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Technical Report

3rd Generation Partnership Project (3GPP);
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Handovers for real-time services from PS domain

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Contents

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Foreword

This Technical Report (TR) has been produced by the 3rd Generation Partnership Project (3GPP), Technical Specification Group RAN.
The contents of this TR are subject to continuing work within 3GPP and may change following formal TSG approval. Should the TSG modify the contents of this TR, it will be re-released with an identifying change of release date and an increase in version number as follows:

Version m.t.e
where:

- m indicates [major version number]
- x the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- y the third digit is incremented when editorial only changes have been incorporated into the specification.

1 Scope

The purpose of the present document is to help the relevant 3GPP groups to specify the changes to existing specifications, needed for the introduction of the “Handover for real-time services from PS domain” Building Block for Release 2000.

The purpose of this R00 work task is to define the relocation procedure to be used when real time services are supported in the PS domain.
The intention with this work item is to provide support for services such as voice over IP and multimedia over IP.

This TR focuses on the requirements for the solution. Possible solutions have been further studied and they are also described in this TR for comparison and evaluation against the requirements. In doing this work, RAN3 has identified some areas of study that are not primarily under RAN3’s responsibility. These are mentioned here so that work can be coordinated with the other 3GPP groups.
Changes to the signalling protocols in UTRAN and CN interfaces have also been studied at a high level.

This document is a ‘living’ document, i.e. it is permanently updated and presented to all TSG-RAN meetings.

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.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1.] UMTS 23.009: "3rd Generation Partnership Project (3GPP) Technical Specification Group Core Network; Handover Procedures".

[2.] UMTS 23.060: "3rd Generation Partnership Project (3GPP) Technical Specification Services and System Aspects; GPRS; Service Description".

[3.] Handovers for real-time services from PS domain, Work Item Description, TSG-RAN#7, submitted as RP-000127rev

3 Definitions, symbols and abbreviations

3.1 Definitions

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

SRNS relocation:
Editor’s note: a definition to be proposed here

Hard handover:
Editor's note: a definition to be proposed here

Relocation:
Editor's note: a definition to be proposed here

Bi-casting:
Editor's note: a definition to be proposed here

Duplication:
Editor's note: a definition to be proposed here

3.2 Symbols

3.3 Abbreviations

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

DL Downlink
GGSN Gateway GPRS Support Node
GTP GPRS Tunnelling Protocol
N-PDU Network PDU
PDCP Packet Data Convergence Protocol
PDU Protocol Data Unit
RLC Radio Link Protocol
RNC Radio Network Controller
RRC Radio Resource Control
SGSN Serving GPRS Support Node
UE User Equipment
UL Uplink

4 GSM and UMTS R99 status

4.1 GSM solution

Inter-BSC handovers in GSM are described in ref. [1].
The 2G systems have been optimized to minimize the interruption of speech during handovers. In DL the standards allow bi-casting from the MSC. In UL this is achieved by fast radio resynchronization by the UE. Typical values are in the range of 60 to 120 ms in UL.

4.2 UMTS R99 status

Relocation in UMTS R99 for the CS domain is described in ref. [1].
Similarly to the GSM solution, the interruption of speech during relocation has been minimised. In DL the standards allow bi-casting from the MSC. In UL this is achieved by fast radio resynchronisation by the UE.

In UMTS R99, relocation for the PS domain is described in ref. [2].

The R99 mechanism was originally designed for non-real-time services. The principle is that the N-PDUs are forwarded from the source RNC buffers to the target RNC. Data buffering is not adapted to real-time services, and means that interruption may exceed the requirement for real-time services.

5 Requirements

5.1 General

- General requirement is to minimise disruption to the user.

5.2 Packet loss

- Frame loss can already occur over the radio. Therefore when relocation occurs, any frame loss happens in addition to the frames lost over the radio. Therefore frame loss should be minimised.

Editor's note: In CS wireless speech, the FER must not be greater than 1% - does this put any requirement on our solution?

- The packet loss should be at least similar to what is achieved currently in 2G systems

5.3 Round-trip delay

- The round-trip delay should be minimised in real-time conversational services
- The round-trip delay should be at least similar to what is achieved currently in 2G systems
- The global delay variation should be minimised

5.4 Speech interruption

- The speech interruption should be at least similar to what is achieved currently in 2G systems

5.5 Frequency of interruption

- The number and frequency of interruption perceived by the user should be minimised.

5.6 Security

Editor's Note: This section is intended to list any security requirements for the real-time handover solution.

5.7 Inter-system operation

Editor's Note: This section is intended to list any requirements for the real-time handover solution due to operation with other systems such as GERAN, UTRAN R99, GSM/GPRS. This is subject to information availability for these other systems.

5.8 Backwards compatibility

Editor's Note: This section is intended to list any requirements for the real-time handover solution in order that it be backwards compatible with current solutions used in UMTS R99, and GSM/GPRS.

6 Study areas

6.1 Solution 1: SRNC duplication

6.1.1 General

The SRNC duplication mechanism handles real-time data from the source RNC based on the model from the PS domain in UMTS R99.

The principle is that the packet anchor is at the source RNC and real time packets are forwarded from the source RNC to the target RNC.
Real-time data is sent both via the Iur to the UE, and to the GTP tunnel for data forwarding to the target RNC. The packet flows during the relocation are shown in the picture below.

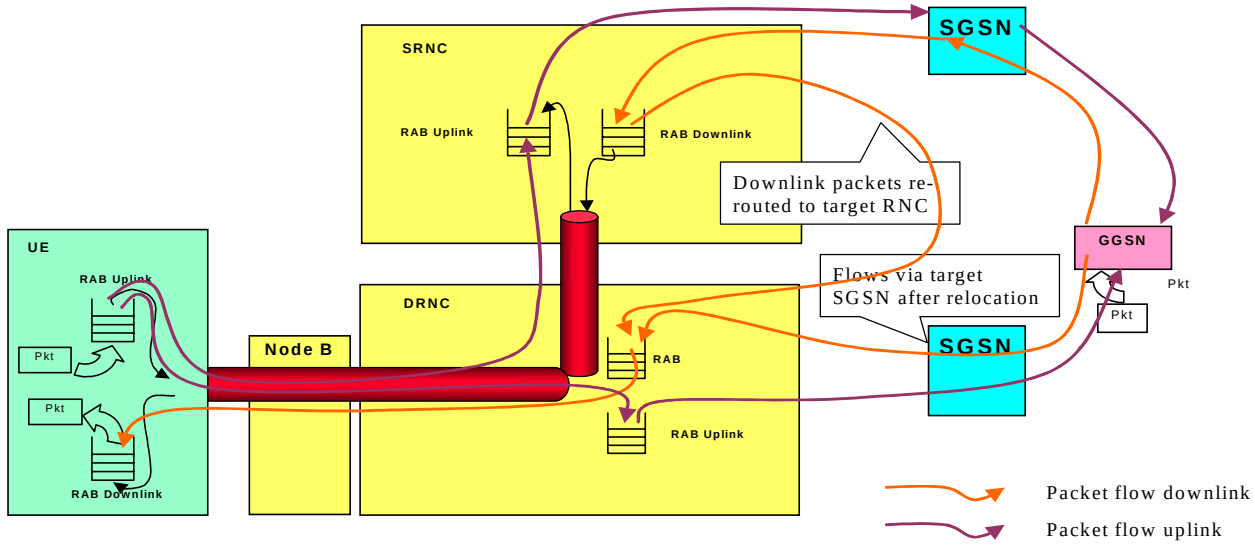


Figure 1: Packet flows during relocation, solution 1

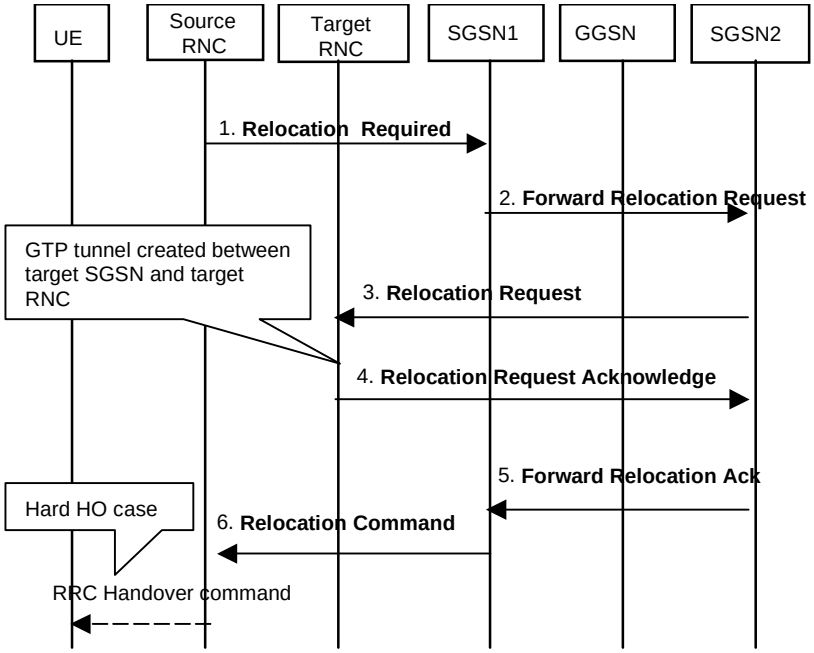
The uplink flow is routed as in R99. The only addition compared to R99 solution is that the source RNC would, during an interim state, duplicate downlink flow to both the UE directly and to the forwarding tunnel.

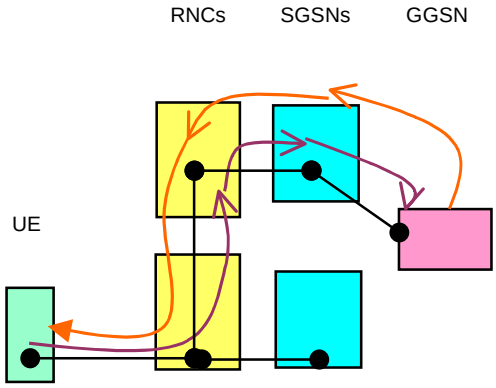
6.1.2 The main steps of Relocation for SRNC duplication

6.1.2.1 Preparation

In this phase the UTRAN reserves resources for the relocation. Then the source SGSN and source RNC are informed when the target RNC is ready.The main steps of Relocation in UTRAN from the data forwarding point of view are as follows.

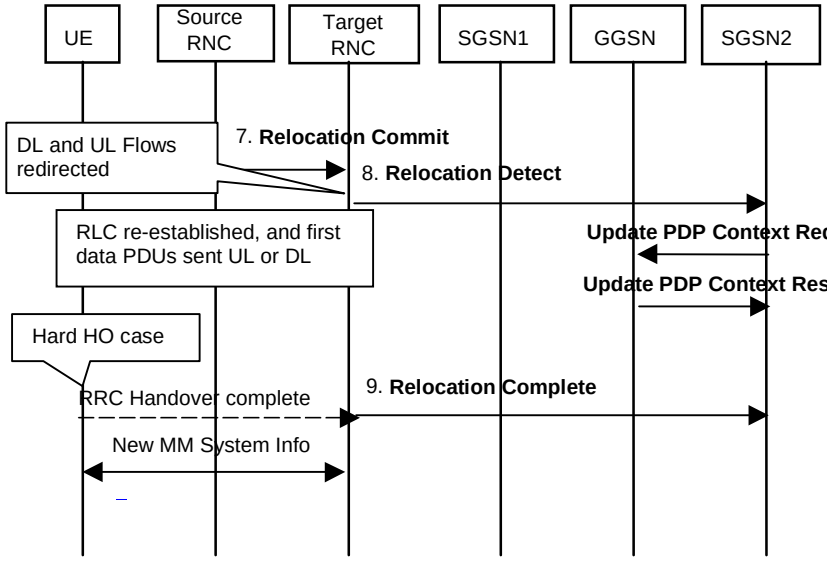
Steps 1-6 comprise the Relocation Preparation phase. The target RNC and the involved CN nodes receive all the relevant information related to the relocation from the source RNC and other involved CN nodes. The new Iu to be used after the relocation is set up during steps 3 and 4. The packet forwarding tunnel is set up during steps 4 - 6. Step 6 completes the Relocation Preparation phase and the source RNC knows that the target and the involved CN nodes are ready for the relocation.
When Iur is available, the source RNC will hand over the serving RNC functionality function to the target RNC by sending a RNSAP RELOCATION COMMIT message.
In a hard handover case without an Iur, the RELOCATION COMMIT message is replaced with three FORWARD SRNS CONTEXT messages via the SGSNs:

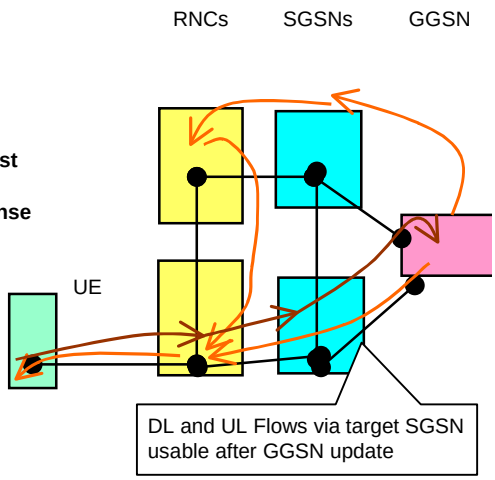




6.1.2.2 Redirection of DL flow and switching of UL flow

In this phase, DL traffic is redirected from the source RNC to the target RNC via the forwarding tunnel between the RNCs. The forwarding tunnel is used only for DL traffic. Also the UE now sends UL traffic to the target RNC and UL traffic needs to be switched to the target SGSN and GGSN, using the new route.





7. Source RNC starts copying arriving DL data of real time bearers to target RNC. Original real time DL data is still sent to the UE via the Iur.

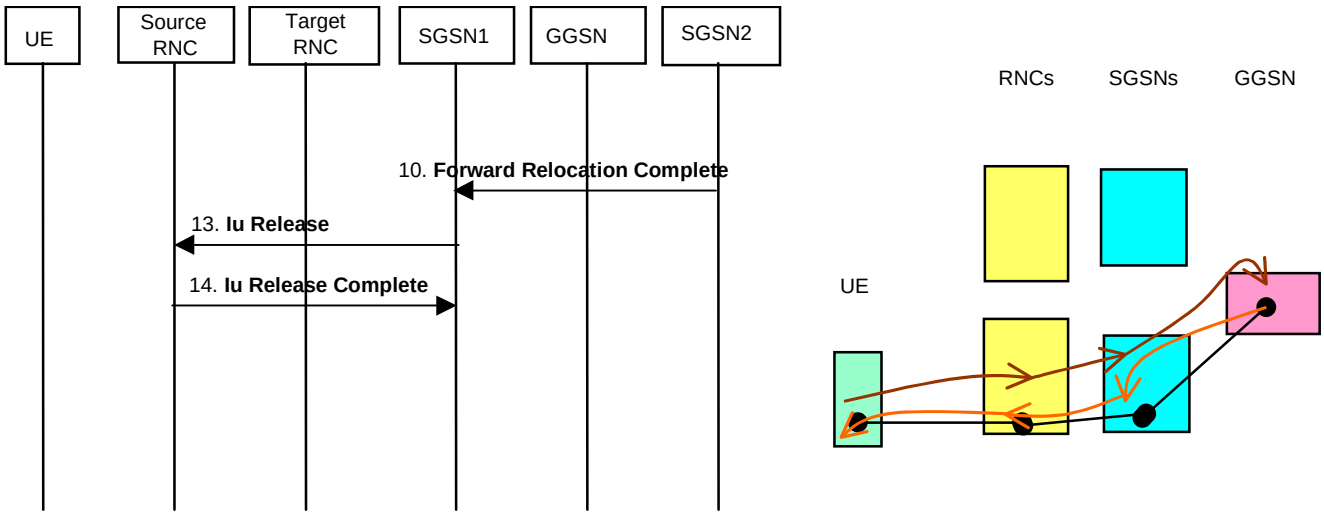
8. Target RNC starts SRNC operation (when RELOCATION COMMIT message is received). It discards all DL data arriving from Iur to the UE when data from the forwarding tunnel is available (it uses that instead) and switches all UL bearers directly to target SGSN, and sends RANAP RELOCATION DETECT to the target SGSN, which will result in the target SGSN updating the contexts in the GGSN.

A break in UL transmission occurs in the hard handover case when the radio transmission is suspended and resumed (between RRC Handover command, and RLC re-establishment).

9. RANAP RELOCATION COMPLETE completes the relocation in the target system.

6.1.2.3 Clearing the resources from the source side

In this phase the document should explain when the resources are cleared and especially the forwarding tunnel.



6.1.3 Specifications Impact

6.1.3.1 Impacts on RAN3 specifications

This section is intended to list the affected specifications which RAN3 is responsible for.

The currently identified impacts to R3 specifications relate to specifying the behaviour of the source and target RNC. This is specified in 25.413.

6.1.3.2 Impacts on other groups' specifications

This section is intended to list the affected specifications which other 3GPP groups than RAN3 are responsible for.

6.1.4 Interaction with other systems

This section is intended to explain how this solution will work with other systems such as GERAN, UTRAN R99, GSM and GPRS. This is subject to information availability for these other systems.

6.1.5 Summary: solution 1

This solution is based on making some procedure enhancements to the R99 mechanisms. During an interim state, the processing of the real time data is done at the source RNC so that the source RNC both sends the traffic to the UE, and forwards it to the target RNC.
This solution also assumes that considering the nature of RT services, there is no need tobuffer any DL or UL traffic in the involved nodes.

The solution relies on transmission delays being minimal for the forwarded data from source to the target RNC.

In a hard handover case, there is a transmission break during the time that the UE performs the hard handover. This affects UL and DL, and is the only break in the UL transmission.

In relocation there might be a break in the UL direction when the UL connection is switched to the new Iu

In any handover or relocation case, for DL there are two situations where frame gaps/overlapping may happen.

The first one occurs when the target RNC switches from the Iur to the forwarding tunnel, in case the Iur was used before, or equivalently for hard HO case, when the target starts receiving forwarded packets. This coincides with radio hard handover..

The second one occurs when the target RNC switches from the forwarding tunnel to the new Iu.

To support handovers for real time services from the PS domain with the SRNC duplication solution, procedural changes are required at the source and target RNC.

6.1.6 Open issues

6.2 Solution 2: GGSN bi-casting

6.2.1 General

The GGSN bi-casting mechanism handles real-time data from the GGSN based on the model from GSM and the CS domain in UMTS R99.

The principle is that the packet anchor is at the GGSN which acts as the equivalent of the three-party bridge in the CS domain MSC.
During the relocation, real-time downlink N-PDUs are duplicated at the GGSN and sent to the SRNC as well as to the DRNC.

The uplink flow is routed as in R99.

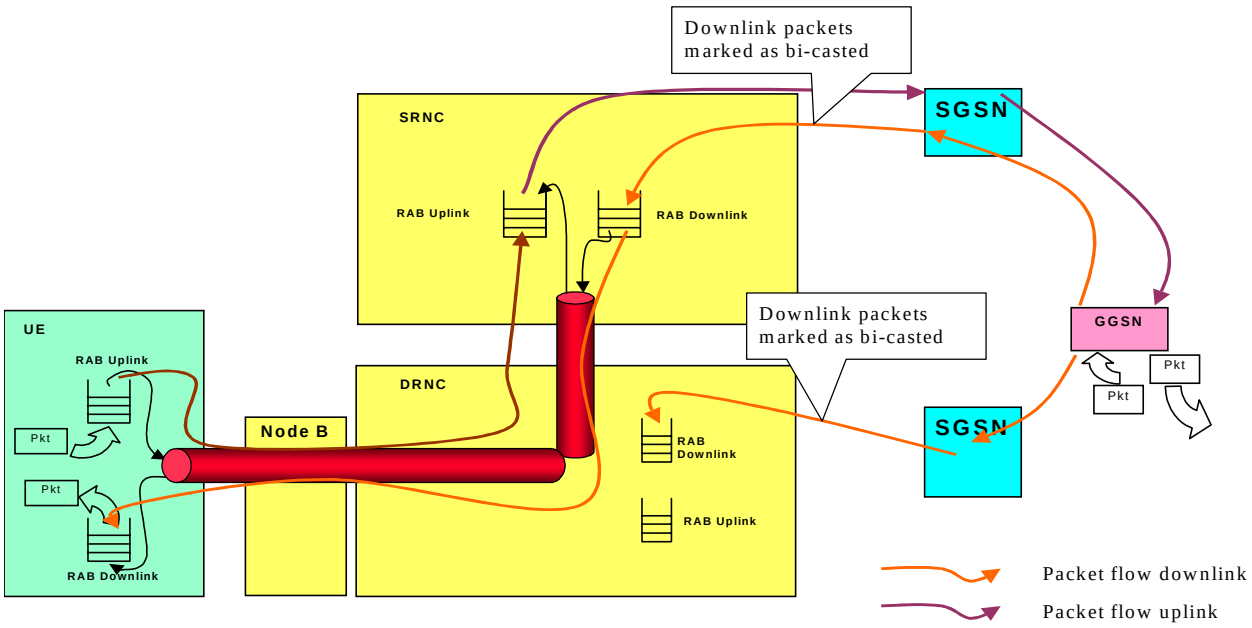
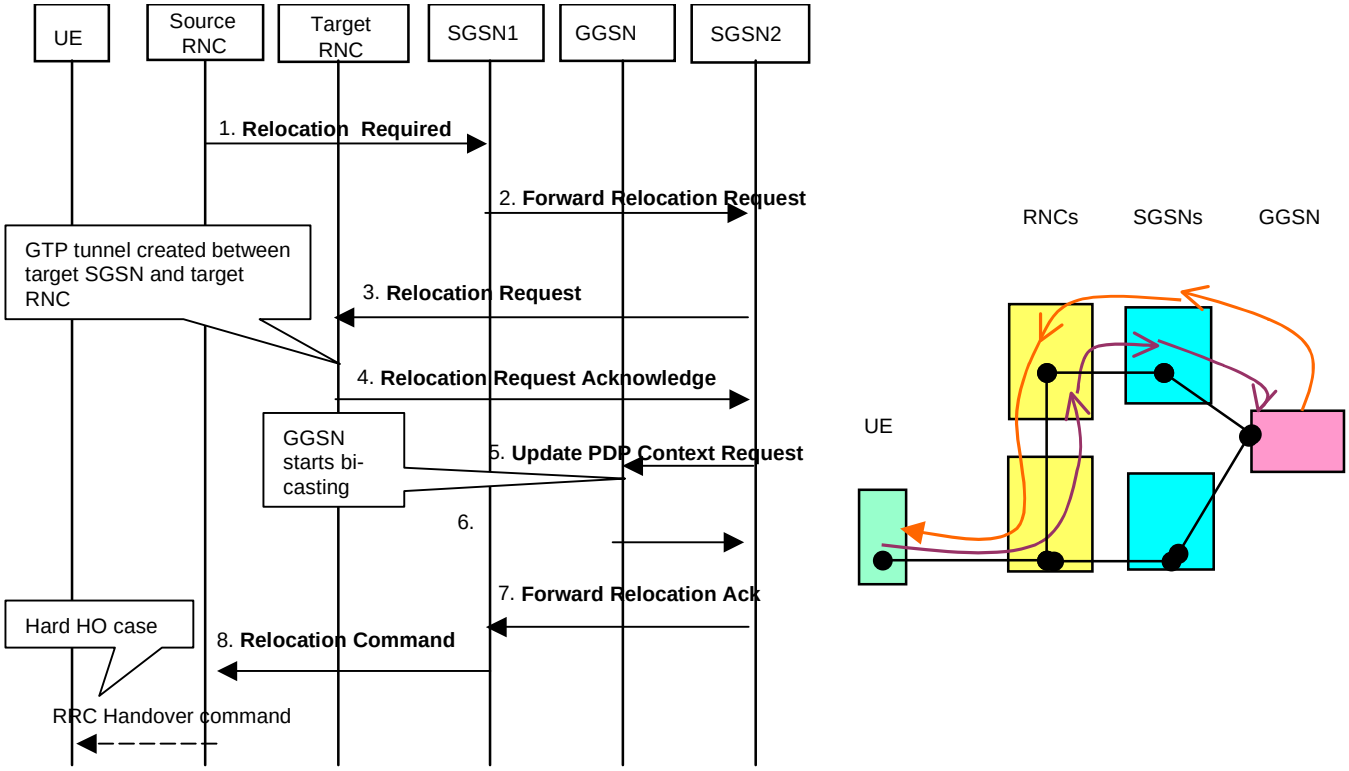


Figure 2: Packet flows during relocation, solution 2

6.2.2 The main steps of Relocation for GGSN bi-casting

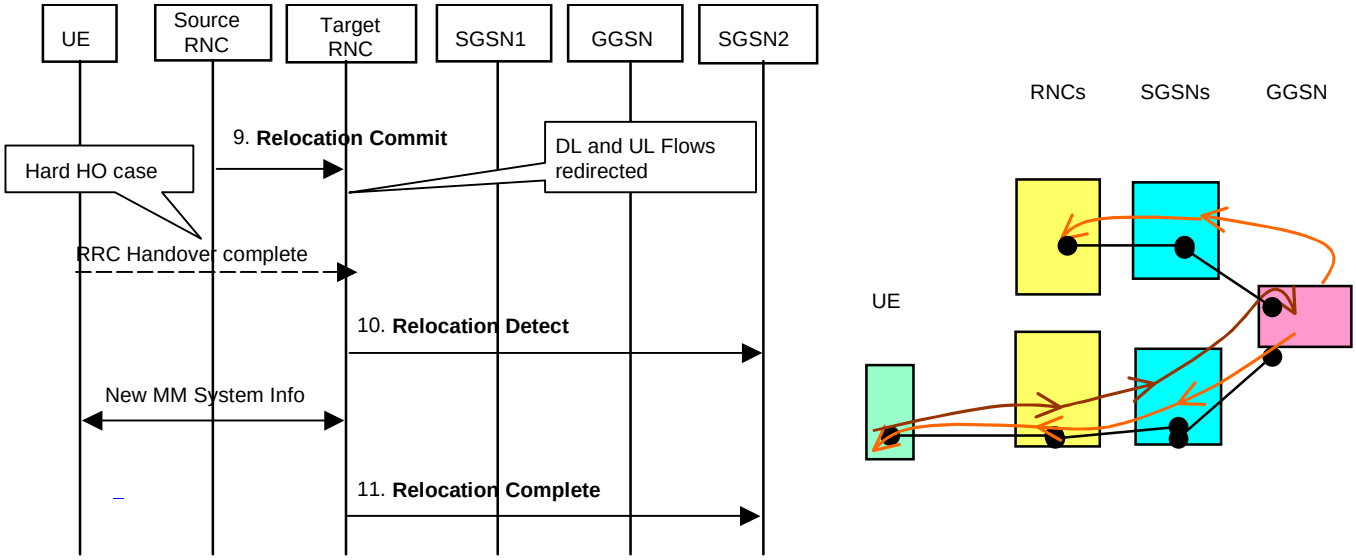
6.2.2.1 Preparation

In this phase the UTRAN reserves resources for the relocation. Then the source SGSN and source RNC are informed when the target RNC is ready. The GGSN is also instructed to start bi-casting downlink N-PDUs as part of the Relocation preparation process.



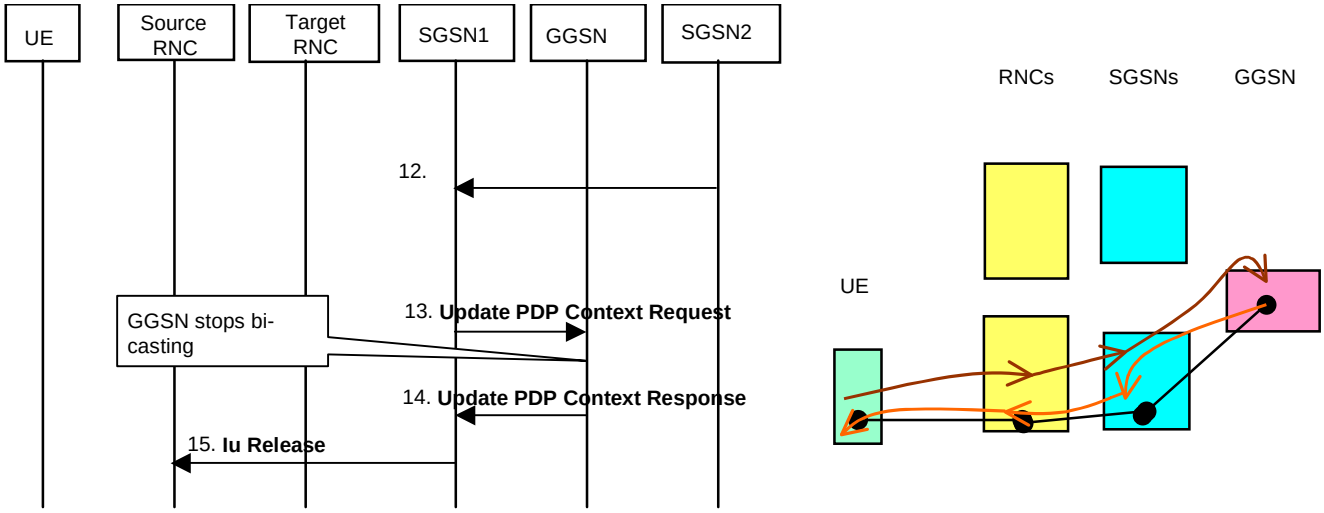
6.2.2.2 Bi-casting of DL flow and switching of UL flow

In this phase, DL traffic is bi-casted from the GGSN to the target RNC (as well as to the source RNC). Also at this point in both the hard handover and SRNS relocation cases, the UE sends UL traffic to the target RNC and UL traffic needs to be switched to the target SGSN and GGSN, using the new route.



6.2.2.3 Completion

This is the completion of the signalling. Also, the GGSN is instructed to stop bi-casting downlink N-PDUs. At this stage, the relocation has effectively already been completed.



6.2.3 Specifications Impact

6.2.3.1 Impacts on RAN3 specifications

This section is intended to list the affected specifications which RAN3 is responsible for.

The currently identified impacts to R3 specifications relate to specifying the behaviour of the source and target RNC. This is specified in 25.413.

6.2.3.2 Impacts on other groups' specifications

This section is intended to list the affected specifications which other 3GPP groups than RAN3 are responsible for.

The impacts to other groups' specifications relate to inclusion of bi-casting from GGSN to the Gn interface specification and corresponding stage 2 specifications.

6.2.4 Interaction with other systems

This section is intended to explain how this solution will work with other systems such as GERAN, UTRAN R99, GSM and GPRS. This is subject to information availability for these other systems.

6.2.5 Summary: solution 2

In the GGSN bi-casting solution, handling of the real time data is done at the GGSN. Real time support requires that the GGSN is able to bi-cast the DL traffic to the target RNC.

In a hard handover case, there is a transmission break during the time that the UE performs the hard handover. This affects UL and DL, and is the only break in the UL transmission.

In relocation there might be a break in the UL direction when the UL connection is switched to the new Iu.

In any handover or relocation case, for DL there is one possible situation when frame gap or overlapping may happen.
This occurs when the target RNC receives bi-casted DL traffic from the new GTP tunnel as well as the bi-casted traffic from the Iur, and switches from the latter to the former. This coincides with radio hard handover.

To support handovers for real time services from the PS domain with the GGSN bi-casting solution, procedural changes are required at the SGSN, GGSN, and RNC.

6.2.6 Open issues

7 Open items for all solutions

Editor's note: Real time PDCP numbers are a RAN2 issue that has not been resolved yet. The questions to be solved with R2 include whether the RAB contexts (i.e. the sequence numbers) need to be between RNCs or not, and whether the header compression/stripping solution to be selected allows that transmission to UE continues via the Iur (i.e. effectively making the context in RELOCATION COMMIT message outdated).

According to the UMTS release 99 specifications, PDCP sequence numbers are exchanged with the UE as follows:

- UL: Target RNC tells in the PDU causing the RLC to re-establish the UL sequence number which according to the header decompression information should be the next PDCP to be received from the UE. This number might be a few sequence numbers lower than the assumption of UE, since it has still maybe sent a few PDUs via source RNC after commit. UE should roll back the PDCP header compression and thus base the next compressed header of the next real-time PDU to the header information of the UL PDU considered as the last received by the target RNC (the indicated one - 1)
- DL: Similarly UE indicates in the PDU acknowledging the RLC re-establishment the DL Sequence number which PDU according to the DL header decompression information in the UE should next be received by UE. This is not generally the first forwarded but one of the first ones. Target RNC selects appropriate forwarded PDU and bases its header compression to the header of the 'indicated DL PDCP PDU-1'.

8 Comparison of the solutions

9 Agreements

This section is intended to list any agreements that have been reached in RAN3 on this work item.

10 Project Plan

10.1 Schedule

Date	Meeting	Scope	[expected] Input	[expected]Output

10.2 Work Task Status

	Planned Date	Milestone	Status
1.			
2.			

11 History

Document history		
V0.0.0	2000-07	Scope and document outline
V0.0.1	2000-07	First proposal for chapters 4, 5, 6 and 7
V0.1.0	2000-09	Changes agreed at RAN3#15.
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