Conversational QoS over Gb

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Introduction

- The evolved Gb feasibility study addresses the technical realization on supporting conversational QoS class over Gb interface
- With this conversational QoS class also the support of PS handover will evidently be a requirement
- This discussion paper outlines the technical issues that need to be covered and solutions to be proposed for the feasibility study. Some of the issues are not only GERAN specific and thus need discussion also in other TSGs

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Very Basic Requirement for Gb Evolution

- Since its introduction into specifications, GPRS has evolved significantly, and its evolution has followed the basic functionality split that was chosen already in Release 97
- Therefore further evolution should keep the basic functionality split intact and minimize the impact on protocols over Gb and GPRS radio interface

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Requirements for Conversational QoS Class over Gb

- In order to support real-time Conversational traffic class on Gb interface there are number of de-facto mandatory high level requirements to be fullfilled
  - Highest possible spectral efficiency
  - Acceptable QoS especially subjective quality and low delay
  - Seamless handover and interworking between systems
- It is clear that fulfilling these requirements will trigger following changes in Gb interface
  - Modifications to Gb protocol stack (SNDCP, LLC, BSSGP)
  - Modifications to RR, RLC/MAC and Phy
  - PS Handover
    - PS Handover within GSM/EDGE, together with relocation of necessary parameters
    - PS Handover from Gb to Iu-ps and vice versa (both GERAN Iu and UTRAN)
    - Handling of simultaneous A/Gb (DTM links) to Iu-ps and vice versa
- Following sections outline the changes on Gb protocol stack, as well as issues that have system wide impacts

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Impacts on Gb Protocol Stack : *SNDCP-ROHC*

- In order to support any meaningful conversational class of services, SNDCP need to support ROHC
- Performance of ROHC is dependent on the roundtrip delay; therefore some level of degradation compared to GERAN Iu mode is expected and this need to be evaluated
- The longer RTT means that it will take slightly longer to transition to higher order states (where compression efficiency is best). Practically, it could mean sending a few more of the larger headers when transitioning from one state to the next, or when initiating the call (when full headers are sent); it will take a bit more time to know that the decompressor has acquired enough info such that it is ok for the compressor to transition to the higher state

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Impacts on Gb Protocol Stack : *ROHC Context Relocation*

- Another aspect to consider is ROHC context relocation. In UTRAN and GERAN Iu mode there is a mechanism to relocate the ROHC context, and it is believed that such mechanism is required between 2G SGSNs
- However, it is not clear how this relocation can be achieved when going from Gb to Iu-ps and vice versa, and within Gb in case of inter SGSN change. For example in most simple solution could be
  - when moving from Gb to UTRAN or GERAN Iu mode, ROHC should be restarted
  - when moving from UTRAN or GERAN Iu mode to Gb or Gb to Gb in inter SGSN change, the compression method should be negotiated, and ROHC restarted
- These simple solutions would mean severe problems to maintain the conversational QoS during the ROHC relocation process

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Impacts on Gb Protocol Stack : *SNDCP Overhead*

- The SNDCP overhead is 3 octets (acknowledged) or 4 octets (unacknowledged). This is a quite significant overhead for VoIP
- Just to compare the AMR FR case where VoIP signaling is over Iu-ps and over Gb (RLC/MAC headers exluded since the exact header size for RLC/MAC of Conversational Gb is not known):
  - Iu-ps : 8 bits (PDCP) + 28 bits (ROHC) + 95-244 bits (AMR Payload)
  - Gb : 32 bits (SNDCP) + 40 bits (LLC) + 28 bits (ROHC) + 95-244 bits (AMR Payload)
- The comparison shows that there is 64 bits additional overhead for Gb compared to Iu-ps. This translates into 2.7 dB link level loss and 48.5% capacity loss for Gb compared to Iu-ps (GMSK FR - TU3iFH - 900 MHz - PC – DTX)
- Modifying the header will require substantial changes on how SNDCP operates. It could be argued that modifications on SNDCP would lead to basically separate protocol stack on the Gb interface optimized for real-time conversational services
- Negotiation of header compression mechanism in case of Gb is done on SNDCP, peer-to-peer using XID parameter negotiation mechanism. For realtime services, this negotiation may add additional delay on call setup phase compared to UTRAN or GERAN Iu mode. Also in case of inter-SGSN handover the header compression negotiation increases the handover delay significantly

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Impacts on Gb Protocol Stack : *LLC*

- One of the key requirements to support real-time conversational services is spectral efficiency
  - If using Gb stack for VoIP (or other service over IP) packets will be encapsulated in LLC/SNDCP packets over the radio which adds overhead of 9 octets per packet (5 from LLC+4 from SNDCP) compared to 1 octet overhead for PDCP. This is a significant overhead and will kill any idea of VoIP, unless something is done
- One possibility is to add some "LLC light" (type of transparent LLC) and this will effectivly lead towards a different split on functionality from today's Gb
  - Even if we go with some lighter header still it is not sure how much less overhead we can have
- Another feature in LLC is ciphering. Creating a "light version" of LLC (or even transparent) will affect the ciphering. Effectively this would mean moving the ciphering to lower layers e.g. RLC/MAC

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Impacts on Gb Protocol Stack : *Signalling & Data Flows*

- In Gb protocol, there is no separation on signaling and user data flows between network entities
- In order to scale the capacity of network nodes in most optimal and cost efficient way, the separation would be needed between the flows
- To introduce similar separation as in Iu –mode would need introduction of new principles to Gb protocol, which would in turn not favor the current functionality split between Gb protocol layers.

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Impacts on Gb Protocol Stack : *Conclusion*

- Solutions should be found for SNDCP and LLC, also introducing ROHC and ROHC context relocation, without impacting the functional split and supporting the legacy operation of SNDCP and LLC
- The solution for 64 bits header overhead compared to Iu-ps solution should be solved without corrupting the current principles on SNDCP and LLC
- Also the separation of signaling and user data flows between network entities would affect the functional split of Gb protocol layers

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Impact on Radio i/f Protocol Stack : *RLC/MAC*

- In order to support real-time services, similar features as introduced for GERAN Iu mode, are required:
  - RLC/MAC would require a dedicated MAC, something that is being introduced for Iu mode. In addition Multiple TBF would be required
  - It is not clear how would the PS handover look like, but certainly it would require changes on RLC/MAC, further complicating the split between RR and RLC/MAC
  - For example it needs to be described how the access in the new cell is made, which messages are sent from MS to network and vice versa. How abnormal cases are handled
  - Anticipated changes on RLC/MAC could be described on a high level as GERAN Iu mode RLC/MAC minus ciphering (although even the issue of ciphering is not clear)

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Impact on Radio i/f Protocol Stack : *RR & RLC/MAC & BSSGP*

- RR or RLC/MAC and BSSGP would need a kind of "radio bearer concept"´. This would also be needed for support of FLO over Gb.
- It is not clear what kind of new procedures are needed for this. For example, is MS part of the negotiation of these new bearers (if not how LLC packets are routed to appropriate PDP context if "LLC lite is used")

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Impact on Radio i/f Protocol Stack : *Conclusion*

- On the RR and RLC/MAC level the similar changes would be needed compared to GERAN Iu, the only difference being the ciphering that is done in LLC layer
- The security issues need to checked, like already highlighted in LLC layer analysis in this document

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PS Domain Handover in Gb

- There are a number of serious issues that need to be considered:
  - A SACCH like channel is needed that would introduce changes on RLC/MAC and require new channel combination types
  - Which entity is responsible for handover: RR or RLC/MAC? In case of DTM, where CS and PS connections are active same time, if the PS handover is handled in RLC/MAC layer, there is need for clear coordination between RR and RLC/MAC layers
  - BSSGP would require a new set of procedures, and with changes that are definitely required on SNDCP and LLC, the question is how much of the BSSGP/LLC/SNDCP are we going to reuse. From high level it looks like a new protocol stack but keeping old names
  - PS domain handover on Gb interface will require changes on both CN and BSS, affecting ALL protocols (SNDCP, LLC, BSSGP, RR, RLC/MAC, and even Physical Layer)
  - Modified behaviors are needed to for the Routing Area Update procedures to handle the procedure while simultaneously sending user data. Any of the Handover scenarios may result in a Routing Area change. This is a significant change on the way SGSN handles “realtime” MSs and “other” MSs

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PS Domain Handover in Gb : *Conclusion*

- The impact of PS Domain Handover in Gb will affect all the protocol layers, and it would be difficult to maintain the current functional split between protocol layers

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Interworking with Iu –Mode

- Current specifications define handover between GERAN A, GERAN Iu and UTRAN. Cell reselection performance between GERAN Gb and UTRAN is not acceptable for any realtime service (not even for streaming). NACC concept between UTRAN and GERAN Gb would be required
- Introducing a handover for Gb would require interworking concepts inside Gb as well as between Gb and Iu mode that of course does not exist today
- ROHC context and ciphering relocation between GERAN Gb and Iu mode is needed. These two features are residing on different entities in case of Gb compared ot the Iu mode. The solution for relocation is not clear, and certainly there will be a performance price to be paid

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Interworking with Iu –Mode : *Conclusion*

- The new interworking procedures would need to be specified between Evolved Gb, GERAN Iu and UTRAN
- ROHC context and ciphering relocation would be needed between GERAN Gb and Iu mode

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Conclusions

- This contribution outlines the issues to be covered in each Gb stack's protocol layer in order to support Conversational QoS Class over Gb interface
- Based on the issues raised in each layer, it seems very difficult to maintain the current Gb stack functional split
- Enhancing Gb interface to support conversational QoS over PS would likely lead into suboptimal solutions as well as the principles of current Gb protocol stack would not be possible to keep. From high level it looks like a new protocol stack but keeping old names
- Nokia does not see evolving the Gb interface to support conversational QoS as realistic way forward. By changing Gb protocol stack to support conversational QoS would really mean that same mechanisms/concepts would be specified on Gb as are specified for GERAN Iu in BSS, the difference being that Gb is not designed to support conversational QoS and thus suboptimal solutions would be reality
- On top of the BSS side changes, there would be significant system level changes that would affect 2G SGSN as well as interworking procedures between systems.

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