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3GPP TSG GERAN Meeting #10 **GP-022012**
Helsinki, Finland, 24 – 28 June 2002 **Agenda 6.6**

Title: LS on A/Gb evolution
Source: GERAN
To: SA2, SA3
Cc: CN1, CN3
Response to: -

Contact Person:
Name: Frank Mueller
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Attachments: TR ab.cde v0.6.0, "A/Gb mode evolution; feasibility study", GP-021755
Adhoc report on A/Gb evolution, GP-021657

1. Overall Description:

On the last TSG GERAN #9 meeting work items have been presented proposing to evolve the Gb interface to provide enhancements to support streaming services and even further to allow conversational services. The following work items were presented:

- GP-020926 Work Item Description for Multiple TBF in A/Gb mode
- GP-020927 Work Item Description for PS Handover and BSS Relocation in A/Gb mode
- GP-020928 Work Item Description for Enhanced support for Conversational and Streaming Services (IMS) in A/Gb mode

Those were proposed in order to allow the provision and efficient support of all QoS classes over the Gb interface. The Work Item on GP-020926 on Multiple TBF for A/Gb mode has been agreed by TSG GERAN and work is ongoing. The other two work items initiated a debate in TSG GERAN #9 on whether these changes are feasible. Therefore TSG GERAN #9 decided to perform a feasibility study targeting completion in GERAN #10. As a first step a TSG GERAN ad hoc meeting has been held in June and different issues have been identified and captured in the Feasibility study document. Based on the current level of progress of the feasibility study, TSG GERAN #10 could not reach a conclusion on conversational class support for Gb therefore the work is prolonged until GERAN #11.

TSG GERAN wants to inform TSG SA 2 about the ongoing activities and has attached the outcome of the ad hoc as well as the first draft of the feasibility study and kindly requests comments from SA2 experts that would help TSG GERAN conclude the feasibility study.

2. Actions:

To SA2:

- TSG GERAN kindly requests TSG SA2 to review and comment the feasibility study.

To SA3:

- One solution being discussed in TSG GERAN when providing conversational services is to move ciphering from LLC to the radio access network. Does SA3 have any concerns following such an approach?
- TSG GERAN kindly requests TSG SA3 to review and comment the feasibility study.

To CN1 and CN3:

- No specific actions. Provided for information.

3. Date of Next GERAN Meetings:

GERAN #11 26^{th} – 30^{th} August 2002

GERAN #12 18^{th} – 22^{nd} November 2002

3GPP TR ab.cde V0.6.0 (2002-06)

Technical Report

3rd Generation Partnership Project;
Technical Specification Group GERAN;
A/Gb mode evolution;
Feasibility Study
(Release 5)

GLOBAL SYSTEM FOR
MOBILE COMMUNICATIONS

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Keywords

< GERAN, A/Gb mode, evolution, conversational, Iu mode >

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Contents

Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

1. Scope

The present document constitutes a study of the evolution of the GERAN via enhancements to the existing 2G interfaces and protocols. It is the objective of this study to assess the feasibility of such enhancements as well as to estimate the amount of work required for their implementation, both in the standards and in the products. Although the present document refers to *A/Gb mode* evolution, the focus is on enhancements to the packet switched domain i.e. when services are provided over the Gb interface.

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. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document.*

[1] 3GPP TD TSG-GERAN GP#9(02)021233, "Feasibility Study on A/Gb enhancements", source: AWS, Ericsson, Motorola, Nokia, Nortel Networks, Siemens.

NOTE: Alcatel, Cingular Wireless and Vodafone Group to be added as supporting companies in the next revision.

[2] 3GPP TD G2-020151: "Architecture for a Flexible Layer One", source Nokia.

[3] 3GPP TD GP-021033: "On the Introduction of FLOC in GERAN", source Siemens.

[4] 3GPP TD AHAGB-010: "Dedicated Channels for enhanced Gb", source Siemens.

[5] 3GPP TR 21.905: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Vocabulary for 3GPP Specifications".

[6] 3GPP TR 43.055, "3rd Generation Partnership Project; Technical Specification Group GSM/EDGE Radio Access Network; Dual Transfer Mode; Stage 2".

[7] 3GPP TS 21.877 "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Radio optimisation impacts on PS architecture".

[8] 3GPP TS 23.107, "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; QoS Concept and Architecture ".

[9] 3GPP TS 23.207,"3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; End-to-End QoS Concept and Architecture".

[10] 3GPP TS 25.922 "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Radio resource management strategies".

[11] 3GPP TS 43.064,"3rd Generation Partnership Project; Technical Specification Group GERAN; Digital cellular telecommunications system (Phase 2+); General Packet Radio Service (GPRS); Overall description of the GPRS radio interface; Stage 2".

[12] RFC 1144.

[13] RFC 2507

[14] RFC 3095[VF3]

3. Definitions, symbols and abbreviations

3.1. Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TS 21.905 [2] and the following apply.

A/Gb mode: mode of operation of the MS when connected to the Core Network via GERAN and the A and/or Gb interfaces.

Iu mode: mode of operation of the MS when connected to the Core Network via GERAN or UTRAN and the Iu interface.

3.2. Symbols

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

A	Interface between a BSS and an MSC
Gb	Interface between a BSS and an SGSN
Gn	Interface between two SGSNs
Iu	Interface between a BSS/RNC and the CN
Um	Interface between the MS and the BSS
Uu	Interface between the UE and the Node B.

3.3. Abbreviations

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

ATM	Asynchronous Transfer Mode
BSC	Base Station Controller
BSS	Base Station Sub-system
BSSGP	B
BTS	Base Transceiver Station
CN	Core Network
CS	Circuit Switched
DTM	Dual Transfer Mode
EDGE	Enhanced Data rates for GSM Evolution
EEP	Equal Error Protection
FLO	Flexible Layer One
GboIP	Gb over IP
GERAN	GSM/EDGE Radio Access Network
GPRS	General Packet Radio Service
GSM	Global System for Mobile communications
GTP	GPRS Tunnelling Protocol
IMS	IP Multimedia Subsystem
IP	Internet Protocol
LLC	Logical Link Control
MAC	Medium Access Control
MAC-I	Message Authentication Code for Integrity protection
MGW	Media Gateway
MO	Mobile Originated
MPLS	Multi-Protocol Label Switching
MRF	Media Resource Function
MS	Mobile Station
MSC	Mobile Switching Centre
MT	Mobile Terminated
MTU	Maximum Transfer Unit
PDP	Packet Data Protocol
PDTCH	Packet Data Traffic CHannel

PTCCH	Packet Timing advance Control CHannel
PFC	Packet Flow Context
PS	Packet Switched
QoS	Quality of Service
RAB	Radio Access Bearer
RAN	Radio Access Network
RAT	Radio Access Technology
RAU	Routeing Area Update
RLC	Radio Link Control
RNC	Radio Network Controller
ROHC	RObust Header Compression
RTP	Real Time Protocol
SACCH	Standalone Associated Control CHannel
SAPI	Service Access Point Identifier
SGSN	Serving GPRS Support Node
SIP	Session Initiated Protocol
SNDCP	Sub-Network Dependent Convergence Protocol
TBF	Temporary Block Flow
TD	Technical Document
TF	Transport Format
TFC	Transport Format Combination
TFCI	Transport Format Combination Indicator
TR	Technical Report
TS	Technical Specification
UDP	User Datagram Protocol
UE	User Equipment
UEP	Unequal Error Protection
UMTS	Universal Mobile Telephony System
UTRAN	UMTS Terrestrial Radio Access Network
VoIP	Voice over IP
XID	eXchange IDentification

4. Requirements and guidelines for *A/Gb mode* evolution

4.1. General

This clause collates the requirements and guidelines upon which the evolution of *A/Gb mode* shall be based. These are classified into:

- end-user service,
- architecture and
- security.

Requirements are binding statements for all the possible solutions to develop the features described in clause 5; i.e. all the possible solutions shall conform to all the applicable requirements: the general ones described in this clause as well as the feature-specific ones described in the corresponding sub-clauses. As all the requirements shall be met, this document does not contain conflicting requirements.

Guidelines are recommendations for all the possible alternatives to develop the features described in clause 5; i.e. all the possible solutions should conform to all the applicable guidelines: the general ones described in this clause as well as the feature-specific ones described in the corresponding sub-clauses. Guidelines should not conflict with other guidelines. Guidelines shall not conflict with requirements.

NOTE: In order to allow a more flexible study of solutions, some of the statements in this version of the document are presented as guidelines, whereas it is possible that they become requirements in the future.

4.2. End-user service requirements and guidelines

4.2.1. End-user service requirements

An evolved GERAN *A/Gb mode* shall support those services that the four different UMTS Service classes (Background, Interactive, Streaming and Conversational (see 3GPP TS 23.107) would support.

NOTE: There may be some limitations on End-user services due to the different air-interfaces and physical layers in GERAN and UTRAN.

4.2.2. End-user service guidelines

No end-user service guidelines have been identified.

4.3. Architectural requirements and guidelines

4.3.1. Architectural requirements

The following architectural requirements have been identified:

- IMS shall be supported in GERAN *A/Gb mode* (see 3GPP TS 23.207[X]).
- The core network supporting the GERAN shall use the same QoS attributes/parameters as used for the UMTS core network (see 3GPP TS 23.107 [6]).
- GERAN *A/Gb mode* shall support the same UMTS QoS classes (i.e. conversational, streaming, interactive, and background class), as required for the UTRAN (see 3GPP TS 23.107).
- It shall be possible to support services towards the CS and PS domains in parallel.
- Support for multiple sets of QoS attribute values in parallel shall be provided in GERAN *A/Gb mode*.

4.3.2. Architectural guidelines

The following architectural guidelines have been identified:

- The enhancements should be defined so that they can be implemented in phases of increasing functionality.
- GERAN *A/Gb mode* should support the same UMTS QoS attribute value ranges as required for the UTRAN (see 3GPP TS 23.107 [6]).

NOTE: There will be some limitations on the range of QoS attribute values due to the different air-interfaces and physical layers in GERAN and UTRAN.

NOTE: The set of attribute values to be supported is for further study.

- The radio network should not be optimised for a few given services, but instead be flexible enough to deploy efficiently any IP multimedia application.

NOTE: Ericsson proposes to add the following requirement: "The enhancements shall be optional for the mobile station".

- The radio and network resources should be used as efficiently as possible.
- The architecture and the functional split of GSM/GPRS should be maintained: the same or similar functions should continue to be performed in the same network elements and in the same protocol layers.

4.4. Security requirements and guidelines

4.4.1. Security requirements

GERAN *A/Gb mode* shall support the security requirements specified by 3GPP TSG SA WG3.

4.4.2. Security guidelines

No security guidelines have been identified.

4.5. Open issues

Table 1 summarises the issues that remain open regarding the general requirements and guidelines. A collection of all the open issues is included in an annex to this document.

Table 1 – Open issues for requirements and guidelines.

No	Description	Companies	Priority[1]	Status/Comments
4	**QoS set of attribute values** The QoS set of attribute values to be supported has not been identified as yet.		Medium	**Open**
5	**Service limitations** Limitations in the services able to be offered by an evolved GERAN *A/Gb mode* compared to UTRAN need to be identified and notified to SA1.		Medium	**Open** Limitations due to different mobility management need to be taken into consideration.
15	**Functional split** A modification of the current functional split between RAN and CN (in the context of support of real time QoS classes) needs to be studied.		High	**Open**

5. Features for *A/Gb mode* evolution

5.1. General

This clause contains the study of different features that may be considered part of the evolution of *A/Gb mode*. The following features are under the scope of this document:

- Multiple parallel data flows between BSS and MS;
- Handover of PS services;
- Radio channel support for real time QoS;
- DTM enhancements;
- Network transport aspects for support of real time QoS;
- Modification of SNDCP/LLC;
- IP header adaptation;
- Protocol aspects of Unequal Error Protection;
- Integrity protection; and
- Ciphering.

[1] High, Medium or Low.

NOTE: The initial contributions towards the different features are based on the documents discussed at the TSG GERAN ad hoc meeting on A/Gb evolution (Stockholm, Sweden, 11 – 13 June 2002). More information may be found in those contributions. They can be found on the 3GPP server: http://ftp.3gpp.org/ftp/…

Each of these features is analysed in a separate sub-clause. Each of these sub-clauses is sub-divided in a similar structure:

- Feature name
  - Introduction
  - Requirements and guidelines
  - Relationship with other features
  - Description of the solution(s)
    - [Solution 1]
    - [Solution 2]
    …
    - [Solution N]
  - [Preferred solution]
  - [Open issues]

where

- '[…]' denotes optional sub-clauses;

- the sub-clauses *Relationship with other features* should be as descriptive as possible; and

- the sub-clauses *Open issues* contains the feature-specific open issues.

Each of the sub-clauses describing a solution is sub-divided as follows:

- Solution y
  - General description of the solution
  - Impact on the protocol layers
  - Impact on the system elements
    - Impact on the terminal
    - Impact on the RAN
    - Impact on the CN
  - Impact on the standards
    - Affected specifications
    - Estimated standardisation time

where

- the sub-clauses *Impact on protocol layers* are sub-divided further to describe the impact on those of the following protocols that are affected by the incumbent solution: SNDCP, LLC, BSSGP, RR, RLC/MAC and L1/PHY, and

- the sub-clauses *Impact on protocol layers* and *Impact on the standards* refer only to .

5.2. MULTIPLE PARALLEL DATA FLOWS BETWEEN BSS AND MS

5.2.1. Introduction

As mobile station processing capabilities and packet data centric service offerings continue to increase, mobile stations will have to support an increasing number of PDP contexts with increasingly varied quality of service requirements. For instance, mobile users who have a real time audio, a web browser and an e-mail application running at the same time require support for all these applications with their appropriate QoS.

In the core network there are no particular restrictions for multiple, parallel data flows, but in the current GERAN those data flows are multiplexed into a single data flow (TBF) through the BSS and the radio protocol layers managed by the BSS (e.g. RLC/MAC).

To support multiple parallel data flows over the radio interface, a solution with multiple active TBFs for one user is needed. This will give BSS the ability to control the multiplexing of different TBFs on a radio block level.

5.2.2. Requirements and guidelines

5.2.2.1. Requirements

The following requirements for *multiple parallel data flows between BSS and MS* have been identified:

- Multiple TBF operation (i.e. parallel data flows to/from one MS) shall be supported through the introduction of new procedures that allow for multiple TBF scenarios beyond what can be supported in *A/Gb mode* today.
- Multiple TBFs shall be supported both in multi-slot and single-slot operation.
- Multiple TBFs shall be supported for uplink and for downlink data streams.
- Multiple TBFs shall be supported on PDTCHs.
- Each TBF supported by an MS shall be able to possess different QoS characteristics (i.e. a separate RLC instance must be provided for each TBF).
- Multiple TBF operation shall include support for packet transfer mode where one or more PS based applications are supported in parallel where any number of the PS based applications are provided with handover treatment.
- Both dynamic allocation and extended dynamic allocation shall be supported for multiple TBFs. Extended dynamic allocation is only required for a sub-set of MS multi-slot classes.

5.2.2.2. Guidelines

The following guidelines for *multiple parallel data flows between BSS and MS* have been identified:

- A cell that supports multiple TBF operation shall be capable of doing so with or without the presence of the PBCCH.

5.2.3. Relationship with other features

Relations with the following features are foreseen:

- Handover of PS services. This will involve the relocation of one or more TBFs when a cell change is necessary such that resources in the new cell are pre-allocated for the TBFs.
- Radio channel support for real time QoS. It shall be possible to support multiple TBF operation with the new channel combination required for real time QoS. Exact impacts are FFS.

NOTE: The exact impact of *multiple parallel data flows between BSS and MS* on *radio channel support for real time QoS* are for further study..

5.2.4. Description of the solution(s)

5.2.4.1. General description of the solution

5.2.4.1.1. General

- For packet transfer mode, TBFs subject to handover treatment shall be supported in order to accommodate PFC QoS requirements that call for minimal service interruption during cell change.
- When cell change is required during packet transfer mode, a TBF subject to handover shall be allocated resources for use in the new cell prior to cell change and shall be directed to the new cell via a handover command. In the same situation, a TBF not subject to handover shall be released and then re-established once the MS enters the new cell.
- Support for multiple TBF operation in any given cell may be indicated through broadcast information.

5.2.4.1.2. Multiplexing in GERAN-BSS

- Each TBF shall have a single corresponding RLC engine.
- Each RLC instance (i.e. each TBF) shall be associated with only one PFC (in order to use the PFI as an identifier at RLC/MAC level). This could lead to data from one LLC engine being split across multiple TBFs.
- Therefore, one TBF shall be limited to carrying information for one BSS packet flow context.
- TBFs managed using a legacy physical layer (i.e. FLOC is not used) shall adhere to the following MAC multiplexing related procedures:
  - One USF shall be allocated per timeslot allocated to an uplink TBF.
  - A single TFI shall be allocated for an uplink or downlink TBF regardless of how many timeslots the TBF may span.
  - Multiple TBFs shall be multiplexed on a radio block basis.
  - The BSS shall be responsible for scheduling each uplink TBF using USF values according to the restrictions of the number of timeslots allocated.
  - A multiple TBF capable MS shall be allowed to steal one or more radio blocks allocated to a specific uplink TBF in order to send user plane information associated with a different uplink TBF or control plane information.
  - The frequency with which radio blocks allocated to a specific uplink TBF may be stolen shall be limited.
- TBFs managed using a FLOC based physical layer need not adhere to legacy MAC multiplexing procedures.

NOTE: The exact description of the MAC multiplexing procedures when using a FLOC based physical layer is for further study.

- A TBF realised using multiple timeslots shall use the same physical layer format on each timeslot.

5.2.4.2. Impact on the protocol layers

NOTE: The protocol impact of the solution for *multiple parallel data flows between BSS and MS* is for further study.

5.2.4.3. Impact on the system elements

5.2.4.3.1. Impact on the terminal

The following impact has been identified on the MS:

- New procedures for establishment, re-establishment and release of multiple TBFs are needed.
- A new control protocol entity above RLC/MAC may be introduced to support TBFs that are subject to handover treatment.
- Support for multiple uplink and downlink RLC instances has to be introduced.
- Support for new MAC multiplexing procedures when a FLOC based physical layer is used on a PDTCH.

5.2.4.3.2. Impact on the RAN

The following impact has been identified on the GERAN:

- New procedures for establishment, re-establishment and release of multiple TBFs are needed.
- A new control protocol entity above RLC/MAC may be introduced to support TBFs that are subject to handover treatment.
- Support for multiple uplink and downlink RLC instances for any given MS has to be introduced.

- MAC multiplexing procedures and uplink/downlink scheduling of radio blocks to different TBFs belonging to one MS has to be introduced when a legacy physical layer is used on a PDTCH.
- MAC multiplexing procedures when a FLOC based physical layer is used on a PDTCH.

5.2.4.3.3. Impact on the CN

No impact is foreseen on the core network.

5.2.4.4. Impact on the standards

5.2.4.4.1. Affected specifications

Table 2 contains an estimation of the specification changes and work required for the standardisation of multiple TBF.

Table 2 – Standardisation impact for multiple TBF

Body	Specification	TSG / WG	Foreseen modifications	Work (months)
TSG GERAN	44.060	GERAN2	New RLC/MAC procedures for management of multiple TBFs	FFS
Other TSGs	23.060	SA2	Overview of the new procedures	FFS
	23.064 (see note)	SA2	Overview of the new procedures	FFS
Other bodies				

NOTE: Ericsson to check impact on 23.064 (see Annex A: Open issues).

5.2.4.4.2. Estimated standardisation time

NOTE: The estimated standardisation time of *multiple parallel data flows between BSS and MS* is for further study.

5.2.5. Open issues

Table 3 summarises the issues that remain open regarding *multiple parallel data flows between BSS and MS*. A collection of all the open issues is included in an annex to this document.

Table 3 – Open issues for *multiple parallel data flows between BSS and MS.*

No	Description	Companies	Priority[2]	Status/Comments
1	**Impact of 'Multiple TBFs' in 44.064** Should stage 2 description of the feature be described in this TS?	Ericsson	Low	**Open**
16	**Multiple TBFs in DTM** Should DTM mode be expanded to support the case where only one CS based application and one or more PS based applications are supported in parallel (i.e. where none of the PS based applications are provided handover treatment) assuming no changes to legacy DTM mode.		Low	**Open**
17	**Existing or new messages** Multiple TBF scenarios not supported using legacy mode control plane messages shall be accommodated by either defining new control plane messages or modifying legacy control plane messages.		High	**Open**
18	**Number of TBFs** A Multiple TBF capable MS shall support signalling for N uplink TBFs. A Multiple TBF capable MS shall support signalling for M downlink TBFs.		Medium	**Open**
19	**Number of LLC SAPIs** Should we expand the number of LLC SAPIs (only 8 of 16 are currently defined) to support multiple data flows?		Medium	**Open**
20	**PFI-LLC SAPI relationship** Should the specification introduce a limitation regarding the enforcement of a one to one relationship between PFI and LLC SAPI? (And how does this affect the CN impact of this solution?)		High	**Open**

5.3. Handover of PS services

5.3.1. Introduction

One of the key service enhancements required to allow *A/Gb mode* to satisfy better the QoS offerings associated with 3G systems is to reduce the amount of service interruption experienced when a cell change becomes necessary. Specifically, in order to support mobility of services of conversational and streaming QoS classes, the support of handover in the packet switched domain will be required.

The current status of investigations for support of handover via Gb as given in [AHAGB-006/ -015/ -016/ -025] does not yet allow to decide about the feasibility. Within these contributions possible solutions are outlined under certain working assumptions regarding the functional split between the GERAN and the CN to be able to identify open issues, the dependency to other features and the complexity when introducing a *Handover of PS services* in *A/Gb mode*. However, it became clear that due to the additional functionality which will possibly be required within the CN and due to identified open issues, further analysis is needed and other TSGs have to be involved into the discussions before a decision on the introduction of *Handover of PS services* in *A/Gb mode* can be made.

Two possible approaches have been identified so far, together with critical issues still to be solved.
The first approach (cf. to [AHAGB-006/ -015/ -016]) is based on the Relocation procedure, which is already available for *Iu mode* (GERAN and UTRAN), but it takes the different functional split in case of *A/Gb mode* into account, e.g. it assumes that data-duplication will be available within the SGSN. This approach is described in more detail below.

In contrast to this, the second approach assumes a data duplication function towards neighbouring BSS systems inside the BSS. Due to lack of time it is not yet worked out to the level of detail as the first solution. The reader is referred to [AHAGB-025] for more information.

Discussions have shown that both approaches have similar basic problems in common which have to be solved. Nevertheless, it is felt that the approach described in [AHAGB-025] should be analysed in more detail in the future in order to have a clearer view on alternative handover solutions (see 0).

After identifying the basic requirements and guidelines, a description of the first approach is given and the resulting impacts are listed. At this stage of progress the emphasis has been laid on the open issues still to be solved.

2 High, Medium or Low.

5.3.2. Requirements and guidelines

5.3.2.1. Requirements

The main service requirements for PS handover via an enhanced Gb interface are:

- the PS handover procedure shall take special needs of conversational and streaming QoS classes into account;
- the handover scenarios intra-BSS, inter BSS, inter-SGSN and inter-RAT handover (e.g. GERAN to UTRAN) shall be supported; and
- the maximum service interruption time shall be below 150 ms

To meet these service requirements, technical solutions have to fulfil the following requirements:

- a backward handover concept has to be applied (i.e. reservation of network resources in the new cell is performed before the mobile is ordered to the new cell); and
- during a transition phase, data duplication of downlink traffic towards the target cell has to be applied to reduce the period of downlink traffic interruption.

5.3.2.2. Guidelines

The technical solutions proposed make use of the following guidelines:

- the impact on existing Gb implementation should be minimised; in particular the functional split between MS, BSS and CN should be preserved as far as possible;
- the concept should re-use as far as possible the existing concept for handover (Relocation) in *Iu mode* (UTRAN and GERAN); and
- the concept should take the enhancements of the Gb interface into account, which will be required for the basic support of certain real-time QoS classes.

5.3.3. Relationship with other features

Relations with the following features are foreseen:

- *Multiple parallel data flows between BSS and MS* have to be supported to be able to differentiate between flows with different QoS attribute values. The support of this feature is a precondition.
- Enhanced Flow Control on Gb interface has to be supported to be able to differentiate between flows with different QoS attribute values. The support of this feature is a precondition.
- *Radio channel support for real time QoS*: the functions need to be introduced together.

NOTE: The relationship with enhanced DTM procedures is for further study (see 0 for more information).

NOTE: The relationship with Ciphering procedures is for further study (see 0 for more information).

NOTE: Other relationships might arise, if the support of the traffic class conversational requires further enhancements (possibly in SNDCP, LLC layers).

5.3.4. Description of the solution(s)

5.3.4.1. General description of the solution

According to the given requirements and guidelines for handover, the assumptions of the approach given in [??] are as follows.

Assumptions for the RAN:

- The evaluation of measurement reports and the handover decision is executed in the BSS.

- The controlling function for handover in the BSS is located in the RR protocol layer of the BSS.

<u>Assumptions for the CN</u>:

- Ciphering and compression for enhanced Gb is performed in the CN by LLC and SNDCP protocol layer (as is the case today).

NOTE: These assumptions might change in case optimisations are required due to the introduction of the traffic class conversational.

- The controlling part for the handover procedure in the CN is located in the GMM protocol layer of the SGSN.
- During a transition state of handover, data duplication of real time data is provided by the SGSN.

These working assumptions are derived from the guideline that the functional split between the MS, the BSS and the CN should be preserved as far as possible and allow to keep the existing protocol stacks for Gb unchanged (i.e. re-use of existing message formats is possible), although a considerable number of new functions are introduced and new messages on Um, Gb and Gn interface are required.

It should be noted that the involvement of the RR protocol layer is a completely new requirement for Gb and introduces a Layer 3 Control Plane for PS services via Gb similar as is required for PS services via Iu.

To use the GMM protocol layer in SGSN as controlling point for the handover procedure inside the CN introduces new functionality to the SGSN as, in contrast to *Iu mode*, no RAB concept is available for the PS domain in *A/Gb mode*. Iinteractions of Gb handover with mobility management functions as cell update and routing area update cannot be avoided, which is considered as a principle drawback compared to a 3G system.

NOTE: In a 3G system, handover/relocation and RAU are independent from each other; RAU –if necessary– just follows the relocation procedure.

Figure 1 to Figure 3 show the data flow in uplink and downlink direction during the different stages of the handover procedure in case of an Inter-SGSN handover:

Following evaluation of measurement reports of possible handover targets, the source BSS decides to trigger the Handover procedure for a certain MS. It informs the source SGSN, indicating the affected mobile and the target cell. The source-SGSN forwards the handover request together with the required data (e.g. target cell, MM/PDP context data) to the target-SGSN. Before informing the target BSS, the target SGSN stores MM/ PDP context data and allocates the required packet flow contexts. Because the routing area has changed (as it might happen also in the intra-SGSN handover case), a new P-TMSI and TLLI has to be allocated. This impacts a subsequent routing area update initiated by the MS. Upon receipt of the handover request, the target BSS allocates suitable radio resources and acknowledges the successful preparation of resources back to the target SGSN. The target SGSN allocates endpoints for the downlink GTP-tunnel and informs the source SGSN about the successful handover preparation. All necessary data from target BSS and target SGSN are provided to source SGSN, which transfers appropriate information to the source BSC. With the receipt of the message from the target SGSN, the source SGSN is able to set up the downlink GTP-tunnel towards target SGSN required for data duplication.

The status of the User Plane after this preparation phase is as shown in Figure 1.

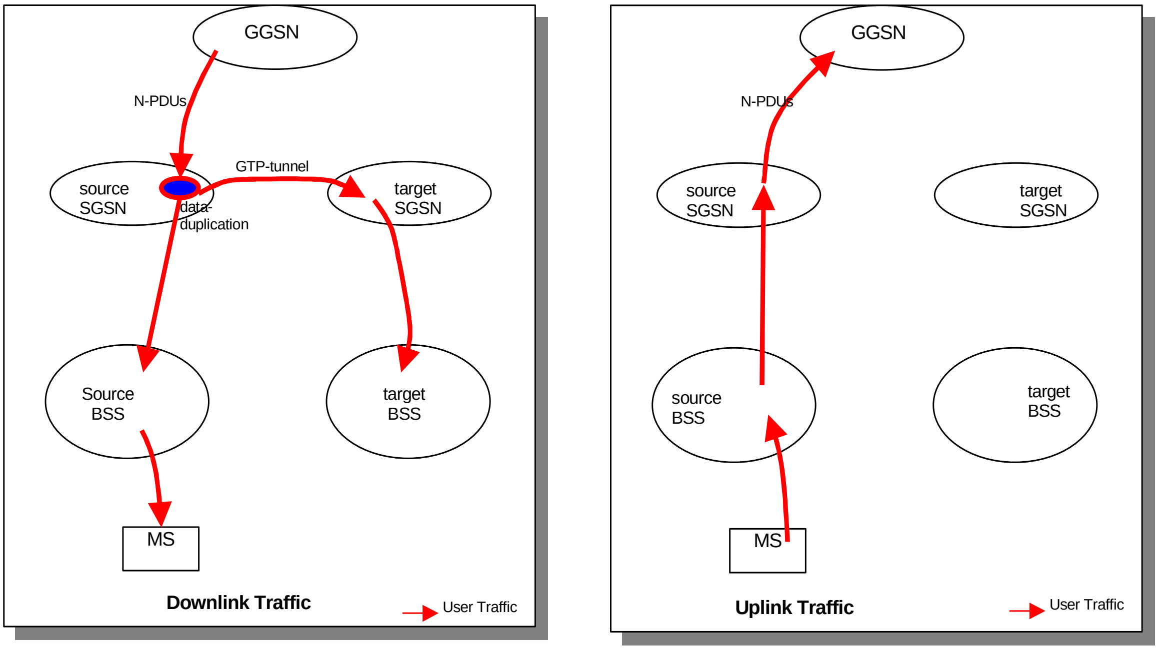


Figure 1: User Plane - Preparation of Inter-SGSN handover

During the next step of the Handover procedure, the source BSS commands the mobile to switch to the target cell by transmitting a HANDOVER COMMAND message to the MS. Parameters in the HANDOVER COMMAND message to the MS include e.g. information about the allocated radio resources in the target cell, allocated packet flow contexts and eventually ciphering and compression parameters to be used in the target cell.

Directly after the mobile has switched to the target cell, data can be transferred along the prepared user data path as indicated in Figure 2.

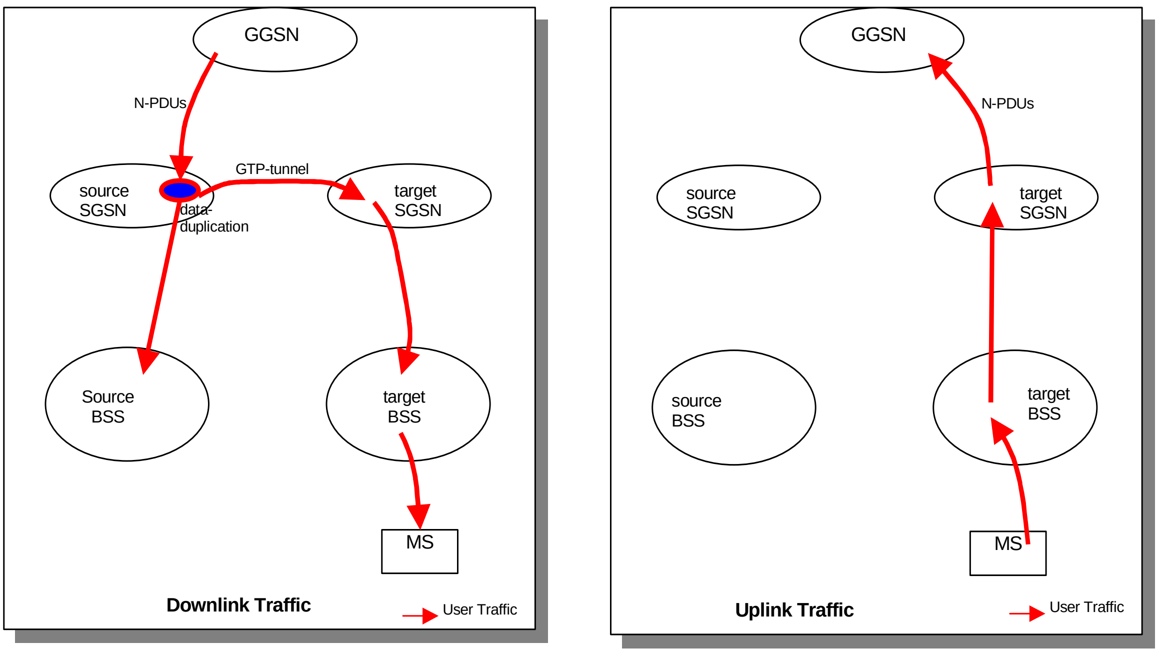


Figure 2: User Plane – Data flow after handover execution (MS moved to target cell)

The Handover procedure is completed by updating the GGSN and switching the downlink user data path from source- to target SGSN (Figure 3).

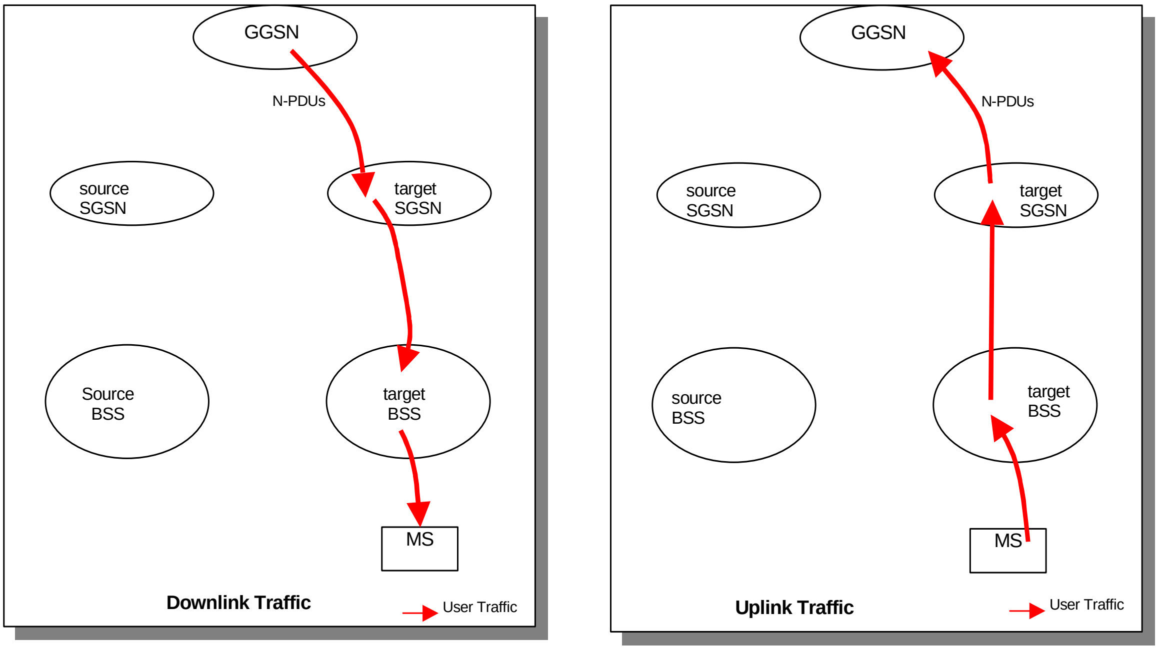


Figure 3: User Plane – Data flow after handover completion

The handling of an intra-SGSN/inter-BSS handover can be derived from the above description in a straightforward way.

NOTE: Further investigation is needed to decide if the concept is applicable also for the intra-BSS cases.

Analysis of a number of open points is still outstanding (see 0).

5.3.4.2. Impact on the protocol layers

The following table shows expected impacts on protocol layers **according to the current status of the analysis**. Note that only impacts which are specifically due to the Handover procedure are taken into account.

Table 4: Expected impacts on protocol layers due to handover for enhanced Gb (preliminary)

Protocol Layer	Impact MS	Impact BSS	Impact SGSN	Impact GGSN	Comments
PHY	impacted	impacted	---	---	Impacted due to new channel combinations to be supported
RLC/MAC	medium to high	medium to high	---	---	f.f.s. (Depends e.g. on chosen solution for Um signalling transfer)
RR	high	high	---	---	E.g. for control of radio resource allocation
BSSGP	---	medium to high	medium to high	---	Support of new handover messages
LLC	f.f.s.	---	f.f.s.	---	E.g. ciphering impact to be clarified (see 0)
SNDCP	f.f.s.	---	f.f.s.	---	E.g. impact of data duplication function and compression to be clarified (see 0)
GTP	---	---	impacted		Possibly new procedures /IEs to be transferred
GMM	impacted	---	high	---	New functionality for the control of the HO procedure, new handling for P_TMSI /TLLI,…
SM	f.f.s.	---	f.f.s.	---	

5.3.4.3. Impact on the system elements

5.3.4.3.1. Impact on the terminal

The following impact has been identified on the MS:

- Continuous measurement reporting for PS handover in packet transfer mode; mandatory support of NC2;
- Support for a new channel type;
- Support of a new handover message;
- Handling of the Routeing Area Update procedure on the radio interface without stopping the real-time data flow;
- TLLI/P-TMSI handling during PS handover; and
- Interworking between the setup of TBFs not subject to handover and those TBFs for which resources will be allocated in the new cell.

5.3.4.3.2. Impact on the RAN

The following impact has been identified on the GERAN:

- Handling of measurement reporting for PS handover; mandatory support of NC2;
- Initiation of the PS handover;
- Reservation of PS resources; controlled by Radio Resource Management;
- Support for new channel type (SACCH; TCH-like configuration is for further study);
- Support of new handover messages on the Gb and Um interfaces;
- Support of indication of which TBF is subject to handover;
- Identification of mobiles which are subject to handover;
- Coordination of Gb handover with CS domain (e.g. support of handover in DTM); and
- Interworking between the setup of TBFs not subject to handover and those TBFs for which resources will be allocated in the new cell.

NOTE: Further impacts may result from the open issue (see 0).

5.3.4.3.3. Impact on the CN

The following impact has been identified on the core network:

- New functionality required for handover with the assumed functional split of today's *A/Gb mode* (no RAB concept available as in *Iu mode*).
- Support of relocation of MM and PDP contexts.
- Support of the transfer of ciphering contexts.
- Establishment and update of GTP tunnels (packet duplication, update of GGSN).
- Support of data forwarding /data duplication mechanisms.
- Support of indication (explicit via flag or implicit by transfer of QoS attribute values to the BSS) of which TBF is subject to handover.
- Increase of test efforts due to additional handover and interworking scenarios.

NOTE: The impacts outlined in this section are related to the chosen function split between the GERAN and the CN and might change if modifications in the function split are required.

5.3.4.4. Impact on the standards

NOTE: At this stage it is unclear as to the exact amount of work required for each of the standards as further work is required to solve the open issues in the proposes solutions.

5.3.4.4.1. Affected specifications

Table 5 contains an estimation of the specification changes and work required for the standardisation of *handover of PS services*.

Table 5 – Standardisation impact for *handover of PS services*

Body	Specification	TSG / WG	Foreseen modifications	Work (months)
TSG GERAN	44.060	GERAN2	FFS; currently seen: Possible introduction/extension of RLC messages and procedures to support cell change/handover command and access in new target cell	FFS
	48.018	GERAN2	FFS; currently seen: Introduction of new BSSGP SAP and messages to support handover signalling	FFS
Other TSGs	23.060	SA2	FFS; currently seen: Change to Routeing Area Update and Relocation procedures for PS handover	FFS
	23.064 (see note)	SA2	FFS	FFS
	29.060	CN2	FFS; currently seen: New procedures / protocol extensions for the transfer of contexts required for PS HO in A/Gb mode	FFS
	44.064 (LLC)	CN1	FFS; currently seen: Possible impacts due to ciphering context transfer	FFS
	44.065 (SNDCP)	CN1	FFS; currently seen: Possible impacts due to packet forwarding / duplication	FFS
	24.008	CN1	FFS; currently seen: RAU handling, P-TMSI / TLLI allocation	FFS
Other bodies				

NOTE: Ericsson to check impact on 23.064 (see Annex A: Open issues).

5.3.4.4.2. Estimated standardisation time

The estimated standardisation time for this feature is high due to its complexity, the need to liase with other standardisation groups and the high impact on the terminal, RAN and CN.

This is initially estimated to be at least a full release.

5.3.5. Open issues

Table 6 summarises the issues that remain open regarding *handover of PS services*. A collection of all the open issues is included in an annex to this document.

Table 6 – Open issues for *handover of PS services.*

No	Description	Companies	Priority[3]	Status/Comments
2	**Impact of 'handover of PS services' in 44.064** Should stage 2 description of the feature be described in this TS?	Ericsson	Low	**Open**
9	**PS handover requirements** The speech/radio performance requirements for the handover of TBFs need to be formulated.		Medium	**Open**
11	**Handover and RAU** Interactions between the Handover and the Routeing Area Update procedures need to be studied.		High	**Open**
21	**Inclusion of other working groups in enhanced Gb discussions** Introduction of handover for the Gb interface impacts MS, BSS and CN. It may also impact the overall system behavior and should therefore be discussed with other working groups, e.g. SA2.		High	**Open**
22	**Consideration of alternative approach for handover** The solution proposed in [AHAGB-025] should be analysed more deeply to get a clearer view on available alternatives and the issues impacting their feasibility.		High	**Open**
23	**Service Interruption Time** The service interruption time, which can be achieved has to be estimated. It has to be verified that the requirement to stay below 150 msec can be met.		High	**Open**
24	**Handling of Ciphering** Security aspects (e.g. use different ciphering parameters on the new Gb-leg in t-SGSN) need further investigation. A new handling for the LLC has to be defined because the LLC is currently reset during the RAU procedure (Inter-SGSN case). This would possibly cause additional delay.		High	**Open**
25	**Handling of Compression** Transfer of compression contexts and negotiation mechanism between MS and network during handover have to be clarified. Results may introduce additional delay before data transfer can be resumed in the target cell.		High	**Open**
26	**Handling of Intra-BSS Handover** Intra-BSS handover case need to be studied in detail. Especially it has to be clarified if data duplication in SGSN may be applied for every cell change (impact on SGSN performance) and the interaction with the cell update procedure.		High	**Open**
27	**Impacts on overall system behaviour** A general difference between the Gb- and the Iu-mode is that in Iu-mode the CN has not to deal with cell level-mobility control. The consequences of maintaining the cell-level mobility in the CN when introducing the backward handover principle for the enhanced Gb mode as well and the corresponding impact on the overall system behaviour need to be studied in detail.		High	**Open**
28	**Coordination between handover and RAU** How to handle Routeing Area Updates whilst allowing the real-time user data to be transmitted and the impact on the MS functionality as well as on the SGSN functionality needs further investigation. In order to allow uplink data transfer in the target cell after handover with a minimum service interruption it appears to be necessary to allocate the new TLLI (t-TLLI) to the MS while it is still in the old cell. The consequence of this is a change in the RAU procedure. The MS has to store two TLLIs and implement new procedures. The CN must be able to split the functionality between allocation of P-TMSI/TLLI and updating of the HLR (new RAU procedure). This leads to considerable impact on the MS and CN and open issues such as; how to distinguish different sorts of RAU. Possible dependence to LAU (e.g. via combined LAU/RAU procedure) has to be investigated.		High	**Open**
29	**Signalling transfer for handover via Um interface** Mechanisms for signalling transfer across radio interface have		High	**Open**

[3] High, Medium or Low.

No	Description	Companies	Priority[3]	Status/Comments
	to be clarified. (e.g. RLC/MAC control messages or RR signalling message format, bandwidth requirements).			
30	**Interaction between handover and FLO** Clarify handover handling in case the impacted mobile uses FLO.		Medium	**Open**
31	**Handover message transfer BSSGP to GMM** Possibly the definition of a new SAP between BSSGP and GMM is required; the existing SAP GMM is currently used for messages originating from a GMM peer.		Low	**Open**
32	**Mobiles and TBF subject to handover** It has to be investigated how the BSS can decide which mobiles and which TBF's are subject to handover via enhanced Gb.		Low	**Open**
33	**Interaction between handover and an optimised LLC/SNDCP protocol handling (if required)** Use of optimised LLC/ SNDCP header might considerably impact handover, e.g. if the optimisation requires ciphering to be performed in BSS.		High	**Open**
34	**Handling of handover for mobiles in DTM state** Combined handover scenarios (ps&cs), especially required coordination between cs and ps domain need to be studied. (Note: currently in A/Gb mode the ps connection follows the cs handover decision in RAN).		Medium	**Open**
35	**Channel types to be supported by handover** Handover procedures will be impacted by the channel types to be handled. Clarify which channels types have to be considered (e.g PDTCH or TCH like channel ?. SDCCH ?).		Medium	**Open**

5.4. Radio channel support for real time QoS

5.4.1. Introduction

In order to support flows from the PS core network with a real-time QoS over the radio interface, the logical channels and the procedures used on the radio interface must ensure real-time treatment. Requirements characterising this real-time treatment are described below.

Currently there are two proposals for the *radio channel for support real time QoS*. Each proposal is captured in separate sub-clauses.

- The first proposal discusses the introduction of a new channel combination over the radio interface, a new possible Radio Resource management layer and corresponding new RLC/MAC functions.

- The second proposal consists in re-using the existing channel combinations for dedicated channels or leveraging on the new Flexible Layer One channel combinations while re-using the existing Radio Resource management layer and the existing DTM procedures.

It should be noted that there are variations from these proposals possible. Possible issues to discuss that could influence both solutions are listed in [AHAGB-010].

5.4.2. Requirements and guidelines

5.4.2.1. Requirements

The following requirements are placed on the *radio interface used for support of real time QoS* (e. g. conversational and streaming services):

- A radio channel that includes a signalling channel for continuous measurement reporting by the MS of neighbouring cells to the BSS shall be supported.

- The radio channel allocated for supporting a flow from the PS domain with real-time QoS shall make it possible for the BSS to provide a guaranteed bit-rate.

- It shall be possible to offer radio channel support for both generic and optimised realisation of Conversational and Streaming services.

- It shall be possible to perform intra-cell or inter-cell handovers of the radio channel supporting a flow with real-time QoS.

5.4.2.2. Guidelines

NOTE: The guidelines for *radio channel support for real time QoS* are for further study.

5.4.3. Relationship with other features

The introduction of radio channel support for real time QoS need to be coordinated with the following features:

- *Multiple parallel data flows between BSS and MS*. It shall be possible to support this channel combination together with multiple flows. Exact impacts are FFS.
- *Handover of PS services*. This feature is completely linked to the PS handover support feature and as such these two features shall not be considered separately.
- *Protocol aspects of unequal Error Protection*. The allocation of radio channels supporting real-time flows from the PS domain needs to be aligned with the protocol aspects of UEP.
- *DTM enhancements*.

5.4.4. Description of the solution(s)

5.4.4.1. Solution one

5.4.4.1.1. General description of the solution

In order to carry measurement data it is proposed to introduce Slow Associated Control CHannel (SACCH) to be used for MS on shared or dedicated channels. The SACCH will either replace the PTCCH in the 52-multiframe structure or use the idle frame. This will make it possible for a shared PDTCH to either support two MS using SACCH or one MS using SACCH together with multiple MS using the PTCCH (including legacy MSs). The SACCH will use LAPDm as a layer 2 protocol. For more detailed description see [AHAGB-014].

For MSs using FLO or other RLC/MAC enhancement the assumption is that the MSs are alone on the same physical timeslot (e.g. dedicated channel).

The requirements for supporting dedicated channels depend primarily upon:

a) whether conversational/streaming services requiring unequal error protection (UEP) are to be supported; and

b) whether FLO is to be introduced.

The type of dedicated channel use will also depend on these questions. Figure 4 shows the types of dedicated channels needed in each of these cases.

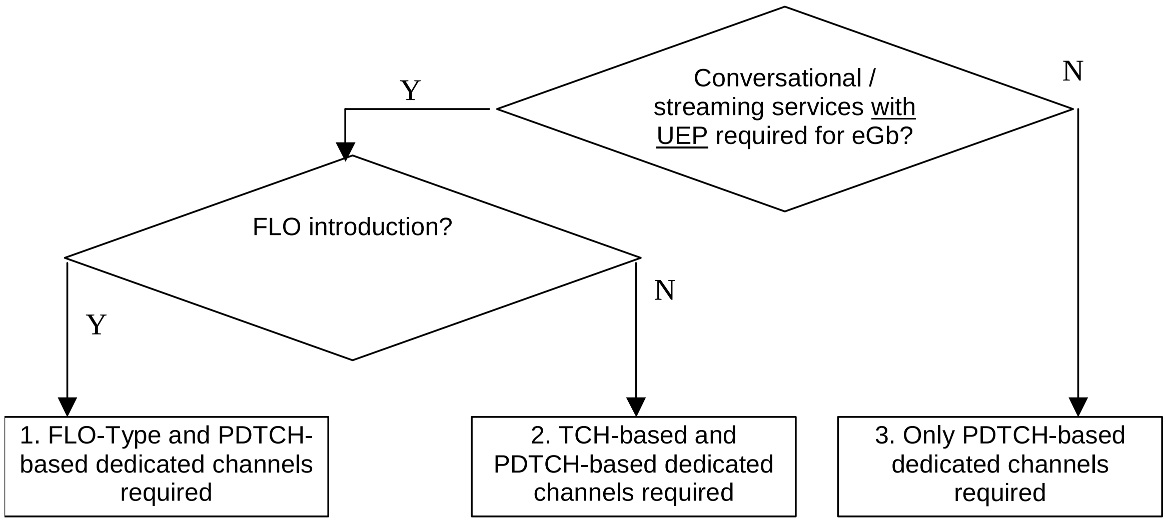


Figure 4: Dedicated channel requirements

A PDTCH-based DBPSCH could be implemented in *A/Gb mode* as a special type of shared channel where just one MS with multiple TBFs is allowed to use the channel and where the TBFs are not automatically released when no data packets have been sent for some time. This type of channel would be sufficient for case 3 above.

The main differences between this type of DBPSCH and the GERAN *Iu mode* DBPSCH are concerning radio resource reservation, scheduling and signalling (including measurement reporting); see TDoc AHAGB-010.

For tasks such as connection set-up / release, handover, measurement reports, etc, a controlling protocol entity is needed. Three alternative locations of this functionality have been considered:

1) In a separate 'Gb-RRC' entity (similar to 3GPP TS 44.118) together with a RANAP-like protocol towards CN,

2) In an RRM entity (see 3GPP TS 44.018) with 'enhanced Gb' enhancements,

3) In the RLC/MAC layer (see 3GPP TS 44.060)

NOTE: It is for further study which solution should be used. Different solutions are discussed in TDoc AHAGB-010.

5.4.4.1.2. Impact on the protocol layers

The introduction of this channel will have impacts on the following protocol layers:

- **PHY**. New channel combination is introduced. Possible impacts to power control and time alignment.

- **RLC/MAC**. The behaviour of RLC/MAC control functions will be different when the MS has been assigned this channel. In principle some RLC/MAC control functions are no longer needed (for instance Packet Cell Change Order). These limitations shall be covered in the section for the feature *Handover of PS Services*.

5.4.4.1.3. Impact on the system elements

5.4.4.1.3.1. Impact on the terminal

- Terminals need to support a new channel combination as well as use the SACCH channel when providing service of the Gb interface.

- Possible impacts to power control and time alignment.

- A new protocol entity is needed for tasks like connection set-up / release, handover, measurement reports etc. This impact is also related to PS handover in general.

- Possible modifications to RLC/MAC

5.4.4.1.3.2. Impact on the RAN

- The RAN needs to support a new channel combination as well as use the SACCH channel when providing service of the Gb interface.
- Possible impacts to power control and time alignment.
- New protocol entity need for tasks like connection set-up / release, handover, measurement reports etc. This impact is also related to PS Handover in general.
- Possible modifications to RLC/MAC.

5.4.4.1.3.3. Impact on the CN

No impacts on the CN have been identified.

5.4.4.1.4. Impact on the standards

5.4.4.1.4.1. Affected specifications

Table 7 contains an estimation of the specification changes and work required for the standardisation of *radio channel support for real time QoS.*

Table 7 – Standardisation impact for *radio channel support for real time QoS*

Body	Specification	TSG / WG	Foreseen modifications	Work (months)
TSG GERAN	(L1 specs)	WG1	FFS	FFS
	44.060	WG2	RLC/MAC modification	FFS
Other TSGs				
Other bodies				

NOTE: The impact of solution 1 for *radio channel support for real time QoS* on the standards is for further study.

5.4.4.1.4.2. Estimated standardisation time

NOTE: The estimated standardisation time of solution 1 for *radio channel support for real time QoS* is for further study.

5.4.4.2. Solution two

5.4.4.2.1. General description of the solution

Another solution consists in introducing a new relay function in the BSS:

- in the user plane, the new relay function consists in decapsulating the real-time LLC PDUs from BSSGP PDUs and encapsulating them onto the Abis interface framing protocol for sending over dedicated channels in the downlink (inverse operation in the uplink);
- in the control plane, the existing RR management layer, making use of LAPDm, is proposed to be used for assigning, handover, modification and release of the dedicated channel(s) used for the real-time flow. The relay function couples signalling on the radio interface carried over the RR layer with signalling on the Gb interface carried over the BSSGP layer. The existing GTTP protocol can be used for transport of NAS signalling.

It is believed that support of conversational services requires UEP on the radio interface. The support of streaming services can be achieved through a TBF on shared channels since such a service is more tolerant to transfer delays. The support of conversational and streaming services in a synchronised manner requires, according to this solution, the support of several dedicated channels in parallel. For the support of UEP on the radio interface, two solutions are possible:

1) reuse of the existing TCH channels: this requires header removal in the SGSN, which does not work in case of synchronised flows; and

2) support of a Flexible Layer One for configuring TCH layer 1 parameters according to the required QoS parameters for the real-time flow. This is certainly a much more future-proof solution.

For a more detailed description of the solution, see TDoc AHAGB-023.

Support of real-time services coming from the PS domain is proposed through the following functions:

1) Support of the IMS Core Network architecture and protocols as defined in Rel-5: the work is being completed and no impact is anticipated since IMS services are supposed to be radio access independent.

2) Support of the Packet Flow Context procedure to negotiate R99 QoS parameters with the SGSN upon PDP context activation/modification: this function already exists.

3) When a PFC is created/modified for a real-time flow, the unit triggers the set-up/modification of a dedicated channel: new function in the BSS but very limited impact on the radio access network, Abis and radio interfaces.

4) The real-time PDUs received/sent on the Gb interface are transported over the radio interface through dedicated channels: new function in the BSS + support of header removal in the SGSN (then PDUs can be mapped on existing TCH channels) or header compression in the SGSN and a flexible layer one in the GERAN.

5) Support of relocation of the Gb link (from BSS A-SGSN A to BSS B-SGSN A/B) when the MS moves to a cell controlled by a different BSS and there is an on-going real-time session through the Gb interface: new function; non-negligible impact expected on the SGSN.

6) When a handover is required on the radio interface, the existing procedures and mechanisms defined on dedicated channels are used from a radio standpoint; the only difference is that the MSC is not informed; instead, the unit connected to the Gb interface is informed and ensures the relocation of the Gb link if necessary: new function in the BSS but no impact on the radio access network.

If we consider the scenarios of a Mobile Originated call and of a Mobile Terminated Call through the PS domain, one step will be the set-up of a dedicated channel upon PFC creation. The IMS 3GPP specifications (3GPP TS 23.228 and 3GPP TS 24.228) define the various call set-up flows (Mobile Origination and Mobile Termination, UE in the home network or UE in a visited network). In all scenarios, the important step for this section is the “resource reservation”. In the case of an MO session set-up, this happens between the sending of the “Final SDP” and “Resource Reservation Successful” messages. In the case of an MT session set-up, this happens after the Final SDP has been received from the calling party.

Note that the SIP client operating in GERAN *A/Gb mode* will need to know the radio access capabilities of its serving BTS prior to media flow characteristics negotiation at SIP level. To this avail, a solution similar to the one retained in the technical report on optimised voice could be used whereby the BSS makes known its capabilities to the MS at the time of or before the PDP context activation for SIP signalling.

It is assumed that the PDP context for SIP signalling is established and that the MS is in packet idle mode when performing resource reservation (if a TBF is ongoing, then the first TBF set-up is skipped). The following flow diagram illustrates the various steps proposed by this solution.

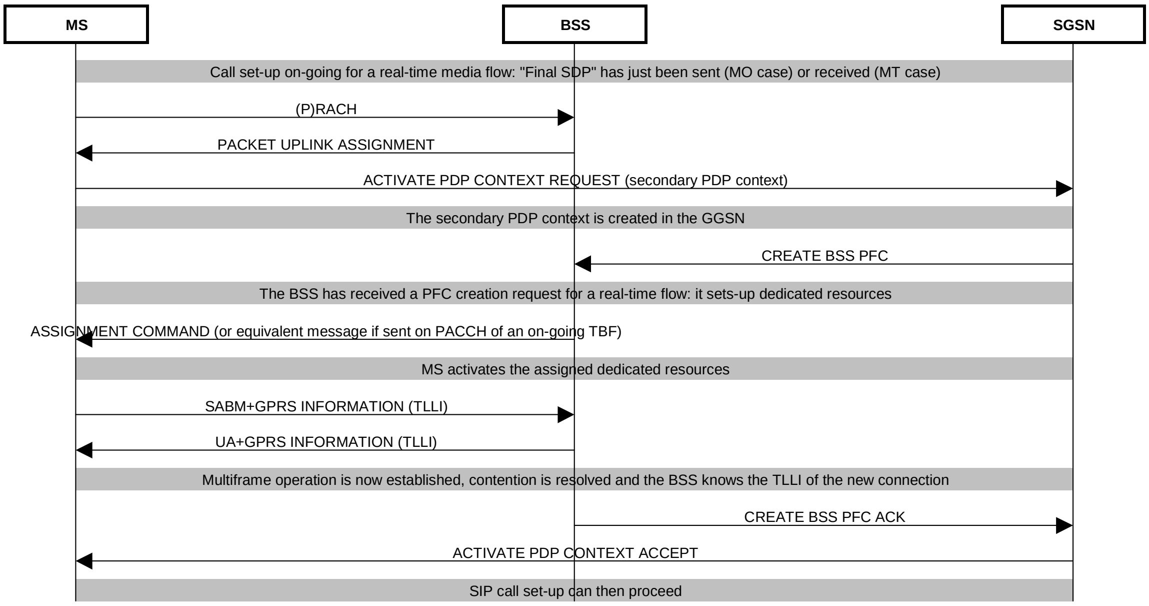


Figure 5: Flow diagram for this solution.

1) The MS triggers a secondary PDP context activation for the media flow, the QoS parameters of which have been negotiated at SIP level. For this purpose, the MS requests an uplink TBF on shared channels.

2) When the SGSN receives the ACTIVATE PDP CONTEXT REQUEST message from the MS, it creates the PDP context in the GGSN and then sends a CREATE BSS PFC message on the Gb interface, in order to ask the BSS to reserve the necessary radio resources for the real-time media flow.

   The requested QoS indicates real-time characteristics. The proposal is to allow the BSS allocating dedicated resources, possibly using flexible layer one allocation protocols. It can be noted that the MS is necessarily in the GMM READY state state since an uplink LLC PDU has just been sent, containing the ACTIVATE PDP CONTEXT REQUEST message. The BSS assigns the dedicated resources through a new message sent on the common control channels (MS in packet idle mode, ASSIGNMENT COMMAND message could be reused) or on the PACCH of an on-going TBF (MS in packet transfer mode). The MS then activates the new resources (possibly switching to RR Dual Transfer Mode, if one or more TBF(s) were ongoing, and enhancements to DTM are brought) and establishes the layer 2 signalling link. The MS then sends the GPRS INFORMATION message containing the TLLI, which is forwarded to the BSS.

3) The BSS then acknowledges the PFC creation to the SGSN. Note that in case the BSS could not assign dedicated resources meeting the requested QoS, it can first try to negotiate the QoS parameters, and if the negotiation is successful, it would then perform the dedicated channel set-up.

4) The PDP context activation is then completed (through the set-up of a TBF, or using the GPRS INFORMATION message, or using an on-going TBF if still running).

5) The call set-up can then be completed at SIP level.

During the real-time flow, measurement reports are sent from the MS to the BSS through the existing SACCH. Based on those reports, the BSS can perform handovers, using existing mechanisms. When a handover decision is taken, the radio link can be relocated as today; the Gb link may also need to be relocated. DTM procedures can be re-used if one or more TBFs are required to be set-up in parallel to the real-time flow.

5.4.4.2.2. Impact on the protocol layers

- **Physical layer**: introduction of a flexible layer one.

- **LAPDm**: no impact.

- **RLC/MAC**: new dedicated channel assignment message (usable on PCCCH or PACCH).

- **RR**: new dedicated channel assignment message for the case of an MS camping on CCCH (existing ASSIGNMENT COMMAND message could be reused; PFI will need to be included) + support of flexible layer one assignment/handover protocol.
- **Upper layers**: no impact.
- **Gb interface**: no impact.
- **BSSGP**: no impact (open issue: mapping of PDP contexts over Packet Flow Contexts; interworking with LLC SAPIs).

5.4.4.2.3. Impact on the system elements

5.4.4.2.3.1. Impact on the terminal

Apart from the new dedicated assignment message, no impact is anticipated on top of the support of a flexible layer one (and possibly UEP protocols if MS is impacted). Of course, the terminal has to support IMS and the SIP layer needs an interface to the Session Management layer.

5.4.4.2.3.2. Impact on the RAN

A new function is required in the BSC to be able to:

- Route packets received/sent from/to the SGSN to/from dedicated channels. Basically this requires a user-plane between the unit connected to Gb and the unit connected to the A interface.
- Set-up/modify dedicated resources upon PFC creation/modification for real-time services using flexible layer one protocols and physical layer.
- Reserve some bandwidth on the Gb interface if based on frame relay.

NOTE: If the Gb interface is based on IP, it is for further study what enhancements are required to be able to support real-time flows.

It is assumed that the BSS supports DTM procedures, PFC procedures and R99 QoS handling. It should be noted that the transcoding function is no longer needed in the RAN; only the multirate codec mode control is left.

5.4.4.2.3.3. Impact on the CN

As such, there is no impact in the CN when it comes to the radio support of real-time QoS. Considering the network support, the SGSN will be required to support Gb link relocation procedures (for further study) and it is a pre-requisite that it supports PFC procedures. Also, support of UEP is probably a must in order to achieve a decent quality of service.

5.4.4.2.4. Impact on the standards

5.4.4.2.4.1. Affected specifications

Table 7 contains an estimation of the specification changes and work required for the standardisation of *radio channel support for real time QoS*. Apart from the specification of a flexible layer one, the effort seems very limited since this solution relies on an internal BSC relay function, which cannot be standardised.

Table 8 – Standardisation impact for *radio channel support for real time QoS*

Body	Specification	TSG / WG	Foreseen modifications	Work (months)
TSG GERAN	44.018	GERAN2	Introduction of the new assignment message when the BSS has to assign dedicated resources via the CCCH (FFS if ASSIGNMENT COMMAND message can be reused). Definition of the dedicated channel set-up procedures when such an assignment is received (the GPRS INFORMATION message is proposed to be used). A priori no impact on handover (the PFI may need to be added; also, depending on what enhancements are brought to security mechanisms, an HFN may be introduced and special handling will be required upon handover). Introduction of a means to make known to a SIP agent what are the codec capabilities of the local BSS. Support of FLO protocols.	
	45 series	GERAN1	Support of flexible layer one	
	48.018	GERAN2	Clarification that upon PFC creation/modification for a real-time flow, dedicated resources can be assigned.	
	48.058	GERAN2	Impact likely if new dedicated assignment message/paging field is introduced	
Other TSGs	23.060	SA2	Description of the IMS support in GERAN *A/Gb mode*.	
Other bodies				

5.4.4.2.4.2. Estimated standardisation time

NOTE: The estimated standardisation time of solution 2 for *radio channel support for real time QoS* is for further study.

5.4.5. Open issues

Table 9 summarises the issues that remain open regarding *radio channel support for real time QoS*. A collection of all the open issues is included in an annex to this document.

Table 9 – Open issues for *radio channel support for real time QoS.*

No	Description	Companies	Priority[4]	Status/Comments
12	**Dedicated channels** It is for further study whether or not dedicated channels are needed.		Medium	**Open**
36	**Relation to RLC/MAC and multiple TBFs** It is for further study how radio channel will work together with general RLC/MAC functions as well as the support for Multiple TBFs.		Medium	**Open**
37	**Relation to FLO** It is for further study how the channel combination in solution one would work together with FLO.		Medium	**Open**
38	**Control entity** It is for further study where the control entity is located and which tasks it handles (e.g. connection set-up / release, handover, measurement reports etc); see TDoc AHAGB-010.		High	**Open**
39	**Solution 1: Layer 2** It is for further study whether RLC/MAC or LADPm is used as Layer 2 protocol for solution 1.		Medium	**Open**

5.5. DTM ENHANCEMENTS

5.5.1. Introduction

Dual Transfer Mode (DTM) was defined in the Release 99 standards as a solution to provide simultaneous CS and PS services to the same terminal. This solution is based on the network co-ordination of all the radio resources (CS and PS) allocated to the terminal. The network ensures that the assigned resources are compatible with the multislot capabilities of the terminal, thus not requiring simultaneous operation in two different frequencies.

DTM was enhanced in Release 4 to define additional multislot classes.

In general, DTM offers the same QoS for each of the domains as when those services are serviced on their own. Some exceptions may be:

- PS data rates in DTM may be lower than in packet transfer mode;
- Interruption of the PS service may be shorterat cell change in DTM than in packet transfer mode.

A number of optimisations for the PS domain were considered during the standardisation of DTM, although they were not pursued since they would only apply when there is a CS call in parallel and not, typically most of the time, in packet transfer mode. This may change with the introduction of the *handover of PS services* feature.These and other possible enhancements to DTM are considered in this sub-clause.

5.5.2. Requirements and guidelines

5.5.2.1. Requirements

NOTE: The requirements for *DTM enhancements* are for further study.

5.5.2.2. Guidelines

The following guidelines have been identified:

- Improvements of the simultaneous handling of CS and PS services should be based on the existing DTM functionality (see 3GPP TS 43.055 [6]).
- Enhancements to CS operation while in DTM should be aligned to the QoS offered in dedicated mode.
- Enhancements to PS operation while in DTM should be aligned to the QoS offered in packet transfer mode.
- If provided for GPRS in packet transfer mode, multiple TBFs should also be provided while in DTM.

4 High, Medium or Low.

5.5.3. Relationship with other features

The enhancements to DTM here described are related to the following features also contained in this document:

- *Multiple parallel data flows between BSS and MS*: this feature is not needed for DTM operation only; if this feature is defined for packet transfer mode, it should also apply in DTM.
- *Handover of PS services*: this feature is not needed for DTM operation only; if this feature is defined for packet transfer mode, it should also apply in DTM.

5.5.4. Description of the solution(s)

5.5.4.1. General description of the solution

5.5.4.1.1. General

The following enhancements to DTM are outlined in this paper:

1) Multiple TBFs while in DTM.

2) Reduction of PS interruption during the Handover procedure.

3) Direct transition between packet transfer mode and DTM.

NOTE: It is for further study whether there are any requirements to increase the number of dedicated channels to be supported while in DTM, which is currently of one (see open issues in sub-clause 0).

5.5.4.1.2. Multiple TBFs while in DTM

In the current definition of DTM operation, as for normal GPRS operation, there is a current limit of one TBF per direction. Multiple TBFs may also be provided while in DTM in order to be able to continue to support multiple PS services in parallel when e.g. a voice call is established.

NOTE: The impacts of this enhancement are treated together with the general support of *multiple parallel data flows between BSS and MS* (see sub-clause 5.2) and are not described in this sub-clause.

5.5.4.1.3. Reduction of PS interruption during the Handover procedure

In the current definition of DTM operation, upon a handover while in DTM, only resources for the CS service are allocated in the HANDOVER COMMAND message. The TBFs are re-established once the Handover procedure has been completed. This release and re-establishment may lead to PS service interruption times, which may be reduced by the allocation of radio resources for the TBF in the HANDOVER COMMAND message.

NOTE: The impacts of this enhancement are treated together with the general support of *handover of PS services* (see sub-clause 5.3) and are not described in this sub-clause.

NOTE: It is for further study whether the handover of TBFs is necessary in conjunction with the handover of an RR connection (see open issues in sub-clause 0).

5.5.4.1.4. Direct transition between packet transfer mode and DTM

5.5.4.1.4.1. General

In the current definition of DTM operation, the resources for the PS service are released and re-established afterwards upon:

- While in packet transfer mode, upon the establishment of a CS service (e.g. MO/MT voice call). This can be enhanced by allowing to set-up the call while keeping the TBF.
- While in DTM, upon the release of the CS service. This can be enhanced by allowing the MS to keep the TBF while the dedicated resources are released.

These enhancements equate to two new transitions between the different RR modes of operation (see 3GPP TS 43.064 [10]), as depicted in Figure 6.

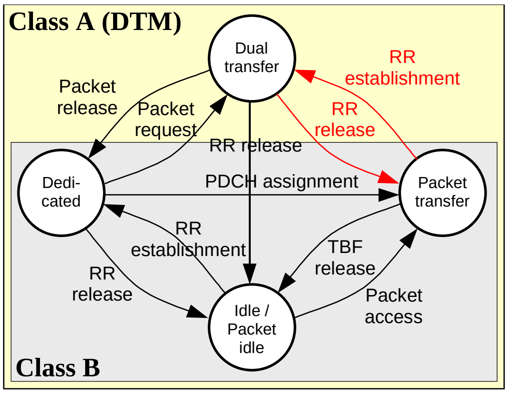


Figure 6: New transitions between RR operating modes in DTM.

NOTE: It is for further study whether the interruption of the PS services during the mentioned transitions needs to be reduced further (see open issues in sub-clause 0).

5.5.4.1.4.2. Transition from packet transfer mode to DTM

Since the MS can already be notified of an incoming CS call while in packet transfer mode, the mentioned enhancement needs of:

- a message doing the functions of the CHANNEL REQUEST message (e.g. the DTM REQUEST message) sent on the PACCH/U; and
- the DTM ASSIGNMENT COMMAND message on the PACCH/D.

This is depicted in Figure 7.

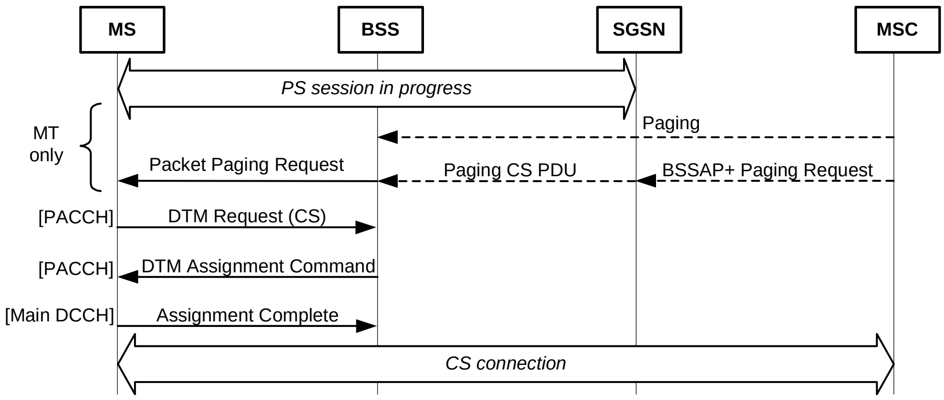


Figure 7: Establishment of a CS connection while in packet transfer mode without interruption of the packet session.

5.5.4.1.4.3. Transition from packet transfer mode to DTM

While in DTM, upon the release of the CS service, the MS may continue to be allowed to use the resources allocated to the TBF(s). In this scenario, the MS needs to be provided with the necessary information to continue operating in packet transfer mode. This information may be contained in existing (e.g. PSI 14) and/or new PSI messages.

NOTE: If, after the release of the CS connection, the remaining PS resources need to be modified, existing procedures can be used.

NOTE: It is for further study whether additional information to that in the PSI 14 message needs to be provided to the MS when releasing the CS connection while in DTM.

5.5.4.2. Impact on the protocol layers

The following impacts have been identified:

- **RLC/MAC**: new procedure (exchange of two messages on the PACCH) to set up the CS resource without releasing the TBF(s).
- **RR**: increased co-ordination between CS and PS domain is required.

5.5.4.3. Impact on the system elements

5.5.4.3.1. Impact on the terminal

A terminal supporting DTM would need to be enhanced to support an additional procedure to set up and release the CS resource without releasing the existing TBF(s).

5.5.4.3.2. Impact on the RAN

A BSS supporting DTM would need to be enhanced to support an additional procedure to set up and release the CS resource without releasing the existing TBF(s).

5.5.4.3.3. Impact on the CN

The enhancements to DTM described in this sub-clause do not impact the CN.

5.5.4.4. Impact on the standards

5.5.4.4.1. Affected specifications

Table 10 contains an estimation of the specification changes and work required for the standardisation of *DTM enhancements*.

Table 10 – Standardisation impact for *DTM enhancements*

Body	Specification	TSG / WG	Foreseen modifications	Work (months)
TSG GERAN	43.055	GERAN	General description of the enhancements	1
	43.064	GERAN	General description of the enhancements	1
	44.060	GERAN2	New procedure to set up the CS resource without releasing the TBF(s)	6
Other TSGs				
Other bodies				

5.5.4.4.2. Estimated standardisation time

The estimated standardisation time of *DTM enhancements* is 6 months.

5.5.5. Open issues

Table 11 summarises the issues that remain open regarding *DTM enhancements*. A collection of all the open issues is included in an annex to this document.

Table 11 – Open issues for *DTM enhancements.*

No	Description	Companies	Priority[5]	Status/Comments
6	**DTM handover** It is not clear whether or not there is a requirement for the evolved GERAN *A/Gb mode* to offer simultaneous handover of CS and PS resources. There are two actions to be solved: • Manufacturers to investigate the PS interruption time at handover while in DTM. • Once the previous point is cleared, operators to investigate whether such interruption is enough for PS services that may happen in parallel with a CS connection.		High	**Open**
40	**Multiple dedicated channels in DTM** Should it be possible to have more than one dedicated channel while in dual transfer mode (i.e. while one —or more (FFS)— TBFs are allocated to the same MS?		High	**Open**
41	**Direct transitions: packet transfer mode ↔ DTM** • Manufacturers to investigate the PS interruption time during these two transitions. • Once the previous point is cleared, operators to investigate whether such interruption is enough for PS services that may happen in parallel with a CS connection.		Medium	**Open** These transitions are visible to the end user.
42	**Information needed at DTM → packet transfer mode** In addition to PSI 14, is there any information that needs to be provided to the MS when releasing the CS connection while in DTM?		Low	**Open**

5.6. Network transport aspects for the support of real time QoS

5.6.1. Introduction

The introduction of real-time packet based services to the Gb interface means that a mixture of non-real time and real packets must be handled at the same time. This implies the requirement for packet prioritisation and scheduling at every node concerned with the transport of packets on the Gb interface, including the BSC, the SGSN and any intervening switch/router.

Both delay and delay jitter must be minimised for the real-time packet flows. A solution should be found to handle both low bandwidth (e.g. n*64 kbit/s where n is 1 or 2) and high bandwidth (e.g. E1/T1 or above) Gb interfaces.

5.6.2. Requirements and guidelines

5.6.2.1. Requirements

The following requirements have been identified:

- The delay jitter shall be minimised on the Gb interface in order to meet the QoS requirements for real-time traffic flows.

5.6.2.2. Guidelines

The following guidelines have been identified:

- The chosen solution should minimise the impact on the existing functionality.

5.6.3. Relationship with other features

There are no relationships with other features identified so far.

---

[5] High, Medium or Low.

5.6.4. Description of the solution(s)

5.6.4.1. General description of the solution

In order to meet the delay and delay jitter requirements for real-time QoS it is necessary to prioritise these traffic streams over non real-time traffic at all multiplexing points in the network path for the Gb interface. This applies to end-points (BSC and the SGSN) as well as intermediate routers/switches.

At the termination points and at each intermediate node in a path all traffic must be classified, placed in a prioritised queue and scheduled for transmission. For a non real-time service it is necessary only to buffer the classified packets and transmit them in order of relative priority as defined by the algorithm implemented in the scheduler (e.g. Round Robin, Weighted Round Robin, Weighted Fair Queuing, etc.). The scheduler is concerned only with the relative priority of packets and not their relative length. This process is illustrated in the top diagram of Figure 8.

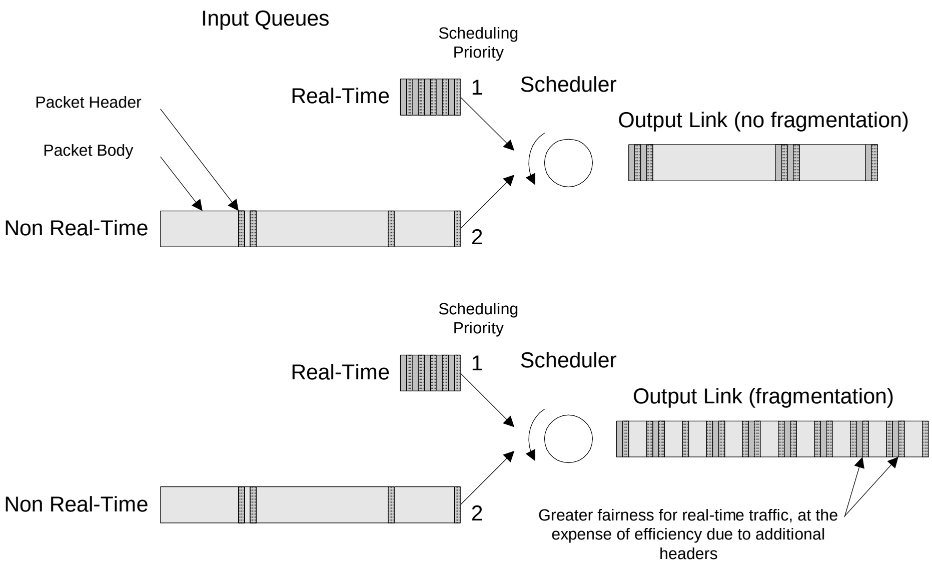


Figure 8: Packet Prioritisation, Scheduling and Fragmentation

Support for real-time services is more complex, as they have stringent delay and delay variation requirements. Simple priority scheduling is generally insufficient as the scheduling of a “long” low priority packet may block the transmission of subsequent higher priority real-time packets i.e. Head of Line Blocking. This can be a significant problem when real-time and non real-time flows are multiplexed over relatively low bandwidth links. Data services will tend to use maximal length packets (~1500 octets) to optimise transmission efficiency whilst real-time services will use relatively short packets (~40 octets) to minimise packetisation delay. Therefore the non real-time data may introduce unacceptable inter-arrival jitter on the real-time service when the bandwidth of the link is low. For example a 1500 octet packet on a 64 kbit/s link will take ~188 ms to transmit. Two main techniques exist for preserving real-time QoS under these conditions:

- Ensuring that the link speed is significantly (i.e. several orders of magnitude) greater than the channels multiplexed over it, so minimising the buffer time within the scheduler.

- If the link or channel speed is comparable to that of the transported data then “long” non real-time packets must be broken into smaller fragments, which may be scheduled individually. In this way real-time packets can pre-empt “long” non real-time data ahead of them in the queue.

The use of fragmentation is shown in the lower diagram of Figure 8. In this case it can be seen that the inter-arrival jitter for the real-time packets has been reduced. Fragmentation has some drawbacks associated with it. Firstly it requires an increase in bandwidth on the link, as a routing header must be added to each fragment on the link. Secondly it requires increased processing in the nodes that perform the segmentation and re-assembly as this must be applied to all traffic on the link regardless of how much is conversational/streaming.

Fragmentation may be implemented either end-to-end or at the head ends of low bandwidth links. In the case of end-to-end fragmentation the intermediate nodes do not need to implement fragmentation support, as they forward fragmented and unfragmented packets in the same way (intermediate node bandwidth is assumed to be high). It therefore appears most efficient to implement any necessary fragmentation support within the BSS and SGSN, in combination with the necessary classification and scheduling algorithms.

Gb over Frame Relay interfaces may chose to apply fragmentation at the frame relay layer. Frame relay is capable of supporting real-time services, however, this requires the further implementation of Frame Relay fragmentation, as defined in FRF.12. These specifications do not form part of the UNI specification for the current Gb interface FRF.1.1, so it seems likely that much existing Frame Relay infrastructure will need to be upgraded to support FRF.12 if this approach is taken.

GboIP implementations are dependent upon the supporting transport layer to implement prioritisation and scheduling for QoS features. The underlying bearer (e.g. Frame Relay, ATM, MPLS, Ethernet etc.) must be capable of supporting the QoS prioritisation and scheduling requirements of the real-time service. However, the IP bearer must also be capable of supporting these features: prioritisation, scheduling and fragmentation. It should be noted that fragmentation must happen at the IP layer or above, where the initial transmit scheduling takes place. Fragmentation could be carried out in the SNDCP layer which already supports segmentation and re-assembly but this would impose some increased performance requirements on the terminal.

It is currently not clear as to which protocol layer should be utilised to support the segmentation and re-assembly function. The maximum fragment size can be negotiated via XID negotiation in SNDCP. In the case of IP it can be set-up administratively or via MTU discovery.

5.6.4.2. Impact on the protocol layers

The impact on the protocol layers is not completely clear as it depends at which layer segmentation and re-assembly is to be applied.

If the existing SNDCP layer segmentation and re-assembly is used then there will be an impact on the terminal. If the function is placed in the Frame Relay layer, FR segmentation and re-assembly must be added to this layer.

NOTE: The impact of *network transport aspects for the support of real time QoS* on the protocol layers is for further study.

5.6.4.3. Impact on the system elements

5.6.4.3.1. Impact on the terminal

There is no impact currently foreseen on the terminal unless segmentation and re-assembly in the SNDCP layer is adopted. In this case the terminal will have significantly more processing to do for non real-time data packets, as there will be a larger number of smaller packets to process than in the current system.

5.6.4.3.2. Impact on the RAN

The BSC must implement segmentation and re-assembly at the appropriate protocol layer. It must also implement prioritisation and scheduling.

5.6.4.3.3. Impact on the CN

The SGSN must implement segmentation and re-assembly at the appropriate protocol layer. It must also implement prioritisation and scheduling.

5.6.4.4. Impact on the standards

5.6.4.4.1. Affected specifications

Table 12 contains an estimation of the specification changes and work required for the standardisation of *network transport aspects for the support of real time QoS*.

Table 12 – Standardisation impact for *network transport aspects for the support of real time QoS*

Body	Specification	TSG / WG	Foreseen modifications	Work (months)
TSG GERAN				
Other TSGs				
Other bodies				

NOTE: The impact of *network transport aspects for the support of real time QoS* on the standards is for further study. As it is still an open issue as to which protocol layer segmentation and re-assembly should be applied, it is not possible to fully define the impact on standards, although it is likely to be quite small if not zero.

5.6.4.4.2. Estimated standardisation time

NOTE: The estimated standardisation time of *network transport aspects for the support of real time QoS* is for further study. The estimated standardisation time is likely to be quite low. However, it is not currently possible to define exactly without knowing at which protocol level segmentation and re-assembly should occur.

5.6.5. Open issues

Table 13 summarises the issues that remain open regarding *network transport aspects for the support of real time QoS*. A collection of all the open issues is included in an annex to this document.

Table 13 – Open issues for *network transport aspects for the support of real time QoS.*

No	Description	Companies	Priority[6]	Status/Comments
43	**Which protocol layer to support segmentation and re-assembly** SNDCP, FR, IP, underlying transport protocol or all of these.		Medium	**Open**

5.7. MODIFICATION OF SNDCP/LLC

5.7.1. Introduction

One of the key requirements to support real-time conversational services is spectral efficiency. If using the Gb protocol 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 (6 from LLC+4 from SNDCP) compared to 1 octet overhead for PDCP. For example, the AMR voice over IP results following headers in Gb, and as a reference same overhead has been calculated for 3GPP Iu-ps:

Gb : 32 bits (SNDCP) + 48 bits (LLC) + 28 bits (ROHC) + 95-244 bits (AMR Payload)

Iu-ps : 8 bits (PDCP) + 28 bits (ROHC) + 95-244 bits (AMR Payload)

The example shows that there is 72-bit overhead compared to 3GPP Iu-ps. The example assumes that ROHC is used on SNDCP. This overhead should be removed in order to have same performance compared to services over 3GPP Iu-ps.

The SNDCP layer needs to support also efficient compression mechanism. One of the possibilities is to add ROHC to SNDCP.

Sections FFS and FFS describe two solutions. The difference between *Solution 1* and *Solution 2* is that in *Solution 2* the SNDCP/LLC header overhead down scaling is not considered. The only considerations in *Solution 2* are the mode of SDNCP and LLC layers operate and moving the ciphering from LLC layer to another layer.

[6] High, Medium or Low.

5.7.2. Requirements and guidelines

5.7.2.1. Requirements

In order to support real-time Conversational traffic class on Gb interface there are number of mandatory high-level requirements to be fulfilled:

- Highest possible spectral efficiency.
- Acceptable QoS especially subjective quality and low delay.
- Seamless handover and interworking between systems.

5.7.2.2. Guidelines

The current functional split between protocol layers should be kept.

5.7.3. Relationship with other features

- *Handover of PS services*. To support conversational QoS over Gb, the PS handover is needed on top of the LLC and SNDCP layer modifications.
- *Multiple parallel data flows between BSS and MS*. It is commonly accepted that conversational services over Gb will require multiple TBF feature.

5.7.4. Description of the solution(s)

5.7.4.1. Solution one

5.7.4.1.1. General description of the solution

This solution is to remove all possible header overhead from LLC and SNDCP layers. When doing so, the functionality split between layers cannot be kept, especially due to moving the ciphering to lower layers. The intent in this solution is to make LLC nearly transparent, only keeping the information that cannot be moved elsewhere.

The current LLC header overhead is 48 bits. The current SNDCP header overhead is 32 bits.

NOTE: The actions to make LLC and SNDCP headers overhead smaller or removed are still for further study.

NOTE: The impacts to implement ROHC on SNDCP are still for further study. Also the ROHC context relocation mechanism is for further study.

In the simple relocation solution following scenario could be possible. 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.

NOTE: The effect of this simple solution on conversational QoS class is FFS.

5.7.4.1.2. Impact on the protocol layers

NOTE: The impact of solution 1 for *modification of SNDCP/LLC* on the protocol layers is for further study.

5.7.4.1.3. Impact on the system elements

5.7.4.1.3.1. Impact on the terminal

NOTE: The impact of solution 1 for *modification of SNDCP/LLC* on the terminal is for further study.

5.7.4.1.3.2. Impact on the RAN

NOTE: The impact of solution 1 for *modification of SNDCP/LLC* on the RAN is for further study.

5.7.4.1.3.3. Impact on the CN

NOTE: The impact of solution 1 for *modification of SNDCP/LLC* on the CN is for further study.

5.7.4.1.4. Impact on the standards

5.7.4.1.4.1. Affected specifications

Table 14 contains an estimation of the specification changes and work required for the standardisation of *modification of SNDCP/LLC*.

Table 14 – Standardisation impact of solution 1 for *modification of SNDCP/LLC*

Body	Specification	TSG / WG	Foreseen modifications	Work (months)
TSG GERAN				
Other TSGs				
Other bodies				

NOTE: The impact of solution 1 for *modification of SNDCP/LLC* on the standards is for further study.

5.7.4.1.4.2. Estimated standardisation time

NOTE: The estimated standardisation time of solution 1 for *modification of SNDCP/LLC* is for further study.

5.7.4.2. Solution two

5.7.4.2.1. General description of the solution

5.7.4.2.1.1. SNDCP Layer

- The mapping of SNDCP primitives received from the network layer into corresponding LLC primitives is to be passed to the LLC layer, and vice versa. This assumption is not changed for optimised conversational service.

- The multiplexing of N-PDUs from one or several N-SAPIs onto one LLC SAPI: N-SAPIs that are multiplexed onto the same SAPI shall use the same radio priority level, QoS traffic handling priority and traffic class. For an optimised conversational service there is a one-to-one relation between N-SAPI and SAPI, which means that there is no multiplexing of flows from different N-SAPIs to one SAPI. In addition there is a one-to-one relation between N-SAPI and PFI; therefore there is not need to include any SAPIs in the SNDCP/LLC header

NOTE: The exact procedure is for further study.

- Compression of redundant protocol control information and user data. As an addition to the available compression methods, the SNDCP has to be updated to include also the ROHC header compression.

- Segmentation and reassembly. The output of the compression sub-functions are segmented to maximum-length LLC frames. Neither segmentation nor reassembly is required for the optimised conversational service.

5.7.4.2.1.2. LLC Layer

- Service primitives allowing the transfer of SNDCP PDUs between the SNDCP and the LLC layer. This assumption is not changed for optimised conversational service.
- Procedures for transferring LL-PDUs between the MS and SGSN, including:
  - procedures for unacknowledged delivery of LL-PDUs between the MS and the SGSN; and
  - procedures for acknowledged, reliable delivery of LL-PDUs between the MS and SGSN.

  For an optimised conversational service only unacknowledged LLC is used.
- Procedures for detecting and recovering from lost or corrupted LL-PDUs. No recovering from lost or corrupted LL-PDUs is required for optimised conversational service. Detection of corrupted LL-PDUs may be needed depending on residual bit error ratio in QoS parameters (for further study). If no error detection is needed, the 3-octet FCS field can be removed.
- Procedures for flow control of LL-PDUs between the MS and the SGSN. Flow control is not required for optimised conversational service.
- Procedures for ciphering of LL-PDUs. The procedures are applicable to both unacknowledged and acknowledged LL-PDU delivery. Multiple ciphering options exists for Optimized Conversational Service:
  - Keep the ciphering unchanged in LLC.
  - Keep it in LLC but reduce the header/overhead. (for further study).
  - Move ciphering to lower layer (for further study).

5.7.4.2.2. Impact on the protocol layers

NOTE: The impact of solution 2 for *modification of SNDCP/LLC* on the protocol layers is for further study.

5.7.4.2.3. Impact on the system elements

5.7.4.2.3.1. Impact on the terminal

NOTE: The impact of solution 2 for *modification of SNDCP/LLC* on the terminal is for further study.

5.7.4.2.3.2. Impact on the RAN

NOTE: The impact of solution 2 for *modification of SNDCP/LLC* on the RAN is for further study.

5.7.4.2.3.3. Impact on the CN

NOTE: The impact of solution 2 for *modification of SNDCP/LLC* on the CN is for further study.

5.7.4.2.4. Impact on the standards

5.7.4.2.4.1. Affected specifications

Table 15 contains an estimation of the specification changes and work required for the standardisation of *modification of SNDCP/LLC.*

Table 15 – Standardisation impact of solution 2 for *modification of SNDCP/LLC*

Body	Specification	TSG / WG	Foreseen modifications	Work (months)
TSG GERAN				
Other TSGs				
Other bodies				

NOTE: The impact of solution 2 for *modification of SNDCP/LLC* on the standards is for further study.

5.7.4.2.4.2. Estimated standardisation time

NOTE: The estimated standardisation time of solution 2 for *modification of SNDCP/LLC* is for further study.

5.7.5. Open issues

Table 16 summarises the issues that remain open regarding *modification of SNDCP/LLC.* A collection of all the open issues is included in an annex to this document.

Table 16 – Open issues for *modification of SNDCP/LLC.*

No	Description	Companies	Priority[7]	Status/Comments
44	**SNDCP/LLC Solution 1: Removal of LLC functionality** What can be removed/moved from LLC header? What are the layers that need to be extended with functionality removed from LLC?			**Open**
45	**SNDCP/LLC Solution 1: Removal of SNDCP functionality** What can be removed/moved from SNDCP header? What are the layers that need to be extended with functionality removed from SNDCP?			**Open**
46	**SNDCP/LLC Solution 1: spectral efficiency** What is the expected spectral efficiency after scaling down LLC and SNDCP headers?			**Open**
47	**SNDCP/LLC Solution 2 : spectral efficiency** What is the expected spectral efficiency if LLC/SNDCP headers are not scaled down?			**Open**
48	**SNDCP/LLC Solution 1 & 2: ROHC** ROHC on SNDCP?			**Open**
49	**SNDCP/LLC Solution 1 & 2: ROHC context relocation** ROHC context relocation mechanism to be applied			**Open**
50	**SNDCP/LLC Solution 2: LLC header size** If ciphering is kept in LLC, what is the LLC header size?			**Open**
51	**SNDCP/LLC Solution 1 & 2: LLC header size** If ciphering is moved from LLC, what is the LLC header size?			**Open**
52	**SNDCP/LLC Solution 1 & 2: Ciphering** If ciphering is removed from LLC, what is the entity that the ciphering functionality is added?			**Open**
53	**Conversational sub-classes** Are there different subclasses within conversational class service (i.e. optimised and generic)?			**Open**

NOTE: The associated priorities in Table 16 are missing.

5.8. IP HEADER ADAPTATION

5.8.1. Introduction

Many conversational services are characterised by small and frequent packets with strict delay requirements. It is anticipated that for this service each packet has an RTP/UDP/IP header. Since this header is 40 or 60 octets, it may very well be comparable in size to the application payload, leading to an unacceptable waste of air interface resources.

[7] High, Medium or Low.

This problem has been solved in principle with the concept of Robust Header Compression (ROHC). The scheme provides powerful compression, down to a few octets. ROHC is not sensitive to lost packets, i.e. the full header can be constructed even if some previous compressed headers have been lost. Furthermore, ROHC provides a good compromise between compression and flexibility.

The compression scheme relies on both ends of the RTP/UDP/IP transmission path maintaining up-to-date so-called header compression contexts. During the initial part of the session, the sender transfers the header compression context to the receiver. During subsequent part of the session, small increments are transferred, and these increments have a typical nominal size of 2-3 octets, depending on the ROHC configuration.

5.8.2. Requirements and guidelines

5.8.2.1. Requirements

The basic requirements associated with the introduction of ROHC are as follows:

- The ROHC algorithm for RTP/UDP/IP header compression shall be supported.

5.8.2.2. Guidelines

The following guidelines are associated with the introduction of ROHC:

- To keep the functional split of the Gb interface, ROHC should be introduced in the SNDCP layer in the MS and the SGSN.
- To reach acceptable interruption time at a PS handover it is deemed necessary that the ROHC configuration (XID parameters) for SNDCP and the ROHC context are transferred between source and target system.

5.8.3. Relationship with other features

The introduction of ROHC will have to be coordinated with the following other features. ROHC can, however, be introduced separately from these features:

- *PS of handover services*. It requires functionality for relocation of ROHC between SGSN. ROHC shall also work together with a bi-casting/duplication solution.
- *Modification of SNDCP/LLC*. It may be related to ROHC depending on modifications introduced.
- *Protocol aspects of Unequal Error Protection*. It may be related to ROHC depending on the solution selected.
- *Multiple parallel data flows between BSS and MS* ration. A TBF used to convey RTP/UDP/IP header (compressed according to ROHC) and RTP payload must be able to adapt to real time variations in the amount of bandwidth required for the compressed header without diminishing the bandwidth available for the RTP payload.

5.8.4. Description of the solution(s)

5.8.4.1. General description of the solution

For a general description of the ROHC algorithm see the introduction section and RFC 3095 [14].

NOTE: Descriptions of the solutions to the open issues are for further study.

5.8.4.2. Impact on the protocol layers

The impact of ROHC on protocol layers is as follows:

- SNDCP is modified to handle ROHC.
- New procedures required for inter-SGSN handover should support ROHC context relocation.

5.8.4.3. Impact on the system elements

5.8.4.3.1. Impact on the terminal

The impact of ROHC on the terminal is as follows:

- SNDCP is modified to handle ROHC.

5.8.4.3.2. Impact on the RAN

No impacts to the RAN have been identified.

5.8.4.3.3. Impact on the CN

The impact of ROHC on the CN is as follows:

- SNDCP is modified to handle ROHC.
- New procedures required for inter-SGSN handover shall support ROHC context relocation.

5.8.4.4. Impact on the standards

5.8.4.4.1. Affected specifications

Table 17 contains an estimation of the specification changes and work required for the standardisation of *IP header adaptation*.

Table 17 – Standardisation impact for *IP header adaptation*

Body	Specification	TSG / WG	Foreseen modifications	Work (months)
TSG GERAN				
Other TSGs	44.065	CN1	ROHC introduced in the SNDCP specification.	FFS
Other bodies				

NOTE: The impact of *IP header adaptation* on the standards is for further study.

5.8.4.4.2. Estimated standardisation time

NOTE: The estimated standardisation time of *IP header adaptation* is for further study.

5.8.5. Open issues

Table 18 summarises the issues that remain open regarding *IP header adaptation*. A collection of all the open issues is included in an annex to this document.

Table 18 – Open issues for *IP header adaptation.*

No	Description	Companies	Priority[8]	Status/Comments
54	**ROHC performance evaluation in Gb architecture** In the Gb architecture it is assumed that ROHC is placed in the SNDCP layer. A longer round trip delay (compared to GERAN Iu mode) will possibly degrade the performance of the compression algorithm in the case a re-initialisation of the ROHC context is needed. A study performance of ROHC in the Gb needs to be performed. This study should cover: • Quantitative effect of re-establishing the compressors in the SNDCP layer. • Its effect on speech quality. • Analysis of the impact of peer-to-peer delay on ROHC performance. • An assessment of how frequent ROHC context re-initialisations are.		High	**Open**
55	**Different size of compressed IP packets** It is for further study how the varying size of the compressed IP packets is handled.		Low	**Open**
56	**Inter SGSN handover** Configuration of SNDCP entities and relocation of ROHC context at an inter SGSN (intra-RAT) handover is for further study.		Medium	**Open**
57	**Inter-RAT handover** Configuration of SNDCP or PDCP entities and relocation of ROHC context at an inter-RAT handover is for further study.		Medium	**Open**

5.9. PROTOCOL ASPECTS OF UNEQUAL ERROR PROTECTION

5.9.1. Introduction

5.9.1.1. General

As a part of the feasibility study on A/Gb evolution, it is being investigated how to support real time QoS classes and IMS within an enhanced A/Gb mode, and it is envisaged that Unequal Error Protection (UEP) could be provided for PS multimedia services.

For CS voice calls, UEP allows to differentiate the most and least important speech bits in order to apply different levels of protection for different sets of bits over the radio interface.

Discussions in SA2 are currently ongoing to introduce UEP in UTRAN and GERAN *Iu mode* for Release 6. The common expected solution should lower at a minimum the impacts on the existing features.

It is important to gain an understanding of the impact of UEP on an enhanced *A/Gb mode* compared to GERAN *Iu mode* in order to complete the view on the long term aspects of *A/Gb mode* evolution. Specifically, it needs to be understood whether the *A/Gb mode* protocol architecture is able to support UEP functionality in order to recognize possible limitations.

5.9.1.2. Functionality required for support of UEP

To support UEP, the MS and its far end (other MS, MGW, MRF…) counterpart use a framing structure in which each codec subflow is carried in one RTP subflow. These RTP subflows are carried inside a single RTP flow exchanged between the MS and the far end (other MS, MGW, MRF...) destination of the media. This single RTP flow is mapped on a single PDP context.

It is assumed that Transport Format Combinations are configured for the RTP subflows within one RTP flow carried by one PDP context. The TFC may change dynamically (by adaptation functions or multiplexing of several streams onto one packet flow).

The compressed header is added as separate sub-flow to the RTP subflows as proposed by [4].

In the case of Equal Error Protection (EEP) in GPRS, an IP packet is currently modified by the following functions:

8 High, Medium or Low.

- **Header Compression**: the TCP/IP and UDP/IP headers are compressed. The current compression schemes in the SGSN (RFC 1144 [12] and 2507 [13]) do not compress the RTP header.

- **Ciphering**: after the header compression, the SGSN ciphers the IP packet.

- **Segmentation**: the BSS segments the IP packet according the current coding scheme.

The introduction of UEP would require accordingly additional functions:

- **Providing information** to the RNC/BSC about the payload format: this may be performed explicitly (similar to the CS domain in UTRAN/GERAN *Iu mode*, where the RNC is informed by the CN node about the user data structure within RAB Assignment) or implicitly (the RNC/BSC has knowledge of the RTP Profile). This is needed to determine a TFC set to use on Uu interface in advance.

- **Determination of payload format**: the IP packet is checked to determine the subflow combination needed for the splitting function. For this function several concepts are proposed – e.g. checking the RTP header and the payload specific header (proposed for AMR in header removal concepts) or to use the length of the RTP payload (assumes unique length for each subflow combination).

- **RTP Header Compression**: an efficient header compression protocol capable of compressing RTP/UDP/IP headers needs to be introduced. For example, a VoIP packet with AMR payload may have an RTP/UDP/IP header of length 40 bytes with AMR payload of length 32 bytes. Robust Header Compression (ROHC) would be able to reduce the IP/UDP/RTP header from 40 to 2-4 bytes!

- **Splitting the payload** into subflows: the payload is split into subflows according to the determined payload format. Each subflow should correspond to a predefined transport format. This function may replace the segmentation function when the payload length does not exceed the transmission capability of the air interface. In this case, the RLC may work in transparent mode (as in UTRAN for Iu-CS UEP).

- **Rate adaptation** is the function whereby the set of Transport formats is limited (or expanded) depending on the radio conditions of the radio resources involved in the communication. In UTRAN, these radio resources are either controlled by the RNC executing the rate adaptation or by the RNC issuing a rate control command in case of mobile-to-mobile communication. Note further, that the 'natural' place for the rate adaptation functionality is the RNC/BSC (according to TR 25.922 [10]).

Two architectural mappings are proposed hereafter:

- one based on the GERAN *A/Gb mode* functional split; and

- one based on the (UTRAN - GERAN) *Iu mode* functional split.

5.9.2. Requirements and guidelines

5.9.2.1. Requirements

No requirements for *protocol aspects of Unequal Error Protection* have been identified.

5.9.2.2. Guidelines

The following guidelines have been identified:

- The chosen solution should minimise the impact on the existing features.

- It is assumed that FLO (Flexible Layer One) is used as layer 1 protocol.

5.9.3. Relationship with other features

5.9.3.1. General

The *protocol aspects of Unequal Error Protection* here described are related to the following features:

- Flexible Layer One (FLO). The relationship with FLO is detailed in the sub-clause hereafter.

- *Handover of PS services*. Some UEP-specific signalling may be required depending on the chosen solution.
- *Modification of SNDCP/LLC*. The second approach (alignment to Iu functional split) would require a move of the compression and ciphering functions from SNDCP/LLC to a new RAN protocol entity.

5.9.3.2. Relationship with FLO

For efficient support of UEP services, the Flexible Layer One (FLO) approach is currently investigated in a work item for establishment in GERAN Release 6. Hence efficient support of FLO in an enhanced *A/Gb mode* is an important criterion for the support of IMS.

The current working assumption for FLO is that dedicated channels need to be supported; assumptions for their connection setup are made in [2].

FLO will cause additional signalling load on the radio access network as described in [3]. In particular it will have an impact on the control plane, i.e. it requires the transmission of transport formats and transport format configurations at call set up and also at handover.

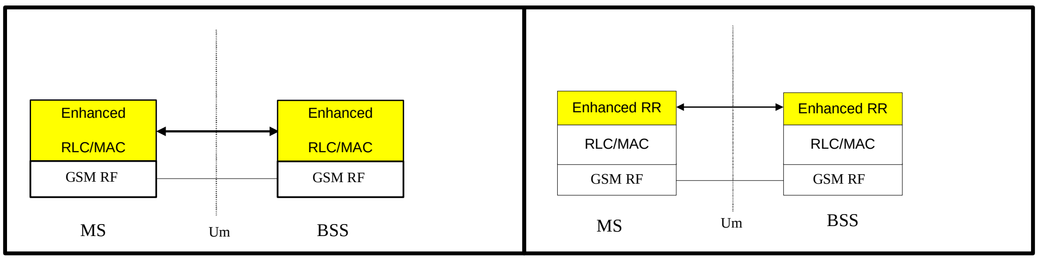
For *Iu mode*, RRC will be responsible for setting up this user related signalling. An RRC entity exists in both the MS and the BSS and executes the transfer of signalling messages. Appropriate transport formats and transport format combinations are selected based on QoS requirements.

For Enhanced A/Gb mode this is described below.

For the following considerations it is assumed that the BSC has all payload information available in order to determine the appropriate transport formats and transport format configurations, i.e. only the air interface relevant signalling is regarded.

If an IMS bearer is set up and the BSS decides to set up a dedicated connection, then the BSS has to signal all supported transport formats and transport format combinations to the MS. Two options exist:

1) The RLC/MAC gets enhanced functionality in BSS and MS to incorporate the transport formats and to control the transport format signalling at call set-up or handover.
2) An enhanced RR functionality is introduced in BSS and MS, which executes all RR related procedures. The advantage of this option would be that it facilitates the re-use of this functionality for services using the A interface. Only one protocol entity is responsible for transport format configuration assignment and signalling, comparable to RRC in UTRAN.



Option 1: Enhanced RLC/MAC functionality. Option 2: Enhanced RR functionality.

Figure 9: Options for the signalling of the TFs and TFCs to the MS.

To summarize, significant functionality needs to be introduced in order to enable a flexible layer one in enhanced *A/Gb mode*, either RLC/MAC or RR protocol functionality.

5.9.4. Description of the solution(s)

5.9.4.1. Solution 1: approach based on the existing functional split

5.9.4.1.1. General description of the solution

The first mapping assumes the current function split between SGSN and BSS: header compression and ciphering remain in the SGSN.

- **SGSN**: The payload determination function is located in the SGSN to have access to the un-compressed and un-ciphered IP packet.
- **BSS**: The splitting function is located in the BSS to enable the direct mapping of subflow formats to the transport formats defined in BSS and MS.
- **MS**: The MS must support both the SGSN related functions and the BSS related functions. The reuse of UMTS functions is not possible due to the different protocol structure (the functions are located in different protocol entities).

The main issue to resolve for this approach is the required interaction between SGSN and BSS.

- The BSS has to know in advance which subflow formats are to be handled (e.g. for appropriate MS configuration of TF and TFCIs).
- In each direction, there is a need to signal the current subflow combination.

For the CS domain, in UTRAN and GERAN *Iu mode*, this interaction is handled by RANAP (subflow negotiation during RAB Assignment procedure) and Iu-UP (transport of subflows in Iu-CS).

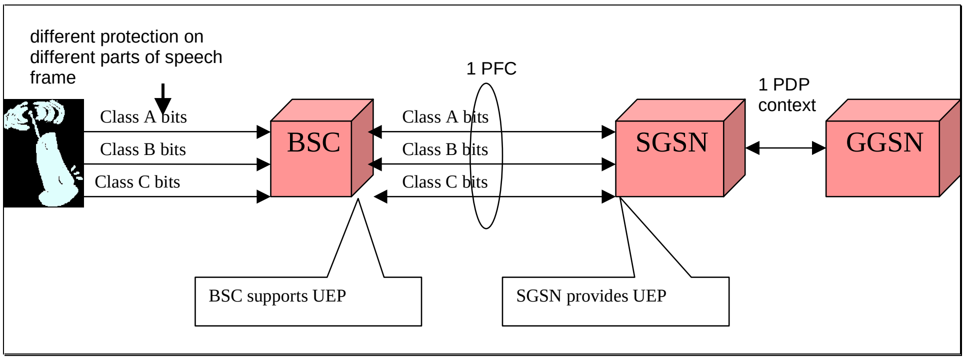


Figure 10: Implementation of UEP with the existing functional split.

This kind of interaction is currently not specified on Gb interface since the Gb protocols are not designed to handle this type of services.

5.9.4.1.2. Impact on the protocol layers

Since no complete solution can be given at the moment, the impact of this approach for *protocol aspects of Unequal Error Protection* on the protocol layers is for further study.

5.9.4.1.3. Impact on the system elements

5.9.4.1.3.1. Impact on the terminal

The MS must support both the SGSN related functions (payload determination) and the BSS related functions (splitting function).

5.9.4.1.3.2. Impact on the RAN

The splitting function is located in the BSS to enable the direct mapping of sub-flow formats to the transport formats defined in BSS and MS.

5.9.4.1.3.3. Impact on the CN

The payload determination function is located in the SGSN to have access to the un-compressed and un-ciphered IP packet.

5.9.4.1.4. Impact on the standards

5.9.4.1.4.1. Affected specifications

Table 19 contains an estimation of the specification changes and work required for the standardisation of solution 1 for *protocol aspects of Unequal Error Protection*.

Table 19 – Standardisation impact of solution 1 for *protocol aspects of Unequal Error Protection*

Body	Specification	TSG / WG	Foreseen modifications	Work (months)
TSG GERAN				
Other TSGs				
Other bodies				

NOTE: The impact of solution 1 for *protocol aspects of Unequal Error Protection* on the standards is for further study.

5.9.4.1.4.2. Estimated standardisation time

NOTE: The estimated standardisation time of solution 1 for *protocol aspects of Unequal Error Protection* is for further study.

5.9.4.2. Solution 2: approach based on an Iu-like functional split

5.9.4.2.1. General description of the solution

This mapping would assume a significant change of the functional split between core and radio access network and would move the header compression and ciphering functions into the BSS. The SGSN would work transparently.

- **SGSN**: The SGSN transfers the IP packet unchanged (transparent) as the 3G-SGSN today.
- **BSS**: All UEP functions are located in the BSS. A new protocol entity for header compression is introduced in analogy to GERAN Iu-mode (use of the UMTS PDCP concept).
- **MS**: The MS must support both the new BSS related functions (where some reuse of UMTS functions is possible due to similar protocol architectures) and the transparent SGSN related functions.

The SGSN – BSS interaction for the transfer of user data remains unchanged, but the SGSN – BSS function split is completely changed compared to GERAN *Iu mode* (see Figure 11).

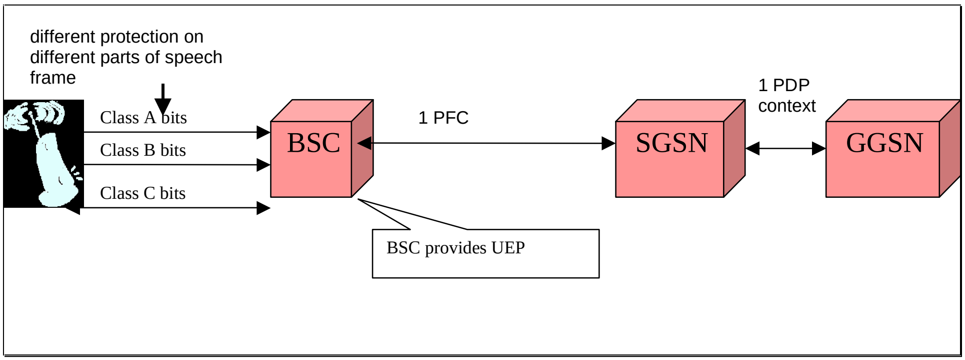


Figure 11: Implementation of UEP based on an Iu-like functional split.

It can be seen that this approach would provide a better potential re-use between GERAN *Iu mode* / UTRAN on one hand and enhanced *A/Gb mode* on the other hand, in both terminal and network entities. However, a change of functional split on the Gb interface to this extent is certainly not recommended according to the guidelines currently understood for *A/Gb mode* evolution.

5.9.4.2.2. Impact on the protocol layers

Since no complete solution can be given at the moment, the impact of this approach for *protocol aspects of Unequal Error Protection* on the protocol layers is for further study.

However, it can be seen that header compression function needs to be moved from CN-located SNDCP protocol to a PDCP-like entity in the RAN. Also ciphering would be moved to lower layers.

5.9.4.2.3. Impact on the system elements

5.9.4.2.3.1. Impact on the terminal

The MS must support both the new UEP functions introduced in the BSS and the transparent relaying of IP packets as performed in the SGSN.

5.9.4.2.3.2. Impact on the RAN

All UEP functions are located in the BSS. A new protocol entity for header compression is introduced in analogy to GERAN *Iu mode* (use of the UMTS PDCP concept). Ciphering functionality would be introduced in BSS.

5.9.4.2.3.3. Impact on the CN

The SGSN transfers the IP packet unchanged (transparent) as the 3G SGSN today. No compression or ciphering is performed in the SGSN.

5.9.4.2.4. Impact on the standards

5.9.4.2.4.1. Affected specifications

Table 20 contains an estimation of the specification changes and work required for the standardisation of solutions 2 for *protocol aspects of Unequal Error Protection*.

Table 20 – Standardisation impact of solution 2 for *protocol aspects of Unequal Error Protection*

Body	Specification	TSG / WG	Foreseen modifications	Work (months)
TSG GERAN				
Other TSGs				
Other bodies				

NOTE: The impact of solution 2 for *protocol aspects of Unequal Error Protection* on the standards is for further study.

5.9.4.2.4.2. Estimated standardisation time

NOTE: The estimated standardisation time of solution 2 for *protocol aspects of Unequal Error Protection* is for further study.

5.9.5. Open issues

Table 21 summarises the issues that remain open regarding *protocol aspects of Unequal Error Protection*. A collection of all the open issues is included in an annex to this document.

Table 21 – Open issues for *protocol aspects of Unequal Error Protection.*

No	Description	Companies	Priority[9]	Status/Comments
58	**Support of UEP** Clarify if there is a requirement to have support of UEP in an enhanced Gb mode.		High	**Open**
59	**UEP architecture** Clarify status of SA2 discussions in order to enable discussions on an overall architecture level.		Medium	**Open**

5.10. INTEGRITY PROTECTION

5.10.1. Introduction

Integrity protection is an essential security feature in UTRAN and GERAN *Iu mode*. It can be assumed that it would be considered beneficial for an enhanced *A/Gb mode* to provide a similar level of security as in UTRAN and GERAN *Iu mode* by employing integrity protection.

Integrity protection provides the possibility to verify in the receiving entity that signalling data has not been modified in an unauthorised way since it was sent and that the data origin of the signalling data received is indeed the one claimed.

This is for example extremely crucial for control messages dealing with resource allocation. They should be integrity protected to prevent any possibilities to steal bandwidth. However, the protection of control messages for radio resource allocation protect against denial-of-service attacks. This is not a major security threat as long as a non-legitimate user cannot use the bandwidth, which can only be the case if encryption is disabled. In this case, a new procedure similar to the Counter Check procedure can be used.

NOTE: This assumption is for further study and it needs to be verified with SA3.

Integrity protection is as much needed for uplink control messages as for downlink control messages. It should protect against both "false network" and "false MS" cases.

For UTRAN, integrity protection is used on almost all dedicated MS ↔ network signalling messages (RRC, MM, CC, GMM, SM). It was decided to adopt this principle also for GERAN *Iu mode* although the RLC/MAC signalling messages are not integrity protected.

In order to integrity protect a message, a Message Authentication Code (MAC-I) needs to be included in the message so that the receiving end can confirm its origin. This might, depending on the protocol and the message, lead to additional message segmentation and result in delayed resource allocation. During the GERAN *Iu mode* discussions, it was however thought that the benefits of introducing integrity protection outweigh these side effects. It is therefore assumed that it would also be attractive for an enhanced *A/Gb mode* to support integrity protection in order to enable future proof security mechanisms.

[9] High, Medium or Low.

5.10.2. Requirements and guidelines

5.10.2.1. Requirements

NOTE: The requirements for *integrity protection* are for further study.

5.10.2.2. Guidelines

The following guidelines have been identified:

- The same requirements should apply for integrity protection for CS and PS domain related signalling.
- Introducing integrity protection should not cause a change of the functional split between core and radio access network.
- For a certain domain, integrity protection and ciphering should be performed in the same network node.

5.10.3. Relationship with other features

- Ciphering: From an architectural point of view, solutions for integrity protection and ciphering should be considered together.
- Handover: Security related contexts have to be transferred during handover to the target node and security parameter setting in the new cell needs to be clearly specified.
- *Modification of SNDCP/LLC*: Introducing integrity protection in LLC would need to be considered.

5.10.4. Description of the solution(s)

5.10.4.1. General description of the solution

At this point in time, no solution for introducing integrity protection in an enhanced *A/Gb mode* is described. This is outlined in the following.

In UTRAN and GERAN *Iu mode*, RRC protocol in RNC/BSC is performing integrity protection for signalling messages independent from the domain (PS/CS). In GERAN *Iu mode*, RLC/MAC signalling messages are not integrity protected.

Obviously, such a protocol entity is not available at this point in time for *A/Gb mode*. It has also to be noted that ciphering/deciphering for CS connections on the network side is done in L1/BTS whereas it is done in LLC/SGSN for PS connections.

Therefore, in case an RRC like protocol entity is to be introduced in an enhanced *A/Gb mode*, also the ciphering functionality should probably be moved to the BSC entity.

From architectural point of view it would be beneficial to co-locate ciphering and integrity protection functionality. For PS domain, this would mean to introduce integrity protection in LLC protocol. This would only provide integrity protection for NAS messages originating from the PS domain.

NOTE: It is for further study whether integrity protection of NAS messages only is deemed sufficient and it needs to be verified with SA3.

For CS domain, co-locating ciphering and integrity protection functionality would mean introduction of integrity protection in the L1 in BTS. This is not really a realistic approach. Introducing integrity protection in the BSC results in a completely new BSC internal functionality, which is likely to end up in an RRC like approach already discussed.

NOTE: It is for further study whether ciphering for the CS domain can be performed at the BSC.

Therefore, there does not seem to be a satisfying solution enabling integrity protection for both CS and PS domain. Introducing integrity protection in the PS domain only is a questionable approach, since there should be the same requirements valid for both domains.

NOTE: It is for further study whether enhancements to *A/Gb mode* security may only apply to the PS domain and it needs to be discussed with SA3.

It is open which messages in an enhanced *A/Gb mode* should be subject to integrity protection. Integrity protection of RLC/MAC control messages was discussed during GERAN *Iu mode* discussions and was not chosen.

In *A/Gb mode*, there are no signalling radio bearers common for PS and CS domain, this would again require a common RRC entity responsible for this.

PS domain originating NAS messages could be integrity protected in case the LLC protocol is enhanced with this functionality.

No solution for integrity protection for CS domain originating NAS signalling or any RR originating signalling messages is available.

5.10.4.2. Impact on the protocol layers

The following text describes the impact of introducing integrity protection in LLC protocol. As explained in sub-clause 5.10.4.1 this can not obviously be considered as a complete solution, since it is only covering NAS messages from the PS domain.

Input parameters in UTRAN and GERAN *Iu mode* for Integrity Protection are the Integrity Key IK, COUNT-I, DIRECTION and FRESH (a random value generated at NW side), besides the message itself. COUNT-I consists of the RRC HFN (incremented at each SN cycle and initialised by START), and RRC SN (available in each RRC PDU).

UIA1, Kasumi, is specified as integrity protection algorithm supported for 3G networks.

Introducing integrity protection in a 2G SGSN therefore means to support Integrity Key and algorithm handling in the SGSN. For establishing the security context in both network and MS side, the UMTS authentication procedure could be re-used.

The negotiated integrity key and algorithm would be passed by GMM to LLC layer by the already existing primitives used for conveying the ciphering parameters.

An input parameter similar to COUNT-I (or similar to INPUT used for ciphering in LLC?) would need to be generated.

In order to avoid that a user is replaying any old message authentication codes, a value FRESH would need to be generated by the network within the 2G SGSN and made available to the MS. This would result in a new message or message part within LLC protocol.

For a defined start of integrity protection in both network and MS, a synchronisation (reset?) procedure would need to be defined which needs to take place before the first NAS signalling message is sent (compare to RRC Connection Setup and Security Mode Command procedures). Also at inter-SGSN change (between enhanced A/Gb capable SGSNs), it must be ensured that the integrity protection context is transferred in order to avoid reuse of the same input parameters. Interactions with routeing area update and integrity protection of the related messages is unclear.

Furthermore, in case the source SGSN supports the enhanced *A/Gb mode* and the target SGSN does not, it is not clear how the integrity protection should be handled, in order for the mobile to know that integrity protection is not applied any more.

Impact on other protocol layers than LLC cannot be described at the moment, since no complete solution for integrity protection can be given.

5.10.4.3. Impact on the system elements

5.10.4.3.1. Impact on the terminal

According to 3GPP TS 33.102, a ME supporting only *A/Gb mode* needs not support the USIM interface.

An issue of importance is the question whether 64 or 128 bit keys need to be supported (for ciphering and integrity protection). SIM cards generate one 64 bit Kc key, whereas USIM generates a 128 bit integrity key IK and a 128 bit ciphering key CK. 128 bit keys are obviously providing considerably superior protection compared to the 64 bit keys.

From a security point of view, 128-bit keys derived by a conversion function from a 64-bit key, only do provide the strength of the 64-bit key.

Deriving 2 keys (CK' and IK') from 64-bit information and using it will provide integrity protection to the message but at the same time give an attacker more information on the plaintext and hence his possibility to retrieve the keys and the plaintext. A direct consequence is that such derived keys shall be replaced more frequently (a higher frequency of authentication will be needed in enhanced *A/Gb mode* than *A/Gb mode* for a GSM subscriber).

If an ME is supporting integrity protection, it must be ensured that an ME can distinguish between SGSN-LLC entities supporting integrity protection or not supporting integrity protection in order to provide the appropriate functionality. It is currently not clear how this information is made available to the ME.

In order to achieve the same level of security as in GERAN *Iu mode*, it is required to fully support 3G security. USIM support in the mobile is needed in order to provide true 128 bit keys.

5.10.4.3.2. Impact on the RAN

Since no complete solution can be given at the moment, the impact of integrity protection on the RAN is for further study. In case a change of functional split between core and radio access network is involved (e.g. introduction of signalling radio bearers or RRC like functionality), there would however be significant impact.

5.10.4.3.3. Impact on the CN

In case of introducing integrity protection functionality to LLC protocol, the SGSN has to introduce the functionality outlined in section 5.10.4.2.

In case a change of functional split between core and radio access network is involved, additional impact is expected.

5.10.4.4. Impact on the standards

NOTE: Since no reasonable solution can be given at the moment and requirements for integrity protection have to be clarified first, it is considered to be too early to provide statements on impact on the standards.

5.10.4.4.1. Affected specifications

Table 22 contains an estimation of the specification changes and work required for the standardisation of *integrity protection*.

Table 22 – Standardisation impact for *integrity protection*

Body	Specification	TSG / WG	Foreseen modifications	Work (months)
TSG GERAN				
Other TSGs				
Other bodies				

NOTE: The impact of *integrity protection* on the standards is for further study.

5.10.4.4.2. Estimated standardisation time

NOTE: The estimated standardisation time of *integrity protection* is for further study.

5.10.5. Open issues

Table 23 summarises the issues that remain open regarding *integrity protection*. A collection of all the open issues is included in an annex to this document.

Table 23 – Open issues for *integrity protection.*

No	Description	Companies	Priority[10]	Status/Comments
60	**Requirements for integrity protection** It is not clear at the moment: • Whether a requirement to introduce integrity protection in enhanced A/Gb mode exists. If yes, it needs to be studied to which messages it should apply. • Whether integrity protection can be applied to the PS domain only. • Whether integrity protection can be applied to NAS signalling messages only.		High	**Open** This needs to be discussed with SA3.
61	**Overall solution for integrity protection** A reasonable solution providing integrity protection for both CS and PS domain related signalling has not been provided so far.		Medium	**Open**

5.11. CIPHERING

5.11.1. Introduction

NOTE: The introduction to *ciphering* is for further study.

5.11.2. Requirements and guidelines

5.11.2.1. Requirements

NOTE: The requirements for *ciphering* are for further study.

5.11.2.2. Guidelines

NOTE: The guidelines for *ciphering* are for further study.

5.11.3. Relationship with other features

NOTE: The relationship of *ciphering* with other features is for further study.

5.11.4. Description of the solution(s)

5.11.4.1. General description of the solution

NOTE: The general description of *ciphering* is for further study.

5.11.4.2. Impact on the protocol layers

NOTE: The impact of *ciphering* on the protocol layers is for further study.

5.11.4.3. Impact on the system elements

5.11.4.3.1. Impact on the terminal

NOTE: The impact of *ciphering* on the terminal is for further study.

5.11.4.3.2. Impact on the RAN

NOTE: The impact of *ciphering* on the RAN is for further study.

[10] High, Medium or Low.

5.11.4.3.3. Impact on the CN

NOTE: The impact of *ciphering* on the CN is for further study.

5.11.4.4. Impact on the standards

5.11.4.4.1. Affected specifications

Table 24 contains an estimation of the specification changes and work required for the standardisation of *ciphering*.

Table 24 – Standardisation impact for *ciphering*

Body	Specification	TSG / WG	Foreseen modifications	Work (months)
TSG GERAN				
Other TSGs				
Other bodies				

NOTE: The impact of *ciphering* on the standards is for further study.

5.11.4.4.2. Estimated standardisation time

NOTE: The estimated standardisation time of *ciphering* is for further study.

5.11.5. Open issues

Table 25 summarises the issues that remain open regarding *ciphering*. A collection of all the open issues is included in an annex to this document.

Table 25 – Open issues for *ciphering.*

No	Description	Companies	Priority[11]	Status/Comments

6. Outcome of the feasibility study

NOTE: The outcome of this paper is for further study. It should be completed at the TSG GERAN #10 meeting (24 – 28 June 2002;Helsinki, Finland).

[11] High, Medium or Low.

Annex A:
Open issues

Table 26 contains the open issues identified during the elaboration of this feasibility study, with their priority and status. If applicable, it also contains the name of the companies working on the corresponding issue.

Table 26 – Open issues

No	Description	Companies	Priority[12]	Status/Comments
1	**Impact of 'Multiple TBFs' in 44.064** Should stage 2 description of the feature be described in this TS?	Ericsson	Low	**Open**
2	**Impact of 'handover of PS services' in 44.064** Should stage 2 description of the feature be described in this TS?	Ericsson	Low	**Open**
3*	**Two sub-clauses for real time QoS** Is there need for two sub-clauses to cover real time related issues, namely *Radio channel combinations for support of conversational and streaming services* and *Support for PS services with real-time QoS*?	Ericsson	Medium	**Open**
4	**QoS set of attribute values** The QoS set of attribute values to be supported has not been identified as yet.		Medium	**Open**
5	**Service limitations** Limitations in the services able to be offered by an evolved GERAN *A/Gb mode* compared to UTRAN need to be identified and notified to SA1.		Medium	**Open** Limitations due to different mobility management need to be taken into consideration.
6	**DTM handover** It is not clear whether or not there is a requirement for the evolved GERAN *A/Gb mode* to offer simultaneous handover of CS and PS resources. There are two actions to be solved: • Manufacturers to investigate the PS interruption time at handover while in DTM. • Once the previous point is cleared, operators to investigate whether such interruption is enough for PS services that may happen in parallel with a CS connection.		High	**Open**
7	**Delay for conversational services** A study on the delay for the support of conversational services need to be performed. This study should cover: • Quantitative effect of re-establishing the compressors in the SNDCP layer. • Its effect on speech quality. • Comparative analysis with the delay and delay variations in GERAN *Iu mode*. • Investigations on possible reductions to the delay between the MS and the SGSN.		High	**Open** See G2-020601
8*	**Flow control per PFC and multiple TBFs** It needs to be decided whether or not the work on 'flow control per PFC' and 'multiple TBFs in *A/Gb mode*' should be within the scope of this Feasibility Study.		High	**Open** See G2-020601
9	**PS handover requirements** The speech/radio performance requirements for the handover of TBFs need to be formulated.		Medium	**Open**
10	**LS from SA2 on IMS** Include the contents (or reference) to the LS from SA2 (S2-021529/G2-02xxxx) in sub-clause 5.7.		High	**Open**
11	**Handover and RAU** Interactions between the Handover and the Routeing Area Update procedures need to be studied.		High	**Open**
12	**Dedicated channels** It is for further study whether or not dedicated channels are needed.		Medium	**Open**
13*	**FLO** Impact on the Flexible Layer 1 WI by the radio support for real time QoS needs to be studied.		High	**Open**
14*	**Transport network** The capabilities of the current transport network/technologies to support real time traffic need to be studied.		High	**Open**
15	**Functional split** A modification of the current functional split between RAN and CN (in the context of support of real time QoS classes) needs to be studied.		High	**Open**
16	**Multiple TBFs in DTM** Should DTM mode be expanded to support the case where only one CS based application and one or more PS based applications are supported in parallel (i.e. where none of the PS based applications are provided handover treatment)		Low	**Open**

[12] High, Medium or Low.

No	Description	Companies	Priority[12]	Status/Comments
	assuming no changes to legacy DTM mode.			
17	**Existing or new messages** Multiple TBF scenarios not supported using legacy mode control plane messages shall be accommodated by either defining new control plane messages or modifying legacy control plane messages.		High	**Open**
18	**Number of TBFs** A Multiple TBF capable MS shall support signalling for N uplink TBFs. A Multiple TBF capable MS shall support signalling for M downlink TBFs.		Medium	**Open**
19	**Number of LLC SAPIs** Should we expand the number of LLC SAPIs (only 8 of 16 are currently defined) to support multiple data flows?		Medium	**Open**
20	**PFI-LLC SAPI relationship** Should the specification introduce a limitation regarding the enforcement of a one to one relationship between PFI and LLC SAPI? (And how does this affect the CN impact of this solution?)		High	**Open**
21	**Inclusion of other working groups in enhanced Gb discussions** Introduction of handover for the Gb interface impacts MS, BSS and CN. It may also impact the overall system behavior and should therefore be discussed with other working groups, e.g. SA2.		High	**Open**
22	**Consideration of alternative approach for handover** The solution proposed in [AHAGB-025] should be analysed more deeply to get a clearer view on available alternatives and the issues impacting their feasibility.		High	**Open**
23	**Service Interruption Time** The service interruption time, which can be achieved has to be estimated. It has to be verified that the requirement to stay below 150 msec can be met.		High	**Open**
24	**Handling of Ciphering** Security aspects (e.g. use different ciphering parameters on the new Gb-leg in t-SGSN) need further investigation. A new handling for the LLC has to be defined because the LLC is currently reset during the RAU procedure (Inter-SGSN case). This would possibly cause additional delay.		High	**Open**
25	**Handling of Compression** Transfer of compression contexts and negotiation mechanism between MS and network during handover have to be clarified. Results may introduce additional delay before data transfer can be resumed in the target cell.		High	**Open**
26	**Handling of Intra-BSS Handover** Intra-BSS handover case need to be studied in detail. Especially it has to be clarified if data duplication in SGSN may be applied for every cell change (impact on SGSN perfor-mance) and the interaction with the cell update procedure.		High	**Open**
27	**Impacts on overall system behaviour** A general difference between the Gb- and the Iu-mode is that in Iu-mode the CN has not to deal with cell level-mobility control. The consequences of maintaining the cell-level mobility in the CN when introducing the backward handover principle for the enhanced Gb mode as well and the corresponding impact on the overall system behaviour need to be studied in detail.		High	**Open**
28	**Coordination between handover and RAU** How to handle Routeing Area Updates whilst allowing the real-time user data to be transmitted and the impact on the MS functionality as well as on the SGSN functionality needs further investigation. In order to allow uplink data transfer in the target cell after handover with a minimum service interruption it appears to be necessary to allocate the new TLLI (t-TLLI) to the MS while it is still in the old cell. The consequence of this is a change in the RAU procedure. The MS has to store two TLLIs and implement new procedures. The CN must be able to split the functionality between allocation of P-TMSI/TLLI and updating of the HLR (new RAU procedure). This leads to considerable impact on the MS and CN and open issues such as; how to distinguish different sorts of RAU.		High	**Open**

No	Description	Companies	Priority[12]	Status/Comments
	Possible dependence to LAU (e.g. via combined LAU/RAU procedure) has to be investigated.			
29	**Signalling transfer for handover via Um interface** Mechanisms for signalling transfer across radio interface have to be clarified. (e.g. RLC/MAC control messages or RR signalling message format, bandwidth requirements).		High	**Open**
30	**Interaction between handover and FLO** Clarify handover handling in case the impacted mobile uses FLO.		Medium	**Open**
31	**Handover message transfer BSSGP to GMM** Possibly the definition of a new SAP between BSSGP and GMM is required; the existing SAP GMM is currently used for messages originating from a GMM peer.		Low	**Open**
32	**Mobiles and TBF subject to handover** It has to be investigated how the BSS can decide which mobiles and which TBF's are subject to handover via enhanced Gb.		Low	**Open**
33	**Interaction between handover and an optimised LLC/SNDCP protocol handling (if required)** Use of optimised LLC/ SNDCP header might considerably impact handover, e.g. if the optimisation requires ciphering to be performed in BSS.		High	**Open**
34	**Handling of handover for mobiles in DTM state** Combined handover scenarios (ps&cs), especially required coordination between cs and ps domain need to be studied. (Note: currently in A/Gb mode the ps connection follows the cs handover decision in RAN).		Medium	**Open**
35	**Channel types to be supported by handover** Handover procedures will be impacted by the channel types to be handled. Clarify which channels types have to be considered (e.g PDTCH or TCH like channel ?. SDCCH ?).		Medium	**Open**
36	**Relation to RLC/MAC and multiple TBFs** It is for further study how radio channel will work together with general RLC/MAC functions as well as the support for Multiple TBFs.		Medium	**Open**
37	**Relation to FLO** It is for further study how the channel combination in solution one would work together with FLO.		Medium	**Open**
38	**Control entity** It is for further study where the control entity is located and which tasks it handles (e.g. connection set-up / release, handover, measurement reports etc); see TDoc AHAGB-010.		High	**Open**
39	**Solution 1: Layer 2** It is for further study whether RLC/MAC or LADPm is used as Layer 2 protocol for solution 1.		Medium	**Open**
40	**Multiple dedicated channels in DTM** Should it be possible to have more than one dedicated channel while in dual transfer mode (i.e. while one —or more (FFS)— TBFs are allocated to the same MS?		High	**Open**
41	**Direct transitions: packet transfer mode ↔ DTM** • Manufacturers to investigate the PS interruption time during these two transitions. • Once the previous point is cleared, operators to investigate whether such interruption is enough for PS services that may happen in parallel with a CS connection.		Medium	**Open** These transitions are visible to the end user.
42	**Information needed at DTM → packet transfer mode** In addition to PSI 14, is there any information that needs to be provided to the MS when releasing the CS connection while in DTM?		Low	**Open**
43	**Which protocol layer to support segmentation and re-assembly** SNDCP, FR, IP, underlying transport protocol or all of these.		Medium	**Open**
44	**SNDCP/LLC Solution 1: Removal of LLC functionality** What can be removed/moved from LLC header? What are the layers that need to be extended with functionality removed from LLC?			**Open**
45	**SNDCP/LLC Solution 1: Removal of SNDCP functionality** What can be removed/moved from SNDCP header? What are the layers that need to be extended with functionality removed from SNDCP?			**Open**
46	**SNDCP/LLC Solution 1: spectral efficiency** What is the expected spectral efficiency after scaling down LLC and SNDCP headers?			**Open**

No	Description	Companies	Priority[12]	Status/Comments
47	**SNDCP/LLC Solution 2 : spectral efficiency** What is the expected spectral efficiency if LLC/SNDCP headers are not scaled down?			**Open**
48	**SNDCP/LLC Solution 1 & 2: ROHC** ROHC on SNDCP?			**Open**
49	**SNDCP/LLC Solution 1 & 2: ROHC context relocation** ROHC context relocation mechanism to be applied			**Open**
50	**SNDCP/LLC Solution 2: LLC header size** If ciphering is kept in LLC, what is the LLC header size?			**Open**
51	**SNDCP/LLC Solution 1 & 2: LLC header size** If ciphering is moved from LLC, what is the LLC header size?			**Open**
52	**SNDCP/LLC Solution 1 & 2: Ciphering** If ciphering is removed from LLC, what is the entity that the ciphering functionality is added?			**Open**
53	**Conversational sub-classes** Are there different subclasses within conversational class service (i.e. optimised and generic)?			**Open**
54	**ROHC performance evaluation in Gb architecture** In the Gb architecture it is assumed that ROHC is placed in the SNDCP layer. A longer round trip delay (compared to GERAN Iu mode) will possibly degrade the performance of the compression algorithm in the case a re-initialisation of the ROHC context is needed. A study performance of ROHC in the Gb needs to be performed. This study should cover: • Quantitative effect of re-establishing the compressors in the SNDCP layer. • Its effect on speech quality. • Analysis of the impact of peer-to-peer delay on ROHC performance. • An assessment of how frequent ROHC context re-initialisations are.		High	**Open**
55	**Different size of compressed IP packets** It is for further study how the varying size of the compressed IP packets is handled.		Low	**Open**
56	**Inter SGSN handover** Configuration of SNDCP entities and relocation of ROHC context at an inter SGSN (intra-RAT) handover is for further study.		Medium	**Open**
57	**Inter-RAT handover** Configuration of SNDCP or PDCP entities and relocation of ROHC context at an inter-RAT handover is for further study.		Medium	**Open**
58	**Support of UEP** Clarify if there is a requirement to have support of UEP in an enhanced Gb mode.		High	**Open**
59	**UEP architecture** Clarify status of SA2 discussions in order to enable discussions on an overall architecture level.		Medium	**Open**
60	**Requirements for integrity protection** It is not clear at the moment: • Whether a requirement to introduce integrity protection in enhanced A/Gb mode exists. If yes, it needs to be studied to which messages it should apply. • Whether integrity protection can be applied to the PS domain only. • Whether integrity protection can be applied to NAS signalling messages only.		High	**Open** This needs to be discussed with SA3.
61	**Overall solution for integrity protection** A reasonable solution providing integrity protection for both CS and PS domain related signalling has not been provided so far.		Medium	**Open**

NOTE: Open issues marked with the '*' symbol are only mentioned in this table; the remaining ones also appear in similar tables throughout the document.

Annex B: Contact details

Table 27 contains the details for the contacts in the companies supporting the creation of the Work Item for this feasibility study.

Table 27 – Contact details

Company	Contact	Telephone	E-mail
Alcatel	Jacques ACHARD	+33 1 3077 0670	jacques.achard@alcatel.fr
AT&T Wireless Services	Bernard GUARINO	+1 425 580 5889	bernard.guarino@attws.com
Cingular Wireless	Marc GRANT	+1 512 372 5834	marc.grant@cingular.com
Ericsson	Gunnar MILDH	+46 8 764 12 24	gunnar.mildh@era.ericsson.se
Motorola			
Nokia Corporation			
Nortel Networks	René FAURIE	+33 1 39 44 51 06	faurie@nortelnetworks.com
Orange Group	Lionel OBADIA	+33 1 45 29 67 96	lionel.obadia@francetelecom.com
Siemens	Christina GEβNER	+49 89 722 34355	christina.gessner@icn.siemens.de
Vodafone Group Plc	José Luis CARRIZO MARTÍNEZ	+44 1635 676093	jose-luis.carrizo@vodafone.co.uk

Annex D: Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
24/4/2002		E-mail			Subject: [A/Gb+] Version 0.1.0 of feasibility study From: Carrizo Martinez Jose Luis To: 3GPP_TSG_GERAN@LIST.ETSI.FR Sent: Wed 24/04/2002 17:35		0.1.0
7/5/2002		E-mail			Subject: [A/Gb+] CR to Version 0.1.0 of feasibility study. From: Johan Magnusson (ERA) To: 3GPP_TSG_GERAN@LIST.ETSI.FR Sent: Tue 07/05/2002 16:02	0.1.0	0.2.0
14/5/2002		E-mail			Subject: [A/Gb+] Version 0.2.0 of feasibility study. From: Carrizo Martinez Jose Luis To: 3GPP_TSG_GERAN@LIST.ETSI.FR Sent: Tue 14/05/2002 10:05		0.2.0
30/5/2002		G2-020601			Requirements extracted by the editor from: "Real Time Services Over GERAN". Source: AWS, Cingular, Rogers, Vodafone Group		0.3.0
30/5/2002		G2-020605			Editor incorporated agreed changes (by GERAN2 #9bis) from: "Structure of Evolved Gb Feasibility Study & Enhancements". Source: Nokia.	0.2.0	0.3.0
30/5/2002		G2-020661			Editor incorporated agreed changes (by GERAN2 #9bis) from: "CR to the feasibility study v0.2.0". Source: Siemens.	0.2.0	0.3.0
31/5/2002		E-mail			Subject: [A/Gb+] Version 0.3.0 of feasibility study. From: Carrizo Martinez Jose Luis To: 3GPP_TSG_GERAN@LIST.ETSI.FR Sent: …		0.3.0
12/6/2002		AhAGb-026			“TR ab.cde; A/Gb mode evolution; Feasibility Study (v0.4.0)”; source: rapporteur; 3GPP TSG GERAN ad hoc meeting on A/Gb evolution (Stockholm, 11–13 June 2002) - Conversion of requirements into guidelines. - Addition of FFSs as editor’s notes. - Addition of tables of feature-specific open issues. - Addition of subclauses for integrity protection, ciphering and DTM enhancements. - Editorial corrections.		0.4.0
13/6/2002		AhAGb-028			“TR ab.cde; A/Gb mode evolution; Feasibility Study (v0.5.0)”; source: rapporteur; 3GPP TSG GERAN ad hoc meeting on A/Gb evolution (Stockholm, 11–13 June 2002) - Reorganisation of structure. - Addition of feature to clause 5. - Allocation of contributors to annex	0.4.0	0.5.0
19/6/2002		E-mail			Subject: Draft Requirements doc From: Guarino, Bernard To: 3GPP_TSG_GERAN_TDOC@LIST.ETSI.FR Sent: Wed 19/06/02 19:36	0.5.0	0.6.0
21/6/2002		E-mail			Subject: A-Gb Evolution V0.5.0 - CR to section 5.2 (multiple TBFs) - updat ed From: John Diachina (EUS) To: 3GPP_TSG_GERAN@LIST.ETSI.FR Sent: Fri 21/06/02 17:08	0.5.0	0.6.0
18/6/2002		E-mail			Subject: [A/Gb+] Draft CR to sub-clause 5.3 (Handover of PS Services) From: Pieroth Mathias To: 3GPP_TSG_GERAN@LIST.ETSI.FR Sent: Tue 18/06/2002 18:14	0.5.0	0.6.0
20/6/2002		E-mail			Subject: Re: [A/Gb+] Draft CR to sections 5.2, 5.4 and 5.8 of FS V0.5.0 From: Gunnar Mildh (ERA) To: 3GPP_TSG_GERAN@LIST.ETSI.FR Sent: Thu 20/06/2002 15:41	0.5.0	0.6.0
20/6/2002		E-mail			Subject: Re: [A/Gb+] Comments to the CR to section 5.5 of the feasibility stud y From: Carrizo Martinez Jose Luis To: 3GPP_TSG_GERAN@LIST.ETSI.FR Sent: Thu 20/06/2002 14:24	0.5.0	0.6.0
18/6/2002		E-mail			Subject: [A/Gb+] Draft CR to sub-clause 5.6 (Network Transport Aspects for the support of real time QoS) From: Davis, Simon	0.5.0	0.6.0

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
					To: 3GPP_TSG_GERAN@LIST.ETSI.FR Sent: Tue 18/06/2002 17:22		
20/6/2002		E-mail			Subject: Re: [A/Gb+] Draft CR to sub-clause 5.7 (Modification of SNDCP/LLC) From: Kari Pihl To: 3GPP_TSG_GERAN@LIST.ETSI.FR Sent: Thu 20/06/2002 15:14	0.5.0	0.6.0
18/6/2002		E-mail			Subject: [A/Gb+] Draft CR to sections 5.2, 5.4 and 5.8 of FS V0.5.0 From: John Diachina (EUS) To: 3GPP_TSG_GERAN_TDOC@LIST.ETSI.FR Sent: Tue 18/06/2002 19:38	0.5.0	0.6.0
21/6/2002		E-mail			Subject: [A/Gb+] LAST VERSION OF: Draft CR to sub-clause 5.9 (Protocol Asp ects Of Unequal Error Protection) From: Rene Faurie To: 3GPP_TSG_GERAN@LIST.ETSI.FR Sent: Fri 21/06/2002 14:35	0.5.0	0.6.0
20/6/2002		E-mail			Subject: Re: [A/Gb+] Draft CR to sub-clause 5.10 (Integrity Protection) From: Carrizo Martinez Jose Luis To: 3GPP_TSG_GERAN@LIST.ETSI.FR Sent: Thu 20/06/2002 13:21	0.5.0	0.6.0
24/6/2002	G #10	GP-021755			“TR ab.cde; A/Gb mode evolution; Feasibility Study (v0.6.0)”; source: rapporteur; 3GPP TSG GERAN meeting #10 (Helsinki, 24–28 June 2002). - Incorporations of the draft CRs to version 0.5.0, as agreed on the e-mail reflector. - Editorial corrections.		0.6.0

Summary of the A/Gb evolution ad hoc meeting

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- The meeting was held 11 - 13. 6. 02 in Kista/Sweden
- 37 people participated in the meeting, representing 15 different organisations
- 28 documents have been available
- The joint effort of the participants was to progress the feasibility study work started in GERAN #9
- Aim was to have more comprehensive input to the study for GERAN #10
- First discussions took place in GERAN #9bis and by means of the Email reflector

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AGENDA

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- 1. Opening of the meeting
- 2. Approval of the Agenda
- 3. Report from G2 bis #9 concerning A/Gb mode evolution
- 4. Review of the feasibility study report
    - 4.1. Review of its structure
    - 4.2. Review of Requirements and Guidelines section
    - 4.3. Other contributions towards the feasibility study report
- 5. Contributions on features for A/Gb evolution
    - 5.1. Handover of PS services
    - 5.2. Support of real time QoS Classes
    - 5.2.1 Radio support for real time QoS
    - 5.2.2 Network support for real time QoS
- 5.3. IMS Support
- 5.4. Security
- 5.5. Multiple TBF (in relation to the above mentioned issues)
- 5.6. Other technical contributions
- 6. Outcome and input for GERAN #10
- 7. Any other business
- 8. Closing of the meeting

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Work report

- The meeting initially reviewed the structure of the feasibility study
- The treatment of the requirements and guidelines was matter of a debate.
  It was finally found that it is more beneficial to review the technical contributions first.
- All the requirements in section 4 were therefore considered of a guideline character for the moment in time
- The review of the technical contributions in section 5 was executed entering great level of detail
- All available documents were reviewed during the meeting
- A procedure was agreed to progress the report in the given tight time schedule

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Procedure to progress the feasibility study

- It was agreed that all written contributions dealt in that meeting shall be attached to an annex for information.
- For the sub-sections in section 5 text proposals have to be drafted
- The draft parts are allocated to individual companies, which take the responsibility to text fitting to the sub-section structure.
- This first text has to be provided to the Email reflector for review. Deadline for this is the 18.06.02
- If there are comments, and conflicting views get identified, the issues shall be resolved by email discussion until 20.06.02
- The final version has to be delivered to the rapporteur 21.06.02 04:00 UTC.

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Subsection drafting

- If more than one solution exists, the solutions shall be described independently
- Common elements of different solutions shall be found in a common part
- For each of the sub-section issues some input shall be drafted
- Identified Open issues are added to each of the subsections
- Estimated effort in standardisation should also be indicated

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Structure of Chapter 5

- **Multiple parallel data flows between BSS and MS;**
- **Handover of PS services;**
- **Radio channel support for real time QoS;**
- **DTM enhancements;**
- **Network transport aspects for support of real time QoS;**
- **Modification of SNDCP/LLC;**
- **IP header adaptation;**
- **Protocol aspects of Unequal Error Protection;**
- **Integrity protection; and**
- **Ciphering.**

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Example of the structure of subsections

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- 5.2.1. Introduction
- 5.2.2. Requirements and guidelines
- 5.2.2.1. Requirements
- 5.2.2.2. Guidelines
- 5.2.3. Relationship with other features
- 5.2.4. Description of the solution(s)
- 5.2.4.1. General description of the solution
- 5.2.4.2. Impact on the protocol layers
- 5.2.4.3. Impact on the system elements
- 5.2.4.3.1. Impact on the terminal
- 5.2.4.3.2. Impact on the RAN
- 5.2.4.3.3. Impact on the CN
- 5.2.4.4. Impact on the standards
- 5.2.4.4.1. Affected specifications
- 5.2.4.4.2. Estimated standardisation time
- 5.2.5. Open issues

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- Features — Companies
- 4 Requirements and guidelines — AWS
- 5.2 Multiple parallel data flows between BSS and MS — Ericsson
- 5.3 Handover of PS services — Siemens
- 5.4 Radio channel support for real time QoS — Ericsson
- 5.5 DTM enhancements — Vodafone
- 5.6 Network transport aspects for the support of real time QoS — Siemens
- 5.7 Modification of SNDCP/LLC — Nokia
- 5.8 IP header adaptation — Ericsson
- 5.9 Protocol aspects of Unequal Error Protection — Nortel Networks
- 5.10 Integrity protection — Siemens
- 5.11 Ciphering — na

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Outcome of the meeting

- The meeting reviewed all documents and agreed a procedure to progress the feasibility study
- The level of technical discussion was very detailed
- The meeting was not in a position to draw a general conclusion from the discussions now
- GERAN #10 is therefore asked to give guidance whether or not the FS shall be continued
- The feasibility study as provided to GERAN #10 reflects the technical discussion as progressed so far

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