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MEMORANDUM

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Agenda Item:	**7.1**
Source:	**Alcatel**
Title:	**Sequence charts of User Data Retrieve at SRNS Relocation for IP domain**
Document for:	Approval

Sequence charts of User Data Retrieve at SRNS Relocation for IP domain

1 INTRODUCTION

This contribution is intended to describe the different phases of SRNS Relocation procedure, and more precisely, when and how the transfer of downlink data stored in the Source SRNC are transferred to the Target SRNC.

It is a companion Tdoc to paper "Principles of User Data Retrieve at SRNS Relocation and GSM-UMTS Hand-Over for IP domain" (Tdoc R3-99437)[3].

Beware that all along this study, 3G-MSC and 3G-SGSN correspond to functional entities that may or may not (according to implementation choice) be located inside a single physical CN node. To ease the understanding of the figures, apart when explicitly mentioned, only the following case is described: SRNS relocation involving only the IP domain and where source RNC and target RNC are connected to different 3G_SGSN.

2 DISCUSSION

2.1 Recall of some principles of inter SGSN RA update

This corresponds to extract of GSM 03.60 V6 [4] with some parts (not relevant for the issue of data retrieve) having being abstracted.

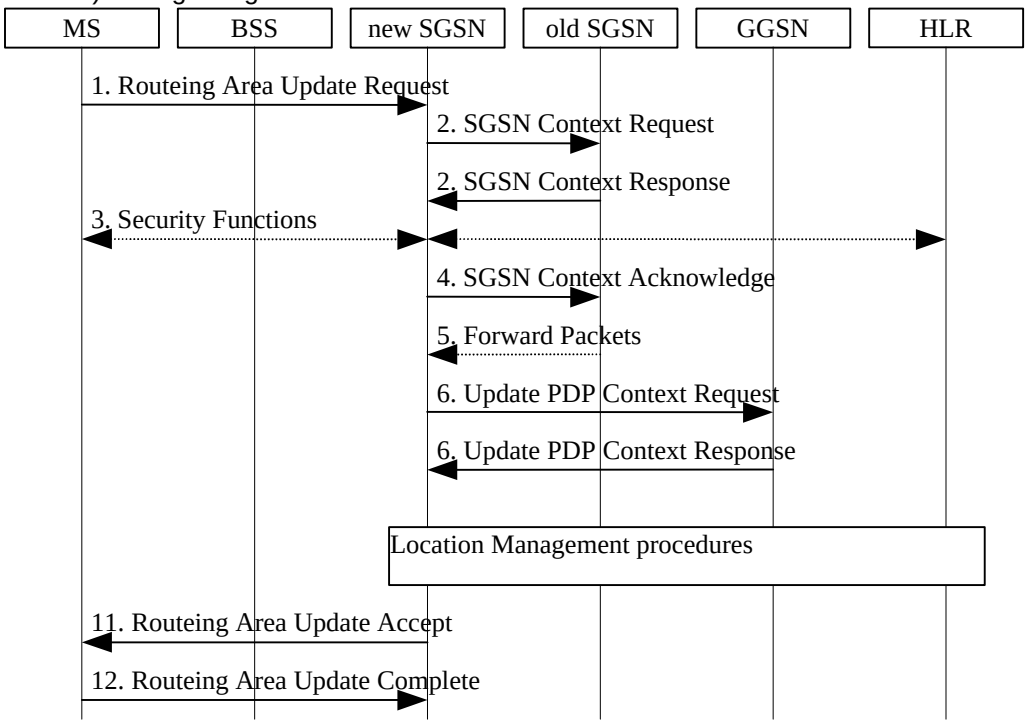


Figure 1: Inter SGSN Routeing Area Update Procedure

1) The MS sends a Routeing Area Update Request to the new 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. If the old P-TMSI Signature was valid or if the new SGSN indicates that it has authenticated the MS, the old SGSN responds with SGSN

Context Response (MM Context, PDP Contexts, LLC Ack). The old SGSN stores New SGSN Address, to allow the old SGSN to forward data packets to the new SGSN. LLC Ack contains the acknowledgements for each LLC connection used by the MS (The Receive State Variable V(R) in the old SGSN for all LLC SAPI in asynchronous balanced mode). Each PDP Context includes 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.

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.

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 and that are not yet acknowledged by the MS are tunnelled together with the number of the LLC frame that transferred the last segment of the N-PDU. 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) to 10) Location Update procedure are carried out

11) The new SGSN validates the MS's presence in the new RA. 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, LLC Ack, P-TMSI Signature). LLC Ack contains the acknowledgements for each LLC connection 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, LLC Ack). LLC Ack contains the acknowledgements for each LLC connection used by the MS, thereby confirming all mobile-terminated N-PDUs successfully transferred before the start of the update procedure. If LLC Ack 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 locally.

If the timer described in step 2 expires and no Cancel Location (IMSI) was received from the HLR, then the old SGSN shall stop forwarding N-PDUs to the new SGSN.

2.2 Discussion on SRNS Relocation

This example shows SRNS relocation when source RNC and target RNC are connected to different 3G_SGSN. Figure 3 and Figure 4 illustrate the situation before respective after the SRNS relocation and location registration. Figure 5 illustrates the signalling sequence where each step is explained in the following list.

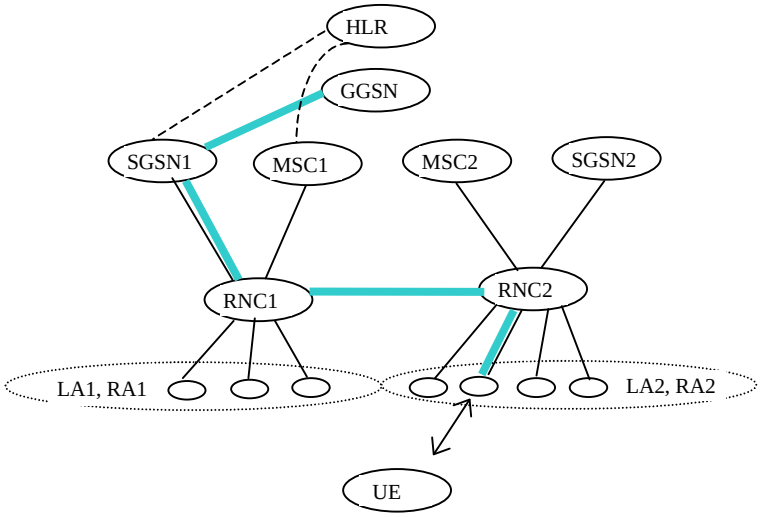


Figure 3 Before the SRNS relocation and location registration

Before the SRNS relocation and location registration the UE is registered in SGSN1 and in MSC1. The UE is in state MM connected towards the SGSN1 and in state MM idle towards the MSC1. The RNC1 is acting as SRNC and the RNC2 is acting as DRNC.

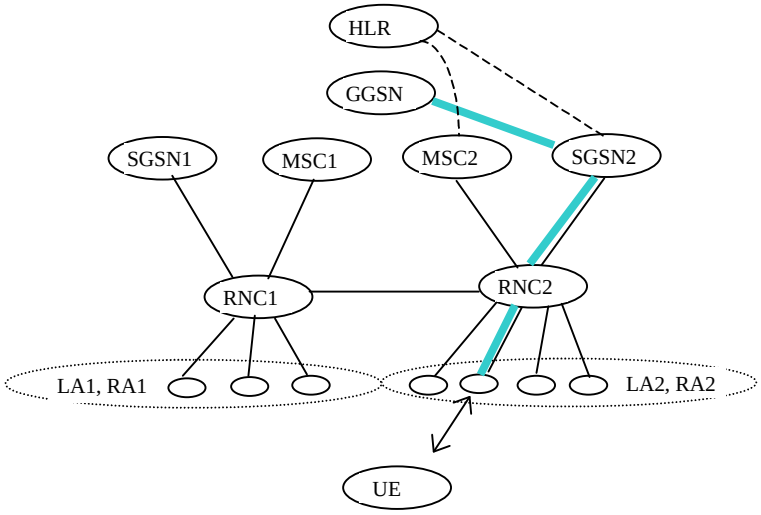


Figure 4 After the SRNS relocation and location registration

After the SRNS relocation and location registration the UE is registered in MSC2 and in SGSN2. The UE is in state MM connected towards the SGSN2 and in state MM idle towards the MSC2. The RNC2 is acting as SRNC.
At SRNS relocation:

- The source and target SGSN exchange CN level information (CN classmark, list of established PDP contexts)
- The source and target SRNC exchange UTRAN level information (UTRAN classmark, list of established radio bearers) and information used to ensure that no user packet is lost nor duplicated during the SRNS relocation procedure

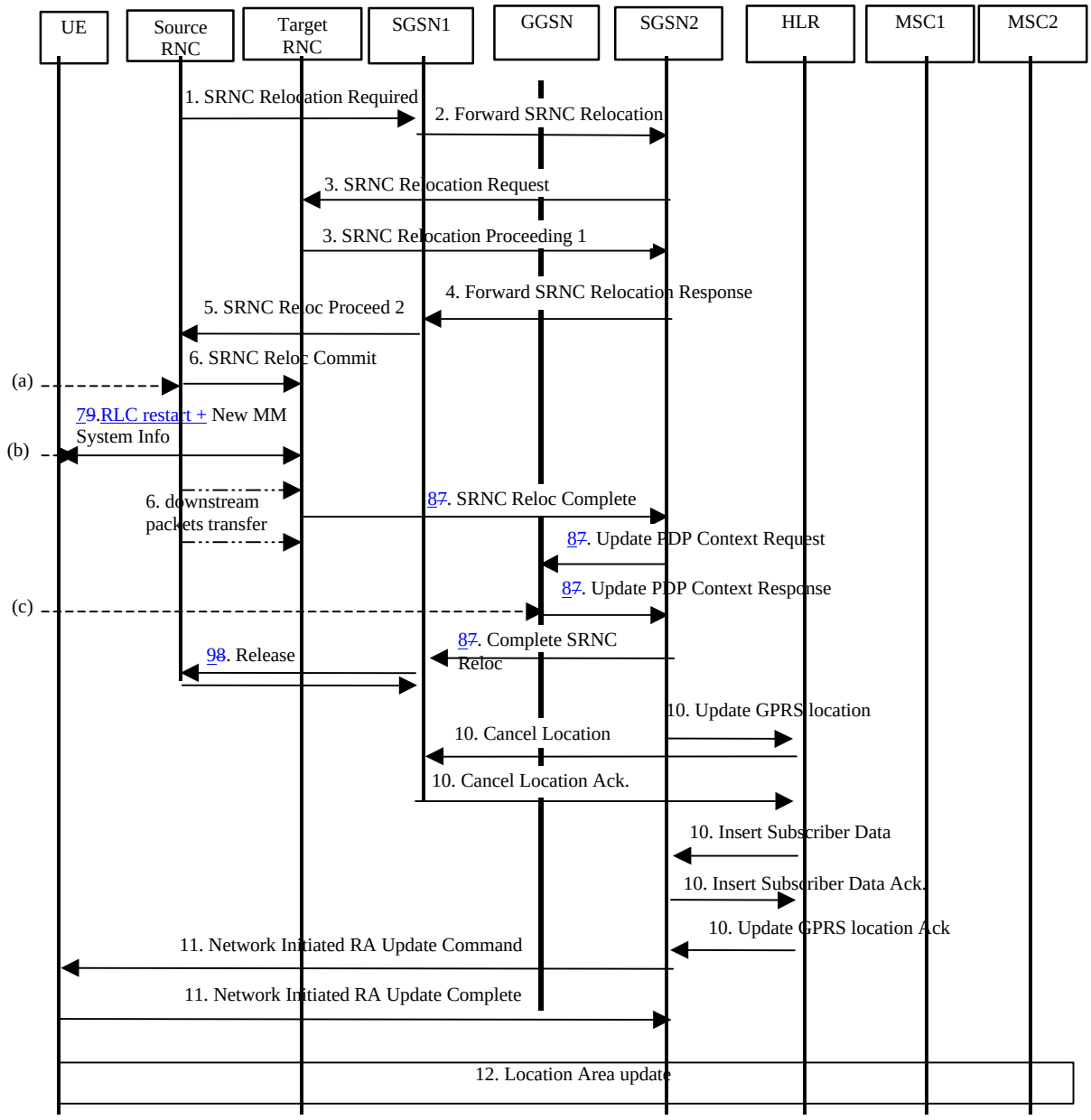


Figure 5 Interface information transfer for SRNS relocation update when changing SGSN area resulting in a change of registered location and followed by location registration in new Location Area.

"Resource reservation" Phase

During this phase, the transmission of packets between GGSN and UE through the source SRNC goes on.

1) UTRAN (source SRNC) makes the decision to perform the Serving RNC relocation procedure. This includes decision on into which RNC (Target RNC) the Serving RNC functionality is to be relocated. The source SRNC sends SRNC Relocation required messages to the SGSN1. This message includes parameters such as target RNC identifier and an information field that shall be passed transparently to the target RNC.

2) Upon reception of SRNC Relocation required message the SGSN1 determines from the received information that the SRNC relocation will (in this case) result in change of SGSN.
The SGSN will then send a Forward SRNC relocation request to the applicable SGSN, SGSN2, including the information received from the Source SRNC and necessary information for the change of SGSN (e.g. MM context, PDP context). The PDP context information contains the list of the PDP

context (including PDP type, requested / negotiated QoS) currently established by the UE along with the address of the associated GGSN. It does not contain any information linked with packet transmission (sequence numbers) because such information is under the responsibility of the UTRAN.

3) The SGSN2 sends a SRNC Relocation Request message to the target RNC. This message includes information for building up the SRNC context, transparently sent from Source SRNC (e.g. UE id., no of connected CN nodes, UE capability information), and directives for setting up Iu user plane transport bearers.
When the Iu user plane transport bearers have been established, and target RNC completed its preparation phase, SRNC Relocation Proceeding 1 message is sent to the SGSN2.

4) When the traffic resources between target RNC and SGSN2 has been allocated and the SGSN2 is ready for the SRNC move, then the Forward SRNC Relocation Response is sent from SGSN2 to SGSN1. This message indicates that necessary resources have been allocated for the SRNC relocation: SGSN2 / target RNC is ready to receive from source SRNC the downstream packets not yet acknowledged by UE. It contains the IP address(es) (possibly one address per PDP context) on which to send these packets.

5) When the Forward SRNC Relocation Response has been received in the SGSN1, the SGSN1 indicates the completion of preparation phase at the CN side for the SRNC relocation by sending the SRNC Relocation Proceeding 2 message to the Source RNC. This message contains the IP address(es) (possibly one address per PDP context) on which to send the downstream packets not yet acknowledged by UE.

"Actual hand-over of Serving RNC" Phase

6) When the source SRNC has received the SRNC Relocation Proceeding 2 message, the source RNC sends a SRNC Relocation Commit message to the target RNC(list of (SNU, UP_RLC_ack)). SNU is the GTP sequence number for the next uplink packet to be tunnelled to the GGSN. UP_RLC_Ack contains the acknowledgements for upstream PDU received by the source SRNC on each RLC connection used by the UE (i.e. the Receive State Variable V(R) for all RLC SAPI in acknowledged mode). The source SRNC starts a timer T3-TUNNEL , stops the exchange of the packets with the UE (point (a)), and starts tunnelling the buffered downstream packets towards the target SRNC.The target RNC executes switch for all bearers at the earliest suitable time instance.

7) The target RNC starts acting as SRNC. The target SRNC :

- Restarts the RLC connections. This includes the exchange between the target SRNC and the UE of the UP_RLC_Ack and DOWN_RLC_ACK. DOWN_RLC_ACK confirms all mobile-terminated packets successfully transferred before the start of the relocation procedure. If DOWN_RLC_ACK confirms reception of packets that were forwarded from the source SRNC, then these packets shall be discarded by the target SRNC. UP_RLC Ack confirms all mobile-originated packets successfully transferred before the start of the relocation procedure. From now on the exchange of the packets with the UE can restart (point (b)).

- Sends New MM System Information to the UE indicating e.g. relevant Routing Area and Location Area. Additional RRC information may then also be sent to the UE, e.g. new RNTI identity. This may trigger a location update procedure (see 12)

8) Immediately after a successful switch at RNC, target RNC (=SRNC) sends SRNC Relocation Complete message to the SGSN2. Upon reception of this message, the SGSN2 updates the GGSN with a Update PDP Context Request including the new SGSN address. The GGSN will then update the PDP context and return Update PDP Context Response. The SGSN sends a Complete SRNC Relocation towards the SGSN1.

9) At reception of the Complete SRNC Relocation, SGSN1 sends a release indication towards the Source RNC. All radio bearer resources allocated to this UE are then released but it is only when this message has been received and timer T3-TUNNEL has expired that Iu_PS resources that were related to this UE are released. During timer T3-TUNNEL all downstream packets received from the GGSN are sent towards the target SRNC.

10) The SGSN2 informs the HLR of the change of SGSN by sending Update GPRS location (IMSI, new SGSN address etc.) to the HLR. The HLR cancels the context in the old SGSN, SGSN1, by sending Cancel Location (IMSI). The SGSN1 removes the context and acknowledges with Cancel Location Ack. The HLR sends Insert subscriber data (IMSI, subscription data) to the SGSN2. The SGSN2 acknowledges with Insert Subscriber Data Ack. The HLR acknowledges the Update GPRS location by sending Update GPRS Location Ack to the SGSN2.

11) At reception of Insert subscriber data from HLR, the SGSN2 will initiate the update of MM information stored in the UE. This is done by sending Network Initiated Routing Area Update Command to the UE. This message will include new RAI, and possible also new P-TMSI. When the UE has made necessary updates it answers with Network Initiated Routing Area Update Complete.

12) When receiving new MM system information indicating a new Location Area, the UE will, in this case, initiate a Location Area update procedure towards the MSC2. This implies that the Location Area update will be performed in parallel to the above indicated activities related to the SGSN side of the Core Network.

Before point (a), in Figure 5, the connection is established between UE and GGSN via Source RNC and SGSN1. Between point (a) and point (b) in Figure 5, the transmission of packets between the UE and the network is interrupted. Hence, the duration of the service interruption is very short: it is limited to the transmission of one message between source and target SRNC and to the restart of the RLC connection between the UE and the target SRNC.
After point (c), in Figure 5, the connection is established between UE and GGSN via Target RNC and SGSN2.

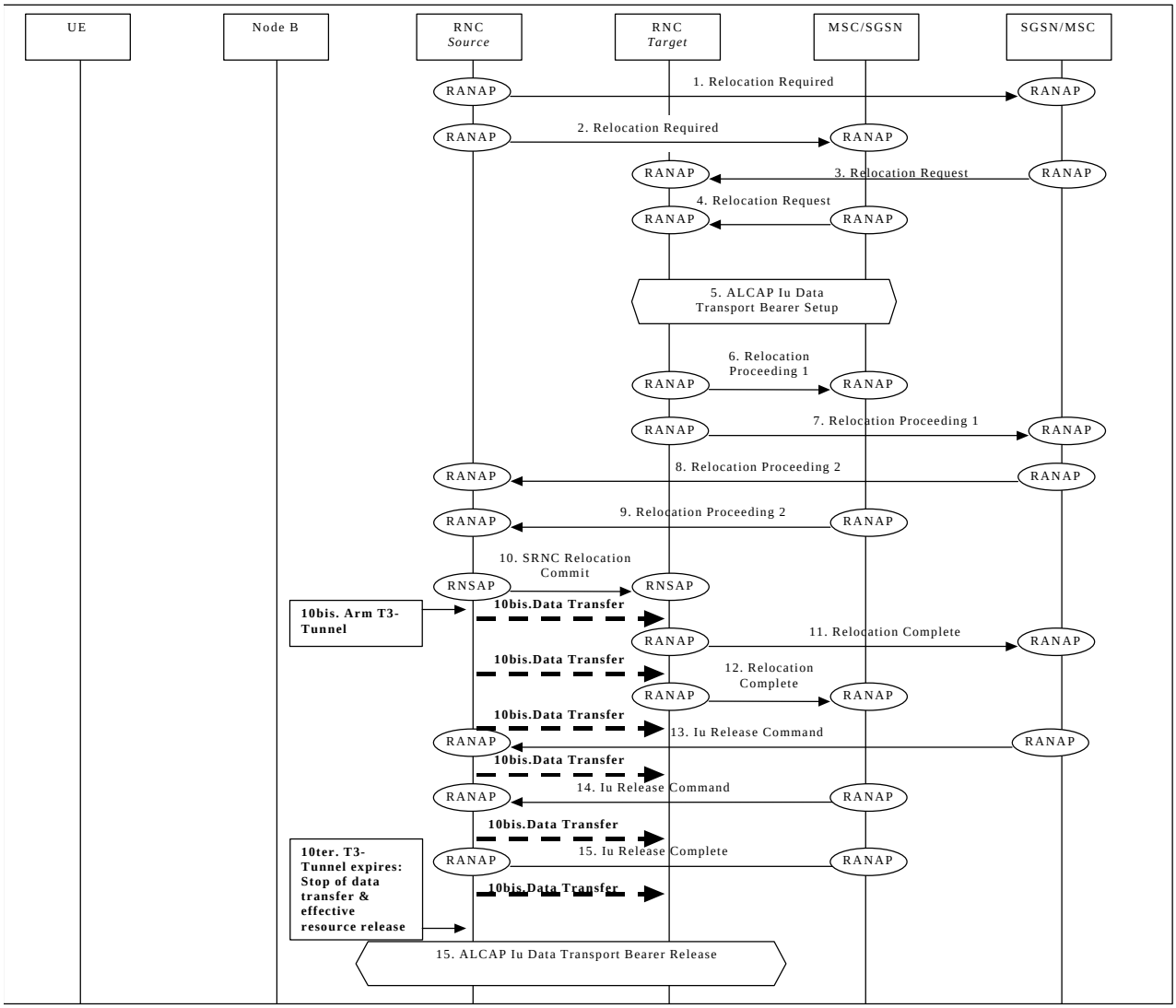
2.3 Proposed text for UMTS 25.931 [1] section 9.16.2 "Serving RNS Relocation"

According to the principles described in sect. 2.1 and in [3], it is proposed to modify [1] section 9.16.2 "SRNS Relocation" as follows:

9.16.2 SRNC Relocation (UE connected to two CN nodes)

Editor note: the text description need to be aligned to the figure contents.
This example shows SRNS Relocation, in situation in which the UE is connected to two CN nodes simultaneously. It is assumed that:

- all cells in the active set are in one DRNC;
- the CN performs hard switching of the user traffic.



SRNC Relocation (UE connected to two CN nodes)

Note that the SRNC makes the decision to perform the Serving RNC relocation procedure. The Serving RNC also decides into which RNC (Target RNC) the Serving RNC functionality is to be relocated.

1./2. The source SRNC sends **Relocation Required** messages to both CN nodes.
Parameters: target RNC identifier, Information field that the CN node(s) shall pass transparently to the target RNC. This transparent field contains the UE identifier, number of CN nodes and other TBD data.
Upon reception of **Relocation Required** message the CN element prepares itself for the switch and may also suspend user data traffic and/or signalling between UE and itself for some bearers.

3./4. When preparation is completed the CN node conveys a **Relocation Request** message to the target RNC.
Parameters: indication of which bearers should be routed towards this CN node, transparent information field sent by the source RNC, UE identifier.

The target RNC uses the UE identifier to link the requests from multiple CN nodes to each other and to the resources (e.g. Iub links) that the UE is currently using.

FFS: The target RNC allocates necessary Iur branches to be used after the SRNC relocation switch will be made.

5./6. The target RNC and CN node establish the new Iu transport bearers for each Radio Access Bearer related to that CN node.
When the RNC has completed its preparation phase, **Relocation Proceeding 1** message is sent to CN. At this point, the target SRNC is ready to receive the downlink user data that have not been acknowledged by the UE, from the Source SRNC.

7./8. When the CN node is ready for the SRNC move, the CN node indicates the completion of preparation phase at the CN side for the SRNC relocation by sending the **Relocation Proceeding 2** message. To the source RNC.

9. ~~9.~~ When the source RNC has received **Relocation Proceeding 2** messages from all the CN nodes, the source RNC sends a **Relocation Commit** message to the target RNC. The target RNC executes both the DL and UL switch for all bearers at the earliest suitable time instance.
After the switch UL traffic from node-B's is routed via the newly established Macro Diversity Combiner to the new MAC/RLC entities and finally to the correct Iu transport bearer. UL data transmission to the old Iur transport bearer is ceased.
DL data arriving from the new Iu link is routed to newly established RLC entities, to the MAC and to the Macro Diversity Splitter and Nodes B. ~~The DL data received from the old Iur is discarded.~~ The UL data that were still in the Source SRNC continue to be transmitted normally to the Source SGSN.

10 bis. The Source SRNC arms a timer "T3-Tunnel" that is used for the transfer of the downlink data (GTP-PDUs) stored in the Source SNRC and that have not been acknowledged by the UE, as well as the downlink data that continue to arrive at the Source SRNC. These data are transferred to the Target SRNC through the Iu interfaces via the 3G-SGSN(s).

10./11. Immediately after a successful~~!~~ switch at RNC, target RNC (=SRNC) sends **Relocation Complete** messages to the involved CN nodes.
Upon reception of messages 9 and 10, the CN switches from the old Iu transport bearers to the new ones.

12./13. After a successful switch at the CN node, the CN node initiates the release of the Iu connection to the source RNC by sending the RANAP message **Iu Release Command**.

10ter. Upon reception of the release requests from the CN nodes, and when the T3-Tunnel timer has expired, the old SRNC executes all necessary procedures to release all visible UTRAN resources that were related to the RRC connection in question.

At any phase, before the **SRNC Relocation Complete** message is sent, the old communication link between the CN and UE is all the time existing and working and the procedure execution can be stopped and original configuration easily restored. If any such abnormal thing occurs a **SRNC Relocation Failure** may be sent instead of any message numbered 3-11 described.

~~Note: The whole described procedure is FFS~~

2.4 Proposed text for UMTS 25.413 [2] section 8.1 "Serving RNS Relocation"

According to the principles described in sect. 2.1 and in [3] it is proposed to modify [2] section 8.1 "SRNS Relocation" as follows:

8.1 Serving RNS relocation

[Editor's note: The contents of this chapter must be restructured to show the elementary procedures over the Iu interface. Also, it need to be aligned with the corresponding procedure in Signalling examples document.]

[Editor's note:

Study item Iu/2 has been solved. Signalling channel setup and setup response messages are not needed.

Study item Iu/3 has been solved. Relocation Proceeding 1 & 2 messages will be used.]

[Editor's note: ***Study item Iu/4 has been solved. No requirement for SRNS relocation to be triggered by the target RNS****]*

Serving RNS relocation is a procedure in which the serving RNS functionality of a specific RRC connection is relocated from one RNS to another without changing the radio resources or even without interrupting the user data flow.
When the serving RNS makes an algorithmic decision to relocate the serving RNS functionality to an other RNS a RANAP message to indicate that a Relocation is required is sent to the Core Network which is having an active RANAP connection related to the UE in question. This RELOCATION REQUIRED message includes essentially the target RNS identifier and an UTRAN information field (transparent to the core network).
Upon reception of the RELOCATION REQUIRED message the core network element should check whether the relocation is possible to be performed (This check is FFS). In successful case it sends a RELOCATION REQUEST message to the target RNS. The RELOCATION REQUEST contains essentially the received UTRAN information field and bearer identifier of each bearer to be established to the new Iu interface.

When the target RNS has received RELOCATION REQUEST message and all active bearers are identified, it should send a RELOCATION PROCEEDING1, message to the CN. At this point, the target SRNS is ready to receive the downlink user data that have not been acknowledged by the UE, from the Source SRNS.

This message contains essentially the Binding ID for each Iu leg to be established between UTRAN and CN.
Upon reception of RELOCATION PROCEEDING1 (FFS) the CN should setup Iu legs (and indicate corresponding binding ID to UTRAN). After completion of this, the CN should send a RELOCATION PROCEEDING2 message to the source RNS. The source RNC will then send a RNSAP RELOCATION COMMIT message to the target RNC via the Iur interface as described in RNSAP protocol specification.
The Source SRNS also arms a timer "T3-Tunnel" that is used for the transfer of the downlink data (GTP-PDUs) stored in the Source SNRS and that have not been acknowledged by the UE, as well as the downlink data that continue to arrive at the Source SRNS. These data are transferred to the Target SRNC through the Iu interfaces via the 3G-SGSN(s).
Target RNS can, after having received RELOCATION COMMIT from the source RNC, start to act as the serving RNS for the RRC connection in question. After completing this, the target RNS (i.e. the new Serving RNS) sends RELOCATION COMPLETE to CN elements. CN elements will then send Iu RELEASE COMMAND to the Source SRNS. ~~release all bearers towards the old source RNS.~~ All radio bearer resources allocated to this UE are then released but it is only when this message has been received and timer T3-TUNNEL has expired that Iu_PS resources that were related to this UE are released. During timer T3-TUNNEL all downstream packets received from the GGSN are sent towards the target SRNC.
An example of a corresponding message flow at Iu interface in a successful situation is presented in Figure.

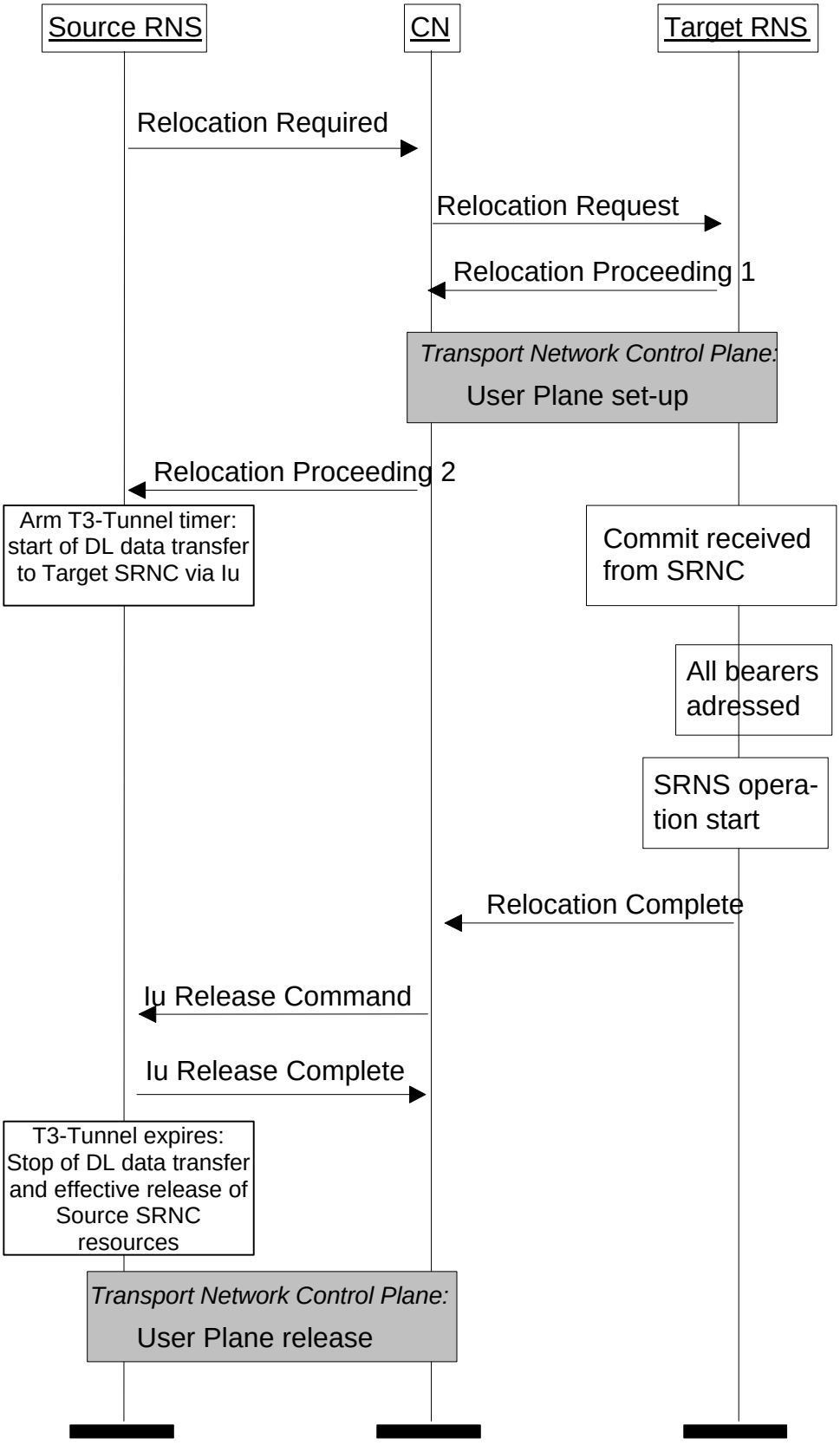


Figure1. An example RANAP protocol message flow at Iu interface related to relocation of the Serving RNS functionality. A successful case.

3 PROPOSAL

It is proposed to include the text and the figures of section 2.3 in UMTS 25.931 [1] section 9.16.2 "Serving RNS Relocation".

It is proposed to include the text and the figures of section 2.4 in UMTS 25.413 [2] section 8.1 "Serving RNS Relocation".

4 REFERENCES

[1] UMTS 25.931 UTRAN functions, examples on signalling procedures
[2] UMTS 25.413 UTRAN Iu interface, RANAP signalling
[3] Tdoc R3-99437 "Principles of User Data Retrieve at SRNS Relocation and GSM-UMTS Hand-Over for IP domain"
[4] GSM 03.60 Version 6, Release 1997, GPRS Service Description Stage 2+