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Principles of User Data Retrieve at SRNS Relocation and GSM-UMTS Hand-Over for IP domain

1 Introduction

This contribution discusses the architecture for the retrieve of user data in the IP domain at SRNS relocation and at UMTS<=>GPRS hard-handover. It proposes a solution that allows GPRS-UMTS interworking with minimum impact on 2G-SGSN.

It is based on the following assumptions:

- Buffering capability is removed from the SGSN, as stated in 23.930 (see [1] section 4.2, bullet 8): "In case the lu connection point is changed (e.g. SRNS relocation, streamlining), the CN is not supposed to buffer packets in view of ensuring a high data reliability. Hence, at SRNC relocation, for high reliability Radio Access Bearers, the old SRNC has to send downstream packets not yet acknowledged by UE to the new SRNC."
- SNDCP is removed from the SGSN and replaced by a Header Compression function, located in the UTRAN.
- Ciphering function is moved from SGSN to UTRAN.
- In case of non real-time data, there is a need for ensuring data reliability at SRNS relocation.
- Interworking with 2G-GPRS is required and should imply a minimum impact on 2G-GPRS

The architectures also take into account the location of interception function and the location of charging function.

2 Discussion

2.1 Reliability at SGSN change in GPRS

In 2G-GPRS, the reliability of data at a SGSN change is ensured by:

- *An ARQ mechanism between the SGSN and the UE via the LLC layer as long as the SGSN is not changed.*
- *When the SGSN is changed:*
 - *For downstream data, the reliability is ensured by the transfer of all data that have not been acknowledged by the MS between the source SGSN and the target SGSN (called hereafter Data Retrieve). GTP is used to ensure this data retrieve.*
 - *For uplink data, the data received by the source SGSN or by the target SGSN are always transmitted to the GGSN via GTP.*

In case of reliability class different from the reliability class 1 dedicated to X25, the data transfer between GGSN and SGSN as well as the data retrieve between SGSN(s) at SGSN change are not secured because low loss is assumed. The loss of data being infrequent, it is acceptable that user-to-user TCP layer is used for the re-transmission of lost IP frames.

In case of reliable traffic, a 2G-SGSN increments its charging records only when the data has been acknowledged by the MS.

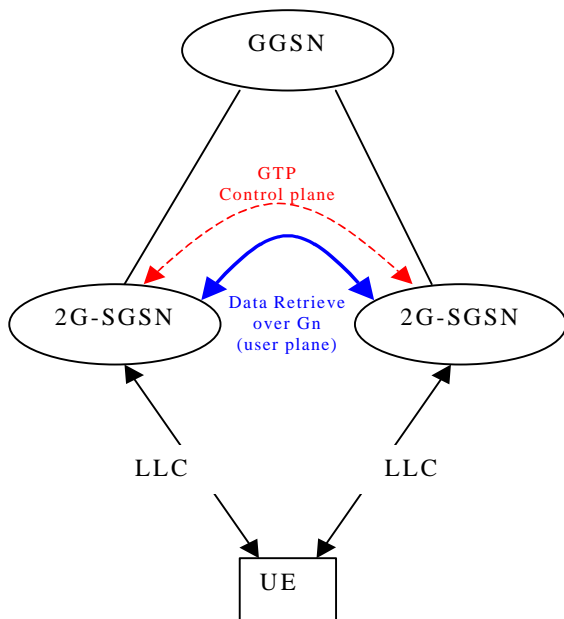


Figure 1: Data retrieve in GPRS

2.2 GPRS ⇌ UMTS handover

2.2.1 Requirements for Data retrieve at GPRS/UMTS handover

The same reliability as in inter 2G-SGSN RA update case has to be provided at GPRS to/from UMTS handover. Therefore, the data retrieval should be ensured between 2G-SGSN and SRNC as it is ensured between two 2G-SGSNs.

Between two 2G-SGSNs, data retrieve is carried out via the Gn interface i.e. via GTP-u¹/UDP/IP. In order that the 2G-SGSN is not modified for data retrieve with the SRNC, the 2G-SGSN should keep the same protocol stack.

2.2.2 Discussion

The data retrieve procedure in the user plane may be performed:

- 1) Either through a single GTP pipe between SRNC and 2G-SGSN through the CN IP transport network (the 2G-SGSN belongs to the CN) or through the 3G-SGSN used as an IP router.
- 2) Or through 3G-SGSN with two concatenated GTP pipes (one between RNC and 3G-SGSN and one between 3G-SGSN and 2G-SGSN).

This is summarised in [Figure 2](#).

¹ GTP-u stands for GTP user plane protocol

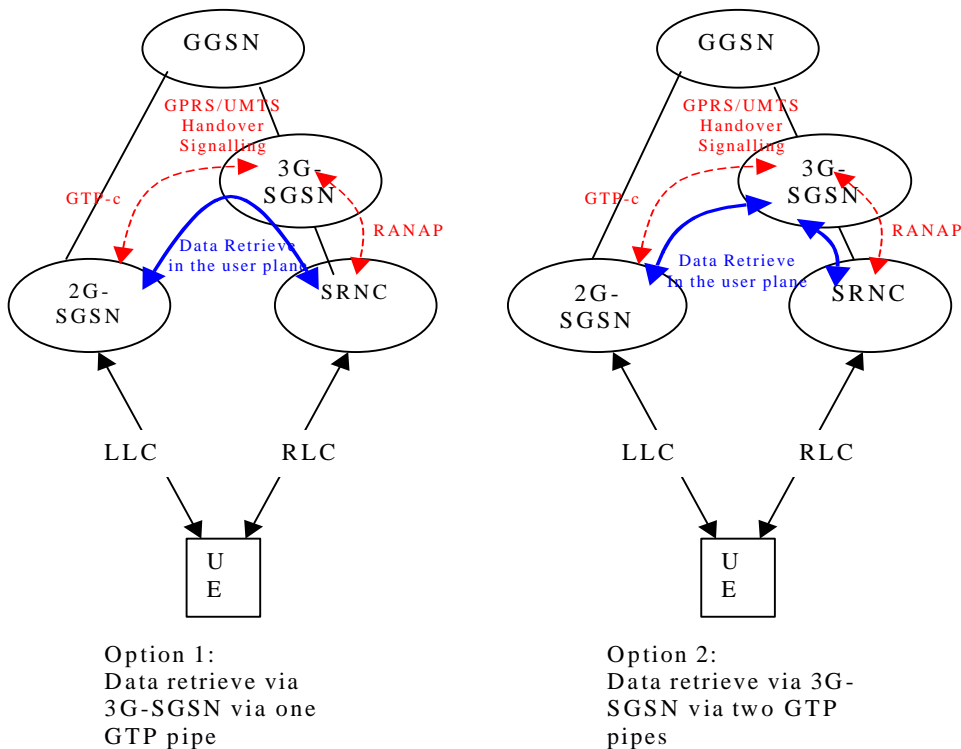


Figure 2: Alternatives for Data retrieve between GPRS and UMTS

2.2.2.1 Discussion for the SRNS Relocation procedure Control Plane

Regarding the SRNS Relocation procedure Control Plane, 2G-SGSN uses GTP-c²/UDP/IP protocol stack.

1. The first possibility is to use RANAP messages between SRNC and 3G-SGSN, and GTP-c between 3G-SGSN and 2G-SGSN.

2. The second possibility is to terminate GTP-c/UDP/IP in the SRNC.

However, since some parameters transported by GTP-c are CN related only (e.g. CN classmark, CID), it is necessary to terminate GTP-c signalling exchanged with the 2G-SGSN in the 3G-SGSN and to use RANAP signalling on Iu between 3G-SGSN and SRNC. Furthermore, the use of GTP-c/UDP/IP is not in line with the agreement to have a single radio network signalling protocol (RANAP) over Iu.

Therefore, only the first possibility (using RANAP between SRNC and 3G-SGSN) is acceptable.

2.2.2.2 Discussion for the user plane

- Regarding the user plane, all above solutions use GTP-u³/UDP/IP which is in line with what has been decided for Iu user plane in the IP domain.
- Regarding charging and interception, downstream data should not be charged nor intercepted twice:

GPRS => UMTS handover

downstream data that have not been transmitted to/acknowledged by the MS (at LLC layer) are sent by 2G-SGSN to the RNC or to the 3G-SGSN, and have not been counted by 2G-SGSN in the charging records..

Hence, as accounting is carried out in the 3G-SGSN, these data have to go through the 3G-SGSN in order to be counted: As in option 1 the 3G-SGSN acts in the user plane only as a router, only option 2 provides the requested charging of this traffic. Hence only this option is considered in the

² GTP-c stands for GTP control plane protocol

³ GTP-u stands for GTP user plane protocol

rest of this section.

UMTS => GPRS handover

Downstream data that have not been transmitted to/acknowledged by the UE (at RLC layer) should not be counted in 3G-SGSN charging records because they will be transmitted to the 2G-SGSN and counted at LLC layer (upon acknowledgement of the MS) by 2G-SGSN.

As these downstream data were already counted by the 3G-SGSN, there are two alternatives:

- the RNC notifies the 3G-SGSN of the data are transmitted towards 2G-SGSN. The 3G-SGSN has to subtract them from the cumulative result. The same mechanism as used to notify the 3G-SGSN of packets discarded by the UTRAN can be used.
- As with solution 2, data sent from SRNC to 2G-SGSN go through the 3G-SGSN, the 3G-SGSN has to decrement its charging counters each time it handles a packet sent by the SRNC and to be sent to the 2G-SGSN.

2.2.3 Adopted solution for data retrieve at GPRS-UMTS handover

For Control Plane: Since some parameters transported by GTP-c are CN related only (e.g. CN classmark,...), it is necessary to terminate GTP-c signalling exchanged with the 2G-SGSN in the 3G-SGSN, and to use RANAP signalling on lu between 3G-SGSN and SRNC.

For User plane: As Charging of the retrieved data is to be carried out at 3G-SGSN, data exchanged between SRNC and 2G-SGSN are handled by the 3G-SGSN (two GTP pipes: SRNC – 3G-SGSN and 3G-SGSN – 2G-SGSN). This ensures that:

- 3G-SGSN can increment charging counters for user data sent from 2G-SGSN to SRNC
- 3G-SGSN can decrement charging counters for user data sent from SRNC to 2G-SGSN avoiding that such data are charged twice (in 3G-SGSN and in 2G-SGSN)

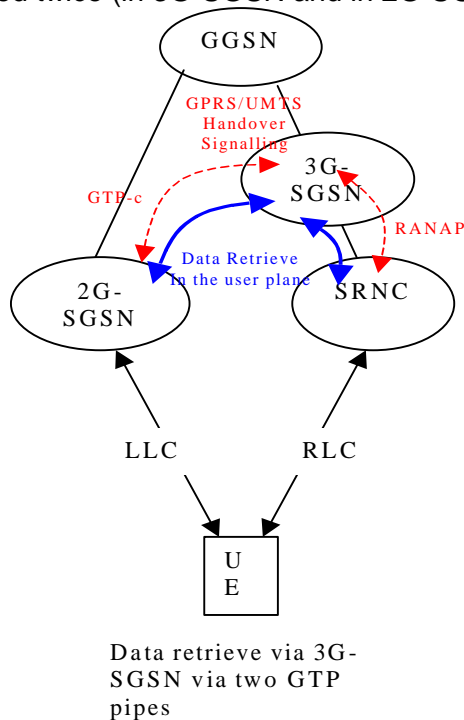


Figure 43: Data retrieve between GPRS and UMTS

2.3 Data retrieve in UMTS

2.3.1 Requirements for data retrieve at SRNS relocation

Since,

- there is no buffering in the 3G-SGSN
- there is an ARQ mechanism in the Serving RNC (the RLC layer) similar to the LLC layer in the 2G-SGSN,

the data reliability is ensured by the transfer of non-acknowledged user data from the Source RNC to the Target RNC. This transfer ("data retrieve") can be performed with a mechanism similar to the one used between 2G-SGSNs in GPRS.

The Data retrieve between two RNCs belonging to the same UTRAN is required for non real-time data services during a SRNS relocation procedure.

Regarding the SRNS Relocation procedure Control Plane, SRNS relocation procedure uses both RANAP signalling over the lu and RNSAP signalling over the lur.

Regarding the user plane, some requirements can be listed:

Synchronisation:

Since the 3G-SGSN does not buffer downstream data, the source RNC may have to buffer all GTP frames that are not yet transmitted or acknowledged at RLC layer. It also has to buffer all GTP frames that continue to arrive from the GGSN (the GGSN continues to send them to the source RNC as long as its PDP context has not been updated by the SGSN. Furthermore, data that are sent by the GGSN may take a certain time to get to the source RNC).

This means that:

- The target RNC has to start as Serving RNC just after having received SRNS Relocation Commit message from the source RNC even if all downstream data have not been retrieved yet.
- The user data retrieve may last a relatively long time. A timer is armed in the Source SRNC at the beginning of the data transfer phase. The contexts related to the UE in the Source SRNC will be released when the timer expires, i.e. when downstream data from GGSN is considered as finished.

Data reliability:

Depending upon the required reliability, there could be a need for a layer 2 protocol or not. In the GPRS, the user data is transfer via GTP/UPD/IP if the user-to-user data is IP-based, and via GTP/TCP/IP if the user-to-user data is X25-based. Here, only GTP/UDP/IP is considered.

Multiplexing of PDP contexts during data retrieve:

Several SRNS Relocation procedures for different users and/or different bearers may be carried out simultaneously and independently. GTP is used to differentiate the data retrieve contexts.

Associated signalling:

Considering signalling, there are two kinds of signalling:

- Signalling linked with transmission of CN parameters. This corresponds to signalling exchanged on Gn between 3G-SGSNs during the (first) phase of resources for the SRNS relocation.
- Signalling linked with the transmission of the sequence numbers of the acknowledged

protocol (RLC) between SRNC and UE. This can be done over Iur when the source SRNC actually hands-over the role of SRNC (when sending the RNSAP "Relocation commit" to the target SRNS).

2.3.2 Mechanisms used for data retrieve at SRNS relocation

The data retrieve procedure in the user plane could be performed

- either via a direct "pipe" between the two RNCs
- or via several cascaded "pipes" terminated in 3G-SGSNs.

The different possibilities for the SRNS Relocation procedure control plane path and the user plane path are shown for GPRS and UMTS in figure 1.

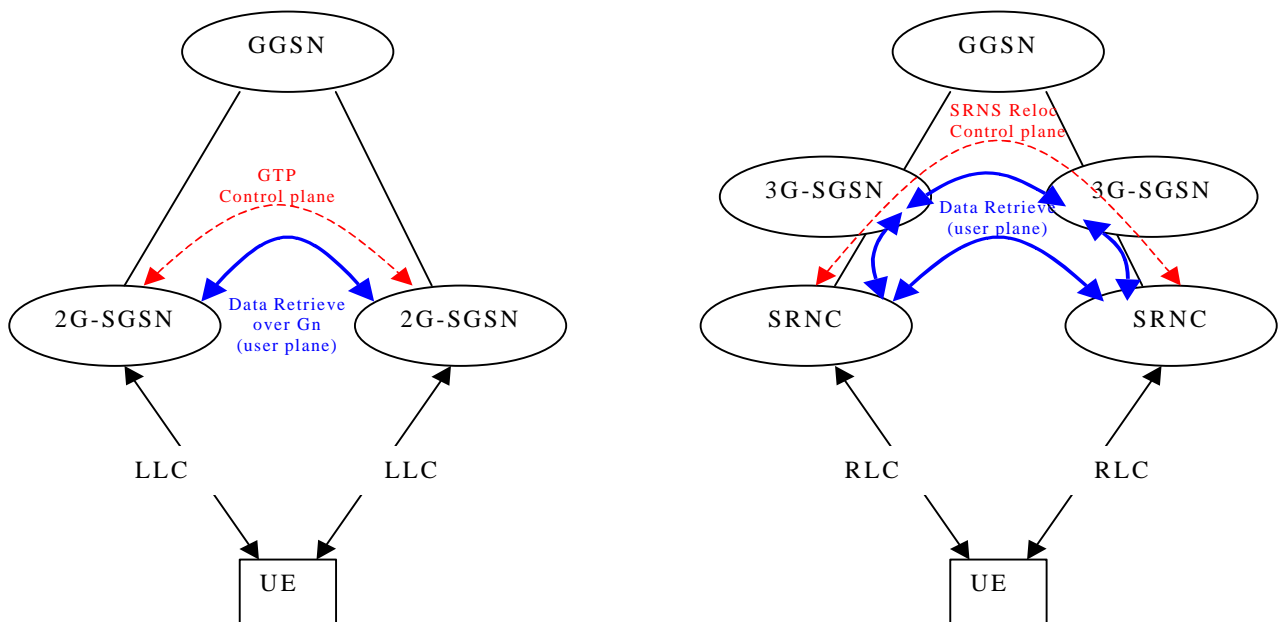


Figure 54: Data Retrieve procedure in GPRS versus UMTS

User data retrieve may be performed via several ways as shown in the next figure:

1. Either (**Option 1**) via a single GTP pipe between source RNC and target RNC,
2. Or (**Option 2**) via several GTP pipes terminated in the 3G-SGSNs.

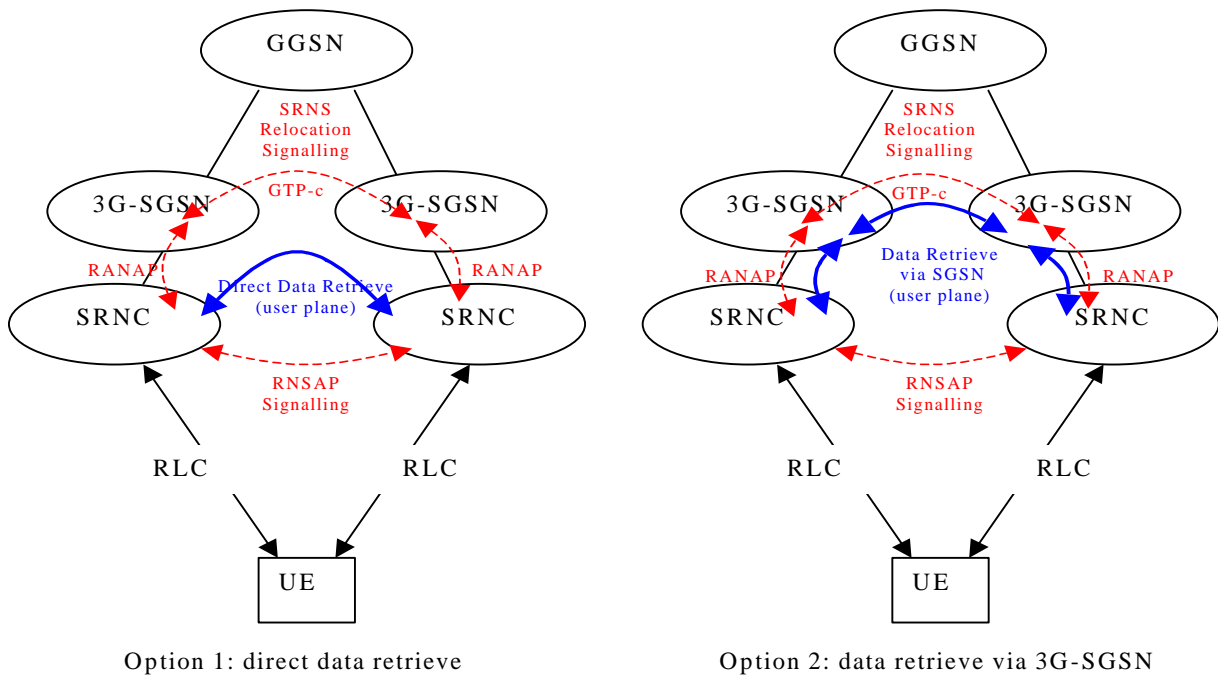


Figure 65: Alternatives for User data retrieve in UMTS

2.3.2.1 Comparison on a charging point of view

As accounting (for charging) is ensured by the 3G-SGSN,

- If data are transferred over cascaded GTP pipes (solution 2) that terminate at 3G-SGSN, the source 3G-SGSN can decrement its charging counters each time it handles a packet received from the source SRNC and to be sent to the target SRNC via the target 3G-SGSN.
- If data are transferred directly over one single GTP pipe (through Iu or Iur), no subtraction is possible but no subtraction is needed

Therefore, both options 1 and 2 are possible.

2.3.2.2 Comparison on a bearer point of view

2.3.2.2.1 Option 1

Two sub-options are considered:

Option 1.a: transfer via Iur

Option 1.b: transfer via Iu

2.3.2.2.1.1 Option 1.a: via Iur

Two cases are considered:

- Case 1: For the data retrieve, RNCs are connected directly via AAL5/ATM connections.
- Case 2: For the data retrieve, RNCs are connected across an IP network.

Case 1:

GTP frames can be up to 1500 octets long. Hence, they should not be transferred over AAL2 but over AAL5 which is more appropriate.

RNCs can be connected via Iur:

- Either via semi-permanent AAL5/ATM connections,
- Or via switched AAL5/ATM connections.

In the first case, a full ATM meshing with significant bandwidth is needed. This leads to huge bandwidth on

lur and this is not acceptable.

In the second case, data retrieve may be very long and complex since there is a need to establish an AAL5/ATM connection between the Source RNC and the Target SRNC (possibly via one or several transit RNCs). Furthermore it implies the use of e.g. B-ISUP/MTP3/SAAL/ATM or P-NNI/SAAL/ATM over the lur to establish these connections.

Case 2:

Adjacent RNCs can be connected to the IP network via lur over semi-permanent AAL5/ATM connections. Then the data to be transferred from a Source RNC to a Target RNC are routed across the IP network, but at the cost of bandwidth on the lur interface, with a relatively poor usage (little trunking effect).

2.3.2.2.1.2 Option 1.b: via Iu

The use of the ATM big fat pipe on the Iu interface allows for sharing the bandwidth for all SRNS relocations with all RNCs.

The bandwidth usage efficiency is better than with option 1.a.

Furthermore, the transfer via Iu is the only possibility when GPRS/UMTS handover is considered and it is more homogeneous to use it also for SRNS Relocation.

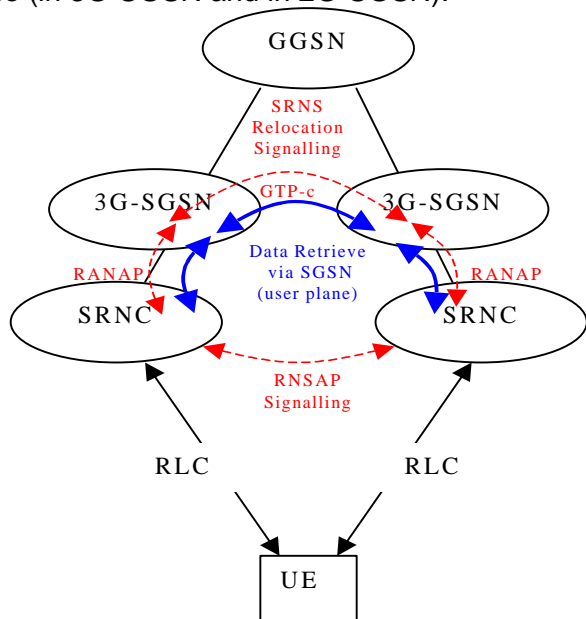
2.3.2.2.2 Option 2

The use of the ATM big fat pipe on the Iu interface allows for sharing the bandwidth for all SRNS relocations with all RNCs as for option 1.b.

2.3.3 Adopted solution for data retrieve at SRNS relocation

Data Retrieve procedure at SRNS relocation shall be carried out through the Iu interface: data exchanged between source and target SRNC are handled by the 3G-SGSN (3 GTP pipes: source SRNC – source 3G-SGSN, source 3G-SGSN – destination 3G-SGSN and destination

Source 3G-SGSN has to decrement charging counters for user data sent from SRNC to 2G-SGSN avoiding that such data are charged twice (in 3G-SGSN and in 2G-SGSN).



data retrieve via 3G-SGSN

2.4 User plane protocol stack for data retrieve in UMTS

2.4.1 User plane protocol stacks for UMTS data retrieve

The user plane for data retrieve between two RNCs is based on GTP-u/UDP/IP. The GTP connections terminated in the 3G-SGSNs as described in the following figure.

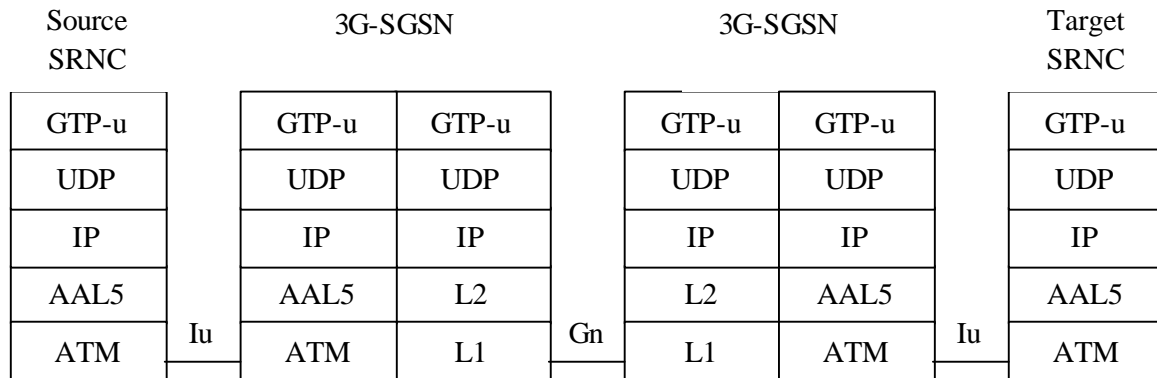


Figure 76: User plane protocol stack for data retrieve in UMTS

2.4.2 User plane protocol stacks for data retrieve between UTRAN and 2G-SGSN

The user plane for data retrieve between UTRAN and 2G-SGSN is based on GTP-u/UDP/IP. The protocol stack and the GTP connections termination points are described in the following figure.

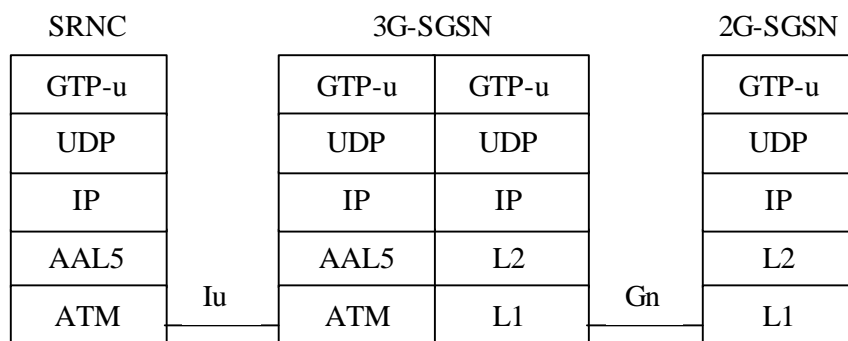


Figure 87: User plane protocol stack for data retrieve between GPRS and UMTS

3 Proposal

It is proposed that the following text is included in [2] section 6.1:

" According to [1] section 4.2, at SRNC relocation, for high reliability Radio Access Bearers, the downstream packets not yet acknowledged by the UE have to be transferred between the old SRNC and the new SRNC.

In case of GPRS-UMTS handover, the downlink packets not yet acknowledged by the UE have

to be transferred between the 2G-SGSN and the SRNC.
In both cases, this transfer of packets is performed via the Iu-PS user plane."

It is also proposed to create a new section 6.4.2 in [2], called "Data Retrieve at SRNS Relocation and at GPRS-UMTS handover", with the following text:

"At SRNS Relocation in the PS domain and at GPRS-UMTS handover, the transfer of downstream packets that have not been acknowledged by the UE shall be carried out in the Iu user plane over the PS domain protocol stack GTP-u/UDP/IP/AAL5/ATM."

4 References

- [1] UMTS 23.930 V1.2.0, Iu Principles
- [2] UMTS 25.415 Iu Interface UTRAN-CN User Plane Protocols