Prepared (also subject responsible if other)		No.		
TEI/RFN M. Benedetti, R. De Bernardi, ESM/GB/A Christer Mejerland, ESM/GB/B Brian Fairbanks Terry		006 92-FAF 102 434		
Approved	Checked	Date	Rev	Reference
Sebastian Schaplitz	TEIMOLT;TEILLUN	16/02/2009	B	

WRAN HSPA Optimization - Technical Guide

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TEI/RFN M. Benedetti, R. De Bernardi, ESM/GB/A Christer Mejerland, ESM/GB/B Brian Fairbanks Terry		006 92-FAF 102 434		
Approved	Checked	Date	Rev	Reference
Sebastian Schaplitz	TEIMOLT;TEILLUN	16/02/2009	B	

1 Introduction

1.1 General

The WCDMA RAN HSPA Optimization (WRHSO) service is an option of the Network Performance Improvement (NPI) service family.

WRHSO deals with HSDPA and EUL with regards to the following aspects:

- Optimizing network performance
- Aligning the network setting with the customer strategy
- Providing short- and long-term recommendations to improve the network

Share Ericsson knowledge in radio technology, network monitoring, tool usage and strategy definition

- Identify main specific network bottlenecks and critical issues

1.2 Purpose and limitations

The purpose of this document is to describe improvement methods, measurements and KPIs to be used in the delivery of the WCDMA RAN HSPA Optimization (WRHSO) service. The target release is P6,0 but P5 limitations as well as P6 vs P5 comparison will be given whenever is considered a relevant change. In the KPI section there are some formulas related to P6.1 but whenever they are depicted, they are always advised to be used only in P6.1 release.

Mainly passive measurements and analysis are included in this document.

Only the KPIs and counters not being described in [6] are fully explained in this document.

The URA_PCH state is not considered in this document.

1.3 Outline

Section 2 explains the technical/strategic pre-study, which is an important activity prior to the test activities of the WCDMA RAN HSPA Optimization module.

Section 3 of this document describes the areas of optimization. It covers parameters to be turned on for the selected functionalities, as well as parameters for optimization and tests.

Section 4 briefly describes the KPIs to be monitored for each area of optimization. Detailed descriptions are only given in [6].

Section 5 summarizes all the references that have been used to create this WCDMA RAN HSPA Optimization Technical Guide.

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2 Technical/Strategic pre-study

The main objective of the pre-study is to define which test/activities will be performed in the execution phase. The scope of the service should be tailored to the actual operator's needs and network condition.

2.1 Service Scenario definition

For any technical pre-study to be successful, the specific conditions of the network and the operator's concerns need to be fully understood.

The main network conditions to be obtained are:

- Network topology (one, 2 or 3 layers, GSM interaction, amount of CEs, type of TX board used)
- Maturity of the network (start up, low traffic, high traffic)
- Traffic mix (mainly speech, mixed, HS only, EUL)
- Operator priority (speech main focus and PS best effort, high throughput)

The customer concerns can be grouped in the following key areas:

- Throughput limitation
- Capacity limitation
- Mobility/Traffic Management
- Coverage
- Accessibility/retainability KPIs improvement
- E2E problems

The information above can be combined to define the specific **service scenario** on which the execution phase will be carried out and, consequently, to select the most suitable test activities.

For guidelines about service scenario and tests definition, see also [1].

2.2 Service Activities selection

Once the network conditions and customer concerns (service scenario) have been identified, the hottest issues to deal with should be cleared up.

It should be stressed since the beginning that the actual end-user perception can be affected by several reasons, such as:

1. Coverage of the main HS channel or the control channels
2. Availability of Radio (e.g. Power/Codes/CEs) and/or Transport resources
3. Scheduler settings
4. Mobility, both on the same carrier or between carriers and systems
5. Retainability
6. UE characteristics (e.g. terminal category)
7. Time to access HS and EUL resources
8. Uplink performance
9. Non optimal parameter setting
10. E2E such as packet losses and/or application/traffic characteristics

Clearly, only a sub-set of the above aspects/issues can be present in the operator network and approached during the service. Which one to concentrate is decided in the service scenario definition phase, see Section 0 and [1].

2.3 Additional notes

It is important to remember that, in most of the cases, there is not necessarily an absolute optimum setting, but a setting that best fits with the operator strategy.

It should also be highlighted that the HSPA Cell and User Throughput KPIs mentioned in this document (see Section 4.2.1) do not enable to monitor the actual end-user perception but only to provide the HSPA radio performance.

For example, these throughput KPIs will be marginally affected by radio optimization activities that aims at optimizing issues 7 and 8 in Section 2.2 while the actual end-user perception could be much better.

However, in these cases, other KPIs are discussed which can give some indications of the effects of certain actions, e.g. parameter changes, on user performance.

In order to be able to monitor completely the impact of the radio optimization activities on the end-user performance, a different type of approach (e.g. based on the use of E2E tools, such as Moniq) could be followed.

Finally, if the main operator concern is E2E problems, and/or the work-force delivering the service realizes that this is the main issue, this service may be complemented with an "HSPA Performance Investigation – TCP focused" service (which is based on active testing), see [2].

3 Areas of optimization

3.1 General

The main areas of optimization have been divided into 5 sections, 3.2 to 3.6. These sections contain all the main parameters to be considered for optimization and some indications that have been obtained from on-field activities.

For details regarding how to identify which specific areas should be included in the service, refer to [1].

The service module should identify and analyze, from a radio perspective, the root causes to non-optimal HSPA performance. Improvement actions are implemented and long-term recommendations are provided.

3.2 Basic HSPA parameters

3.2.1 General

The purpose of the optimization of the basic parameters aims at finding a solution optimized for higher throughput, which also improves the scheduling ratio and guarantees the performance of the users in poor radio conditions.

Actual optimization of the basic parameters may not be relevant or possible, but a sanity check and strategic choice applicable to the customer network is often needed.

3.2.2 Main HSDPA parameters

3.2.2.1 **flexibleSchedulerOn** and **queueSelectAlgorithm**

flexibleSchedulerOn is used to activate the HSDPA flexible scheduler feature, and the scheduling algorithm is chosen through the parameter **queueSelectAlgorithm**.

One aspect in the choice of scheduling algorithm is the judgment of fairness.

It is recommended to use the proportional fair and Max CQI algorithms together with the CQI adjustment feature, in order to achieve a throughput gain compared to round robin. When using proportional fair without CQI adjustment in poor radio conditions, the *NACK ratio* can be very high, leading to lower cell throughput than with round robin.

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The equal rate scheme aims at providing an equal bit rate to all users. The highest system throughput is expected to be reached with the Max CQI algorithm, which also provides the less fairness between users.

The default value for **queueSelectAlgorithm** is ROUND_ROBIN. With this scheduling algorithm all users are equally scheduled. MAX_CQI maximizes the cell throughput, but UEs in bad radio conditions will probably not be scheduled. A trade-off between throughput gain and UE scheduling fairness can be achieved with the PROPORTIONAL_FAIR algorithms. Note that the utilization of MAX_CQI and PROPORTIONAL_FAIR need the CQI adjustment feature to be activated in order to guarantee good performance.

To monitor, evaluate and optimize scheduling algorithms, the HSDPA mode reports in TEMS Investigation from the UE and the RBS throughput KPIs need to be captured. These are given in 4.2.

3.2.2.2 cqiAdjustmentOn

CQI adjustment is an RBS optional feature which processes the ACKs and NACKs received from the UE, evaluating in this way the UE's CQI reporting accuracy, and gives as output an adjusted CQI value so that the *NACK ratio* remains in the order of 10%.

Since the accuracy of the CQI reporting depends on the UE vendor and model, it is recommended to enable the CQI adjustment feature so that both cell and user throughput are maximized. This is particularly important when proportional fair or Max CQI is selected as scheduling algorithm.

It should be noted that in cells with very good coverage (such as indoor cells), the *NACK ratio* may naturally be lower than 10% and the CQI adjustment feature may lead to throughput degradation, since the algorithm will adjust the *NACK ratio* up towards 10%.

The method to evaluate **cqiAdjustmentOn** is to monitor RBS throughput KPIs given in 4.2.

3.2.2.3 **Delta** parameters

The uplink HSDPA control channel, HS-DPCCH, is used for transmitting ACK/NACK for the HARQ processes and CQI information. The quality of the HS-DPCCH can be adjusted with the parameters **deltaCqi1**, **deltaCqi2**, **deltaAck1**, **deltaAck2**, **deltaNack1** and **deltaNack2**. There are two sets of parameters for the information sent on HS-DPCCH, one used in soft handover and the other in non-soft handover.

From a coverage perspective HSDPA is uplink limited. As the user is approaching the cell edge the performance of the uplink A-DCH channel starts to degrade the HSDPA performance (e.g. due to sub-optimal TCP ACKs transmission). To maximize the performance for an HSDPA user, the power allocated to these channels should be increased. This can be done by reducing the power on the UL control plane by adjusting the **deltaAck1**, **deltaNack1** and **deltaCQI1** leaving more power for the dedicated channel. A 1 dB coverage improvement has been seen in field by setting these values to **deltaAck1=3**, **deltaNack1=3** and **deltaCQI1=3.**

The negative consequence of reducing the power in the control plane is that the downlink throughput in good radio environment deteriorates due to more retransmissions. Therefore, it is worth to monitor both coverage improvement and actual average HSDPA throughput in order to find the best trade-off.

3.2.2.4 blerQualityTargetUl

An often neglected effect is the impact of UL BLER target on the DL throughput. In fact, the TCP RTT depends on the UL BLER as much as on the DL one. A 10% UL BLER can seriously impact on the DL performance, especially for high bit rates. Hence, this parameter has to be considered as well. The downside of a lower UL BLER target can be: increased RSSI, lower UL coverage and higher drop probability.

Recent tests have shown that changing the UL BLER target from 1% to 0.1% has a significant improvement on the Downlink (around 10-15% improvement for 384 UL RB, around 5% improvement for 64 UL RB)[1]. The drawback by this change is an increase in UE Transmit power and interference; however the degradation on R99 performance was tolerable.

3.2.3 Main EUL parameters

3.2.3.1 EulmaxRotCoverage and EulMaxOwnUuLoad

Estimation of noise rise, and own cell interference load are taken care of by UL Uu load estimator principle as shown in the following figure

[1] Note that these improvements are not totally visible from RBS throughput KPIs, but active tests are needed.

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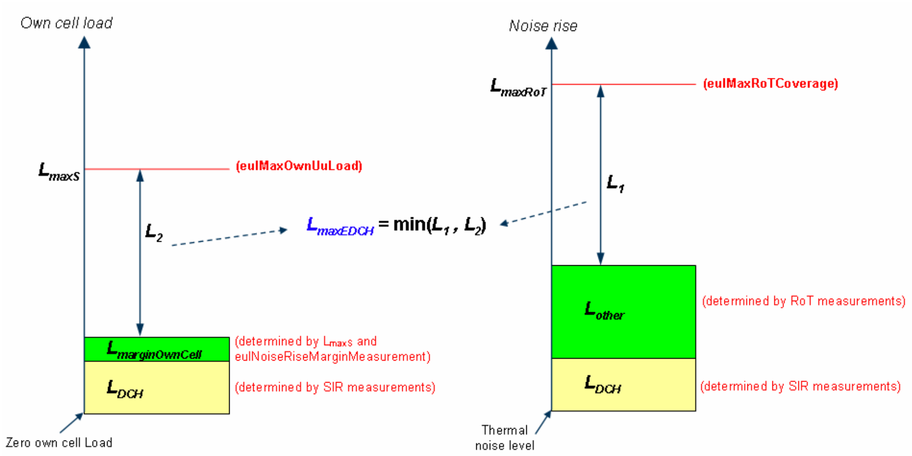

EulMaxRotCoverage parameter defines the EUL area of coverage with a certain throughput. In fact it is used to set the threshold for the interference in UL over which the scheduler acts to reduce the granted throughput to the UE. The higher the threshold the higher is the interference allowed in UL, and the higher could be the throughput especially in not very good conditions. On the other hand, the higher interference allowed can affect the R99 performances. Due to this, a good trade off is needed to optimize EUL throughput without affecting R99 performances.

EulMaxRotCoverage can be tuned differently according to R99 traffic and number of carriers. In networks with a second carrier mainly used for HSPA, this parameter can be set to high values. If only one carrier with lot of R99 traffic is present, then the default value is suggested.

RSSI and ROT related counters are useful to determine the increase in UL interference, and together with R99 accessibility/retainability performances and EUL throughput, they can be used to evaluate the goodness of the parameter setting.

EulMaxOwnUuLoad is used to prevent power rushes that can affect R99 and EUL performances. It sets the threshold for the own cell interference determined by the SIR for all the DCH users connected to the cell. A low value for this parameter is dramatically affecting the EUL throughput performances.

Note that in cells with no RX-diversity (for example indoor cells) the parameters **eulMaxOwnUuLoad** and **eulMaxRotCoverage** should be reduced with 3 dB as compared to the normal RX-diversity case. The reason for this is that Uu load estimation algorithm assumes a factor for RX diversity gain when calculating the Uu load. This will require modification of system constant which is not recommended for indoor cell investigation.

These parameters are specified in terms of noise rise using a logarithmic scale (dB). To convert these values into load (fraction of the pole capacity) the following equation can be used:

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$L = 1 - 10^{-B\_IUL/10}$

where B_{IUL} is the noise rise in dB and L is the load. As an example 3 dB noise rise corresponds to 50% of the pole capacity and 8 dB noise rise corresponds to 86% of the pole capacity. This means that the capacity gain of increasing the noise rise parameters to ever higher values is limited.

The headroom reported to the EUL scheduler is always the minimum of the two.

3.2.3.2 eulNoiseFloorLock and eulOptimalNoiseFloorEstimate

If the thermal noise calculation from RTWP measurements is considered unreliable, there is a possibility to lock the thermal noise level by setting the parameter **eulNoiseFloorLock** to "true". This locks the thermal noise value to a value given by the parameter **eulOptimalNoiseFloorEstimate**. If **eulOptimalNoiseFloorEstimate** is set to -1 (= undefined), the thermal noise value is instead locked to either **eulThermalLevelPrior** (if the lock parameter is set to "true" at system start) or to the thermal noise level at that particular point in time (if the lock parameter is changed to "true" during on-going operation of RBS).

3.2.4 Additional HSDPA parameters

3.2.4.1 hsMeasurementPowerOffset

The purpose of this parameter is to adjust the reported CQI values from the UEs with an offset so that the reported values are distributed between minimum CQI value zero and maximum CQI value 30.

If the RBS receives CQI equal to zero from a UE, no data is sent to that particular UE the coming TTI and the HSDPA throughput is impacted. Therefore, it is important that the CQI distribution is not clipped on the lower end resulting in unnecessary CQI-equal-to-zero-reports.

The throughput performance is also degraded when the CQI distribution is clipped on the higher end (CQI = 30). The best performance is obtained when all reported CQI values are distributed between 0 and 30.

The **hsMeasurementPowerOffset** parameter should be set to its recommended value 80, which has shown good performance in field. When the share of CQI=0 is higher, or other than 0%, measured by *pmReportedCqi*[0] / *pmReportedCqi*[0..30], one could consider an adjustment of this parameter.

3.2.4.2 **numHsScchCodes** and **hsScchMaxCodePower**

It is possible to transmit to **numHsScchCodes** users, or maximum up to four users, in the same TTI. To avoid excessive power usage, HS-SCCH is power controlled when using code multiplexing, and the maximum power level related to P-CPICH, is given by **hsScchMaxCodePower**.

HSDPA code multiplexing increases cell throughput in cases where one UE is not able to utilize the whole RBS power and the available HS-DSCH code resource in one TTI. In poor radio the single UE will consume more of the RBS power resource, in some cases even all available RBS power. There is not much RBS power left for a second user on the same TTI, and therefore the capacity gain from code multiplexing is smaller.

The recommended parameter value for **hsScchMaxCodePower** is depending on if HS-SCCH power is fixed, transmitting with constant power, or if HS-SCCH power control is used. When using HS-SCCH power control, the power save compared to fixed HS-SCCH is significant. Field trials have shown that the average power can be reduced more than 3 dB when using power controlled HS-SCCH. A trade-off between power consumed and throughput needs to be made. For the case when HS-SCCH is power controlled, field trials have shown that HSDPA throughput performance is improved, when increasing the maximum allowed code power for HS-SCCH by 1 dB from default setting (from -2 dB to -1 dB relative CPICH). This is done by increasing the parameter **hsScchMaxCodePower**.

The method to evaluate power consumption versus cell throughput is to monitor `pmNoOfHsUsersPerTti`, `pmSumOfHsScchUsedPwr` and the RBS throughput KPIs given in 4.2.

3.2.4.3 **dynamicHsPdschCodeAdditionOn**, **numHsPdschCodes** and **maxNumHsPdschCodes**

With **dynamicHsPdschCodeAdditionOn** it is possible to enable Dynamic Code Allocation in a cell. **numHsPdschCodes** must be set to at least one HS-DSCH code in order to activate HSDPA in a cell. **maxNumHsPdschCodes** is used together with Dynamic Code Allocation and sets the maximum number of SF16 codes that can be allocated to HS-DSCH.

The average code tree utilization, reported on the SF256 level, is captured by `pmSumDlCode` combined with `pmSampleDlCode`. Note that these counters do not capture the peak usage, and do only consider the R99 portion.

The previous counters do not measure the HS-DSCH codes allocated by the dynamic code allocation algorithm, since this algorithm is executed in the RBS and the information of code allocation is not reported to the RNC.

If dynamic code allocation feature is enabled, RBS counters `pmSumNumHsPdschCodesAdded` and `pmSampleNumHsPdschCodesAdded` should be used to measure the HS-DSCH codes utilized in the cell. This counters have to be used with attention. In fact they are stepped only if the number of codes allocated by DCA is changed, so they are not providing a distribution of code used per each TTI

To make use of the counters above, they need to be combined with the RBS throughput KPIs given in 4.2.

Information on which site is equipped with various TX boards need to be correlated. For instance, a TX-15 board might require a different configuration than a TX-45 board. **numHsPdschCodes** and **maxNumHsPdschCodes** can be increased in a carrier mainly dedicated to HSPA.

3.2.4.4 codeThresholdPdu656

When using bit rates above 6 Mbps it is necessary to increase the RLC PDU size from 336 bits to 656 bits in order to not be throughput limited by the RLC PDU size. The PDU size is controlled by the parameter **codeThresholdPdu656**.

If **codeThresholdPdu656** is smaller than **numHsPdschCodes** the 656 bit RLC PDU size will be used for Category 7-10 UEs, otherwise the 336 bit RLC PDU size is used. If Category 10 UEs are used in the system, and very high downlink throughput is important, it is recommended to set **codeThresholdPdu656** < **numHsPdschCodes**.

No service triggered fallbacks to R99 are possible when the HS connection is established with 656 bit RLC PDU size. However, it s possible to make a coverage triggered fallback to R99 when leaving HSDPA coverage. It is also possible to make a cell change between cells configured for different RLC PDU sizes (656 or 336 bits).

Therefore it is recommended to use a 656 RLC PDU size only for high networks where high performance is prioritized over limited RAB change capability and downlink throughput demos

3.2.5 Additional EUL parameters

3.2.5.1 SIRMax and SirMaxTTI2

Optimal settings for these parameters are important to assure that the Outer Loop Power Control can maintain the wanted retransmission rate for EUL. Higher setting is needed for Eul 2ms TTI (17.3 dB suggested). If no EUL enabled then SIRMax can be set lower (recommended is 10dB), while with EUL 10 ms the recommended value is 12 dB.

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3.2.5.2 ulInitSirTargetEdch and ulInitSirTargetEdchTti2

These parameters set the initial uplink sir target for 10 or 2 ms TTI users. Higher values are recommended for 2ms users. In fact to provide improved performance at high bit rates the gain factors for the PS interactive RAB on 2ms TTI are updated. As a consequence, the initial Uplink SIR Target for 2 ms TTI users shall be increased as the DPCCH SIR rises due to the lower power offsets.

3.2.5.3 EulSchedulingWeight

In P6 it is possible to assign to each logical channel a certain Scheduling Priority Index (SPI), separated for UL and DL. In UL, Each Scheduling Priority is associated with a configurable weight factor eulSchedulingWeight Only the scheduled logical channels are considered to determine the overall SPI for a user (userspi). In case a user has more than one scheduled logical channel, the user’s SPI and the eulSchedulingWeight shall be taken from the scheduled flow that has the highest SPI.

This parameter is a sequence of 16 weight factors associated with the 16 Scheduling Priority Indicators (SPIs). The weight factors represent the relative bandwidth between users assigned to the different Scheduling Priorities. It is used to differentiate UL QoS between users.

User priority has been changed compared to P5, taking *qosPrio* and *userSpi* into account, according to the following formulas

1) *qosPrio*

$$- \frac{\text{grantedRate}}{eulSchedulingWeight}$$

If eulSchedulingWeight < infinity

0 if eulSchedulingWeight = infinity

2) *userSpi*

3) Number of TTI the user has been unhappy

3.2.5.4 EulTargetrate and EulLowrate:

If the scheduled grant is below eulTargetRate, the EUL scheduler always tries to increase the scheduled grant to become at least equal to the eulTargetRate. If the user is transmitting at lower throughput than granted one, then the absolute grant can be reduced down to EulLowrate.

During rescheduling, a user with lower priority and higher rate can never be rescheduled to a rate lower than EulTargetRate. For this reason too high values of EulTargetRate can prevent the low rate users to be rescheduled to higher bit rates due to the impossibility to reschedule high bit rate users to lower values below EulTargetRate, and they can be stuck at low UL throughput values.

3.2.5.5 eulSlidingWindowTime

The thermal noise is also calculated by RTWP measurements, but selecting only those samples that represent a situation free or almost free of traffic. To do that, the load estimator collects a number of samples in a sliding window, during a configurable time**, eulSlidingWindowTime**. A short sliding window time may cause spurious variations in the thermal noise level; a long time might be unable to capture normal variations in the thermal noise level, such as temperature drift. The recommended value is 20 hours (72000 sec). The calculations are facilitated by the use of prior information regarding the noise floor level, **eulThermallevelPrior**. This value represents the anticipated thermal noise floor level of the RBS. Default value (1800 sec) might be too low and cause wrong estimation of the noise floor.

3.3 HSPA mobility and traffic management

3.3.1 General

HSPA mobility is very important for customers in which a second carrier has been deployed. In the case of multi-carriers, this chapter could be part of a larger “strategic traffic management” scope. This could include cell selection, HS mobility, and Inter Frequency Load Sharing for example.

The HSDPA Phase II mobility feature provides mobility improvements in the sense that the HSDPA connection is not dropped at a HSDPA coverage border or over Iur, but switched down to R99 DCH. It also has the ability to switch up a R99 DCH to HS when there is HS coverage. (Only R99-DCH is available in D-RNC until the call is released). In P6 this feature is enhanced by allowing the possibility to perform a Serving HS-DSCH Cell Change to or between external DRNC cells (over Iur), and to perform upswitches from DCH to HSDPA over Iur.

The main benefit in using the phase 2 mobility feature is that the packet connection is kept. The UE remains under control and the interruption in data transfer is minimized.

For KPI analysis, *HS Drop Rate* can be used, however it is strongly recommended to focus on *HS Minutes per drop* as this KPI gives a clearer picture of actual performance.

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3.3.2 Main HSDPA Parameters

3.3.2.1 hsToDchTrigger

Transition Types from HS to R99 can be allowed or disabled with the following mobility phase 2 parameters:

hsToDchTrigger.poorQualityDetected

If the quality of the connection is poor and inter-frequency or inter-RAT neighbors would provide better coverage (event 2d or 6d), the poorQualityDetected feature will trigger a transition from HS-DSCH to R99 DCH.

One suggested strategy is to only use the poorQualityDetected feature when IFHO is to be performed on an HSDPA capable cell[2]. In all other cases, it would be recommended to keep the HSDPA call in HSDPA coverage, and wait to reselect the other carrier or RAT once it is dropped.

KPI degradations resulting from ping-pong effects should be closely monitored when feature is enabled. This is because the HS user may experience bad quality due to self-generated interference when transmitting, then it is moved to DCH. After moving to DCH, the interference situation would then become good again (no HS transmission anymore) and the UE makes a switch towards HS again.

It is for this reason, together with the fact that the parameter is set at whole RNC level, that many operators have chosen to disable this feature (poorQualityDetected = OFF).

The *Channel Switching Success Rate* should be closely monitored as it has been reported that the success rate is low due to the radio quality is too poor.

Note certain types of UEs (such as Huawei E220 USB Modem) have reported experiencing high drops when attempting to perform downswitch from HS to R99. This has caused the *PS Drop Rate* to be very high.

hsToDchTrigger.servHsChangeInterRNC

[2] A typical example is at the border between an island of cells with two carriers (HS on f2) and a mainland with one carrier (HS on f1).

If the parameter **servHsChangeInterRnc** is ON, a downswitch to DCH is triggered as the call moves towards an Iur border. This applies when the serving cell is removed from the active set and the best cell is an inter-RNC external cell (event 1b or 1c). The packet call can then be kept on DCH (R99) on the DRNC. No transition to HS-DSCH is possible until the UE has been inactive and has been moved to FACH state. When in FACH state the UE may be upswitched to HS-DSCH again.

If a transition to DCH is not allowed (feature is OFF), an RRC connection release is triggered. The RRC connection release message will contain the cause value ”directed signaling connection re-establishment”, which makes a call re-establishment immediately attempted on the new best cell (on HSDPA or R99 depending on the new best cell capabilities). If a call is using HS+CS multi RAB, then the CS part only can remain over Iur.

Note that, with 656 bit RLC PDU size, inter RNC HSDPA mobility behavior is not supported (even if parameter if **servHsChangeInterRnc** is ON).[3]

hsToDchTrigger.servHsChangeIntraRnc (at event 1b or 1c)

If the parameter **servHsChangeIntraRnc** is ON, a downswitch to DCH is triggered when the serving cell is removed from the active set and the best cell an intra-RNC, non-HS internal cell (event 1b or 1c). This is similar to feature **servHsChangeInterRNC.** However, in this situation; the call is not at the Iur border.

If **servHsChangeIntraRnc** is OFF, then the connection is released. Therefore, this feature can be beneficial in reducing outage times.

hsToDchTrigger.changeOfBestCellIntraRnc

If an event 1d HS is triggered and there is no suitable HS-DSCH cell (based on hsHysterysis1d) as a target cell, a transition to DCH is initiated. This will happen if the parameter **changeOfBestCellIntraRNC** is ON. If the parameter is OFF, then no action is taken.

P5 Software Limitation (at event 1d HS)

If the parameter **hsCellChangeAllowed** = FALSE, then the feature **changeOfBestCellIntraRNC** does not work as described in CPI documents.

This parameter should trigger the change to R99 when there will be event 1d HS triggered and the neighbour cell is not HSDPA capable or the parameter that enables cell change is set to FALSE.

[3] It has been reported that 656 bit RLC PDU size, mobility does not work **intra**-RNC (in addition to inter-RNC); however this needs to be confirmed.

Tests have shown that there will be no change to R99. Instead of downswitch to R99, a drop call occurs and afterwards a DCH establishment. The workaround for the problem is to set **hsCellChangeAllowed**=TRUE as well as having **changeOfBestCellIntraRnc** = 1 (ON). Refer to TR Report (See HJ37455) for details.

hsToDchTrigger.changeOfBestCellIntraRNC

It is new in P6 and indicates whether a trigger for a HS-DSCH to DCH transition is accepted or not, when Serving HS-DSCH Cell Change can not be completed, when it has been triggered by a change of best cell (event 1d) indication and the cell is an inter-RNC UTRAN Cell.

3.3.2.2 cellCapability.hsdschSupport

In order to allow HS cell change over Iur, **cellCapability.hsdschSupport** has to be set ON for the Managed Objects ExternalUtranCell and IurLink. Moreover for external DRNC cells over Iur, both a coverage relation and a neighbour relation must be defined to support Cell Selection, and hspaPathlossThreshold applies for cell selection for DRNC cells (default =170)

3.3.2.3 loadSharingMargin

If R99 only cells and HSDPA enabled cells are deployed on separate frequencies, and if IFLS (Inter Frequency Load Sharing) is deployed, the **loadSharingMargin** parameter can be used to artificially load the HSDPA cells. In this way more R99 users will be kept on (or re-directed to) the R99 only cells and the power in the HSDPA can be reserved for HSDPA users. The amount of resource excluded from load-sharing use is specified by the cell parameter **loadSharingMargin** as a percentage of **pwrAdm**.

The **loadSharingMargin** default setting is 0, however it is suggested to increase this parameter in the HSDPA enabled cell on separate frequency if too much R99 traffic is being redirected to it and the HSDPA performance is reduced due to lack of power. Results from the field indicate that a **loadSharingMargin** of 30% in the HS cell is able to reduce very much the IFLS activity rate.

An alternative setting is: **loadSharingMargin**=100% in the HS enabled cell and **loadSharingMargin**=20% in the R99 only cell. In this way the HS frequency is kept cleared on non-HS traffic until the R99 frequency is at **loadSharingMargin** of **pwrAdm**. This results in a power buffer equal to **loadSharingMargin** in the R99 cell, which turns out to be suitable to handle legacy UEs, mobility or R99 up-switches.

It should not be forgotten that IFLS is based only on power. Other capacity limits such as channelization codes or channel elements[4] are not considered in IFLS. When DL power is not the most limiting resource, it is still possible to reduce **pwrAdm** in the R99 cell and set **loadSharingMargin**=0 in the HSDPA cell so as to trigger the IFLS at an earlier stage (lower power resource usage) and to avoid blocking of R99 due to other resources.

Finally, **loadSharingMargin** > 0 in the HS enabled cell is also an effective way to provide soft power reservation to HS traffic in case of “normal“ R99 traffic sharing between the R99 and the HS cell.

3.3.2.4 hsHysteresis1d, hsTimeToTrigger1d

Two main parameters that can directly affect HS Cell change are **hsHysteresis1d** and **hsTimeToTrigger1d**. Generally, a high number of cell changes results in more traffic interruptions (outage times) and greater risk of RLC retransmission. This will have a direct impact on the *HS user throughput*.

A main goal would be to minimize the number of cell changes (impact of ping pong effects), while, at the same time, maintaining low retransmission rate as the HS coverage could decrease.

<u>High</u> values of **hsHysteresis1d** and **hsTimeToTrigger1d** can be expected to:

- Reduce number of ping pong changes (increase throughput)
- Possibly lower reported CQI values due to longer time on non best serving cell (reduced throughput)

<u>Low</u> values of **hsHysteresis1d** and **hsTimeToTrigger1d** can be expected to:

- Increase number of ping pong cell changes (reduce throughput)
- Possibly higher reported CQI values due to shorter time on non best serving cell (increased throughput)

Some initial testing with increasing **hsTimeToTrigger1d** from 640ms to 1280ms has shown that the number of ping pong cell changes reduces, which has lead to an increase in throughput. No major degradation in reported CQI values could be confirmed with the change.

Other testing on **hsHysteresis1d** has shown that an increase from 1 dB to 4 dB results in a reduction of mobility events up to 35% at whole RNC level (monitored by `pmNoHsCcAttempt`/*ERL_PS_HS*). The *Minutes per Drop HS Data* is not affected and there is no visible impact on average reported CQI (even if the impact should be monitored by looking at the whole distribution). The *HS Data Retransmission Rate* (RLC level) seems to increase by 60% even if the absolute value remains below 0.4%. Finally, the throughput at RNC level remains stable.

3.3.3 Main EUL Parameters

3.3.3.1 EulMaxShoRate

It defines the maximum rate that may be allocated in the serving cell for scheduled data to an E-DCH user during a soft handover.

It is quantized for 10ms or 2ms Ues. If the value is set higher than the maximum for 10ms tti, then it is quantized to the maximum for 10 ms. It is recommended to use maximum value, but it can be decreased to control UL interference.

3.3.3.2 EulNonServHwRate

When a user is in soft handover the HW resources allocated for processing data in the non serving cell have to be statically allocated because the new RBS does not know the absolute rate granted by the serving cell. EulNonServHwRate sets the amount of hardware resources (in terms of a bit rate) that dynamically may be allocated, if available, to a non-serving E-DCH radio link for processing scheduled data.

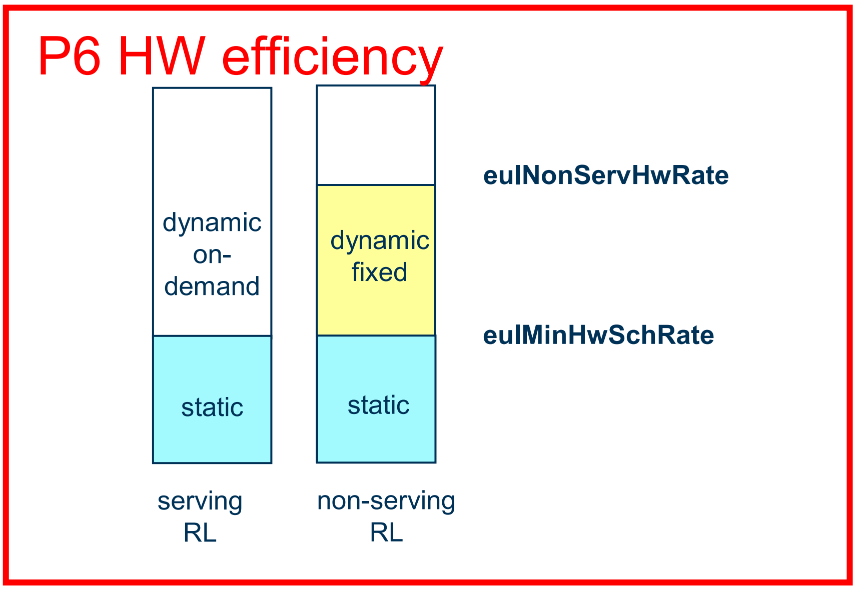
For each rate between EulNonServHwRate and EulMaxShoRate, there are no resources in the non serving RBS to process the data, so there will be no data sent to RNC in the additional Iub link, and the consequence will be the lost of the possible sho gain. Data will still be sent on the serving Iub link, with a rate up to the value set by EulMaxShoRate.

In the air interface, the non serving radio link will still be on air, and it will also take actions in the power control algorithm.

If there is not the possibility to allocate in the non serving RBS the HW resources set by EulNonServRate, due to R99 traffic, then only a minimum set of resources are reserved in the non serving RBS.This minimum amount of quantity is equal to **eulMinHwSchRate** (32kbps by default), and it’s the only part of the UL HW considered by admission control algorithm,.

Whenever R99 needs, the amount of resources set by **EulNonservHwRate** in the non serving cell can be subtracted down to **eulMinHwSchRate.** For this reason, the parameter **eulNonServHwRate** could be decreased to reduce the channel element consumption associated to non-serving EUL radio links. However, it should be noted that EUL soft handover overhead should not have a big impact on the R99 capacity since the CE allocation in non-serving cell is dynamic, and CEs can always be taken from R99 when needed.

The following figure represents the algorithm in P6



No intermediate steps between EulMinHwSchRate and EulNonServHwRate are allowed to be allocated in the non serving cell. For this reason **EulNonServingHwRate** should be set low enough to guarantee most of the times the chance to allocate this amount of HW in the non serving RBS, and high enough to exploit the sho gain in the RNC.

3.3.3.3 event1dRncThreshold and event1dRncOffset

When a EUL user moves into a cell where EUL is not supported, the connection must firstly be reconfigured to DCH in UL so that the non-EUL cell then can be added to the active set, since non-EUL cells can never be added in a EUL active set.

This is triggered by monitoring periodic 1a and 1c event reports requesting to add the non-EUL cell to the active set. If **event1dRncThreshold** number of consecutive event1a and/or event1c reports are received requesting to add the same non-EUL capable cell, and where all the reports are **event1dRncOffset** stronger than the current serving cell, then a reconfiguration to DCH in UL is triggered. When the connection has been reconfigured to DCH/HSDPA, ie without EUL, then soft/softer HO shall execute the latest 1a or 1c report and add or replace the non-EUL cell to the active set.

Prepared (also subject responsible if other)		No.		
TEI/RFN M. Benedetti, R. De Bernardi, ESM/GB/A Christer Mejerland, ESM/GB/B Brian Fairbanks Terry		006 92-FAF 102 434		
Approved	Checked	Date	Rev	Reference
Sebastian Schaplitz	TEIMOLT;TEILLUN	16/02/2009	B	

The sensitivity of this trigger, that is how long the user can keep the EUL connection when driving into a non-EUL cell, can be adjusted with the parameters event1dRncThreshold and event1dRncOffset**.** If **event1dRncThreshold** = 0 then event 1d-RNC shall never be triggered.

The higher is the time to wait to reconfigure to DCH/HSDPA, the higher will be the time in EUL with the chance of having higher UL throughput, but simultaneously, the higher will also be the interference in UL, due to the fact that the connection is power controlled by a cell that is getting farther, while the probable best cell cannot be added in the AS.

A setting to execute a fast reconfiguration could be used to decrease interference at EUL edge of coverage, while in order to have higher UL throughput performances, a delayed reconfiguration should be considered.

The event 1d-RNC evaluation and calculation shall be restarted if the actions initiated by a previous event 1d-RNC failed and the connection remains on E-DCH.

If the switch to DCH in UL is blocked by Admission Control or fails the connection shall be released.

3.3.4 Additional HSDPA parameters

3.3.4.1 hsQualityEstimate

The UE measurement criterion for HS cell change is determined by parameter **hsQualityEstimate.** It is recommended to keep the default value of this parameter, which is CPICH_RSCP, instead of CPICH_Ec/No, in order to have a more stable behavior (avoiding ping-pong situations) as CPICH RSCP is not load dependent and fluctuates less than Ec/No.

Another reason for avoiding CPICH_Ec/No as a quality measurement is that Ec/No degrades in cells carrying HSDPA traffic: after an HS cell change, Ec/No of the old serving HS cell improves whereas that of the new serving HS cell suddenly becomes worse. This might cause undesired ping-pong behavior.

Using CPICH_RSCP might create problems in special circumstances, such as thermal noise limited (coverage limited) areas (indoor coverage areas for example).

3.3.4.2 hsPathlossThreshold

In a network with two carriers, f1 purely R99 capable and f2 having both R99 and HSDPA enabled, a configuration allowing HSDPA calls for all HSDPA capable UEs is to define a coverage relation between each pair of cells belonging to the same sector. This way, a UE initiating a packet call on f1 will be able to set up an HSDPA call on f2 through blind hard handover, provided that the path loss criteria is verified.

The default value, for **hsPathlossThreshold** parameter is 170 dB, which allows all HSDPA capable UEs initiating a packet call on f1, to attempt a hard handover to a coverage related f2 cell. To optimize the *hard handover success rate*, **hsPathlossThreshold** can be set to a value lower than default. To tune this parameter, the statistics of the *blind hard handover success rate* can be evaluated. Most of field results have shown very high hard handover success rate with the default settings. In other studies, it has been found that a proposed settings down to **hsPathlossThreshold** = 120 is optimum for KPI performance.

The **hsPathlossThreshold** default value allows all UEs on f1 to attempt a blind hard handover to the coverage related cell. It should be however noted that a failed hard handover could result either in an attempt to establish an R99 PS RAB on the f1 source cell, or sometimes in an accessibility failure. To ensure a high *blind hard handover success rate*, the **hsPathlossThreshold** parameter can be set to a lower value than the default one, for example equal to **primaryCpichPower** minus *minimum CPICH RSCP*, where *minimum CPICH RSCP* is the median value of CPICH RSCP measurements at hard handover failures.

3.3.5 Additional EUL parameters

3.3.5.1 eulNonServingCellUsersAdm

This parameter sets the admission threshold for the number of E-DCH users having this cell as non-serving cell. It is impacting the mobility as well as the capacity. In fact it can be used to limit the impact of static channel element reservation for non-serving radio links in an RBS different from the serving one.

3.4 Channel switching

3.4.1 General

Channel Switching is a key algorithm to be considered when dealing with HSPA optimization. The purpose of the Channel Switching feature is to dynamically change the physical resources allocated to the UE, according to the amount of data that needs to be transmitted in UL and DL and the network availability. This is achieved by switching the interactive RAB users between different transport channel types. Two types of channel switching are considered:

- Channel type switching between
    - FACH and EUL/HSDPA
    - FACH and DCH/HSDPA
- Channel rate switching from
    - DCH to EUL/HSDPA
    - DCH to DCH/HSDPA
    - DCH/HSDPA to EUL/HSDPA

A full description of the Channel Switching feature and algorithm is given in [3].

The purpose of the channel switching optimisation activity is to find a trade-off between resource usage and switching transitions or user access time. One can save Erlang (and hardware consumption in UL) on one side, or reduce the unnecessary up/downswitches on the other (which imply lower access time and better end-user perception).

3.4.2 Main parameters

3.4.2.1 hsdschInactivityTimer

It sets the time during which throughput has to be low in order to trigger a downswitch (dedicated to FACH) for a UE in state DCH/HS or in state EUL/HS.

A high timer value leads to a reduction in the channel switching activity and a quicker access time. The UE will experience the delay of switching from FACH to the dedicated and shared HS channels less frequently. In low loaded cells, this should improve user experience without affecting resource utilization in terms of codes and UL HW to a great extent. A too high increase in Erlang could lead to resource shortage and blocking probability. In high loaded cell it will bring to low accessibility due to lack of resources.

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TEI/RFN M. Benedetti, R. De Bernardi, ESM/GB/A Christer Mejerland, ESM/GB/B Brian Fairbanks Terry		006 92-FAF 102 434		
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There is an important relationship to the two parameters **dlThroughputDownswitchTimer** and **ulThroughputDownswitchTimer**. If both of these timers are configured to a shorter time than the **hsdschInactivityTimer**, the HS/384 connection downswitch to HS/64 before any downswitch to FACH is made.

An increased **hsdschInactivityTimer** value from 2 sec to 10 sec typically increases the *RNC Traffic HS (RNC_ERL_HS)* by 20-50%, when the HS/64 bearer is considered. A similar decrease in upswitches from FACH to HSDPA can be captured with `pmUpswitchFachHsAttempt` and `pmUpswitchFachHsSuccess`. The *Minutes per Drop HS Data* remains almost stable while it is difficult to monitor user experience improvements in terms of throughput with the existing counters.

On the other hand, a lower value allow to save HW consumption in UL, especially considering that datacard users often send or receive something in background due to normal way of working of several PC applications. Same behaviour is expected for new generation I-phones. In case of R99, at least the CEs for a 64 Kbps (4CEs) can be released. In case of EUL, the amount of HW equal to **eulMinHwSchRate** (3 CEs by default, or 2 in case of optional CEs ladder)**,** can be released. For this reason, in a network where the UL HW resources are a major concern, the possibility to reduce it down to 1 second could be considered. If the 16/HS RAB is enabled, then the impact of reducing the parameter value on CEs usage is lower.

The FACH channel is dimensioned for a rate of 15 kbps per cell based on the average for the 90-percentile of the heaviest loaded cells. Normally, the traffic volumes on FACH are far from the dimensioned levels. Nevertheless, it needs to me monitored with `pmDlTrafficVolumePsCommon`.(especially in case of low **hsdschInactivityTimer** values). A drawback with high FACH load is DL power consumption. The FACH channel is not power regulated and could use a lot of downlink power considering the limited downlink rate.

On the basis of field results, where the mentioned aspects have been evaluated, a parameter value of 10 sec seems to be a too high value. 2 or 3 sec is more appropriate. One second is suggested if UL CEs is a major concern.

3.4.2.2 inactivityTimer

The **inactivityTimer** determines the time, without data transmission, after which a UE in state FACH is switched down to state Idle.

A high timer value leads to a reduction in the channel switching activity and a quicker access time. The UE does not need to experience often unnecessary down-switches to Idle. In less loaded cells, this should improve user experience without affecting FACH Erlang to a great extent.

An increased **inactivityTimer** value from 30 sec to 60 sec typically reduces the *pmChSwitchFachIdle* and *pmTotNoRrcConnectReqPs* to 50%, i.e. both signaling and access time are reduced. The difference can also be captured by *RNC Traffic Ps Data (RNC_ERL_PS)* taking only the UeRc for FACH into account.

As an increased value **inactivityTimer** is strictly correlated to FACH Erlang, the 15 kbps dimensioning rate should be considered in heavily loaded cells.

A parameter value of 30 sec is definitely a too low value. 60 sec or even 90 sec is worth considering.

3.4.3 Additional parameters

3.4.3.1 **downSwitchThreshold** and **downSwitchTimerThreshold**

hsdachInactivityTimer starts if both UL and DL throughput equal or fall below **downSwitchThreshold**, and stops if both UL and DL throughput exceed **downSwitchTimerThreshold**.

downSwitchThreshold of 0 kbps and **downSwitchTimerThreshold** of 0 kbps, combined with **hsdschInactivityTimer** of 2 sec, results in that the UE stays in connected-DCH state most of the time, even when not actively downloading. This will cost unnecessary hardware resources and block other users from using HSDPA services. This setup is optimized for shorter latency, and is often not the wanted behaviour. Instead a different set of parameter values should be considered, when optimizing for capacity, For instance, **downSwitchThreshold** of 8 kbps and **downSwitchTimerThreshold** of 16 kbps could be considered. This will result in that the UE stays in FACH state most of the time when there is only background traffic sent and received to/from the computer.

Note that changing the parameters from default will result in worse small PING performance since small PINGs do not add up enough traffic to move the UE to connected-DCH state. Instead the small PINGs will be sent from FACH with resulting longer PING times.

Finally, it should be stressed that in certain P5 release drops (e.g. P5.0.17 and P5.0.24) the change of parameters from the default does not lead to any performance change due to a known problem. For further information, please check WRNae02535.

3.4.3.2 **dlRlcBufUpswitch/ulRlcBufUpswitch**

These parameters are the DL/UL threshold for channel switching from FACH to dedicated channel for a single RAB.

Threshold values of 500/256B seem to be high enough to keep most spurious traffic on FACH. Decreasing the values has a too big impact on the resource usage and number of switches measured by `pmChSwitchFachDch` and `pmChSwitchDch64Fach`. Similar impact is also measurable with RNC *Traffic Ps Data (RNC_ERL_PS)*, if only the PS64 RB is considered, as the connection is so short that no up-switch is possible. By reducing the threshold values to, for instance, 100/8B, it is possible to evaluate the importance of the amount of traffic transmitted on FACH.

The default seems a good setting even if it's still not clear why the setting for UL and DL are not equal.

3.4.3.3 dlThroughputDownswitchTimer/ulThroughputDownswitchTimer

Time during which the DL/UL throughput must be lower than that specified by **dlDownswitchBandwidthMargin**/**ulDownswitchBandwidthMargin** before a downswitch request is issued.

3.5 Downlink power allocation

3.5.1 General

Downlink power settings are quite important where HSPA is deployed on a single carrier network, or where HSPA is deployed on second carrier and R99 traffic is high. Changing power allocation settings can have a direct impact on both R99 and HS performance. An optimum balance between coverage and capacity should be a main goal for R99. From the HSDPA perspective, it is important to have sufficient P-CPICH coverage to ensure required CQI measurements. In addition, HSDPA requires sufficient power to maintain high throughput values.

3.5.2 Main Parameters

3.5.2.1 PrimaryCpichPower

The P-CPICH power is set by the parameter **PrimaryCpichPower**. The power level of all other R99 downlink common channels is expressed as an offset relative to it.

PrimaryCpichPower tuning related activities should be considered in conjunction with other NPI modules such as Capacity Optimization [8] or Traffic Management [7]. If, for example, the **primaryCpichPower** is increased, then the coverage area of the cells is increased, which also implies a possible increase of the R99 traffic carried by the cells. However, the overall amount of unused power available for HSDPA will be reduced and the average interference level from R99 might increase, and hence the HS throughput could suffer.

From the perspective of improving HSDPA throughput, lowering the **primaryCpichPower** can free up power.

However, the high utilisation of the DL carrier brought about by HSDPA transmission must be considered. Even though the HSDPA traffic is best effort, it could still influence and degrade the RF conditions for R99 traffic. For example, assuming a 20watt power amplifier, if **primaryCpichPower=27 and maximumTransmissionPower = 41** and HSDPA is transmitting at full power, then maximum Ec/No value in the cell will be 27- 41 = -14 dB. The Ec/No value at cell border would most likely be worse due to potential inter-cell interference. Ec/No like this can trigger entry of R99 traffic to compressed mode (if Ec/No triggers are enabled) and follow on with GSM HO or IFHO. The parameters controlling entry into compressed mode, IFHO, and GSM HO (such as usedFreqThresh2dRscp, usedFreqThresh2dEcNo, usedFreqRelThresh4_2bEcNo, etc) can be considered for optimization as well if high HS utilisation is causing RF performance degradations.

In scenarios where HSDPA and R99 traffic are mixed, the **primaryCpichPower** should be high enough to guarantee that the maximum Ec/No value in the cell is well above (e.g. 1-2 dB) the thresholds for (bad) connection quality monitoring and IFHO/GSM HO in order to minimize the impact of HSDPA transmission on R99 traffic.

On the contrary, when HSDPA is deployed on a separated carrier the focus can be on the optimal **primaryCpichPower** that optimizes the HSDPA throughput.

3.5.2.2 hsPowerMargin

The main purpose of this parameter is to provide headroom in the total carrier power when the scheduler is allocating the remaining power to HSDPA.

In general, when the **hsPowerMargin** is decreased, the HSDPA throughput increases as more power is available for HSDPA.

If the **hsPowerMargin** parameter is set too low, then there is a possibility of power instability or cell breathing problems. For networks in which HSDPA is deployed on the same carrier as R99 (such as one carrier solution), it is recommended to keep the **hsPowerMargin** setting to default value.

If HSDPA is deployed on a separate carrier (two carrier solution), the **hsPowerMargin** setting can be reduced from the default one.

However, in general, the default setting for **hsPowerMargin** can be used and ensures good performance.

R99 power usage should be monitored closely when modifying this parameter as any change in HS power transmitted can affect the overall amount of interference in the cell, and hence required amount of power needed for R99 traffic.

3.5.2.3 hsScchMaxCodePower, (hsScchMinCodePower, qualityCheckPower)

These parameters can be set by considering the trade-off between leaving more power available to HS-DSCH and making HS-SCCH robust enough to be able to guarantee a high success rate of decoding this channel (bringing information to the UE about how to decode the HS-DSCH data and certain HARQ information), see also Section 3.2.4.2.

3.5.2.4 maxUserEHichERgchPowerDl and maxEAgchPowerDl

These parameters set the maximum downlink power for an individual E-HICH/E-RGCH and AGCH in the cell. In order to improve the reception of E-AGCH, EHICH/E-RGCH in areas with poor coverage, the power levels at which they are transmitted should be increased. The increase should lead to a minor but acceptable increase in DL power consumption.

The most affecting parameter change regards the power for HICH, because this channel has an higher activity factor (always on air when data sent in UL) compared to the activity factor of AGCH and RGCH, where information is sent only when it changes. For this reason, an increase in **maxUserEHichERgchPowerDl** has a greater impact on interference in DL, and also on power available for HSDPA, so that reducing the HSDPA performances. On the contrary a value too low might lead to a high percentage of UL retransmissions, which will affect not only UL, but also DL performances.

3.5.2.5 MCPA Power Increase

Increasing the Multi Carrier Power Amplifier (MCPA) is a mean to improve HSDPA throughput. The benefit is expected to be higher in a noise limited scenario (e.g. deep indoor coverage from outdoor sites or rural scenarios) than in an interference limited scenario.

As for the interaction between HSDPA and R99, increasing the MCPA will not improve the R99 performance due to worsening of CPICH Ec/No, unless other parameters are changed as well. These changes include the P-CPICH power values, Compressed Mode/IFHO thresholds, or **hsPowerMargin**.

3.6 Capacity management

3.6.1 General

HSPA do consume radio resources. Therefore, it is important to find suitable settings that optimize the usage of the radio resource for HS. This is especially true when HS traffic is mixed with R99 traffic and the traffic is medium/high.

The DL transmitted carrier power does not require an actual optimization as the RBS scheduler ensures that HS can utilize almost all the remaining power from the R99 traffic.

The UL hardware has to be carefully considered since each radio link set carrying A-DCH in UL may consume 4 or 16 channel elements (CE) depending on whether 64 kbps A-DCH or 384 kbps A-DCH are used, or at least 3 CEs reserved in case of EUL (2 with optional CEs ladder). In case the 16/HS RAB is enabled, then only 1 CEs in UL will be consumed.

The DL hardware does not need to be optimized since all the resources needed for HSDPA traffic are statically reserved in the HS Tx boards.

The DL channelization codes are important in case the Dynamic Code Allocation feature is turned off and/or the number of SF16 codes reserved for HS (**numHsPdschCodes**) is high, see also 3.2.4.3.

3.6.2 Main parameters

3.6.2.1 ulHwAdm

The Ericsson recommended values for the UL hardware (HW) admission policy are: **ulHwAdm**=100. This setting actually disable the UL HW admission policy. The main downside of this is that, in case of UL HW shortage, the operator has no means to control the priority handling for different types of connections. For example, a *guaranteed* speech connection may be affected in the same way as a *non-guaranteed* PS interactive connection, both over R99 and HS.

Another drawback is that the failures due to UL HW shortage will not be registered by Admission Control related counters (e.g. `pmNoReqDeniedAdm`) but they will reflected in the general accessibility KPIs (and also registered in `pmNoFailedAfterAdm`).

Starting from P5 release, UL HW admission policy activation is beneficial to prioritize admission of higher priority users (e.g. *guaranteed*) in case of lack of CEs. Moreover, the enhanced soft congestion opens up new opportunities for the optimization of the corresponding Admission Policies thresholds.

Results from the field indicate that, when the UL HW policy is activated, even if the number of blocked PS interactive calls on R99 or HS increases, the general accessibility KPIs are higher due to the enhanced soft congestion mechanism. In addition, the accessibility of *guaranteed* connections shows significant improvements during congested periods due to the effective control brought about by the UL HW admission policy and enhanced soft congestion mechanism.

In P5 UlHwAdm=95% and beMarginUlHw=10% have been tested on field and proven as suitable settings. In P6 best effort margins have been removed, so ulHwAdm values lower than 95% can be considered. In case of higher ulHwAdm (e.g. 98%) the expected benefit from the higher threshold level might be somehow jeopardized by the higher blocking rates for handover request.

The UL A-DCH (associated to HS) can use the 64 kbps or the 384 kbps rates. Since the 384 kbps radio bearer consumes a lot of “radio” resources (i.e. 16 CE or ~40 ASE) it is possible to limit the maximum number of 384 kb/s radio links by means of the parameter **sf4AdmUl**.

sf4AdmUl = 0 or 1 is often used in order to limit the impact of this type of connection. The hard limit has the following impacts on HS performance:

- Upload performance
- Download performance when high DL bit rates would be possible (e.g. 10 codes terminals)
- Download performance in case of E2E problems

In case the UL HW is the main concern, it is better to enable high usage of UL 384 RB when enough UL CEs are available and to rely on admission control policy and enhanced soft congestion to promote the utilization of 64 kbps radio bearer during congestion periods. This can be achieved by enabling the corresponding policies (by setting UlHwAdm equal or lower than 95%) and by setting **sf4UlAdm=2**, or even 4.

Results from the field have shown that removal of limit for UL SF4 (**sf4UlAdm=4**) improves availability of higher UL bit rates, which is beneficial for HS performance, without any impact on basic accessibility/retainability KPIs.

Active tests have shown throughput gain of 10% when using 384 kbps RB in UL rather than 64 kbps during HSDPA downloads in normal conditions. The gain in case of E2E problems is much higher than this[5].

It should be noted that in order to exploit the benefits on the removal of limit for UL SF4 the UL ASE admission policy should be disabled by setting **aseUlAdm**=500 and **aseUlAdmOffset**=0 (recommended values).

In order to reduce accessibility problems due to UL HW, it could also be considered the use of 16/HS RAB as the preferred initial rate to set up the connection (see 3.6.2.3).

[5] This is a typical situation where the gain of end-user perception cannot be fully monitored by means of the RBS throughput KPIs mentioned in this document.

3.6.2.2 **dlCodeAdm**, **beMarginDlCode** and **numHsPsdchCodes**

Similarly to the UL Hardware admission policy, the DL codes admission policy can be optimized in order to prioritize admission of higher priority users (e.g. *guaranteed*) in case of lack of channelization codes. Since enhanced soft congestion is present, it is possible to search the minimum **beMarginDlCode** so as to maximize accessibility of PS interactive traffic on HS without compromising the accessibility of higher priority requests.

Another interesting possibility for optimization comes from the interaction between **dlCodeAdm** and **numHsPdschCodes**. Since the number of SF16 codes reserved for HS-DSCH is subtracted from the total pool when calculating the DL code usage for admission control purposes there are two interesting implications:

1. A single R99 user consumes a higher percentage of the pool when **numHsPdschCodes** is high (e.g. = 5)

2. Assuming a certain code usage level, the remaining absolute number of codes before filling the pool entirely (which can be used for handover purposes) is higher when **numHsPdschCodes** is low (e.g. = 1).

Assuming now that the default setting for **dlCodeAdm**/**numHsPdschCodes** (80/5) is working well with respect to handover performance. Then, in case **numHsPdschCodes** is decreased to 1 it is possible to increase **dlCodeAdm** to 85 and experience the same handover performance.

Finally, it should not be forgotten that similar interaction exists between **beMarginDlCode** and **numHsPdschCodes**. In particular, if one thinks in terms of absolute number of codes, when **numHsPdschCodes** is decreased, **beMarginDlCode** should be decreased as well. However, since the unit of measurement of **beMarginDlCode** is 5%, it is more difficult to play with this parameter.

The setting **of NumHsPdschCodes** is then very important in term of capacity issues.

In networks with only one carrier an high value would dramatically affect R99, while a value too low would not guarantee sufficient HSDPA performances in case of high R99 traffic.

In networks with 2 carriers, in general one of them can be mainly dedicated to HSPA traffic, and the value of statically allocated DSCH codes can be increased. Results on field show good performances when setting this value equal to 10 in the second carrier mainly dedicated to HSPA.

3.6.2.3 RateSelectionPsInteractive.UlPrefRate

The Flexible Initial Rate Selection Feature allows, on a per cell basis, to select the rate at which the packet interactive RAB is established. High initial rate is beneficial to the end user since it will take shorter time before he can reach a high throughput. On the other hand, in areas where coverage for the higher rate is not provided, it is better to select a lower initial rate. Moreover it will require less resources in the admission control algorithm, so that a higher accessibility can be achieved.

The selection of a preferred channel type is allowed when the feature Dynamic PS Interactive/Background RAB Establishment is enabled. The preferred channel-type is selected through the RateSelectionPsInteractive.channelType parameter and can be set to either FACH or DCH. If it is set to DCH, the DCH rate is chosen according to the feature Flexible Initial Rate Selection, if the feature is enabled.

The preferred rate can be chosen separately for UL and DL through parameters **RateSelectionPsInteractive.ulPrefRate** and **RateSelectionPsInteractive.dlPrefRate.**

By setting **RateSelectionPsInteractive.ulPrefRate** equal to 16, the system will firstly try to set up the RAB on 16/HS or 16/DCH. This will dramatically improve accessibility, because fewer resources (CE, codes, ASE) are requested for 16 kbps compared to 64 kbps. As a drawback an increase in channel up-switching rate can be observed in the network.

3.6.2.4 hsdschInactivityTimer

Refer to section 3.4.2.1 in order to understand the main impact on capacity issues related to this parameter setting.

3.6.2.5 eulServingCellUsersAdm and eulServingCellUsersAdmTTI2

These couple of parameter set the maximum allowed number of 10ms or 2 ms Eul users. If eulServingCellUsersAdmTti2 is exceeded at a new RAB establishment attempt or a channel switch aiming for 2 ms EUL, then a try to set up the user on 10 ms EUL instead is performed and admission control for a 10 ms EUL RAB according to the serving and non-serving EUL admission policy will be evaluated

eulServingCellUsersAdmTTI2 can be used to limit the number of serving radio link for EUL 2 ms users, so that the whole EUL users can get a sufficient throughput. If the value of this parameter is greater than the value of eulServingCellUsersAdm, then this parameter will have no effect.

3.6.3 Additional parameters

3.6.3.1 hsdpaUsersAdm

This parameter can be used to maximize HSDPA accessibility, especially if channel switching parameters are set so that background traffic from the PC is holding a lot of users on HS (see Section 3.4).

In principle, **hsdpaUsersAdm** could be set very close to the maximum number of licensed HS users. However, in that case incoming cell change performance might worsen due to blocking on license.

3.6.3.2 schMinPowerNonGbrHsUsers

SchMinPowerNonGbrHsUsers, which defines the minimum reserved power for the *non-guaranteed* services using HSDPA, in order to have a better sharing of the DL power between *non-guaranteed* services on HSDPA and *non-guaranteed* services on R99 PS DCH.

For the non-GBR services the congestion situation is defined as the case when <u>both</u> following conditions are met:

• The ratio between the total transmitted HS-DSCH power (measured during the previous 100 ms), for all non-GBR service PQs regardless of scheduling priority class, and the maximum downlink power is less than **schMinPowerNonGbrHsUsers**. In other words this means that at least a percentage of power equal to **schMinPowerNonGbrHsUsers** is reserved for non GBR HS service.

• The average number non-GBR service PQs, that are not scheduled even though passing the queue validation procedure, during the previous 100ms is equal to or more than the parameter **schCongThreshNonGbr**.

When the congestion situation for the non-GBR service users is detected the HSDPA Scheduler will report to the RNC that the HS required power is just **schMinPowerNonGbrHsUsers** (that is the RBS measurements are truncated at this value).

By default the congestion situation is detected only when the number of PQ not served is >=2 (second bullet, schCongThreshNonGbr=2) while schMinPowerNonGbrHsUsers default value is equal to 0. This means that HS congestion resolving mechanism is disabled. This is the situation of P5, where no mechanism for HS congestion occurs. Values higher than 0 may affect R99 performances

In a cell pre-dominantly carrying R99 traffic, one can maximize capacity (reduce blocking) by increasing the **pwrAdm**. To utilize the full MCPA capability, and rely on the Congestion Control mechanisms, **pwrAdm+pwrOffset** could equal 99%. This would still trigger the congestion resolve actions. **pwrAdm** can, for instance, be set to 84%, while maintaining **pwrOffset** at 15%.

The setting above could also be combined with the soft power reservation for HSDPA traffic (e.g. **schMinPowerNonGbrHsUsers**=15%) in order to avoid lack of radio resources for PS services carried over HSPA during R99 traffic peaks.

3.6.4 Additional Hardware

3.6.4.1 UL Channel Elements (CEs) increase

The licensed amount of UL CEs can impact on HSUPA and R99 performances. A CEs expansion should be considered if accessibility problems are due to lack of CEs (GPEH INTERNAL_SYSTEM_BLOCK event can be used to detect) or if UE gets low EUL throughput, never exceeding the maximum value of the throughput range mapped to a certain CEs value, lower than the maximum (active test can be used to detect).

3.6.4.2 T X45 deployment

If TX15 are mostly deployed in the network, and HS performance issues arise, then the usage of TX45 should be considered.

Through active testing, it can be detected if 10 codes are ever allocated to the UE in good coverage. If not, and many HSDPA users in the all 3 sectors of the sites, then they would probably have to share the 15 codes in the site, and the DCA will redistribute the codes according to the number of DSCH codes per user in a cell (the lower the more priority the cell has to get the code)

In this case the deployment of TX45 board (or TX60) can help to solve the problems, allowing for 45 DSCH codes per RBS.

It is worth to remember that if the lack of DSCH codes is due to high R99 traffic, then TX45 board could not solve the issue, and a second carrier deployment is suggested.

4 KPIs and events related to each area of optimization

4.1 General

In this section, all KPIs and counters being mentioned in section 3 are listed per area of optimization. Only the KPIs and counters not fully described in [6] and [6] are explained here. Refer always to [5] and [6] for the KPI full descritpion, for those that are not detailed here. However, some are also included in this technical guide, since they are used together with RBS counters and GPEH based KPIs in the performance evaluation.

The performance indicators to be used during the service can be divided according to the areas of optimization:

- Basic HSPA parameters
- HSPA mobility and traffic management
- Channel switching
- Downlink power allocation
- Capacity management

It should be noted that the definition of the KPIs in the following sections are valid for the P6 release.

4.2 Basic HSPA parameters

4.2.1 KPIs and Counters

For statistical results on MAC-HS level, the following RBS counter formulas are applied:

Description	Formula
HS_Transmission_Ratio_SpiXX*	100*0.002*pmNoActiveSubFramesSpiXX/(Measurement_time [s])
HS_Scheduling_Ratio_SpiXX*	100* 0.002 * (pmNoActiveSubFramesSpiXX + pmNoInactiveRequiredSubFramesSpiXX) / (Measurement_time[s])
HS_UserTh_Net_SpiXX*	pmSumAckedBitsSpiXX/(0.002*pmSumNonEmptyUserBuffersSpiXX)
HS_UserTh_Gross_SpiXX*	pmSumTransmittedBitsSpiXX/(0.002*pmSumNonEmptyUserBufferSpiXX)
MAC_HS _SchedTh_Net1_SpiXX*	pmSumAckedBitsSpiXX/(0.002*pmNoActiveSubFramesS

	piXX)
MAC_HS _SchedTh_Net2_SpiXX*	pmSumAckedBitsSpiXX/(0.002*pmNoActiveSubFramesSpiXX+pmNoInactiveRequiredSubFrameSpiXX)
MAC_HS _SchedTh_Gross1_SpiXX*	pmSumTransmittedBitsSpiXX/(0.002*pmNoActiveSubFramesSpiXX)
MAC_HS _SchedTh_Gross2_SpiXX*	pmSumTransmittedBitsSpiXX/(0.002*pmNoActiveSubFramesSpiXX+ pmNoInactiveRequiredSubFrameSpiXX)
Average_UEs_in_Queue_SpiXX*	pmSumNonEmptyUserBuffersSpiXX/ (pmNoActiveSubFramesSpiXX + pmNoInactiveRequiredSubFramesSpiXX)
HS-SCCH code shortage Number of time the scheduler cannot accept new HSuser because of SCCHcodesshortage	pmRemainingResourceCheck[][0]
HS-PDSCH code shortage Number of time the scheduler cannot accept new HSuser because of PDSCHcodesshortage	pmRemainingResourceCheck[][1]
HS-PDSCH power shortage Number of times the scheduler cannot accept new HSuser because of PDSCHpowershortage	pmRemainingResourceCheck[][2]
Avg_HS-PDSCH_Codes_Dynamic_Allocation: Average Number of allocated codes for HS(RNC+dynamic code allocation)	pmSumNumHsPdschCodesAdded/pmSampleNumHsPdschCodesAdded
DynCode_Allocation_RBS_HW_limit	pmRbsHsPdschCodePrio
HS-SCCH_User_Power	pmSumOfHsScchUsedPwr[][$]
PDF of number of users per TTI (from 0 to 4):	pmNoOfHsUsersPerTti[][$]
Average HS_Scheduled_Users_per_TTI	(pmNoOfHsUsersPerTti[1] + 2 * pmNoOfHsUsersPerTti[2] + 3 * pmNoOfHsUsersPerTti[3] + 4 *pmNoOfHsUsersPerTti[4]) / (pmNoOfHsUsersPerTti[1] + pmNoOfHsUsersPerTti[2] + pmNoOfHsUsersPerTti[3] + pmNoOfHsUsersPerTti[4])
HS-SCCH_Code_Limit	100 * pmRemainingResourceCheck [0]/ pmNoActiveSubFramesSpiXX
HS-PDSCH code limit	100 * pmRemainingResourceCheck [1]/ pmNoActiveSubFramesSpiXX
HS-PDSCH power limit	100 * pmRemainingResourceCheck [2]/ pmNoActiveSubFramesSpiXX
HS_MAC-HS_BLER	100*pmNackReceived/(pmNackReceived+pmAckReceived)
Total_DL_Transmit_Power_NonHS	pmTransmitedCarrierPowerNonHs
Total_DL_Transmit_Power	pmTransmittedCarrierPower[][$]
Total_DL_Transmit_Power_HS(pdf)	pmTransmitedCarrierPowerHs[][$]

* KPI are calculated per each Scheduled Priority Index only in P6.1 (default is SPI3)

For statistical results on MAC-e level, the following RBS counter formulas are applied

EUL UU TRAFFIC VOLUME(kbit)	pmSumNackedBitsCellEul+pmSumAckedBitsCellEul
EUL_Avg_User_ NET SCHED THPT(Mbps)	pmSumAckedBitsCellEul/(pmNoActive10msFramesEul*10)
EUL Avg_User_GROSS SCHED THPT(Mbps)	(pmSumAckedBitsCellEul+pmSumNackedBitsCellEul)/(pmNoActive 10msFramesEul*10)
EUL_Avg_User_ NET SCHED THPT(Mbps)*	pmSumAckedBitsCellEul/((pmNoActive10msFramesEul*10)+ (pmNoActive2msFramesEul*2))
EUL Avg_User_GROSS SCHED THPT(Mbps)*	(pmSumAckedBitsCellEul+pmSumNackedBitsCellEul)/((pmNoActiv e10msFramesEul*10)+ (pmNoActive2msFramesEul*2))
2ms User fraction*	pmNoActive2msFramesEul/(pmNoActive10msFramesEul pmNoActive2msFramesEul)
EUL NACK RATE(percentage)	100*pmSumNackedBitsCellEul/(pmSumNackedBitsCellEul+pmSum AckedBitsCellEul)
RISE OVER NOISE(pdf)	pmTotalRotCoverage[][$]
OWN UU LOAD(pdf)	pmOwnUuLoad[][$]
NOISE FLOOR(pdf)	pmNoiseFloor[][$]
EDCH USERS(pdf)	pmNoSchEdchEul[][$]
TOTAL GRANTED UU RATE(pdf)	pmTotRateGrantedEul[][$]
TIME TO SCHEDULED GRANT(pdf)	pmWaitingTimeEul[][$]
EUL DL COMMON POWER CONS	pmCommonChPowerEul[][$]
EUL RESCH UU INTERF LIMIT	pmNoUlUuLoadLimitEul

pmNoAllowedEul
EUL_INT_USER_UL_THROUGH
#EUL_scheduled_USER(pdf)
UL_RSSI(pdf)
UL_AVE_RSSI
EUL_UL_CE_Usage
	pmNoAllowedEul
	pmSumEulIRlcUserPacketThp/pmSamplesEulRlcUserPacketThp
	pmNoSchEdchEul[][$]
	pmNoAllowedEul[][$]
	pmSumUlRssi/ pmSamplesUlRssi
	pmHwCePoolEul

* Formula used only in P6.1

To obtain the details of scheduling algorithms, the mode from the UE reports in TEMS Investigations have to be used:

- “HSDPA UL HS-DPCCH information” containing UL information in terms of UE reported CQI and ACK/NACK/DTX indicator. 100 TTIs are reported in each Mode Report.

- “HSDPA HS Decode Status” containing DL information on New Transmission, CRC result and TBS. 100 TTIs are reported in each Mode Report. The starting sub-frame-number of the DL report has an offset equal to 4 compared to the UL report.

- “HSUPA E-DPCH Log Packet” containing EUL informations on happy bit and E-TFCI used, reported from UE to the RBS. 20 TTIs of 10ms are reported in each message. If 2ms User, then 100 TTIs are reported

- “HSUPA Combined L1/MAC Log Packet” contains EUL information for AGCH and RGCH sent by RBS to UEs.

- HSUPA L1/MAC Statistics Log Packet groups all the previous information per 200ms (20 TTI of 10ms Users)

The following pdf counter can be used to monitor CQI reporting:

`pmReportedCqi`

Possible transport network limitations to HSDPA performance per each Scheduling Priority index can be monitored by means of:

`pmCapAllocIubHSLimitingRatioSpiXX`

pmHsDataFramesReceivedSpiXX and *pmHsDataFramesLostSpiXX*

Possible transport network limitations to EUL performance can be monitored by mean of

pmEdchIubLimitingRatio

and in case that more than 1 EUL UE is simultaneously uploading, it can be combined with the counter

pmNoUlIubLimitEul

providing information about redistribution of bandwidth (bitrate) between E-DCH users in a situation when one or more resources are limiting the allocation of higher rates to an E-DCH user in a cell. It is performed by a decrease in rate for one EDCH user to accommodate an increase in the rate for another E-DCH user

R99 Code utilization can be monitored as follows:

`pmSumDlCode`

`pmSampleDlCode`

4.2.2 Events

The throughput of PS interactive data users can be monitored by means of the following GPEH event:

441 INTERNAL_PACKET_DEDICATED_THROUGHPUT

This enables to follow the throughput of specific users. This information can be also correlated with other GPEH events in order to get the throughput while the user is a specific RAB state (e.g. using HSDPA).

4.3 HSPA mobility and traffic management

4.3.1 KPIs and Counters

HS Data Retransmission Rate: *HS_RETRANSM_RATE*

HSDPA Cell Change Success Rate: *HS_CC_SUCC_RATE*

EUL Cell Change Success Rate: EUL_CC_SUCC_RATE

HSDPA to DCH Reconfiguration Success Rate: *HS_DCH_SUCC_RATE*

RAB Drop Rate PS Interactive HS: *DROPRATE_PS_HS*

RAB Drop Rate PS Interactive HS: DROPRATE_PS_EUL

Minutes per Drop HS Data: *MPD_PS_HS*

Minutes per Drop EUL Data: *MPD_PS_EUL*

IF Hard HO Hs Success Rate: *IFHHO_SUCC_HS*

IF Hard HO Hs Success Rate Incoming: *IFHHO_SUCC_HS_IN*

IF Hard HO Hs Success Rate Outgoing: *IFHHO_SUCC_HS_OUT*

IF Hard HO Hs Failure Rate Incoming: *IFHHO_FAIL_HS_IN*

IF Hard HO Hs Failure Rate Outgoing: *IFHHO_FAIL_HS_OUT*

IFLS Activity Rate: *IFLS_ACTIVITY*

IFLS Activity Rate PS: *IFLS_ACTIVITY_PS*

IFLS Activity Rate CS: *IFLS_ACTIVITY_CS*

RAB Establishment Success Rate PS Interactive DCH/FACH: *PS_NON_HS_RABSUCCRATE*

4.3.2 Events

The following GPEH events are useful to monitor and optimize HS mobility:

432 INTERNAL_SUCCESSFUL_HSDSCH_CELL_CHANGE

433 INTERNAL_FAILED_HSDSCH_CELL_CHANGE

442 INTERNAL_SUCCESSFUL_TRANSITION_TO_DCH

443 INTERNAL_FAILED_TRANSITION_TO_DCH

438 INTERNAL_SYSTEM_RELEASE

4.4 Channel switching

4.4.1 KPIs and counters

RNC Traffic HS: *RNC_ERL_HS*

RNC Traffic EUL: *RNC_ERL_EUL*

`pmUpswitchFachHsAttempt`

`pmUpswitchFachHsSuccess`

`pmDlTrafficVolumePsCommon`

`pmChSwitchFachIdle`

`pmTotNoRrcConnectReqPs`

RNC Traffic Ps Data: *RNC_ERL_PS*

Channel Upswitch Failure Rate: USWITCH_FAILRATE_UL_EUL

4.4.2 Events

The following GPEH events are useful to monitor and optimize channel switching performance:

19 RRC_RRC_CONNECTION_RELEASE

34 RRC_RRC_CONNECTION_REQUEST

415 INTERNAL_RAB_ESTABLISHMENT

387 INTERNAL_CHANNEL_SWITCHING

392 INTERNAL_CONGESTION_CONTROL_CHANNEL_SWITCH_AND _TERMINATE_RC

4.5 Downlink power allocation

4.5.1 KPIS and counters

RRC Failures Admission CS: *ADMCONTROL_RRC_DEN_CS*

RRC Failures Admission PS: *ADMCONTROL_RRC_DEN_PS*

RAB Establishment Success Rate PS Interactive HS: *PS_HS_ RABSUCCRATE*

RAB Establishment Success Rate PS Interactive EUL: PS_EUL_RABSUCCRATE

RAB Establishment Success Rate Speech: *SPEECH_RABSUCCRATE*

IFLS Activity Rate: *IFLS_ACTIVITY*

RAB Drop Rate Speech: *DROPRATE_SPEECH*

Cell Traffic Speech: *ERL_SPEECH*

Cell Traffic PS HS: *ERL_PS_HS*

Cell Traffic PS EUL: *ERL_PS_EUL*

Power Limit Failure: *REQDEN_DLPOWER*

Congestion Time UL: *UL_CONG_TIME*

Congestion Time DL: *DL_CONG_TIME*

Number of CM Users per Cell: *AVG_NUM_CONN_CM*

CS IRAT HO Activity Rate: *IRATHO_ACTIVITY_RATE*

`pmTransmittedCarrierPowerNonHs`

`pmTransmittedCarrierPower`

`pmTransmittedCarrierPowerHs`

4.5.2 Events

393 INTERNAL_START_CONGESTION

394 INTERNAL_STOP_CONGESTION

4.6 Capacity management

4.6.1 KPIS and counters

Overall Accessibility Success Rate Speech: *CSSR_SPEECH*

Overall Accessibility Success Rate PS Interactive: *CSSR_PS*

Overall Accessibility Success Rate PS Interactive HS: *CSSR_PSHS*

Overall Accessibility Success Rate PS Interactive EUL: CSSR_PSEUL

RAB Drop Rate PS Interactive HS: *DROPRATE_PS_HS*

RAB Drop Rate PS Interactive EUL: *DROPRATE_PS_EUL*

Minutes per Drop HS Data: *MPD_PS_HS*

Minutes per Drop EUL Data: *MPD_PS_EUL*

RAB Drop Rate Speech: *DROPRATE_SPEECH*

RRC Setup Admission Control Failure: `pmNoRrcDeniedAdm`

Requests Denied due to Admission for RAB Speech: *NONHO_REQDEN_SPEECH*

Requests Denied due to Admission for RAB PS Interactive: *NONHO_REQDEN_PS*

Requests Denied due to Admission for RAB HS: *NONHO_REQDEN_HS*

Code Usage Failure: *REQDEN_CODES*

UL HW Limit Failure: *REQDEN_ULHW*

Total Failures after Admission: `pmNoFailedAfterAdm`

Downgraded PS Data Connections Adm: *PS_CONG_DOWNS_ADM*

`pmSumUlCredits`, `pmSumSqrUlCredits`, `pmSamplesUlCredits`

`pmUlCredits`

`pmSumDlCode`, `pmSumSqrDlCode`, `pmSamplesDlCode`

4.6.2 Events

The following GPEH event enables the precise calculation of who is blocked (e.g. guaranteed/non-guaranteed; handover/non-handover) and what is the limiting resource:

431 INTERNAL_SYSTEM_BLOCK

438 INTERNAL_SYSTEM_RELEASE

Prepared (also subject responsible if other)		No.		
TEI/RFN M. Benedetti, R. De Bernardi, ESM/GB/A Christer Mejerland, ESM/GB/B Brian Fairbanks Terry		006 92-FAF 102 434		
Approved	Checked	Date	Rev	Reference
Sebastian Schaplitz	TEIMOLT;TEILLUN	16/02/2009	B	

5 References

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[12] HS Impact on R99 Traffic (Centra Session)

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