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Contents

Foreword

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

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x the first digit:

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

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Introduction

Energy saving is important for operators' operational efficiency. Energy consumption is a significant operational cost factor, for example in developing markets, up to 30% of OPEX is spent on energy. For one operator group, almost 80% of base stations in Africa and India use diesel as the primary or as a backup power source. Furthermore, base stations account up to 80% of the total CO_2 emissions in a mobile operator network. Many operators have a target to cut CO_2 emissions as part of their environmental objectives. With increasing voice usage, data usage (e.g. introduction of smart phones, MTC devices, etc) and more dense networks, the thirst for energy consumption is expected to increase further, hence, motivating the need for low energy base station technology. Increasing the energy efficiency of base stations or reducing the energy consumption of base stations will also facilitate the possibility for operators to power all types of base stations with alternative fuels and rely less on fossil fuels either from diesel generators or from the electricity grid.

1 Scope

The present document provides a study into BTS energy saving solutions. The document analyses and evaluates different solutions to determine the benefits provided compared to the legacy BTS energy consumption.

Specific considerations are given to the following solutions:

- Reduction of Power on the BCCH carrier (potentially enabling dynamic adjustment of BCCH power)
- Reduction of power on DL common control channels
- Reduction of power on DL channels in dedicated mode, DTM and packet transfer mode
- Deactivation of cells (e.g. Cell Power Down and Cell DTX like concepts as discussed in RAN [4])
- Deactivation of other RATs in areas with multi-RAT deployments, for example, where the mobile station could assist the network to suspend/minimise specific in-use RATs at specific times of day
- And any other radio interface impacted power reduction solutions.

The solutions shall also consider the following aspects:

- Impacts on the time for legacy and new mobile stations to gain access to service from the BTS
- Impacts on legacy and new mobile stations to keep the ongoing service (without increasing drop rate)
- Impacts on legacy and new mobile stations implementation and power consumption, e.g. due to reduction in DL power, cell (re-)selection performance, handover performance, etc.
- Impacts on UL/DL coverage balance, especially to CS voice

Solutions shall be considered for both BTS energy saving non-supporting and supporting mobile stations (i.e. solutions that are non-backwards compatible towards legacy mobile stations shall be out of the scope of this study).

The contents of this report when stable shall determine the modifications to existing GERAN specifications.

2 References

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

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TR 41.001: "GSM Release specifications".

[3] ETSI TS 102 706, "Energy Efficiency of Wireless Access Network Equipment".

[4] 3GPP TR 25.927, "Solutions for Energy Savings within UTRA NodeB", V.10.0.0

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

busy hour: one hour period during which occurs the maximum total load in a given 24-hour period

busy hour load: average BTS load during busy hour

energy efficiency: relation between the useful output and energy/power consumption

low load: average BTS load during time when there is only very low traffic in network

medium term load: defined BTS load level between busy hour and low load levels

3.2 Symbols

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

<symbol> <Explanation>

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

BBU	Base Band Unit
BHT	Busy Hour Traffic
BTS	Base Transceiver Station
GoS	Grade of Service
IRC	Interference Rejection Combining
MCBTS	Multi-Carrier BTS
MCPA	Multi-Carrier Power Amplifier
RE	Radio Equipment
SAIC	Single Antenna Interference Cancellation
SCPA	Single Carrier Power Amplifier
TRX	Transceiver
VAMOS	Voice services over Adaptive Multi-user channels on One Slot

4 Study Considerations

This section depicts considerations on appropriate network scenarios and on qualitative analysis of the BTS energy consumption.

4.1 Network Scenario Considerations

All the scenarios to be studied in BTS energy saving are listed in this subclause. The scenarios should consider deployment, GERAN configuration (e.g. CS+PS resource dimensioning, EGPRS, EGPRS2), cell utilisation, etc.

Below is a list of aspects that could be used to characterise the energy saving scenarios:

- Deployment and coverage:

- GERAN only, multi cell, single band, 900 coverage layer
- GERAN only, multi cell, single band, 1800 capacity layer
- GERAN only, multi cell, dual band with 900 coverage layer, 1800 capacity layer
- GERAN overlay coverage, UTRAN/E-UTRAN micro/hotspot coverage

- BTS configuration
  - Number of sectors and carriers
  - SCPA (Normal BTS) and MCPA (MCBTS)
- The following traffic and load models are assumed:
  - SDCCH configuration model
  - Traffic load profiles for low load, medium term load and busy hour load subscriber traffic (derived from ETSI TS 102 706 Annex D [3])
- Backward compatibility to previous MS releases

The investigated scenarios in this feasibility study are limited to GERAN networks. This does not prevent the inclusion of supplementary investigations based on mixed-RAT networks.

4.2 Energy Consumption of BTS

This section contains a qualitative analysis of energy consumption breakdown of current BTSs for different antenna/carrier configurations, topologies and DL and UL loading scenarios.

The components listed below are the main parts in a BTS energy consumption breakdown, containing BBU, REs, power supply, coaxial feed, and other related consumptions. The relation in Table 4.2-1 is summarized based on a variety of configurations of BTSs under a low load assumption specified as 10% in ETSI TS 102 706 [3].

Table 4.2-1: Power Consumption breakdown of a BTS

BTS power consumption	Qualitative contribution to Total Power Consumption
Base Band Unit (BBU)	Medium
Radio Equipments (RE)	High
Primary DC Power Supply (i.e. rectifiers, battery)	Medium
Coaxial feed pressurization/dehydration	Medium (vary with feeder length and diameter)
Other related consumption(like fan, lighting, alarm, etc.)	Low (under typical environmental conditions)

From Table 4.2-1, the RE appears to contribute the most to the total BTS power consumption. However, the qualitative analysis above does not take into consideration the different permutations of BTS type and configuration, which can influence alternative energy saving solutions and is an important aspect in the definitions of the scenarios.

5 Objectives

This section describes how to evaluate the solutions and the rules for adopting energy saving solution into this technical report. To this purpose performance and compatibility objectives are defined. For each objective an evaluation metric will be defined for benchmarking the proposed candidate solutions. A candidate solution will not be necessarily discarded, if it does not fulfil a particular objective, but this will be taken into account in the overall evaluation of the candidate solution and in the comparison against other candidate solutions.

5.1 Performance Objectives: energy efficiency target

The energy efficiency shall be measured in terms of relative energy savings in % versus a reference configuration, where the reference configuration does not apply any energy saving mechanism and is based on the configuration specified in subclause 6.1 and based on the agreed minimum GoS requirements as stated in subclause 5.2.1 and 5.2.2 and the fulfillment of the requirement stated in subclause 5.2.3. The relative energy savings are to be evaluated in regard to TRX power consumption and in regard to average RF output power as stated in subclause 6.6.2.

5.2 Compatibility Objectives

There are seven compatibility objectives defined for this study.

5.2.1 Avoid impact to voice user call quality

The introduction of a candidate solution shall minimise degradation of voice quality as perceived by the user. The acceptable limit for the call blocking rate is less than 2%. For the candidate solution the call quality shall fulfil the target of at least 95% of satisfied users, where the call FER shall be less than 2% for FR codecs and less than 3% for HR codecs. The percentage of satisfied users shall be recorded for the reference case and the candidate solution.

5.2.2 Avoid impact to data user session quality

The introduction of a candidate solution shall minimise degradation of active data sessions for the user. The degradation of the session throughput shall be recorded at the 10th, 50th and 90th percentiles of the session throughput cumulative distribution function.

5.2.3 Avoid impact to cell (re)selection and handover

Impact to cell (re)selection and handover should be minimised with any candidate solution, in that additional cell reselections and handovers compared to the reference case shall be minimised. The call drop rate shall not be higher than 0.2% for the reference case and the candidate solution.

5.2.4 Support of legacy MSs

Legacy MS types shall be supported.

5.2.5 Implementation impacts to new MSs

The introduction of any candidate solution proposed under this study should avoid changes to MS hardware. Additional complexity in terms of processing power and memory should be kept to a minimum for a new MS. Impacts to power consumption should be avoided.

5.2.6 Implementation impacts to BSS

The introduction of any candidate solution proposed under this study should change BSS hardware as little as possible and HW upgrades to the BSS should be avoided.

5.2.7 Impacts to network planning

Impacts to network planning and frequency reuse shall be avoided.

6 Common Assumptions

This section lists the common assumptions for the evaluation of candidate solutions.

6.1 Reference Configuration

The reference configuration described hereafter is derived from that specified in Annex D, Table D.1 of ETSI TS 102 706 [3].

6.1-1 below describes the load conditions for various load levels and site configurations. The BCCH TRX is active in every site configuration and for different load levels. The busy hour traffic figures for the three site configurations listed in the rightmost column are taken from 6.3-1.

Table 6.1-1: Load model for different site configuration and offered load level

	Low load	Medium term load	Busy hour load
Load for S222	• BCCH TRX: all TS except TS0 can be allocated for user traffic • Other TRX: all TS allowed for user traffic • Mean Traffic load per sector: 20% of busy hour (see Table 6.3-1)	• BCCH TRX: all TS except TS0 can be allocated for user traffic • Other TRX: all TS allowed for user traffic • Mean Traffic load per sector: 50% of busy hour (see Table 6.3-1)	• BCCH TRX: all TS except TS0 can be allocated for user traffic • Other TRX: all TS allowed for user traffic • Mean traffic load per sector: according to busy hour (see Table 6.3-1)
Load for S444	• BCCH TRX: all TS except TS0 can be allocated for user traffic • Other TRX: all TS allowed for user traffic • Mean Traffic load per sector: 20% of busy hour (see Table 6.3-1)	• BCCH TRX: all TS except TS0 can be allocated for user traffic • Other TRX: all TS allowed for user traffic • Mean Traffic load per sector: 50% of busy hour (see Table 6.3-1)	• BCCH TRX: all TS except TS0 can be allocated for user traffic • Other TRX: all TS allowed for user traffic • Mean traffic load per sector: according to busy hour (see Table 6.3-1)
Load for S888	• BCCH TRX: all TS except TS0 can be allocated for user traffic • Other TRX: all TS allowed for user traffic • Mean Traffic load per sector: 20% of busy hour (see Table 6.3-1)	• BCCH TRX: all TS except TS0 can be allocated for user traffic • Other TRX: all TS per each sector can be allocated and remaining TS idle • Mean traffic load per sector: 50% of busy hour (see Table 6.3-1)	• BCCH TRX: all TS except TS0 can be allocated for user traffic • Other TRX: all TS allowed for user traffic • Mean traffic load per sector: according to busy hour (see Table 6.3-1)
Load level duration	6 hours	10 hours	8 hours

Dedicated signalling channels (SDCCH) are modelled for each cell according to Table 6.1-2. The load model for these channels (i.e. channel usage for call set-up phase, location signalling, etc.), the allocation of these channels (i.e. if allocated on BCCH TRX and/or on any other TRX belonging to the cell) and the energy saving method for these channels (i.e. applied power reduction/power control method) need to be reported.

Table 6.1-2: Number of SDCCH channels per sector for each site configuration and each load profile

Site Configuration	Load Profile 1 Low Traffic Load (20% of BHT) with 100 % FR codec	Load Profile 2 Medium Term Traffic Load (50% of BHT) with 100 % FR codec	Load Profile 3 High Traffic Load (100% of BHT) with 100% FR codec	Load Profile 4 High Traffic Load (100% of BHT) with 100% HR codec
S222	1	1	1	2
S444	2	2	2	4
S888	4	4	4	8

The reference parameter for the purpose of cell size calculation is detailed in Table 6.1-3.

Table 6.1-3: Reference parameter for cell size calculation

Parameter	Value
UE antenna height	1.5 m
UE antenna gain	0 dB
UE sensitivity	-104 dBm (static)
UE RF output power	31 dBm (900 MHz) 28 dBm (1800 MHz)
BTS transmit power for downlink	BCCH TRX power level
Downlink traffic type	Voice, mix of voice/data
Uplink traffic type	Voice, mix of voice/data

6.2 Evaluation Metrics

Appropriate metrics for the evaluation by means of dynamic system simulations need to be identified.

Two Radio Equipment (RE) related performance metrics for energy efficiency evaluation are defined as reflected in the performance objective in clause 5.1:

- RE Performance Metric 1: Gain in Cumulated TRX power consumption for all TRXs belonging to a cell.
- RE Performance Metric 2: Gain in Average RF output power for all TRXs belonging to a cell.

For comparison of candidate techniques RE Performance Metric 1 has higher priority than RE Performance Metric 2.

The evaluation should refer to energy savings in percent versus the reference configuration specified in subclause 6.1. The method for evaluating the performance gain is further described in subclause 6.6.2.

NOTE: Dynamic system simulations can be supported by measurements from real networks.

6.3 Traffic Load profiles

The busy hour traffic for the three site configurations from Table 6.1-1 are detailed in Table 6.3-1. CS voice traffic is 0,020 Erlangs/subscriber during Busy Hour. CCCH is allocated on one timeslot.

Table 6.3-1: Load profiles for different site configuration

Site Configuration	Load Profile 1 Low Traffic Load (20% of BHT) with 100 % FR codec	Load Profile 2 Medium Term Traffic Load (50% of BHT) with 100 % FR codec	Load Profile 3 High Traffic Load (100% of BHT) with 100% FR codec	Load Profile 4 High Traffic Load (100% of BHT) with 100% HR codec
S222	4,8 Erlangs (3×1,6)	12,3 Erlangs (3×4,1)	24,6 Erlangs (3×8,2)	54,9 Erlangs (3×18,3)
S444	12,6 Erlangs (3×4,2)	31,5 Erlangs (3×10,5)	63,0 Erlangs (3×21,0)	131,7 Erlangs (3×43,9)
S888	26,1 Erlangs (3×8,7)	73,2 Erlangs (3×24,4)	146,1 Erlangs (3×48,7)	292,8 Erlangs (3×97,6)

The traffic load levels in Table 6.3-1 are derived from a call blocking rate of 2% assumed for the busy hour traffic in load profile 3 and load profile 4 and from the indicated share of the busy hour load of load profile 3 in case of load profile 1 and load profile 2. Table 6.3-1 is valid for the voice-only scenario.

For the mixed voice/data scenario the traffic load levels need to be modified to accommodate the traffic on data channels. A straightforward way is to use the same traffic load levels as for the voice only scenario depicted in Table 6.3-1 and reuse the call arrival model. For each call arrival it shall be decided with a probability of 70% that a voice call is requested and with a probability of 30% that a data session is requested according to the entry in Table 6.4-1. Note for each data user a session has a size of 800 kb according to the data traffic model in Table 6.4-1. If this session was transported over only 1 TS with an average throughput of only 10 kBit/s, then the session would have a duration of 80 s, which is less than the assumed mean call duration of 90 s for a voice call. Hence the overall traffic load for the mixed voice/data scenario is assumed to not exceed the one for the voice only scenario. The traffic load for the data sessions for load profile 4 is derived from load profile 3 in that it is equal.

BCCH time slot allocation for both traffic scenarios related to voice and data traffic is depicted in Table 6.4-1.

6.4 Reference deployment scenarios

Further detailing of deployment scenarios listed in section 4.1 is of importance to progress evaluations on identified candidate solutions.

Following settings are proposed for network parameters as depicted in Table 6.4-1 below.

Table 6.4-1: Network parameters for site configurations defined in subclause 6.1.

Parameter	Value	Unit	Comment
Sectors per site	3		
Frequency Band	900 / 1800		
Cell size	2000 500	m m	Coverage layer (900 MHz) as investigated in TR 45.050 Annex Z.B.2.3 for MCBTS Capacity layer (1800 MHz) as investigated in 3GPP TR 45.913 and 45.914
BCCH frequency re-use	4/12		BCCH frequency reuse applied also in WIDER, see 3GPP TR 45.913, and MUROS, see 3GPP TR 45.914, feasibility studies.

BCCH TS occupation	TN 0 Traffic scenario 1 (Voice only): TN 1…7 Traffic scenario 2 (Mixed voice/data scenario): - for low load / medium term load: TS occupation for voice and data flexible - for busy hour load: voice: TN 5...7 data: TN 1...4		BCCH/CCCH, multiple CCCH not used. TS for TCH in the voice only scenario excluding TS on BCCH carrier allocated to SDCCH. TS for TCH in the mixed voice / data scenario excluding TS on BCCH carrier allocated to SDCCH. The SDCCH allocation needs to be described for the candidate technique (see subclause 6.1).
TCH frequency re-use	Configuration 2/2/2: 1/1 for RF synthesizer hopping 3/9 for baseband hopping and RF synthesizer hopping Configuration 4/4/4: 1/1 for RF synthesizer hopping 3/9 for baseband hopping and RF synthesizer hopping Configuration 8/8/8: 1/1 for RF synthesizer hopping 3/9 for baseband hopping and RF synthesizer hopping		TCH frequency reuse figures depend on the site configuration under investigation and the frequency hopping type. Site configurations are according to subclause 6.1 .
Frequency Allocation Site configuration 2/2/2 Site configuration 4/4/4 Site configuration 8/8/8	 21 frequencies (12 + 9) 39 frequencies (12 + 27) 75 frequencies (12 + 63)		 BCCH frequencies and TCH frequencies separated by 1 guard frequency (0.2 MHz)
Bandwidth of BCCH layer	2.4 MHz		
Bandwidth of TCH layer Site configuration 2/2/2 Site configuration 4/4/4 Site configuration 8/8/8	 1.8 MHz 5.4 MHz 12.6 MHz		 TCH on adjacent freq. TCH on adjacent freq. TCH on adjacent freq.
Path loss model	Okumura-Hata		ETSI TS 102 706
Log-normal fading st.dev	6	dB	ETSI TS 102 706
Correlation distance	110	m	
Inter-site log-normal correlation coefficient	50	%	
Handover margin	3	dB	
BTS output power for BCCH carrier and other	43	dBm	Other output power levels may in addition be used in

carriers			the study but need to be indicated.
BTS antenna height	40	m	ETSI TS 102 706
BTS Sector antenna pattern	65º deg H-plane, max TX gain 18	dBi	UMTS 30.03 (modified from assumption in ETSI TS 102 706)
BTS feeder and connector loss	3	dB	ETSI TS 102 706
BTS sensitivity BTS noise figure		dBm dB	implementation dependent implementation dependent
MS output power	31	dBm	ETSI TS 102 706
RACH power reduction	Disabled		
MS antenna height	1.5	m	ETSI TS 102 706
MS antenna gain	0	dBm	ETSI TS 102 706
MS sensitivity MS noise figure	-104 8	dBm dB	ETSI TS 102 706
Body loss	3	dB	ETSI TS 102 706
Indoor/Outdoor users	0 / 100	%	Outdoor users are more interesting in a reselection/handover study. This will effectively eliminate the impact of building penetration loss listed in ETSI TS 102 706
Traffic scenarios Traffic scenario 1 Traffic scenario 2	 100 % voice users 70 % voice users, 30 % data users		 First priority for evaluation Second priority for evaluation Note VAMOS channels are not included for voice.
Average power decrease (APD) for voice	0,2,..,APDmax dB Level chosen according to power control.		
Average power decrease (APD) for data	GMSK: 0 dB 8PSK: [4.0] dB 16QAM: [6.0] dB 32QAM: [6.0] dB (Values from 3GPP TS 45.008)		
Average power decrease (APD) for dummy bursts	APDmax dB		
Speech codecs	FR: AFS 12.2 and AFS 5.9 HR: AHS 5.9 and GSM HR		FR codecs are evaluated at all traffic load levels. HR codecs are only evaluated at busy hour traffic load level.
DARP phase I penetration rate	Traffic scenario 1: 60% Traffic scenario 2: 60% for voice, 100% for data		
AMR codec mode adaptation	Disabled		
DTX on DL/UL	Enabled		

Handover	Penalty in terms of speech frame erasures during handover to be taken into account for DL and UL.		Vendor specific penalty. Aligned to MUROS TR 45.913
Voice call model	- Poisson distributed call arrivals and exponential call durations. - mean call duration: 90 sec - min. call duration: 5sec.		Aligned to MUROS TR 45.913
Data traffic model	- PS data transfer size per session: 100kB - MCS belonging to GPRS and EGPRS to be used in phase 1 of the study. MCS for EGPRS2 to be used in phase 2 of the study.		In WIDER TR 45.913 FTP service with 1 MB file size has been assumed. In GERAN Evolution TR 45.912 FTP service with 100 and 120 kB was assumed aside HTTP traffic.
Link adaptation	Enabled		LA kept vendor specific
Fading channel profile	Typical Urban (TU)		
Paging cycle	BS_PA_MFRMS = 4 (4*235.38 ms = 941.5 ms)		relevant for MS measurements in idle mode.
Number of cells in neighbour cell list	12		relevant for measurements in idle and connected mode
Reselection criteria	C2 = C1		Represents the default case in TS 45.008, i.e. no additional parameters for cell reselection are broadcast
MS velocity	3 km/h and 50 km/h		3km/h evaluated for all scenarios 50 km/h only evaluated for certain scenarios, see subclause 6.5.7

Other simulation parameters such as simulated time, network size, usage of propagation wrap around need to be reported.

6.5 MS characteristics

The need for clarification of MS related procedures has been raised during the study in order to create a simplistic model for measurement sampling, averaging and cell reselection procedures and handover preparation in the MS. These items are subject for discussion with MS manufacturers and feedback was requested to derive such a model. Behaviour of legacy MS in field and new MS has to be distinguished. Deviations from the common assumptions stated in this clause need to be reported.

6.5.1 BCCH carrier power measurement sampling

6.5.1.1 Idle mode

In idle mode, information was provided during Telco#1 on BTSEnergy, that the measurement window of the MS for monitoring signal strength of serving cell and neighbour cells is enlarged compared to connected mode, but it is sufficiently different from selecting a time slot on random basis between 0 and 7. Measurements in idle mode are not taken in a continuous manner, since the MS will enter DRX periods and only measure during active periods between two DRX periods. Feedback received from MS manufacturers so far indicates that all BCCH measurements, performed for serving cell and neighbour cells, are done in the time interval where the MS listens to its paging block.

The minimum performance requirement for cell selection in idle mode is specified in 45.008 in subclause 6.6.1:

> Whilst in idle mode an MS shall continue to monitor all BCCH carriers as indicated by the BCCH allocation (BA - See table 1). A running average of received signal level (RLA_C) in the preceding 5 to:
>
> Max {5 , ((5 * N + 6) DIV 7) * BS_PA_MFRMS / 4}
>
> seconds shall be maintained for each carrier in the BCCH allocation. N is the number of non-serving cell BCCH carriers in BA and the parameter BS_PA_MFRMS is defined in 3GPP TS 45.002.
>
> The same number of measurement samples shall be taken for all non-serving cell BCCH carriers of the BA list, and the samples allocated to each carrier shall as far as possible be uniformly distributed over each evaluation period. At least 5 received signal level measurement samples are required per RLA_C value. New sets of RLA_C values shall be calculated as often as possible.

Hence at least 5 samples need to be taken in a period no shorter than 5 seconds for all neighbour cells (i.e. Max {5 , ((5 * N + 6) DIV 7) * BS_PA_MFRMS / 4}). Consequently the number of neighbour cells N is an important parameter to define the length of the averaging period. The meaning of the above formula in TS 45.008 is an important clue to help identify mobiles behaviour. Figure 6.5-1 below shows an example for neighbour cell monitoring in idle mode.

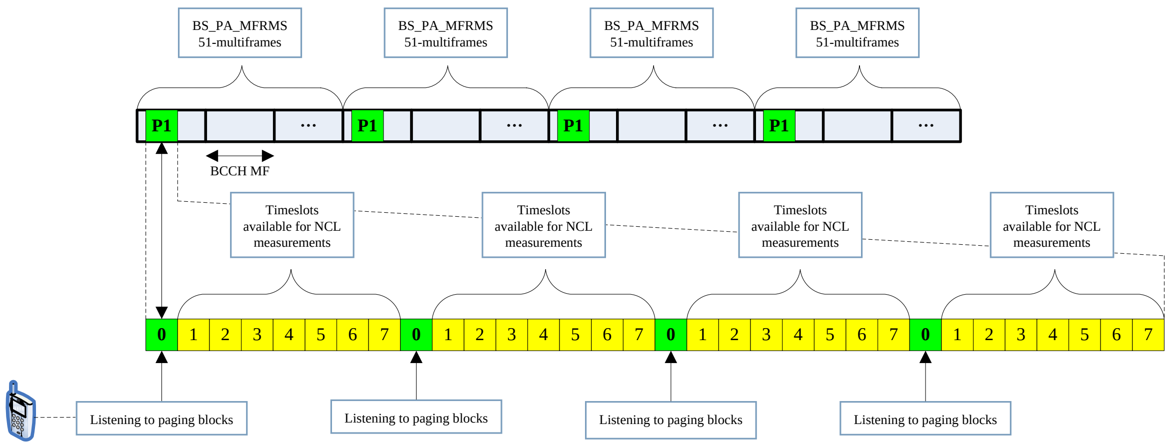

Figure 6.5-1 Example for MS neighbour cell monitoring in idle mode.

The MS belonging to P1 paging group needs to monitor downlink CCCH for paging. During reading paging messages there are totally 28(7*4) idle slots for mobiles to monitor neighbour cells (7 timeslots in each frame). The time for each neighbour cell measurement is consisted of the monitoring time for measurements and the switching time between two neighbour BCCH frequencies. To guarantee the time for measurements is sufficiently long we can assume that during this period totally 7 samples are made for neighbour cells (i.e. the sampling is made every 4 timeslots). Suppose for each neighbour cell 5 samples are made then the total number of paging blocks which completes the measurement for all neighbour cells reach to (5 * N + 6) DIV 7). Since the period for each paging group equals to 240ms* BS_PA_MFRMS (≈BS_PA_MFRMS/4), the total time for samples averaging approximately equals to ((5 * N + 6) DIV 7) * BS_PA_MFRMS / 4.

From the above analysis we can assume that when 5 samples are required for each neighbour cell and sampling is made every 4 timeslots (7 samples are collected in each paging reading), the averaging time reaches to ((5 * N + 6) DIV 7) * BS_PA_MFRMS / 4.

It is thus necessary to define typical values for the mentioned parameters including BS_PA_MFRMS, number of neighbour cells and number of samples to be taken into account in the performance evaluations. At GERAN#50 agreement was found on following parameters in Table 6.5-1.

Table 6.5-1: Parameters for MS measurements in idle mode

Parameters	value
Number of neighbour cells	12
BS_PA_MFRMS	4
Number of samples per neighbour cell for cell (re)selection	5

Based on these figures, the minimum requirement as depicted in TS 45.008 related to cell (re)selection can be derived. In addition measurement patterns for neighbour cells in idle mode can be derived based on the assumption that sampling is made every 4 timeslots in the non-DRX mode as depicted above.

6.5.1.2 Connected mode

In connected mode it is assumed that the MS performs only 1 neighbour cell BCCH power measurement per TDMA frame. This would be rather on the same time slot (e.g. on time slot preceding DL receive timeslot or any other suitable time slot). Note this assumption is expected to apply for a multislot supporting mobile, that has a bidirectional data transfer ongoing, such as class 12 (4+1) and higher. Also for a MS handling voice service, it is expected that one time slot per TDMA frame is available for sampling the received power of one neighbour cell.

6.5.2 BCCH carrier power measurement accuracy

A sufficient large measurement sampling window of 64 symbols for idle and connected mode at MS side is assumed, yielding a margin of ±1 dB for the tolerances in regard to difference between power measurements as confirmed by feedback of MS manufacturers. This figure is valid for a non-fading channel only. The impact of the fading radio channel has to be superposed on top of this level of accuracy.

6.5.3 BCCH carrier power measurement averaging

The MS behaviour related to averaging of neighbour cell measurements in idle mode is described in subclause 6.5.1.1.

In the connected mode, TS 45.008, subclause 7.2, specifies that comparison of averaged power measurements for neighbour cells shall be based on the time period of 2 SACCH block periods, in order to derive the need for BSIC detection. Feedback received from MS manufacturers indicates that averaging of serving cell and neighbour cell measurements is done per SACCH period. This means that 100 TDMA frames are available if 4 search frames are used for BSIC decoding and other measurement tasks. With the assumption stated in subclause 6.5.1 above that 1 neighbour cell BCCH can be measured per TDMA frame, which is assumed to be valid both for legacy MS with voice calls or multislot MS as depicted in subclause 6.5.1 above, and that the complete BA list is processed, the number of measurements per neighbour cell for averaging then solely is dependent on the length of the neighbour cell list N, i.e. N_av = int (100 / N). For the agreed value of N = 12 (see table 6.5-1), the number of neighbour cell measurement samples per SACCH period equals 8.

6.5.4 BSIC Decoding

The identification of suitable cells, i.e. the serving cell in case of idle mode and neighbour cells in case of connected mode, is subject to successful BSIC decoding, once the neighbour cell has sufficient signal strength. For instance TS 45.008, subclause 6.6.1 describes the BSIC decoding requirement for idle mode:

> The MS shall attempt to check the BSIC for each of the 6 strongest non-serving cell BCCH carriers at least every 30 seconds, to confirm that it is monitoring the same cell.

Further TS 45.008 subclause 7.2 specifies the BSIC decoding requirement in dedicated mode:

> If, after averaging measurement results over 2 SACCH block periods, the MS detects one or more BCCH carriers, among the 6 strongest, whose BSICs are not currently being assessed, then the MS shall as a matter of priority attempt to decode their BSICs.

Modelling of the BSIC decoding process in idle and in connected mode, such as defining a minimum radio channel quality for successful BSIC decoding, was discussed during Telco#2. Feedback received from MS manufacturers indicates that the overall impact of BSIC decoding is seen as low since the process is much less executed than the frequent BCCH power measurements and a decoding failure is unlikely to result in a cell (re)selection failure or a handover failure. Thus no modelling of the BCCH decoding process is foreseen in this study.

6.5.5 Power reduction on TS preceding BCCH timeslot

No further power reduction on the timeslot preceding the BCCH or CCCH timeslot is foreseen in comparison to what is allowed in TS 45.008 subclause 7.1 in regard to modulations other than GMSK:

> Furthermore, between a slot used for BCCH/CCCH and the slot preceding it, the difference in output power actually transmitted by the BTS shall not exceed 3 dB.

This includes output power tolerance on BTS transmitter side.

6.5.6 Handover, Cell Selection and Cell Reselection

The impact on cell selection and cell reselection performance shall be evaluated for each candidate solution against the reference case. The number of cell reselections and handovers shall be counted for the reference case and the candidate solution in the evaluation period. The call drop rate shall be evaluated in all cases. The method to derive the call drop rate and the handover failure rate need to be reported. For handover a penalty in terms of speech frame erasures needs to be taken into account as described in Table 6.4-1. For cell (re-)selection NC1 mode is assumed.

6.5.7 Mobile velocity

Mobile velocity of 3 km/h shall be considered for all scenarios.

Mobile velocity of 50 km/h shall be considered for low and medium traffic load profiles, i.e. load profiles 1 and 2 in subclause 6.3, for both selected full rate speech codecs, i.e. AFS 12.2 and AFS 5.9. In addition high traffic load profiles, i.e. load profiles 3 and 4 in subclause 6.3, may be investigated.

The mobility model used in the performance evaluation shall be described for each candidate solution.

6.5.8 Mobile station types

The MS types used in the evaluation need to be specified. A distinction is done between traffic scenario 1 (voice only) and traffic scenario 2 (mix of voice and data).

Traffic scenario 1: all MS are single TS mobiles (MSC=1) with DARP phase I penetration rate of 60%.

Traffic scenario 2: MS with voice service: single TS (MSC=1) with DARP phase I penetration rate of 60%,

MS with data service: MSC=12 with DARP Phase I penetration rate of 100%.

6.6 BTS characteristics

The need for clarification of BTS characteristics relevant for the study was raised at BTSEnergy telco#1. Agreement on these aspects was found in BTSEnergy telco#3 and GERAN#50.

6.6.1 Network synchronisation

The study will investigate both synchronized networks and asynchronous networks.

For intra-site synchronisation TDMA frame alignment is assumed in both cases.

For inter-site synchronisation time slot alignment is assumed on random basis with fixed offsets in case of synchronized networks, whilst neither TDMA frame alignment nor multi-TDMA frame alignment is part of this assumption.

For inter-site synchronisation no time slot or frame alignment (multi-frame, TDMA frame, time slot) is assumed in case of asynchronous networks.

6.6.2 Modelling of TRX power consumption

Typically the power consumption of a SCPA TRX is not linear, i.e. a 3 dB decrease in RF output power does not correspond to a 50% decrease of TRX power consumption. Also ramping down of a SCPA TRX may yield to higher energy savings than taken into account in savings for the RF output power. To take any non-linear dependency between RF output power and actual TRX power consumption into account two metrics to quantify the relative power savings during the performance evaluation are introduced based on the definitions in clause 6.2:

- RE Performance Metric 1: relative energy savings in % related to the reference configuration
- RE Performance Metric 2: relative energy savings in % related to the reference configuration

Both metrics refer to the comparison of the candidate solution against the reference configuration depicted in subclause 6.1 and shall be related to the BTS power consumption including BCCH TRX and non-BCCH TRX.

7 Candidate Solution: BCCH Carrier Power Reduction Methodology

7.1 Introduction

This methodology is proposed to involve a dynamic power adjustment scheme to each timeslot on BCCH carrier by traffic load.

7.2 Methodology

The methodology is applied to GMSK modulated BCCH carrier. Two variants have been included. The value of X should be pre-set.

7.2.1 Variant 1

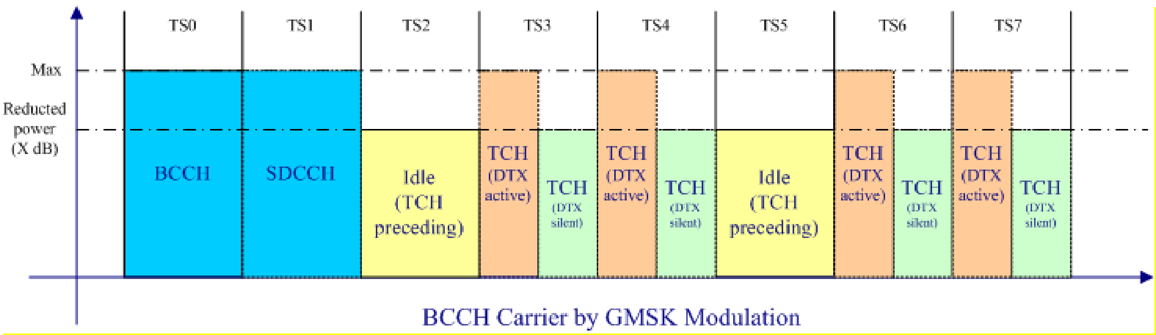

Figure 7.2-1 BCCH Carrier Power Reduction Method; Variant 1

- The timeslots used as control channel (TS0, TS1, blue area) is transmitted with maximum power;
- For idle TCH timeslots (yellow area), the BCCH carrier is transmitted with X dB power reduction;
- During DTX active period (orange area) of TCH timeslots, the BCCH carrier is transmitted with maximum power;
- During DTX silence period (green area) of TCH timeslots, the BCCH carrier is transmitted with X dB power reduction;

Table 7.2-1 Power Scheme of Variant 1

Timeslot Preceding	Traffic Status	DTX status	BCCH Carrier Transmit Power
BCCH/SDCCH	Idle	N/A	Maximum
BCCH/SDCCH	Busy	N/A	Maximum
TCH	Idle	N/A	Reduced by X dB
TCH	Busy	Active period	Maximum
TCH	Busy	Silence period	Reduced by X dB

7.2.2 Variant 2

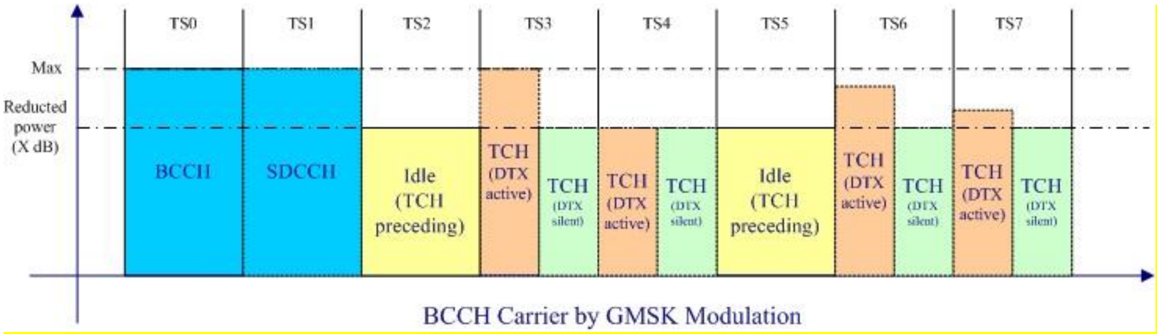

Figure 7.2-2 BCCH Carrier Power Reduction Method; Variant 2

- The timeslots used as control channel (TS0, TS1, blue area) is transmitted with maximum power;
- For idle TCH timeslots (yellow area), the BCCH carrier is transmitted with X dB power reduction;
- During DTX active period (orange area) of TCH timeslots, power control algorithm is applied to BCCH carrier, but the total reduced power is not allowed to exceed X dB;
- During DTX silence period (green area) of TCH timeslots, the BCCH carrier is transmitted with X dB power reduction;

Table 7.2-2 Power Scheme of Variant 2

Timeslot Preceding	Traffic Status	DTX status	BCCH Carrier Transmit

			Power
BCCH/SDCCH	Idle	N/A	Maximum
BCCH/SDCCH	Busy	N/A	Maximum
TCH	Idle	N/A	Reduced by X dB
TCH	Busy	Active period	Power control applied (reduction not exceed X dB)
TCH	Busy	Silence period	Reduced by X dB

7.3 Evaluation

Three cases are simulated to compare:

Reference case: No BCCH power reduction is applied.

Case 1: Variant 1 is applied, with x = 2;

Case 2: Variant 2 is applied, with x = 2;

Assumptions are aligned to current common assumptions.

7.3.1 Simulation Assumptions

Table 7.3-1 Simulation Assumptions

Parameter	Default Value	Unit
Frequency band	900	MHz
BCCH frequency re-use	4/12	-
TCH frequency re-use	1/1 3/9	
Frequency Hopping	1/1 for synthesizer hopping 3/9 for baseband hopping	-
Cell Size	500	m
Network size	84 cells	
Sectors (cells) per Site	3	-
Sector Antenna Pattern	UMTS 30.03	-
Propagation Model	Okumura-Hata	dB
Log-Normal Fading: Standard Deviation	6	dB
Log-Normal Fading: Correlation Distance	110	m
Log-Normal Fading: Inter-Site Correlation	50	%
Adjacent Channel Interference Attenuation	18	dB
Fast Fading	Enabled	
Fast Fading Type	TU3	km/hr
Receiver Type	Conventional Receiver(DL EGC/ UL IRC)	

SAIC penetration rate	60	%
Speech codec	AFS 12.2	
Traffic mix	100 % voice	
Indoor/outdoor users	0/100	%

Table 7.3-2 Traffic Load Configuration

	Low load	Medium load	Busy hour load
Load for 222	• BCCH TRX: all TS except TS0 can be allocated for user traffic • Other TRX: all TS allowed for user traffic • Mean Traffic load per sector: 20% of busy hour	• BCCH TRX: all TS except TS0 can be allocated for user traffic • Other TRX: all TS allowed for user traffic • Mean Traffic load per sector: 50% of busy hour	• BCCH TRX: all TS except TS0 can be allocated for user traffic • Other TRX: all TS allowed for user traffic • Mean traffic load per sector: according to busy hour
Load for 444	• BCCH TRX: all TS except TS0 can be allocated for user traffic • Other TRX: all TS allowed for user traffic • Mean Traffic load per sector: 20% of busy hour	• BCCH TRX: all TS except TS0 can be allocated for user traffic • Other TRX: all TS allowed for user traffic • Mean Traffic load per sector: 50% of busy hour	• BCCH TRX: all TS except TS0 can be allocated for user traffic • Other TRX: all TS allowed for user traffic • Mean traffic load per sector: according to busy hour
Load for 888	• BCCH TRX: all TS except TS0 can be allocated for user traffic • Other TRX: all TS allowed for user traffic • Mean Traffic load per sector: 20% of busy hour	• BCCH TRX: all TS except TS0 can be allocated for user traffic • Other TRX: all TS per each sector can be allocated and remaining TS idle • Mean traffic load per sector: 50% of busy hour	• BCCH TRX: all TS except TS0 can be allocated for user traffic • Other TRX: all TS allowed for user traffic • Mean traffic load per sector: according to busy hour

Table 7.3-4 Load profiles for different site configuration

Site Configuration	Load Profile 1 Low Traffic Load (20% of BHT) with 100 % FR codec	Load Profile 2 Medium Traffic Load (50% of BHT) with 100 % FR codec	Load Profile 3 High Traffic Load (100% of BHT) with 100% FR codec	Load Profile 4 High Traffic Load (100% of BHT) with 100% HR codec
S222	4,8 Erlangs (3×1,6)	12,3 Erlangs (3×4,1)	24,6 Erlangs (3×8,2)	54,9 Erlangs (3×18,3)
S444	12,6 Erlangs (3×4,2)	31,5 Erlangs (3×10,5)	63,0 Erlangs (3×21,0)	131,7 Erlangs (3×43,9)
S888	26,1 Erlangs (3×8,7)	73,2 Erlangs (3×24,4)	146,1 Erlangs (3×48,7)	292,8 Erlangs (3×97,6)

Table 7.3-4 Number of SDCCH channels per sector for each site configuration and each load profile

Site Configuration	Load Profile 1 Low Traffic Load (20% of BHT) with 100 % FR codec	Load Profile 2 Medium Traffic Load (50% of BHT) with 100 % FR codec	Load Profile 3 High Traffic Load (100% of BHT) with 100% FR codec	Load Profile 4 High Traffic Load (100% of BHT) with 100% HR codec
S222	1	1	1	2
S444	2	2	2	4
S888	4	4	4	8

7.3.2 Evaluations

7.3.2.1 Impacts to Radiated Power and Power Consumption

Table 7.3-5 Average Tx power on all carriers including BCCH carrier

TCH Frequency Reuse	Site Configuration	Traffic Load	Reference Case (dBm)	Case 1 (dBm)	Case 2 (dBm)
1/1 Reuse	S222	Busy Hour	TBD	TBD	TBD
		Medium	TBD	TBD	TBD
		Low	TBD	TBD	TBD
	S444	Busy Hour	TBD	TBD	TBD
		Medium	TBD	TBD	TBD
		Low	TBD	TBD	TBD
	S888	Busy Hour	TBD	TBD	TBD
		Medium	TBD	TBD	TBD
		Low	TBD	TBD	TBD
3/9 Reuse	S222	Busy Hour	TBD	TBD	TBD
		Medium	TBD	TBD	TBD
		Low	TBD	TBD	TBD
	S444	Busy Hour	TBD	TBD	TBD
		Medium	TBD	TBD	TBD
		Low	TBD	TBD	TBD
	S888	Busy Hour	TBD	TBD	TBD
		Medium	TBD	TBD	TBD
		Low	TBD	TBD	TBD

Table 7.3-6 Average power consumption on all carriers including BCCH carrier

TCH Frequency Reuse	Site Configuration	Traffic Load	Reference Case (Watt)	Case 1 (Watt)	Case 2 (Watt)
1/1 Reuse	S222	Busy Hour	TBD	TBD	TBD
		Medium	TBD	TBD	TBD
		Low	TBD	TBD	TBD
	S444	Busy Hour	TBD	TBD	TBD
		Medium	TBD	TBD	TBD
		Low	TBD	TBD	TBD
	S888	Busy Hour	TBD	TBD	TBD
		Medium	TBD	TBD	TBD
		Low	TBD	TBD	TBD
3/9 Reuse	S222	Busy Hour	TBD	TBD	TBD
		Medium	TBD	TBD	TBD
		Low	TBD	TBD	TBD
	S444	Busy Hour	TBD	TBD	TBD
		Medium	TBD	TBD	TBD

		Low	TBD	TBD	TBD
	S888	Busy Hour	TBD	TBD	TBD
		Medium	TBD	TBD	TBD
		Low	TBD	TBD	TBD

7.3.2.2 Impacts to Call Quality

The following table includes the percentage of satisfied users (FER ≤ 2%) for different load scenarios and site configurations.

Table 7.3-7 Percentage of satisfied users

TCH Frequency Reuse	Site Configuration	Uplink or Downlink	Traffic Load	Reference Case (100%)	Case 1 (100%)	Case 2 (100%)
1/1 Reuse	S222	UL	Busy Hour	99.57	98.71	97.86
			Medium	98.29	97.44	97.44
			Low	99.9	98.8	98
		DL	Busy Hour	99.15	99.14	98.71
			Medium	99.15	99.15	99.15
			Low	99.7	99.5	99.3
	S444	UL	Busy Hour	97.78	94.85	94.27
			Medium	98.75	98.75	97.18
			Low	98.39	97.58	96.77
		DL	Busy Hour	96.67	94.85	94.58
			Medium	98.75	98.75	97.5
			Low	99.42	99.23	99.19
	S888	UL	Busy Hour	94.72	93.69	93.42
			Medium	98.06	97.93	96.84
			Low	98.58	98.23	97.52
		DL	Busy Hour	93.37	92.52	91.93
			Medium	97.69	96.96	96.84
			Low	98.58	97.86	97.51
3/9 Reuse	S222	UL	Busy Hour	97.83	97.79	97.69
			Medium	99.74	99.49	99.23
			Low	99.9	98.72	98.08
		DL	Busy Hour	96.48	96.34	95.97
			Medium	99.23	98.97	98.46
			Low	99.36	98.08	96.15
	S444	UL	Busy Hour	96.71	96.51	96.49
			Medium	98.72	98.33	98.13
			Low	98.39	98.39	98.12
		DL	Busy Hour	96.09	95.37	94.9
			Medium	97.74	97.64	97.64
			Low	98.93	98.66	98.4
	S888	UL	Busy Hour	95.49	95.2	95.16
			Medium	98.18	98.05	97.89
			Low	99.53	99.3	98.94
		DL	Busy Hour	94.37	94.25	94.17
			Medium	97.72	97.43	96.64
			Low	98.83	98.83	98.59

From the evaluation results, the BCCH power reduction method decreases the percentage of satisfied users. However, in most cases, this KPI still fulfills the 95% target or within 2% degradation compare to reference case. During the busy hours, the power reduction method does not performs well in S444 configuration, 1/1 reuse.

[Editor's Note: The results of call quality should be further investigated.]

7.3.2.3 Impacts to Handover

HO modeling: Use the link FER to determine whether SABM and UA frames are successfully delivered. If the SABM and UA frames fail to be sent/received after retry, a HO failure is marked.

Call drop modeling: 1. HO failure may leads to a call drop; 2. Use the link FER to determine whether SACCH frame is correctly transmitted. The threshold for call drop depends on how many SACCH frame fails within an interval.

HO Penalty: Penalty in terms of speech frame erasures during handover to be taken into account for DL and UL. Aligned to MUROS TR 45.913

Table 7.3-8 Handover number

TCH Frequency Reuse	Site Configuration	Traffic Load	Reference Case	Case 1	Case 2
1/1 Reuse	S222	Busy Hour	188	185	183
		Medium	70	63	60
		Low	45	40	40
	S444	Busy Hour	1030	948	758
		Medium	250	245	230
		Low	78	75	75
	S888	Busy Hour	2795	2750	2723
		Medium	883	825	790
		Low	195	193	178
3/9 Reuse	S222	Busy Hour	685	628	610
		Medium	240	233	223
		Low	105	85	85
	S444	Busy Hour	2323	2280	2178
		Medium	840	788	780
		Low	260	235	230
	S888	Busy Hour	6033	5965	5870
		Medium	2200	2190	2153
		Low	608	603	598

From the evaluation results, the total number of handover slightly decreases after power reduction method had been applied.

Table 7.3-9 Call Drop Rate

TCH Frequency Reuse	Site Configuration	Traffic Load	Reference Case (100%)	Case 1 (100%)	Case 2 (100%)
1/1 Reuse	S222	Busy Hour	0.03	0.05	0.09
		Medium	0.02	0.03	0.05
		Low	0	0	0
	S444	Busy Hour	0.05	0.07	0.11
		Medium	0.03	0.05	0.08
		Low	0	0	0
	S888	Busy Hour	0.09	0.13	0.20
		Medium	0.05	0.08	0.11
		Low	0.05	0.07	0.10
3/9 Reuse	S222	Busy Hour	0.02	0.03	0.05
		Medium	0.01	0.02	0.04
		Low	0	0	0
	S444	Busy Hour	0.04	0.07	0.09
		Medium	0.02	0.05	0.06
		Low	0	0.01	0.01
	S888	Busy Hour	0.07	0.11	0.15
		Medium	0.01	0.04	0.05

		Low	0	0.02	0.05

The call drop rate slightly increased while all cases are within the 0.2% target.

7.4 Conclusion

This methodology has impacts to network KPI. The total handover number slightly decreases when it is applied. The percentage of satisfied users may decrease but be within a 95% target in most cases, especially when the reference case meets the target. It also has limited impacts to the call drop rate.

7.5 References

[7-1] System Simulation on BCCH Carrier Power Reduction; ZTE Corporation. BTS Energy Teleconference #1; 19th Jan 2011.

[7-2] GP110155 - BCCH Carrier Power Reduction Methodology; ZTE Corporation. GERAN #49, Chengdu, Feb 28th ~ Mar 4th, 2011.

[7-3] BTSEnergy_simulation_Huawei; Huawei Technologies Co., Ltd.; BTS Energy Teleconference #3; 4th May 2011.

[7-4] GP110528 Enhancement on BCCH Carrier Power Reduction Methodology; ZTE Corporation. GERAN #50, Dallas, May 16th ~ May 20th, 2011.

[7-5] GP-111210 BCCH Carrier Power Reduction Methodology; ZTE Corporation. GERAN #51, Goteborg, Sweden, August 29th ~ September 2nd, 2011.

[7-6] BTS Energy Draft TR459xx GSM BTS Energy Saving v010; SI Rapporteur, GERAN #51, Goteborg, Sweden, 29th August ~ 2nd September 2011;

[7-7] GP-111210 BCCH Carrier Power Reduction Methodology; ZTE Corporation. GERAN #52, Bratislava, Slovakia, November 21th ~ November 25, 2011.

[7-8] 3GPP TR 45.926 V030 (2011-11) Solutions for GSM/EDGE BTS Energy Saving (Release 11)

[7-9] GP-120105 Evaluation on BCCH Carrier Power Reduction; ZTE Corporation. GERAN #53, Hamburg, Germany. Februry 27th – March 2nd 2012.

8 Summary and Conclusions

Annex A: Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
2010-11	GERAN #48	GP-101819	-	-	Skeleton TR Text Proposals for clauses 1,3,4,5,6 are captured	-	0.0.1
2011-01	GERAN Telco#1		-	-	Skeleton TR Incorporated comments to clauses 4.1, 5.2, 6.2. Added clause 8.	-	0.0.2
2011-01	GERAN #49	GP-110008	-	-	Skeleton TR Incorporated comments to clauses 3.3, 4.1, 5.1, 5.2.1, 5.2.2, 5.2.3, 5.2.4, 6.1, 6.3, 6.4 and 8.	-	0.0.3
2011-03	*GERAN #49*	*GP-110413*	-	-	Skeleton TR *Incorporated comments to clauses 5.2.1, 5.2.2, 5.2.3, 6.3*	-	*0.0.4*
2011-03	*GERAN Telco#2*		-	-	Skeleton TR *Incorporated comments from GERAN#49 to clause 5.2.3*	-	*0.0.5*
2011-05	*GERAN Telco#3*		-	-	Skeleton TR *Incorporated comments from Telco #2 to clauses 5.2.1, 5.2.3, 6.1, 6.2, 6.4, 6.5.1, 6.5.2, 6.5.3, 6.5.4, 6.5.5, 6.5.6, 6.6*	-	*0.0.6*
2011-05	*GERAN #50*	*GP-110769*	-	-	Skeleton TR *Incorporated comments from Telco #3 to clauses 5.1, 6.1, 6.3, 6.5.1, 6.5.3, 6.6.1, 6.6.2*	-	*0.0.7*
2011-07	*GERAN Telco#4*		-	-	Draft TR *Agreements captured in GP-110916 and parts of GP-110624 from GERAN#50 incorporated to clauses 5, 5.2.1, 5.2.2, 5.2.3, 6.1, 6.3, 6.4, 6.5, 6.5.1.1, 6.5.1.2, 6.5.3, 6.5.4, 6.5.6, 6.5.7, 6.5.8, 6.6, 6.6.1*	-	*0.0.8*
2011-07	*GERAN Telco#5*		-	-	Draft TR *Incorporated comments from Telco#4 to clauses 5, 5.2.1, 5.2.2, 5.2.3, 6.1, 6.3, 6.4, 6.5, 6.5.1.1, 6.5.1.2, 6.5.3, 6.5.4, 6.5.6, 6.5.7, 6.5.8, 6.6, 6.6.1*	-	*0.0.9*
2011-08	*GERAN #51*	GP-111090	-	-	Draft TR *Incorporated comments from Telco#5 to clauses 4.1, 5.2.1, 5.2.2, 5.2.3, 6.1, 6.4, 6.5.6*	-	*0.0.10*
2011-08	*GERAN #51*	GP-111284	-	-	Draft TR *Incorporated comments from offline session to clauses 5.2.1, 5.2.2, 5.2.3, 6.4*	-	*0.0.11*
2011-09	*GERAN #51*	GP-111399	-	-	Draft TR *Incorporated comments during WG 1 meeting to clauses 5.2.3, 6.1, 6.4*	-	*0.1.0*
2011-11	*GERAN #52*	GP-111658	-	-	Draft TR *Incorporated agreements and comments from Telco#6 to clauses 5.2.3, 6.1, 6.3, 6.4, 6.5.8*	-	*0.1.1*
2011-11	*GERAN #52*	*GP-111849*	-	-	Draft TR *Incorporated agreements and comments from WG 1 meeting to clauses 5.2.3, 6.1, 6.3, 6.4, 6.5.8, 6.6.1*	-	*0.2.0*
2011-11	*GERAN #52*	*GP-111901*	-	-	Draft TR *Incorporated agreements and comments from WG 1 meeting to clauses 6.1, 6.3, 6.4, 6.6.1*	-	*0.3.0*
2012-02	*GERAN #53*	*GP-120178*	-	-	Draft TR *Incorporated agreements and comments from Telco#7 to clauses 6.1, 6.3, 6.4, 6.5.6, 6.5.7*	-	*0.4.0*
2012-03	*GERAN #53*	*GP-120407*	-	-	Draft TR *Incorporated agreements and comments from GERAN#53 to clauses 6.4, 6.6.2, 7*	-	*0.5.0*
2012-03	*GERAN #53*	*GP-120453*	-	-	Draft TR *Incorporated comments from GERAN#53 plenary to clauses 6.4, 7.1 (revision marks are shown related to 0.4.0 and 0.5.0)*	-	*0.6.0*
2012-05	*GERAN #54*	*GP-120636*	-	-	Draft TR *Incorporated agreements from Telco#8 to clauses 6.4 and 6.5.8*	-	*0.7.0*
2012-08	*GERAN #55*	*GP-120947*	-	-	Draft TR *Incorporated agreements from Telco#9 to clauses 3.1, 3.3, 4.1, 4.2, 5.2.2, 6.2, 6.4, 6.5, 6.5.6, 6.5.7 and 6.6.2*	-	*0.8.0*
2012-08	*GERAN #55*	*GP-121132*			Draft TR *Incorporated agreements from GERAN1#55 to clauses 3.3, 5.1, and 6.2*	-	*0.9.0*
2012-08	*GERAN #55*	*GP-121132*			Draft TR *Editorial refinements to comply with ETSI Drafting rules* *Presented to Closing Plenary for Information.*	-	*1.0.0*