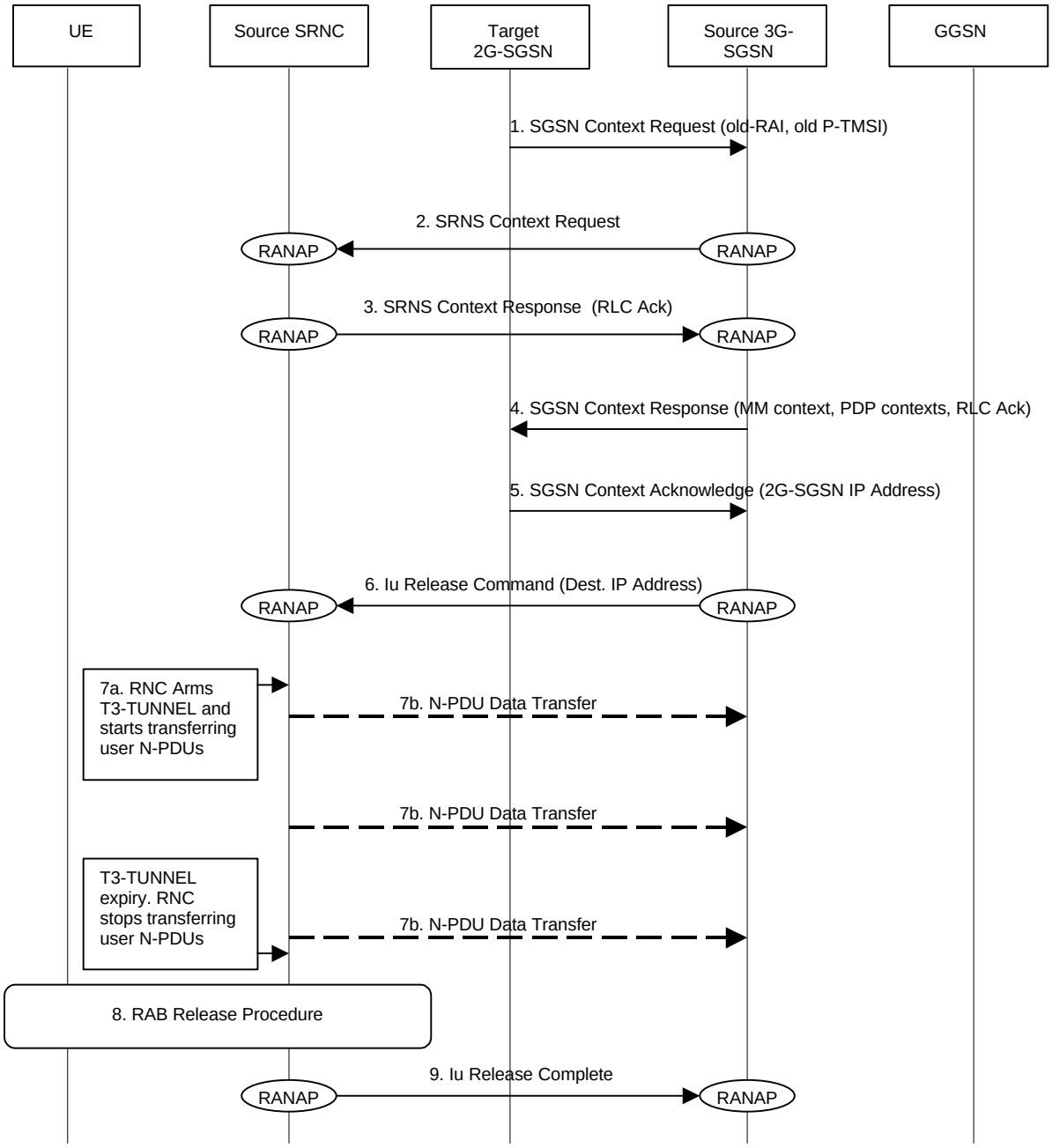

Figure 2: UMTS to GPRS Forward Handover

1. The target 2G_SGSN sends SGSN CONTEXT REQUEST (old RAI, old P-TMSI, Target SGSN Address) to the source 3G_SGSN to get the MM and PDP contexts for the UE.
2. The source 3G-SGSN requests the necessary information to the SRNC by sending it SRNS CONTEXT REQUEST.
3. The source SRNC answers to the 3G-SGSN with SRNS CONTEXT RESPONSE. This message contains the RAB Context information. **Each RAB Context includes**
   - **RLC Ack contains the acknowledgements for each RLC connection used by the UE (The Receive State Variable V(R) in the source SRNC for all RLC SAPI in asynchronous balanced mode),**
   - **the GTP sequence number for the next downlink N-PDU to be sent to the UE, and**
   - **the GTP sequence number for the next uplink N-PDU to be tunnelled to the GGSN.**

   The source SRNC starts the timer T3-TUNNEL and stops the transmission of N-PDUs to the UE.

4. The source 3G_SGSN responds to the target 2G-SGSN with SGSN CONTEXT RESPONSE (MM Context, PDP Contexts, RLC-Ack).
5. The target 2G_SGSN sends an SGSN CONTEXT ACKNOWLEDGE message to the source 3G_SGSN. This informs the source 3G_SGSN that the target 2G_SGSN is ready to receive data packets belonging to the activated PDP contexts.
6. The source 3G-SGSN sends IU RELEASE COMMAND to inform the Source SRNC that the N-PDUs that are not yet acknowledged by the UE have to be tunnelled to the 2G-SGSN via the 3G-SGSN. **This message contains the IP addresses (possibly one address per PDP context) to which the SRNC will have to transfer the N-PDUs and the GTP flow label for each GTP tunnel to be used for the transfer of non acknowledged user data.**
7. Then, the source SRNC starts tunneling the buffered downstream N-PDUs to the 3G-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 and that are not yet acknowledged by the UE are tunnelled together with the number of the RLC frame that transferred the last segment of the N-PDU.** No N-PDUs shall be forwarded after expiry of the timer T3-TUNNEL.
8. Upon expiry of T3-Tunnel, the source SRNC executes all necessary procedures to release all visible UTRAN resources that were related to the RRC connection in question.
9. When these resources are released, the Source SRNC sends IU RELEASE COMPLETE message to the 3G-SGSN.

3 PROPOSAL

3.1 Proposal 1

It is proposed to include the text in section 2.2.3 in a new sub-section of section 4.3 of UMTS 23.121 [4].

3.2 Proposal 2

It is proposed to include the text in section 2.2.3 except the CN to CN messages, in UMTS 25.931 [1] section 9.15.4 "UTRAN to GPRS handover, UE initiated"

3.3 Proposal 3

It is proposed to modify the section 8.5.4 "Iu Release due to successful handover or SRNS relocation" of TS 25.413 [2] as follows:

In the case of a handover or SRNS relocation being successfully completed, then the resources at the old RNS are requested to be released by the CN using the Iu release sequence. However, when a transfer of N-PDU user data from the old RNC has been requested, the UTRAN resources allocated to this UE by the old RNC for the transfer of N-PDUs are released only when both old RNC has received Iu RELEASE COMMAND and timer T3-TUNNEL has expired. Furthermore, the Iu RELEASE COMMAND message contains the IP addresses (possibly one address per PDP context) to which the SRNC will have to transfer the N-PDUs and the GTP flow label for each GTP tunnel to be used for the transfer of non acknowledged user data.

When the RNC receives Iu RELEASE COMMAND, and if Data Retrieve is required, it shall start tunneling the buffered downstream N-PDUs to the 3G-SGSN. Additional N-PDUs received from the source SGSN before the timer T3-TUNNEL expires are also duplicated and tunnelled to the target SGSN**. N-PDUs that were already sent to the UE and that are not yet acknowledged by the UE**

are tunnelled together with the number of the RLC frame that transferred the last segment of the N-PDU. No N-PDUs shall be forwarded after expiry of the timer T3-TUNNEL.

The cause value used by the CN in the Iu RELEASE COMMAND message shall be set to the appropriate value: “handover successful” or “SRNS relocation successful”.
When the RNS detects one of these cause values in an Iu RELEASE COMMAND message, then it shall return an Iu RELEASE COMPLETE message to the appropriate CN and take action to return to idle any resources attached to that particular Iu connection.
In the case where there is a second Iu connection for that particular UE, then the RNC shall wait the second Iu RELEASE COMMAND message before returning the remaining resources assigned to that UE to idle. Once the second Iu RELEASE COMMAND is received, the procedure completes normally.
The signalling flow for Iu Release procedure due to completion of transaction between UE and CN is shown in Figure 3:

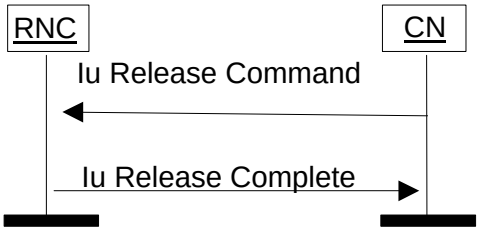

Figure 3. Iu Release: successful handover or SRNS relocation.

3.4 Proposal 4

It is proposed to modify the section 9.1.1.15 "IU RELEASE COMMAND" of TS 25.413 [2] as follows:

Information element	Reference	Type
Message type		M
Cause		M
Destination IP address(es)		C

C: Destination IP address(es) is mandatory when N-PDU data retrieve is required.

3.5 Proposal 5

It is proposed to add a sub-section in section 8.1 in TS 25.413 [2] named "UMTS to GPRS handover" with the following text:

This section describes the handover procedure from UMTS to GPRS on the UMTS side. This procedure starts with the reception of SRNS CONTEXT REQUEST from the Core Network PS domain.

When the Source SRNC receives SRNS CONTEXT REQUEST, the source SRNC answers to the 3G-SGSN with SRNS CONTEXT RESPONSE. SRNS CONTEXT RESPONSE message contains the RAB Context information. **Each RAB Context includes**

- **RLC Ack, which contains the acknowledgements for each RLC connection used by the UE (The Receive State Variable V(R) in the source SRNC for all RLC SAPI in asynchronous balanced mode),**

- **the GTP sequence number for the next downlink N-PDU to be sent to the UE, and**
- **the GTP sequence number for the next uplink N-PDU to be tunnelled to the GGSN.**

The source SRNC starts the timer T3-TUNNEL and stops the transmission of N-PDUs to the UE.

The transfer of N-PDUs from the Source SRNC will start when the SRNC receives Iu RELEASE COMMAND (refer to section 8.5.4).

3.6 Proposal 6

It is proposed to add the RANAP messages "SRNS CONTEXT REQUEST" and 'SRNS CONTEXT RESPONSE" in the section 9.1.1 of TS 25.413 [2] with the following parameters:

SRNS CONTEXT REQUEST

Information element	**Reference**	**Type**
Message type		M

SRNS CONTEXT RESPONSE

Information element	**Reference**	**Type**
Message type		M
Cause		M
RAB Contexts		
RLC-Ack		M
DL GTP Sequence Number		M
UL GTP Sequence Number		M

4 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 "