3GPP TR 25.801 V1.0.0 (2003-05)

Technical Report

3rd Generation Partnership Project;
Technical Specification Group TSG RAN 3;
Feasibility study for improved access to User Equipment (UE) measurement data for Controlling Radio Network Controller (CRNC) to support Time Division Duplex (TDD) Radio Resource Management (RRM)
(Release 6)

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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 purpose of the present document is to help the TSG RAN WG3 group to study aspects of improving CRNC access to UE measurements in preparation for a WI on this topic, as proposed in [1].

As requested by TSG-RAN, the document describes the consequences of the CRNC not having access to UE measurements in the case that the serving RNC does not match the controlling RNC, additionally it studies the complexity of the proposed solutions so that an evaluation of the incremental gain of a solution can be weighed against its additional complexity.

This document is a 'living' document, i.e. it is permanently updated and presented to all 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.*

[1] RP-020901 Study Item Description: "Improved Access to UE Measurement Data for the CRNC to Support TDD RRM", approved at TSG RAN#18.

[2] 3GPP TS 25.401: "UTRAN Overall Description".

[3] 3GPP TS 25.102: "UE Radio Transmission and Reception (TDD)", v5.3.0.

[4] 3GPP TR 25.952: "TDD Base Station Classification", v5.1.0.

[5] 3GPP TS 25.423: "UTRAN Iur interface RNSAP signalling ", v5.4.0.

[6] 3GPP TS 25.433: "UTRAN Iub interface NBAP signalling ", v5.3.0.

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.

DCA Dynamic Channel Assignment

3.2 Symbols

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

3.3 Abbreviations

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

4 Introduction

As indicated in [1], in Rel99/Rel4/Rel5 the CRNC does not have access to UE measurements when the CRNC is a drift RNC (SRNC does not equal CRNC).

In [2], the Dynamic Channel Assignment (DCA) function for TDD is described as follows:

"DCA is used in the TDD mode. It includes Fast DCA and Slow DCA. Slow DCA is the process of assigning radio resources, including time slots, to different TDD cells according to the varying cell load. Fast DCA is the process of assigning resources to Radio Bearers, and is related to Admission Control. "

As a quick example, one DCA function is the process of assigning/reassigning resources in one timeslot based upon the current load.

The objective of this study is to identify the consequences for DCA of not having UE measurements for drift UEs and the complexity of solutions that would give the CRNC access to UE measurements under in all cases.

5 Requirements

The following requirements for the study are identified:

1. The solution should not have any effect on the UE or Uu interface.
2. The solution should not depend upon the reliance of the use of SRNS relocation to eliminate the use of DRNCs entirely.
3. The proposal should not overburden any of the interfaces (Iub/Iur) with excessive traffic.

6 RAN3 Study areas

6.1 General

Any new functionality introduced in Release 6 should be introduced with the least possible impact to the existing R99/R4/R5 specifications.

6.2 Description of Benefits of the CRNC Having Access to UE Measurements

6.2.1 Description of DCA in TDD and its Use of UE Measurements

In TDD mode, given its timeslot structure, the need for a dynamic channel allocation algorithm is necessary. Since each downlink and uplink timeslot has its own unique power and interference characteristics at a given moment in time. The DCA algorithms give the CRNC the ability to assign users to the various timeslots given the current load of each timeslot and the needs of the particular UE. The DCA algorithm will assign new users to the appropriate timeslots and if necessary move existing users around to the most appropriate timeslots.

A good example of the methods of DCA can be shown by simple examples based on the following diagram. In this diagram all of the pictured UEs are assigned one timeslot each in the uplink, UE-1, UE-2, and UE-3 are currently assigned to timeslot 4 and UE-4 and UE-5 are assigned to timeslot 6.

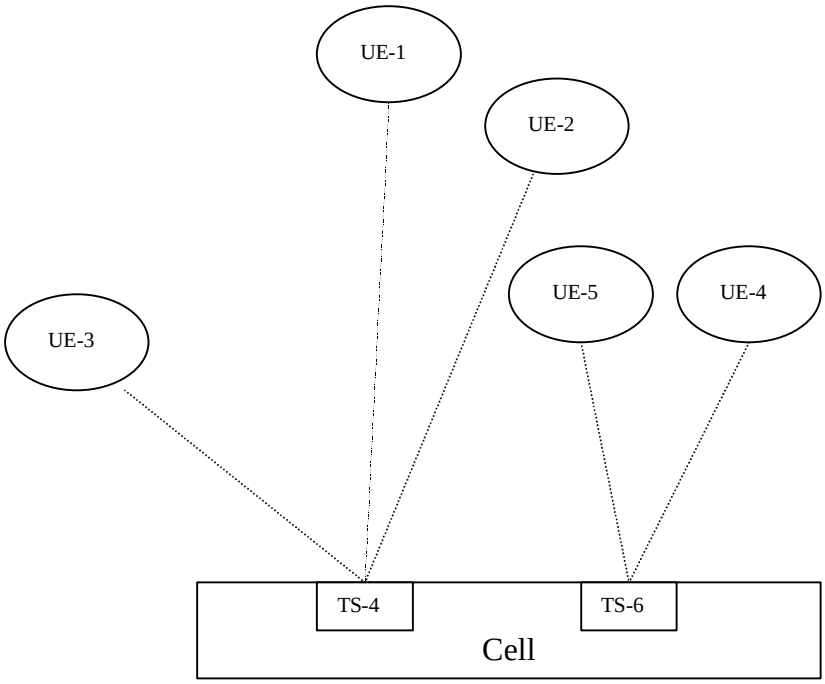


Figure 1: Example of 5 UEs in a Cell

For the first example timeslot number 4 (currently used by UE-1, UE-2, and UE-3) has too much interference reported just above the CRNC threshold in the uplink (determined by the common timeslot ISCP measurement reported using NBAP, for example). In timeslot number 6 (currently used by UE-4 and UE-5) the measured ISCP is 30% below the same threshold. If UE-1, and UE-2 are contributing 40% of the interference and UE-3 is contributing 20%, the CRNC should (assuming no other timeslots are available) move UE-3 from timeslot 4 to timeslot 6. It can estimate the interference by looking at UE transmit power and the reported UE path loss. However if the CRNC <> SRNC for all of these UEs, the CRNC would have no way of estimating how much of the interference UE-1, UE-2 or UE-3 are contributing to the timeslot so it would have to base the decision on which one to move almost randomly. Therefore in two of three random selections (if UE-1 or UE-2 are chosen), the problem is just moved from one timeslot to another. Note that the selection of the UE is only part of the problem; the real problem is to not being able to predict the current load each UE is putting on each timeslot and the load that would be put on the new timeslot if the UE was moved. In face if for example if the load that each of the 3 UEs put on timeslot 4 were 33%/33%/33% instead of 40%/40%/20% the proper decision would be not to move any of the UEs and perhaps look to other methods to reduce load like moving other users (users where this RNC is the SRNC) to other cells.

For the second example consider that a new UE (UE-6) has moved into this cell's coverage and will be handed over from another cell. In the case that this new user is now in a cell where the new CRNC <> SRNC, the Radio link setup or Radio link addition over the Iur will include (if available) the P-CCPCH RSCP (used to calculate path loss) and thus there will be some information in the CRNC to estimate the effect of the user on uplink interference and the DCA will have information on whether the user can fit into timeslot 4 or 6 based on the current interference of the timeslots and the estimate (based on path loss) that the new user (UE-6) would add.

6.2.2 ISCP Measurement Coordination

The SRNC and CRNC have different needs concerning DL timeslot ISCP. The SRNC, given that it is responsible for user QoS, is concerned with the DL timeslot ISCP for the timeslots currently in use. The CRNC being responsible for the cell is concerned not only with the ISCP for the timeslots in use, but with all of the timeslots that the DCA may move the user, in order to maximum cell utilization.

The UE battery power is greatly assisted in the time duplex nature of TDD, given that even when a TDD user is continuously active, the UE can still reduce power during the timeslots it which it does not need to transmit, receive, or measure. For example a TDD UE with a continuous voice service may be "shut down" for 12 of the 15 timeslots. (1 uplink transmit timeslot, 1 downlink receive timeslot, and the P-CCPCH/beacon timeslot). However it is acknowledged

that any UE will have additional overhead since the UTRAN will need additional measurements for proper operation. The need for measurements has to be balanced against UE battery power since every timeslot it is awake, the amount of power it needs is increased.

Since the SRNC does not know the needs of the CRNC (unless SRNC = CRNC) the SRNC has three choices:

1. Don't request the UE to measure additional DL timeslots
2. Request that the UE measure all DL timeslots
3. Pick out "randomly" some additional timeslot(s) to measure and hope that the CRNC can make use of the information.

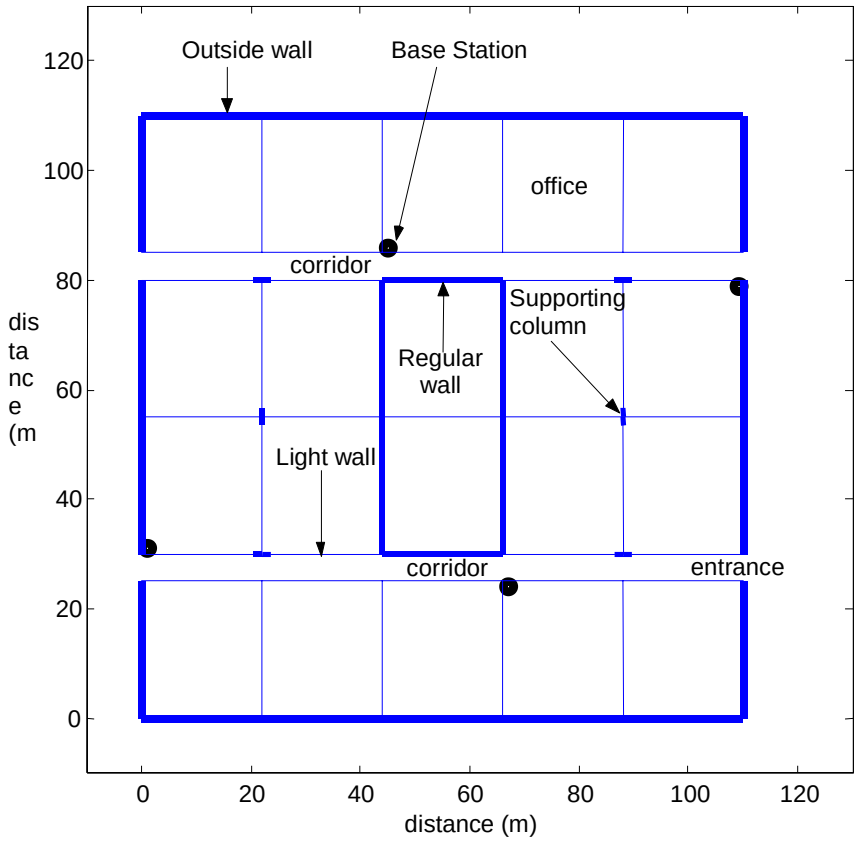
This is particularly important since any good CRNC implementation would ask the UE only for the minimum number of necessary measurements for proper function of DCA, and in particular certain RRM algorithms which more or less segregate real-time and non-real-time (for example an implementation that had 4 timeslots of DCH, and 6 timeslots of DSCH) would benefit here since a UE with an active real-time service would only need to send at most 3 additional timeslots of ISCP measurements for full DCA operation in the CRNC.

Thus it is clear that overall network is benefited if there can be coordination between the CRNC and UE (possibly through the SRNC) on limiting the number of timeslots that UE has to measure for ISCP.

6.2.3 A Look at a Possible Scenario

Although each vendor's RRM algorithms are different, it is possible to simulate some theoretical gains that are achieved by full access to UE measurements in the CRNC.

Take a typical indoor environment such as:



An indoor environment is a conservative choice for this purpose since there are less sources of interference than in other scenarios with more base stations and thus even more dependant on UE reporting, although a scenario like this is very possibly less likely to involve multiple RNC's.

Simulation parameters:

Downlink Simulation using a snapshot model. Where each snapshot models random distributions of UEs with in the service area. The results were generated with 2500 snapshots.

Path loss model: As in [4] (with internal walls modelled individually)

Each user has 144 kbps bit rate (9 codes) channel, as defined in [3] as the 144 kbps reference channel

Required Eb/No is 11 dB (provides a BLER of ~10% with Case 2 multipath channel according to [3]).

Assumed MUD efficiency is 95%, UE noise figure 9 dB

BS maximum transmission power 22 dBm

BS antenna gain (net of cable loss) = 2 dB

Let:

Pu the probability of measurement unavailability due to SRNC in a different node from CRNC

Pd the probability of user not meeting its quality requirement (and dropped)

Nu the number of users in the scenario

- If Pu = 0% (measurements always available), then with Nu = 21 users, Pd = 2%
- If Pu = 10% (10% of users with no UE measurements), then with Nu = 16 users, Pd = 2%

This represents a capacity loss of (21-16)/21 = **23.8 %, (**when one uses as a capacity criterion the number of users such that the probability of the user not meeting its quality requirement is held at 2%) with 10% of the users having no UE measurements in the CRNC.

6.3 Description of the Existing Methods in the Standards to Provide for or Mitigate the Need for UE Measurements

6.3.1 Initial RL Setup

In [5], RADIO LINK SETUP REQUEST includes (if available) P-CCPCH RSCP and DL Timeslot ISCP to allow for the CRNC to set correct initial downlink power and to perform call admission control. Additionally, RADIO LINK ADDITION REQUEST, and RADIO LINK RECONFIGURATION PREPARE also include the same parameters to allow for call admission control to also be performed when adding new radio links. Note that the setting of initial downlink power and call admission control consist of functions that attempt to evaluate the effect of adding a user to a cell, and that the DCA functions described in section 6.2 attempt a similar function but instead of evaluating the addition of a new user it tries to evaluate the effect of moving a user from its existing physical channel configuration to another physical channel configuration.

6.3.2 DL Power Timeslot Control

In [5] and [6], the DL POWER TIMESLOT CONTROL message is used to forward DL Timeslot ISCP from the SRNC to the Node B to assist in potentially offsetting power among timeslots during normal operation. Additionally, in release 5 P-CCPCH RSCP was also added to the procedure to assist in power setting of HS-DSCH. In general this would mean that the CRNC would receive periodically current ISCP and possibly RSCP and could use them in DCA functions. The problems with using this procedure in this way is that the CRNC has no say in how frequent ISCP will be available leading to some possible inter-vendor interoperability problems. Additionally and more importantly, since this procedure is used for power control, an SRNC will only need to send ISCP for the current timeslots in use by this UE.

The DCA functions described in section 6.2 needs ISCP for other timeslots and thus it has the same problem as in the initial RL section above, the UE measurements are probably available but only for the currently physical configuration.

6.3.3 Shared Channels

The DSCH and USCH transport channels use a logical channel between the CRNC and UE, the SHCCH. The PUSCH CAPACITY REQUEST message, which is used by the UE to request PUSCH allocations, contains the same measurements as in RL Setup, the DL timeslot ISCP and the P-CCPCH RSCP. Although these have use in DCA algorithms, the ISCP measurements will only be on the in-use timeslots, and thus are used primarily in assisting the setting of proper downlink power for future PDSCH allocations, in a similar manner as initial power is set for DCHs. Also note that this does nothing for DCH users.

6.4 Option 1: Modification of Existing Procedures

In Release 99 and on, there exists a Downlink Power Timeslot Control procedure that passed the timeslot ISCP and in release 5, the P-CCPCH RSCP to the CRNC over the Iur and to Node B over the Iub, the Node B then uses these parameters to balance power control among the timeslots as per the layer 1 procedure in the RAN1 specifications. The RNSAP message [5] could be extended to include other UE measurements like UE TX Power to allow for other measurements to be passed over the Iur. Additionally the scope of the procedure can be extended to make it clear that it is also used for RRM (making it clear that measurements not directly used for power control can be forwarded).

If this is done, a number of benefits identified in previous sections are provided, however this procedure always had some inefficiencies caused by different vendor implementations due to the fact that the measurements are forwarded when the SRNC wants to forward them (no requirement on the SRNC). Thus the CRNC has no say in which measurements or how often they are forwarded. For R99/R4 this is not a very large problem since a certain rate of measurement reporting is necessary when supporting the downlink power control timeslot balancing, the whole point of the procedure in the first place. However this problem would be made worse if the procedure was extended into RRM since RRM requirements can vary greatly among RNC manufacturers and thus one manufacturer might expect UE TX power every second and another might not use it at all. Thus it is easy to see that there might be a mismatch on the availability of measurements between different operator's RNCs.

6.5 Option 2: Creation of Measurement procedure

6.5.1 Introduction

A complete solution to increase CRNC access to UE measurements involves:

1. A way for the CRNC to request from the SRNC the measurements it needs and the manner to which report (event trigger or periodic).
2. A way for the SRNC to respond back including the ability to deny the request if it doesn't fit into the UE measurements currently active.
3. A way for the SRNC to report the measurement when the measurement is fulfilled.
4. A way for the SRNC or CRNC to terminate the measurement if had the need

The current dedicated and common measurement procedures implemented in [5] perform the above functions except they deal with DRNS measurements reported to the SRNC and thus each dedicated or common procedure exists in the opposite direction that is needed by UE measurements.

However the identical procedures switched around could be used. An example of the procedure text for these procedures is included in the following sections.

6.5.2 UE Measurement Initiation [TDD]

6.5.2.1 General

This procedure is used by a DRNC to request the initiation of UE measurements by the SRNC.

This procedure shall use the signalling bearer connection for the relevant UE Context.

The UE Measurement Initiation procedure shall not be initiated if a Prepared Reconfiguration exists, as defined in subclause 3.1.

6.5.2.2 Successful Operation

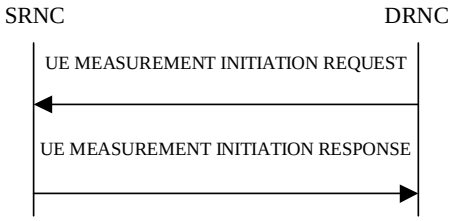


Figure 1: UE Measurement Initiation procedure, Successful Operation

The procedure is initiated with a UE MEASUREMENT INITIATION REQUEST message sent from the DRNC to the SRNC.

Upon receipt the SRNC shall, provided that it determines that the measurement can be performed by the UE, initiate and forward the requested UE measurement according to the parameters given in the request.

6.5.2.3 Unsuccessful Operation

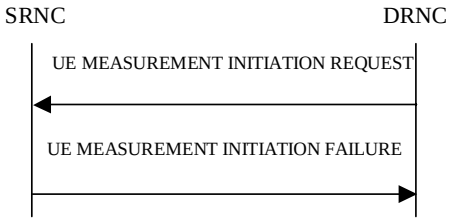


Figure 2: UE Measurement Initiation procedure, Unsuccessful Operation

If the requested measurement cannot be initiated, the SRNC shall send a UE MEASUREMENT INITIATION FAILURE message. The message shall include the same *Measurement ID* IE that was used in the UE MEASUREMENT INITIATION REQUEST message and shall include the *Cause* IE set to an appropriate value.

Typical cause values are:

Radio Network Layer Causes:

- Measurement not Supported For The Object
- Measurement Temporarily not Available
- Measurement Repetition Rate not Compatible with Current Measurements
- UE not Capable to Implement Measurement

Miscellaneous Causes:

- Control Processing Overload
- HW Failure

6.5.2.4 Abnormal Conditions

-

6.5.3 UE Measurement Reporting [TDD]

6.5.3.1 General

This procedure is used by the SRNC to report the results of the successfully initiated measurements requested by the DRNC with the UE Measurement Initiation procedure.

This procedure shall use the signalling bearer connection for the relevant UE Context.

The SRNC may initiate the UE Measurement Reporting procedure at any time after establishing a Radio Link.

6.5.3.2 Successful Operation

Figure 3: UE Measurement Reporting procedure, Successful Operation

If the requested measurement reporting criteria was met in the UE and reported to the SRNC, the SRNC shall initiate the UE Measurement Reporting procedure. The *Measurement ID* IE shall be set to the Measurement ID provided by the DRNC when initiating the measurement with the UE Measurement Initiation procedure.

6.5.3.3 Abnormal Conditions

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6.5.4 UE Measurement Termination

6.5.4.1 General

This procedure is used by the DRNC to terminate a measurement previously requested by the UE Measurement Initiation procedure.

This procedure shall use the signalling bearer connection for the relevant UE Context.

The UE Measurement Termination procedure shall not be initiated if a Prepared Reconfiguration exists, as defined in subclause 3.1.

6.5.4.2 Successful Operation

Figure 4: UE Measurement Termination procedure, Successful Operation

This procedure is initiated with a UE MEASUREMENT TERMINATION REQUEST message, sent from the DRNC to the SRNC.

Upon receipt, the SRNC shall terminate forwarding of UE measurements corresponding to the received *Measurement ID* IE.

6.5.4.3 Abnormal Conditions

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6.5.5 UE Measurement Failure

6.5.5.1 General

This procedure is used by the SRNC to notify the DRNC that a measurement previously requested by the UE Measurement Initiation procedure can no longer be reported.

This procedure shall use the signalling bearer connection for the relevant UE Context.

The SRNC may initiate the UE Measurement Failure procedure at any time after establishing a Radio Link.

6.5.5.2 Successful Operation

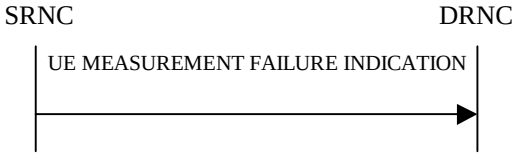

Figure 5: UE Measurement Failure procedure, Successful Operation

This procedure is initiated with a UE MEASUREMENT FAILURE INDICATION message, sent from the SRNC to the DRNC, to inform the DRNC that a previously requested UE measurement can no longer be reported. The SRNC has locally terminated the forwarding of the indicated measurement. The SRNC shall include in the UE MEASUREMENT FAILURE INDICATION message the reason for the failure in the *Cause* IE.

Typical cause values are:

Miscellaneous Causes:

- Control Processing Overload
- HW Failure
- O&M Intervention

6.5.5.3 Abnormal Conditions

-

6.6 Option 3: Direct Reporting to from UE to CRNC

In Release 99 and on, there exists a logical channel in TDD from the CRNC to the UE for shared channel signalling, the SHCCH. If the use of the SHCCH was changed so it was used for dedicated channels in addition, the measurement procedures could be implemented on the channel to allow direct reporting to the CRNC. Another wrinkle could be that only the uplink SHCCH is used for dedicated channels and the normal report mechanism is modified to allow the activation of the measurement normally, but with only the measurement report on the uplink SHCCH. Although the complete impact of this type of change would need to be evaluated by RAN2, there are some obvious observations that could be made. First, all of the UE classes except the lowest 32K class (where it is an option) have mandatory support for shared channels, thus having general support of the SHCCH is less of an issue in TDD than the introduction of a

similar type of channel would be in FDD. However, the SHCCH being generated from the CRNC brings problems, in the case where SRNC <> CRNC you would have to either put the SHCCH traffic on the S-CCPCH or implement a split TFCI type of thing like FDD shared channels, to be able to map the SHCCH on the DCH. Additionally measurements that are needed by both the SRNC and the CRNC (path loss etc.) would either need to be transmitted over the Uu interface twice or not reported directly and forwarded in ways like option 1 or option 2.

In conclusion the pain in making a change like this is at least an order of magnitude larger and thus should only be considered if a significant gain can be claimed over the other methods.

6.7 Comparison of the Complexity vs. the Incremental Gain of each Proposed Solution

The three methods described in the previous sections each allow the CRNC to receive measurements that it needs to optimise its RRM functionality/algorithms, however each differs in the complexity and gain that each can show, particularly pertaining to some of the side issues. The following table shows a side-by-side comparison of each method and its benefits and drawbacks.

	Option 1 – Modification of Existing Procedures	***Option 2 – Creation of Measurement Procedure***	***Option 3 – Direct Reporting***
Problems pertaining to the basic availability of necessary measurements in CRNC when needed.	Inefficiency caused by different Vendor implementation causing issues with data availability	None	None
Data Flow of Measurement in the Network	Data needs to be forwarded back over Iur	Data needs to be forwarded back over Iur	Data may be duplicated over Uu interface if both SRNC and CRNC need the same measurement.
Effects on UE or CN	None	None	UE needs changes
UE Power Savings with ISCP Measurement Scheduling	No savings since CRNC has no input into measurements made	Power Savings Possible	Power Savings possible
Complexity of the necessary changes	Very moderate: Only modification of the Downlink timeslot Power Control Message- expansion of scope and addition of additional measurements to forward.	Moderate: Involves the creation of 4 new procedures. However each is modelled and would have functionality very similar to the already existing measurement procedures over the Iur	Pretty substantial: Changes necessary for the UE no changes needed for UTRAN

6.8 Open issues

The following open issues are identified:

7 Agreements

The following conclusions were agreed:

1. …..

8 Project Plan

8.1 Schedule

Date	Meeting	Scope	[expected] Input	[expected]Output
June 2003	TSG RAN #21	RAN Approval		- TR approved

Annex A
Change history

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

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