3GPP TSG CT Meeting #28 **CP-050147**
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Source: **Nokia**

Title: **Impacts of enabling NSAPI/SAPI/PFI re-mapping on PS Handover Performance**

Agenda item: **9.25**

Document for: **Discussion/ Decision**

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1. INTRODUCTION

The PS Handover mechanism is being standardized in TSG GERAN [3GPP TS 43.129]. The primary goal of this procedure is to enable real-time services in GERAN *A/Gb mode*, but the handover mechanism would be applicable also to other PS services. Due to strict Quality of Service requirements on low latency and packet loss, real-time packet-switched (PS) services require a minimal service interruption of the data transfer during cell change. PS handover is defined following the GSM circuit-switched handover principle of allocating radio resources in the target cell prior to changing cell, such that it fulfils the QoS requirements for real-time services in [3GPP TS 23.107].

Changes to the PS handover mechanism have been proposed for discussion and approval in CT WG1#38 in the documents (C1-050754, C1-050755 and C1-050756).

The major disagreement point is the NSAPI/SAPI/PFI re-mapping issue that have been extensively discussed in GERAN until it was agreed not to support it in TSG GERAN#22 and recently brought up in TSG CT1 group as well as in TSG GERAN2.

The architectural/protocol impacts due to the re-mapping have been highlighted in the document C1-050082. This discussion paper highlights the impact of supporting NSAPI/SAPI/PFI re-mapping on the performance of PS handover due to the proposed changes.

1. IMPACTS ON THE PERFORMANCE DURING PS HANDOVER DUE TO NSAPI/SAPI/PFI REMAPPING

The impacts on the performance of PS Handover due to re-mapping are listed below as follows:

- ***Throughput decline during PS Handover***

  During XID negotiation there are parameters that can impact the performance of the PS Handover. The change of the SAPI during PS Handover can lead to degradation of the PS Handover performance.

  E.g. MS is using SAPI=5 in the old cell for a certain packet flow and during PS handover the network orders MS to use SAPI=3 instead of SAPI=5, when re-mapping is applied.

  As a consequence, all packets already in LLC and RLC with SAPI=5 should be deleted because the receiving SGSN would not understand them. Due to this there will be packet drops at TCP level leading to reduced throughput. The loss of data is not negligible. In EGPRS RLC window sizes can be quite large (see TS44.060 chapter 9.1.9.2), e.g. for 2 uplink slots, the RLC window size can be 256. In a worst-case scenario with MCS-9 coding scheme, the RLC window size would be MCS-9_block_size * 256 = 74 octets * 256 = 18955 octets. With 2 uplink slots the theoretical maximum transfer speed in RLC is 118.4 kbits/s when MCS-9 is used. Discarding 18955 bytes results in 1.28 seconds transfer time. Thus a very large amount of data can be lost due to the change of SAPI.

This problem will not exist if the MS and network utilizes the same SAPI value for the packet flow in the old cell as well as in the new cell. The problem is not relevant for the *Iu mode* to *A/Gb mode* PS handover, because even if MS receives a new SAPI value in this scenario, the 2G buffers are empty and there is no need to discard any packet data.

- ***Degradation of the service from the user's point of view***

From user point of view the transmissions in GPRS level are started fast, but TCP slows down because packets have been lost and have to be retransmitted, or even worse, TCP goes to slow start. This will be seen as a degradation of the service from the user point of view.

- ***Delay of the handover caused by the PS Handover Command segmentation.***

Performing re-mapping at each SGSN change for all NSAPI/SAPI/PFI will result in RLC/MAC segmentation of the PS Handover Command, which will cause unwanted handover delays for PS services.

IF re-mapping is supported, there is a need to include the NSAPI and its newly assigned SAPI and PFI value in the NAS container for each and every PDP Context. This has to be done for all packet flows regardless of their QoS profile and regardless of whether there are resources allocated in the target cell. The NAS Container shall be sent transparently through the air interface to the MS in the RLC/MAC message, i.e. PS Handover Command. The size of this message will obviously grow if re-mapping is supported, up to 23 additional octets, in addition to the radio interface parameters within the air interface handover message. Note that PFI always would have to be sent twice, as it will be included in the radio access container as well as in the NAS container.

Obviously the size of the PS Handover Command will increase if re-mapping is supported and segmentation will have to be applied at the RLC/MAC level as specified in 3GPP TS44.060. The size of PS HANDOVER COMMAND message influences significantly the performance of PS handover. Overlong handover commands will cause long interruptions due to retransmission of control block segments, which increases with the number of segments. When taking into consideration that the service interruption caused by the PS HANDOVER COMMAND message transfer is only a part of overall service interruption during PS handover, it is necessary to minimize it by keeping the PS HANDOVER COMMAND as small as possible. This will however not be possible if the NSAPI/SAPI/PFI re-mapping is to be supported. Additionally it has to be noted that the NSAPI/SAPI/PFI re-mapping will be sent for all PDP contexts regardless of whether a certain PDP context has received radio resource in the target cell or not. This leads to utilizing the PS Handover Command for changing some parameters that are not relevant for the handover procedure itself.

- ***New round of XID negotiation in the target cell to change the default parameters***

  The NAS Container defined in the CR to 3GPP TS 24.008 limits the usage of the old XiD parameters to the re-mapping, i.e. old XiD parameters cannot be used in the target cell if re-mapping is supported. This means that the MS after processing the NAS container will have to start a new XiD negotiation procedure to change the default parameters for each of the received NSAPI/SAPI pair resulting in additional signalling with the core network and usage of the radio resources in the target cell.

- ***Data transfer is not possible any more on the old cell which leads to complete failure of PS Handover***

  If a failure occurs after the MS has processed the NAS container in the new cell, but before the RAU is completed, then falling back to previous cell as described in 3GPP TS43.129 does not work. The reason is that the old SAPI and PFI values have been overwritten at PS handover by the new SGSN. So, MS cannot by any means fall back to the old cell, where the resources would have been still available for the data flows. A dire consequence is that new failure handling procedures have to be defined for the air interface as well as for the Gb interface. However, independently of the new failure handling, the recovery of the data transmission will not be possible, leading to severe service degradation from the user’s point of view.

2. CONCLUSION

This paper demonstrates the negative performance impacts of re-mapping NSAPI/SAPI/PFIs during PS handover in GERAN *A/Gb mode.* Re-mapping NSAPI/SAPI/PFI during PS handover has severe impact not only on the architectural/protocol level, but also on the performance of PS handover. The resulting degradation in PS handover due to re-mapping is the following:

- Not fulfilling the QoS requirements for the real-time services due to:
  - Decrease of throughput during PS Handover and service degradation;
  - Delay on the PS handover and user data transmission due to segmentation of the PS Handover Command message;
  - Additional signalling due to XID negotiation;
- Impossible PS Handover failure recovery in terms of data transfer.

REFERENCES

[1] C1-050082

[2] C1-050754, C1-050755 and C1-050756

[3] 3GPP TS 43.129

[4] 3GPP TS 24.008

[5] 3GPP TS 44.064

[6] 3GPP TS 44.065