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Technical Report

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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

This present document is for the Release 6 work item "Improvement of RRM across RNS and RNS/BSS"(see [1]).

Based on the Release 5 study (see 3GPP TR 25.881[2]), a Release 5 solution was accepted. The objective of this work item is to work on possible further improvements to the Release 5 solution.

The purpose of the present document is to help TSG RAN WG3 to specify the different schemes to improve the RRM acoross RNS and RNS/BSS and to compare them.

This document is intended to gather all information in order to trace the history and the status of the Work Task in RAN WG3. It is not intended to replace contributions and Change Requests, but only to list conclusions and make reference to agreed contributions and CRs. When solutions are sufficiently stable, the CRs can be issued.

This document identifies the affected specifications with related Change Requests.

It also describes the schedule of the Work Task.

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

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. 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.*

[<seq>] <doctype> <#>[([up to and including]{yyyy[-mm]|V<a[.b[.c]]>}[onwards])]: "<Title>".

[1] 3GPP TD RP-01094: "Work Item Description for Improvement of RRM across RNS and RNS/BSS".

[2] 3GPP TR 25.881: "Improvement of RRM across RNS and RNS/BSS".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the [following] terms and definitions [given in ... and the following] apply.

<defined term>: *<definition>.*

example: text used to clarify abstract rules by applying them literally.

3.2 Symbols

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

<symbol> <Explanation>

3.3 Abbreviations

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

<ACRONYM>	<Explanation>
BSS	Base Station Sub-system
CRRM	Common Radio Resource Management
IS HO	Inter System Handover
NCCR	Network Controlled Cell Reselection
RNC	Radio Network Controller
RNS	Radio Network Sub-system
RRM	Radio Resource Management
SI	Study Item
WI	Work Item

4 Introduction

4.1 General

At the 3GPP TSG RAN #14 meeting, based on the study result of the Release 5 SI, "Improvement of RRM across RNS and RNS/BSS", a first solution was introduced. It was also decided to create the WI, "Improvement of RRM across RNS and RNS/BSS" to work on further enhancement to the Release 5 solution.

This chapter introduces the background of this WI and the reason why RRM is important in multi-radio environment.

In the future, the mobile network configurations will not be as simple as in nowadays. Multiple cells from different radio technologies will be overlapped in the same area and multiple layers will co-exist. In this complicated environment, multi-mode mobile can be connected to different cell and unless there is knowledge about each cell it would be very difficult to optimise network performance and to manage resources efficiently.

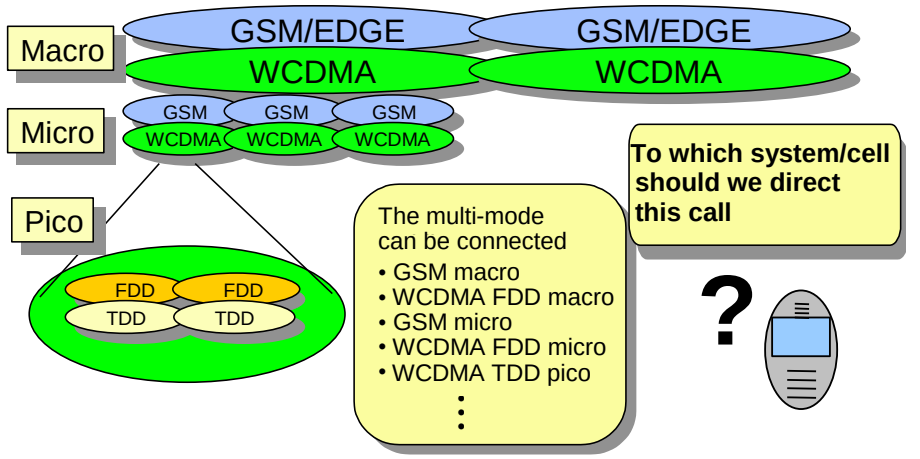

Figure 1: Future Mobile Network Environment

In addition, it would be reasonable to direct different services with different QoS classes to the most suitable radio accesses.

To consider the above situation in Release 5, TSG RAN WG3 and TSG GERAN has a solution. This new WI is intending to further enhance RRM across RNS and RNS/BSS for further releases.

4.2 CRRM functional model

Note: This functional model is not intended to restrict any further CRRM solutions.

4.2.1 Introduction

In this section the CRRM functional model is described including different possibilities of how CRRM mechanisms could be realised and how functional entities may be mapped into physical entities.

4.2.2 Functional model description

The whole set of radio resources for an operator is considered to be partitioned into "radio resource pools".
These radio resource pools are controlled by two different types of functional entities:

- RRM entity: functional entity responsible for Radio Resource Management of *one* radio resource pool, i.e. this characterises the radio resource pool
- CRRM entity: functional entity responsible for a Common Radio Resource Management, i.e. coordination of overlapping/neighbour radio resource pools controlled by different RRM entities.

This new CRRM entity is introduced to allow some kind of coordination among different radio resource pools whose radio resources are linked to the same geographic area in the network.

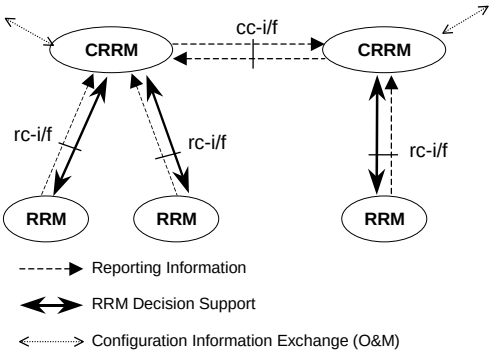

Figure 2: CRRM functional model

4.2.2.1 Functional entities

4.2.2.1.1 Radio Resource Management functional entity

One RRM functional entity represents those radio resource management functions that control one certain pool of radio resources within one radio access network. Such a radio resource pool typically consists of the radio resources of several cells.

Radio resource management in the UTRAN affects different physical entities in a radio access system: e.g.: Node B and UE are contributing by measurements, RNC is controlling the radio resources. However, for the purpose of modelling CRRM, the RRM functions – irrespective of their actual physical location – are shown as one functional entity which resides in one place (typically in an RNC or BSC) which is responsible for the radio resources.

4.2.2.1.2 Common Radio Resource Management functional entity

The main purpose of the CRRM functional entity is to support RRM decisions so that the availability of radio resources in other RRMs and/or other RANs are taken into account. So "CRRM is responsible for that RRM entity" means the CRRM entity supports decisions of a certain RRM entity.

One CRRM entity may be responsible for several RRM entities. In addition, a CRRM entity may have information on the state of RRM entities that are not directly under its responsibility. But such information may only be obtained by communicating with the CRRM entity that is responsible for the according RRM entity.
For the sake of simplicity, this functional model defines that each RRM entity is under the responsibility of one and only one CRRM entity.

4.2.2.2 Interfaces and functions

Figure 2 shows the resulting functional model with the following interfaces between the functional entities:

- rc-i/f: between RRM and CRRM,
- cc-i/f: between two CRRM entities.

The functional relationships between the entities of the functional model are based on two types of functions:

- Reporting Information,
- RRM Decision Support.

Also possible interactions of CRRM with O&M for the exchange of configuration information are indicated (note: interactions of RRM with O&M are not included in the figure).

While rc-i/f supports both types of functions, cc-i/f only supports "Reporting Information" and can thus be regarded as a subset of the rc-i/f. In the following the two functions on these interfaces are described in more detail.

4.2.2.2.1 "Reporting Information" function

The "Reporting Information" function is a one way exchange of static (e.g. like cell capacity) or dynamic information (e.g. measurements like load of a cell). Note that Figure 2 shows only the direction of the report. This does not exclude to trigger such a report from the other direction.

Each RRM entity in the functional model may be requested by its responsible CRRM entity to report certain information (e.g. measurements) with respect to its radio resources. This function shall allow for requesting immediate replies to a measurement request as well as event- or timer-triggered measurement reporting. It is assumed that this reporting is controlled by the responsible CRRM entity.

In addition on the cc i/f, one CRRM entity may request information on radio resources for which it is not responsible from a different CRRM entity which is responsible for these radio resources.

4.2.2.2.2 "RRM Decision Support" function

Each RRM entity in the model may be influenced by one and only one CRRM entity. The "RRM Decision Support" function describes how the CRRM entity takes influence on the RRM entity for which it is responsible, e.g. how it might affect a handover decision.

4.2.3 Application of the CRRM functional model

The question how the two basic functions "Reporting Information" and "RRM Decision Support" are realised by specific procedures and how the CRRM functional model is applied depends on how CRRM is implemented in a network:

1. What kind of CRRM topology, i.e. mapping of functional entities to physical entities, is used:
   a. centralised in new physical nodes,
   b. integrated into existing nodes (this might be also centralised or distributed).

   NOTE: Of course it might also be possible (e.g. for migration reasons) to combine 1a. and 1b. in a mixed CRRM topology provided that both use compatible CRRM implementation related to the following CRRM schemes.

2. Who is the master of decisions (e.g. for handover):
   a. CRRM only advises the RRM entity (RRM is master),
   b. CRRM decisions are binding for the RRM entity (CRRM is master).

3. How tight is the coupling between CRRM and RRM, i.e. how frequent is the interaction between CRRM and RRM entities?
   a. Tight coupling: CRRM is often directly involved in the RRM decisions, e.g.: involved in every Inter System Handover (IS HO) / Network Controlled Cell Reselection (NCCR),
   b. Loose coupling: CRRM defines CRRM policies for the RRM entities and maintains them up to date, e.g.: policy is valid for every IS HO/NCCR until the policy is changed

4.2.3.1 Examples of the functional model applicability

This section provides examples on how the functional model can be used to describe and classify different CRRM solutions.

The following CRRM topologies are provided:

- CRRM integrated into every RNC/BSC,
- CRRM integrated only in some RNC/BSCs,
- CRRM as a stand-alone server.

4.2.3.1.1 CRRM integrated into every RNC/BSC

As illustrated in Figure 3, this approach is characterised by the co-location of RRM and responsible CRRM entities. The functional interface between RRM and CRRM is not realised as an open interface in this solution. Only "Reporting Information" is exchanged over open interfaces.

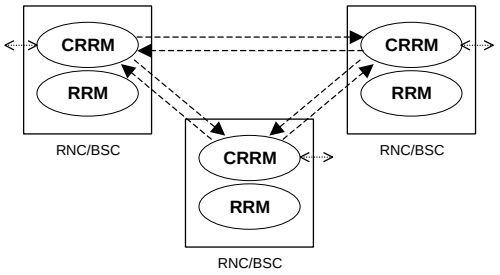

Figure 3: CRRM integrated into every RNC/BSC

This approach is in line with the 'Integrated CRRM' solution proposed in [2] and it reflects the current Release 5 CRRM solution.

The current CRRM solution of Release 5 allows to transfer load information from one RNC in the UTRAN to one BSC in the GERAN and vice versa using the common measurement procedures on Iur-g or handover/relocation procedures via A/Iu interface.

Within the UTRAN the common measurement procedures on Iur can be used.

Only "Reporting Information" function on the interface between different CRRM entities is standardised (mainly as a cell load exchange).

The "Reporting Information" function between CRRM and RRM entities and the "RRM Decision Support" is vendor specific since the CRRM entity must be integrated in every RNC/BSC which has to support CRRM.

4.2.3.1.2 CRRM integrated only in some RNC/BSCs

As illustrated in Figure 4, CRRM is co-located with RRM for only one RNC/BSC. This approach is characterised by being integrated and allowing for open interfaces between RRM and CRRM (for the cases where RRM is not co-located with CRRM). Both "Reporting Information" and "RRM Decision Support" function need to be standardised.

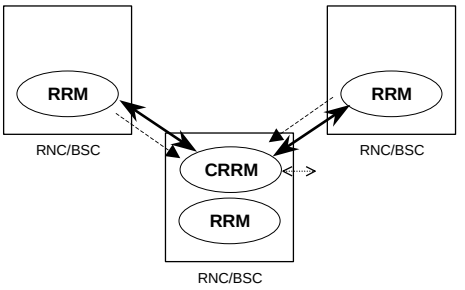

Figure 4: CRRM integrated only in some RNC/BSCs

This approach was not included in [2] but the case where CRRM is integrated into every RNC/BSC (see section before) can be considered as a subset of this case.

Note: This approach may also consider CRRM to CRRM interactions on the cc i/f. This was just omitted in Figure 4 for simplicity reasons.

4.2.3.1.3 CRRM as a stand-alone server

As illustrated in Figure 5, this approach implements RRM and CRRM entities into separate nodes. All of the interfaces among RRMs and CRRMs are open. Both "Reporting Information" and "RRM Decision Support" functions need to be specified.

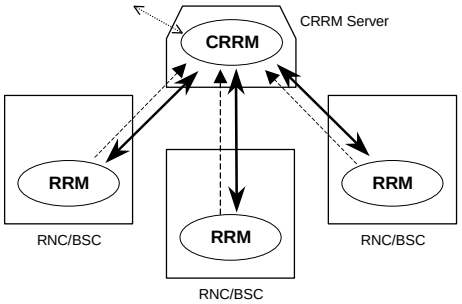

Figure 5: CRRM as a stand-alone server

This approach is in line with the 'CRRM Server' solution proposed in [2].

Note: This solution does not necessarily imply a tight CRRM to RRM coupling (see above) by directly involving CRRM into every IS HO/NCCR, however mostly it was associated with this implementation.

5 Analysis of existing RRM and CRRM mechanisms

This aim of this sub-clause is to analyse any drawbacks of the existing CRRM mechanisms in Release 5 specifications.

1. The current standardisation of the Iur-g means that the Iur-g based CRRM solution is only possible for Iu-mode BSCs. Therefore this mechanism for CRRM could not be carried out between A/Gb-mode BSCs and between A/Gb-mode BSCs and RNCs.

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6 Requirements

6.1 General

To provide optimal resource management and to optimise network performance in multi-radio/multi-vendor environment, any solution (new/enhanced) shall consider the following requirements:

Multi-vendor operation: The solution shall work efficiently in multi-vendor environment.

Backward compatibility: The solution shall be backward compatible and shall affect to existing interface as little as possible.

Transparency to UE/MS: The solution shall not affect to UE/MS functionality/specifications at all.

7 Study Areas

7.1. General Proposals

The aim of this sub-clause is to capture all of the proposals for enhancements to CRRM functionality. Note that this sub-clause is NOT intended to detail or analyse Reporting Information parameters. This analysis will be done in sub-clause 7.2.

7.1.1 CRRM policy based approach

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7.1.1.1 ~~7.1.1~~ Concept

The basic idea behind the "Policy-based CRRM approach" is the standardisation of parameters and information exchange over an open interface between RRM and CRRM entities. This would enable the CRRM entity to provide CRRM policies to the RRM entities, thus allowing the traffic situation in the network to be dynamically adjusted on the basis of a common strategy.

In this proposal the CRRM entity only acts as an advisor, so that the RRM entities still take the final decisions (RRM is the master), but based on parameters adjusted by CRRM.

Such an advice may be for example that CRRM sets some load targets for the cells. Only above these load targets the RRM will consider triggering a load reason cell change.

To choose the best target cell further information about the capacity/load situation of possible candidates is provided by the CRRM to the RRM entity. This information might be a relative ranking of cells or a more detailed information as already agreed for Release 5.

For the Policy-based CRRM approach it is proposed to have a loose coupling between CRRM and RRM entities, i.e.: CRRM policies are valid in the RRM entity for all handovers until the policy is changed by the CRRM entity. (if the policy for a given cell is not changed for more that the time indicated by a certain time-out, than it is assumed that the CRRM entity failed). While the RRM entities take the fast decisions required for each Access Request or Handover Request, the CRRM entity works at a slower time scale and provides policies to the RRM entities whenever an update is necessary. In this sense the frequency for a policy update depends on the traffic variations within the involved cells. The updating frequency can also be subject to configuration.

It is proposed to adopt a centralised CRRM implementation (as in Figure 4 or as in Figure 5), for which it is necessary to standardise an "RRM Decision Support" procedure (see 4.2.2.2.2) that allows the CRRM entity to also take influence on non co-located RRM entities. The CRRM entity can therefore allow for some kind of coordination among different radio resource pools linked to the same geographic area in the network.

Note that the CRRM entity would be able to work on a faster time scale than O&M, in order to dynamically react to traffic load variations in overlapping radio resource pools. The reason for this is that common functions for load control over a certain geographic area (CRRM) should reside in a more dynamic entity than O&M.

In case of CRRM entity failure it is assumed that the supported RRM entities can continue with the last available policy, and after some time-out they can fall back to a predefined default policy. In the latter case, the network performance in the affected area would fall back to the case where no CRRM exists. However, we assume that the probability of such an event is negligible.

7.1.1.2 ~~7.1.2~~ Policy based CRRM: possible procedures

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The "CRRM policy based approach" describes the functional relationship between CRRM and RRM by three functions:

1. CRRM triggers RRM to report measurement/load information or RRM reports initiated by the RRM entity itself.
2. CRRM can inform RRM about CRRM related information (e.g. : cell capacity and load situation of neighbour cells which are not under control of this RRM function.
3. CRRM sets load targets for the RRM functions for which the CRRM entity is reponsible.

This can be obtained by the following four procedures (note: parts of these procedures may be realised in a similar way to the Release 5 common measurements over Iur):

- Measurement Initiating Procedure (CRRM initiated):
  CRRM triggers RRM to report a load measurement for a cell which is controlled by this RRM function. This request can be answered by the corresponding report or just an acknowledgement (similar to Common Measurement Initiation on Iub/Iur) or it can be rejected (definition of cause values is ffs).
  The report characteristics may be e.g. periodic (time parameter), on demand or event driven (e.g. by a load level).
  The possibility to report load measurements for more than 1 cell at one time should be allowed.

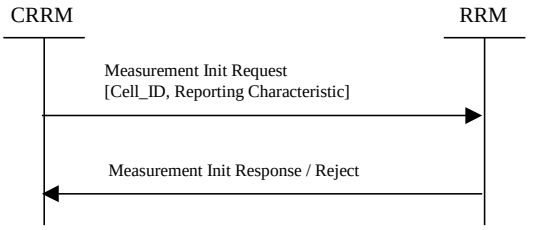

Figure 6: Measurement Initiation Procedure

- Measurement Reporting Procedure (RRM initiated):
  Here the RRM may report load measurements per measurement object to the CRRM which is responsible for this RRM.
  The report can be similar to the Common Measurement Report procedure on Iub/Iur.

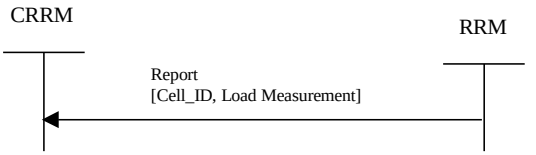

Figure 7: Measurement Reporting Procedure

- Neighbour Cell CRRM Information Procedure (CRRM initiated):

Based on the measurements received from different RRMs the CRRM derives the "Neighbour Cell CRRM

Information" (distinguished per cell and per service) and sends it to all possibly affected RRM instances (neighbour cells in this sense are only those neighbour cells controlled by neighbour RRMs, since for cells of its own RRM no support is needed).

This information is then used by the RRM in case of a handover (if cells of neighbour RRMs are involved) to prioritise the target cell.

NOTE: In contrast to the current Release 5 concept the "Neighbour Cell CRRM Information" does not need to be the actual load information. Since CRRM will get the actual load situations from the RRM entities (and other CRRM entities if needed) it would be sufficient to send just a ranking of target cells to the RRM entity which has to decide about a cell change.

This procedure allows CRRM some centralised control functionality about the load distribution although RRM still takes all decisions about cell changes.

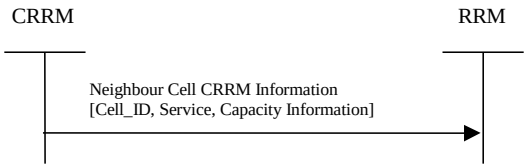

Figure 8: Neighbour Cell CRRM Information Procedure

- Load Target Setting Procedure (CRRM initiated):
  When a load target – which can dynamically be set by CRRM per cell – is exceeded, the serving RRM of the according cell takes autonomous RRM decisions based on the provided policy (Neighbour Cell CRRM Information, e.g. ranking of target cells). This concerns the following RRM decisions:
  - Handover due to load reasons
  - Redirect due to load reasons

  The procedure advises RRM to aim at a certain load level within a cell, however the resulting actions must not increase blocking and dropping rates for calls in the corresponding cell

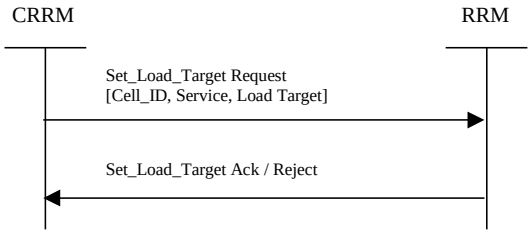

Figure 9: Load Target Setting Procedure

7.1.1.3 ~~7.1.3~~Policy based CRRM: possible implementations

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For all the load definitions of this concept the currently defined 3GPP Release 5 load definition can be reused (whether it fits exactly or further additions are useful is tbd).

For the **integrated CRRM** solution the already available common measurement exchanges on Iur (and later Iur-g) can be reused.

The Neighbour Cell CRRM Procedure and the Load Target Setting Procedure would be needed on the Iur/Iur-g interface.

In this case, there would exist two kind of nodes:

- CRRM manager nodes: with a CRRM function inside,
- CRRM agent node: without a CRRM function inside, but still able to communicate with the responsible CRRM entity.

For the **CRRM server** solution the common measurement procedures of the Iub/Iur could be reused for the new interface. Neighbour Cell CRRM Information Procedure and the Load Target Setting Procedure would be needed in addition.

So standardising the Neighbour Cell CRRM Information Procedure and the Load Target Setting Procedure would allow full flexibility to choose an arbitrary CRRM topology and provided that the whole network uses a ‚CRRM policy based approach' it would even be possible to combine different CRRM topologies in one network.

What was not yet considered in this contribution is the CRRM to CRRM information exchange. For simplicity this exchange can be similar to the load reporting from the RRM entity to the CRRM entity.

Another point which needs some further examination is whether it is useful to express load values relative to its maximum cell load or relative to the target cell load given by CRRM.

7.1.1.4 ~~7.1.4~~Open Issues

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The following open issues related to the policy based CRRM approach have been identified.

- Main open issue: How are the policies defined? Other issues that directly depend on the mail open issue: Is it possible to define CRRM policies that can interoperate with vendor-specific RRM entities? How frequently is an update of the RRM policy by the CRRM entity needed? How is this approach distinguished from network planning? (Especially in the case that update frequency is low.) What is the exact function split between RRM and CRRM? May there be a conflict between CRRM and RRM entities? How to guarantee stability of the CRRM schemes applied in a network?

7.2 Enhancements to Reporting Information

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This sub-clause intends to study different proposals for enhancing the "Reporting Information" parameters, which were defined in Release 5 on the UTRAN Iur, Iu, and Iur-g interfaces, and GERAN A interface.

~~8~~7 Agreements and associated Contributions

The main text of the document should start here, after the above clauses have been added.

~~8~~9 Specification Impact and associated Change Requests

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~~9~~10 Project Plan

~~9~~10.1 Schedule

Date	Meeting	Scope	[expected] Input	[expected]Output

~~9~~10.2 Work Task Status

	Planned Date	Milestone	Status
1.			
2.			

Annex A:
Change history

It is usual to include an annex (usually the final annex of the document) for reports under TSG change control which details the change history of the report using a table as follows:

Change history							
Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	Old	New