ETSI TR 145 926 V13.0.0 (2016-02)

TECHNICAL REPORT

**Digital cellular telecommunications system (Phase 2+) (GSM);
Solutions for for GSM/EDGE BTS Energy Saving
(3GPP TR 45.926 version 13.0.0 Release 13)**

iTeh STANDARD PREVIEW
(standards.iteh.ai)
Full standard:
https://standards.iteh.ai/catalog/standards/sist/ec352ca2-dd72-4a95-9393-7684926bdacb/etsi-tr-145-926-v13.0.0-2016-02

A GLOBAL INITIATIVE

GLOBAL SYSTEM FOR
MOBILE COMMUNICATIONS

Reference
DTR/TSGG-0145926vd00

Keywords
GSM

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

iTeh STANDARD PREVIEW
(standards.iteh.ai)
Full standard:
https://standards.iteh.ai/catalog/standards/sist/ec52ca2-1d02-4a45-a393-7b84926bdacb/etsi-tr-145-926-v13.0.0-2016-02

Important notice

The present document can be downloaded from:
http://www.etsi.org/standards-search

The present document may be made available in electronic versions and/or in print. The content of any electronic and/or print versions of the present document shall not be modified without the prior written authorization of ETSI. In case of any existing or perceived difference in contents between such versions and/or in print, the only prevailing document is the print of the Portable Document Format (PDF) version kept on a specific network drive within ETSI Secretariat.

Users of the present document should be aware that the document may be subject to revision or change of status. Information on the current status of this and other ETSI documents is available at
http://portal.etsi.org/tb/status/status.asp

If you find errors in the present document, please send your comment to one of the following services:
https://portal.etsi.org/People/CommiteeSupportStaff.aspx

Copyright Notification

No part may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm except as authorized by written permission of ETSI.
The content of the PDF version shall not be modified without the written authorization of ETSI.
The copyright and the foregoing restriction extend to reproduction in all media.

© European Telecommunications Standards Institute 2016.
All rights reserved.

DECT™, **PLUGTESTS**™, **UMTS**™ and the ETSI logo are Trade Marks of ETSI registered for the benefit of its Members.
3GPP™ and **LTE**™ are Trade Marks of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners.
GSM® and the GSM logo are Trade Marks registered and owned by the GSM Association.

Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (https://ipr.etsi.org/).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Foreword

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

The present document may refer to technical specifications or reports using their 3GPP identities, UMTS identities or GSM identities. These should be interpreted as being references to the corresponding ETSI deliverables.

The cross reference between GSM, UMTS, 3GPP and ETSI identities can be found under http://webapp.etsi.org/key/queryform.asp.

iTeh STANDARD PREVIEW (standards.iteh.ai) Full standard: https://standards.iteh.ai/catalog/standards/sist/ec352aa2-dd72-4a95-9393-7684926bdecb/etsi-tr-145-926-v13.0.0-2016-02

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

Contents

iTeh STANDARD PREVIEW
(standards.iteh.ai)
Full standard:
https://standards.iteh.ai/catalog/standards/sist/ec352ca2-dd72-4a95-9393-76849266dacb/etsi-tr-145-926-v13.0.0-2016-02

iTeh STANDARD PREVIEW
(standards.iteh.ai)

Foreword

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

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

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

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

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

iTeh STANDARD PREVIEW (standards.iteh.ai) Full standard: https://standards.iteh.ai/catalog/standards/sist/ec52ca2-dd72-4a95-8393-7f8426da-etsi-tr-145-926-v13.0.0-2016-02

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 present document analyses and evaluates different solutions to determine the benefits provided compared to the legacy BTS energy consumption.

In the scope of this study there are 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/minimize specific in-use RATs at specific times of day
- And any other radio interface impacted power reduction solutions

The solutions will 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 will 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 will be out of the scope of this study).

The contents of the present document when stable will determine the modifications to existing GERAN specifications.

iTeh STANDARD PREVIEW
(standards.iteh.ai)
Full standard:
https://standards.iteh.ai/catalog/standards/sist/ec352aa2-dd72-4a95-9393-784920f6cbcb/etsi-tr-145926-v13.0.0-2016-02

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

[5] 3GPP TS 45.002: "Multiplexing and multiple access on the radio path".

[6] 3GPP TS 45.008: "Radio subsystem link control".

[7] 3GPP TR 45.913: "Optimized transmit pulse shape for downlink Enhanced General Packet Radio Service (EGPRS2-B)".

[8] 3GPP TR 45.050: "Background for Radio Frequency (RF) requirements".

[9] 3GPP TR 45.914: "Circuit switched voice capacity evolution for GSM/EDGE Radio Access Network (GERAN)".

[10] 3GPP TS 24.008: "Mobile radio interface Layer 3 specification; Core network protocols; Stage 3".

[11] 3GPP TR 45.912: "Feasibility study for evolved GSM/EDGE Radio Access Network (GERAN)".

[12] 3GPP TS 44.018: "Mobile radio interface layer 3 specification; Radio Resource Control (RRC) protocol".

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

iTeh STANDARD PREVIEW (standards.iteh.ai) Full standard: https://standards.iteh.ai/catalog/standards/sist/c352e2-dd72-4a95-9393-768492 6dacb/etsi-tr-145-926-v13.0.0-2016-02

3.2 Symbols

Void.

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].

AFS	Adaptive multirate Fullrate Speech
AHS	Adaptive multirate Halfrate Speech
APD	Average Power Decrease
BBU	Base Band Unit
BHT	Busy Hour Traffic
BTS	Base Transceiver Station
DARP	Downlink Advanced Receiver Performance
EGPRS	Enhanced General Packet Radio Service
EGPRS2	Enhanced General Packet Radio Service phase 2
FTP	File Transfer Protocol
GoS	Grade of Service
IRC	Interference Rejection Combining
LA	Link Adaptation
MCBTS	Multi-Carrier BTS
MCPA	Multi-Carrier Power Amplifier
NC1	Network Control mode 1
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

iTeh STANDARD PREVIEW
(standards.iteh.ai)
Full standard:
https://standards.iteh.ai/catalog/standards/sist/ec352ca2-dd72-4a95-9393-7684926bdacb/etsi-tr-145-926-v13.0.0-2016-02

4 Study Considerations

4.0 General

This clause 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 utilization, etc.

Below is a list of aspects that could be used to characterize 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
- BTS type and 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 [3], Annex D)
- Backward compatibility to previous MS releases

iTeh STANDARD PREVIEW (standards.iteh.ai) Full standard: https://standards.iteh.ai/catalog/standards/sist/ec355ca2-1d72-4a95-9393-784926bdacb/etsi-tr-145-926-v13.0.0-2016-02

4.2 Energy Consumption of BTS

This clause 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 component	Qualitative contribution to Total Power Consumption of BTS
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 BTS component 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 clause describes how to evaluate the solutions and the rules for adopting energy saving solution into the present document. 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 will 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 will minimize 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 will fulfil the target of at least 95% of satisfied users, where the call FER, determined as average FER over the entire call duration, will be less than 2% for FR codecs and less than 3% for HR codecs. The percentage of satisfied users will 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 will minimize degradation of active data sessions for the user. The degradation of the session throughput will 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 minimized with any candidate solution, in that additional cell reselections and handovers compared to the reference case will be minimized. The call drop rate will not be higher than 0.2% for the reference case and the candidate solution. If the reference case does not meet this call drop rate level, the call drop rate of the candidate solution will not be worse compared to the reference case.

5.2.4 Support of legacy MSs

Legacy MS types will 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.

iTeh STANDARD PREVIEW (standards.iteh.ai) Full standard: https://standards.iteh.ai/catalog/standards/sist/ec352e22-4d73-4a95-9393-7684b96b1a4b/etsi-tr-145-926-v13.0.0-2016-02

5.2.7 Impacts to network planning

Impacts to network planning and frequency reuse will be avoided.

6 Common Assumptions

This clause 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].

Table 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 Table 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 (optional)	- 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

iTeh STANDARD PREVIEW (standards.iteh.ai)

The evaluation will be performed for configurations S222 and S444 and optionally for configuration S888, since configurations S222 and S444 are considered sufficient to prove gains in BTS energy saving. 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 (optional)
S222	1	1	1	2
S444	2	2	2	4
S888 (optional)	4	4	4	8

The evaluation will be performed for load profiles 1 to 3, whilst load profile 4 is optional, since load profiles 1 to 3 are considered sufficient to prove gains in BTS energy saving. Reference deployment scenarios are listed in subclause 6.4.

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.

iTeh STANDARD PREVIEW (standards.iteh.ai) Full standard: https://standards.iteh.ai/catalog/standards/sist/ee352ca2-dd7c-4a05-9393-76849c5bdad1/etsi-tr-145-926-v13.0.0-2016-02

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 (optional)
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 (optional)	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.