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Environmental Engineering (EE); Measurement method for Energy efficiency of Mobile Core network and Radio Access Control equipment

Reference
RES/EE-EEPS007

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Contents

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Foreword

This final draft ETSI Standard (ES) has been produced by ETSI Technical Committee Environmental Engineering (EE), and is now submitted for the ETSI standards Membership Approval Procedure.

Introduction

Energy efficiency is an increasingly important requirement for all modern systems. Governments, communication service providers, vendors, etc do all agree that energy efficiency is a critical "piece" in the joint strive for a more sustainable society.

With the present document, the industry gets a jointly agreed definition of metrics and measurement methods that - over time - can serve as a platform to excel, measure, and report energy efficiency of the core networks of telecommunication systems. The present document provides robust and reproducible measurements for products used in core telecom networks.

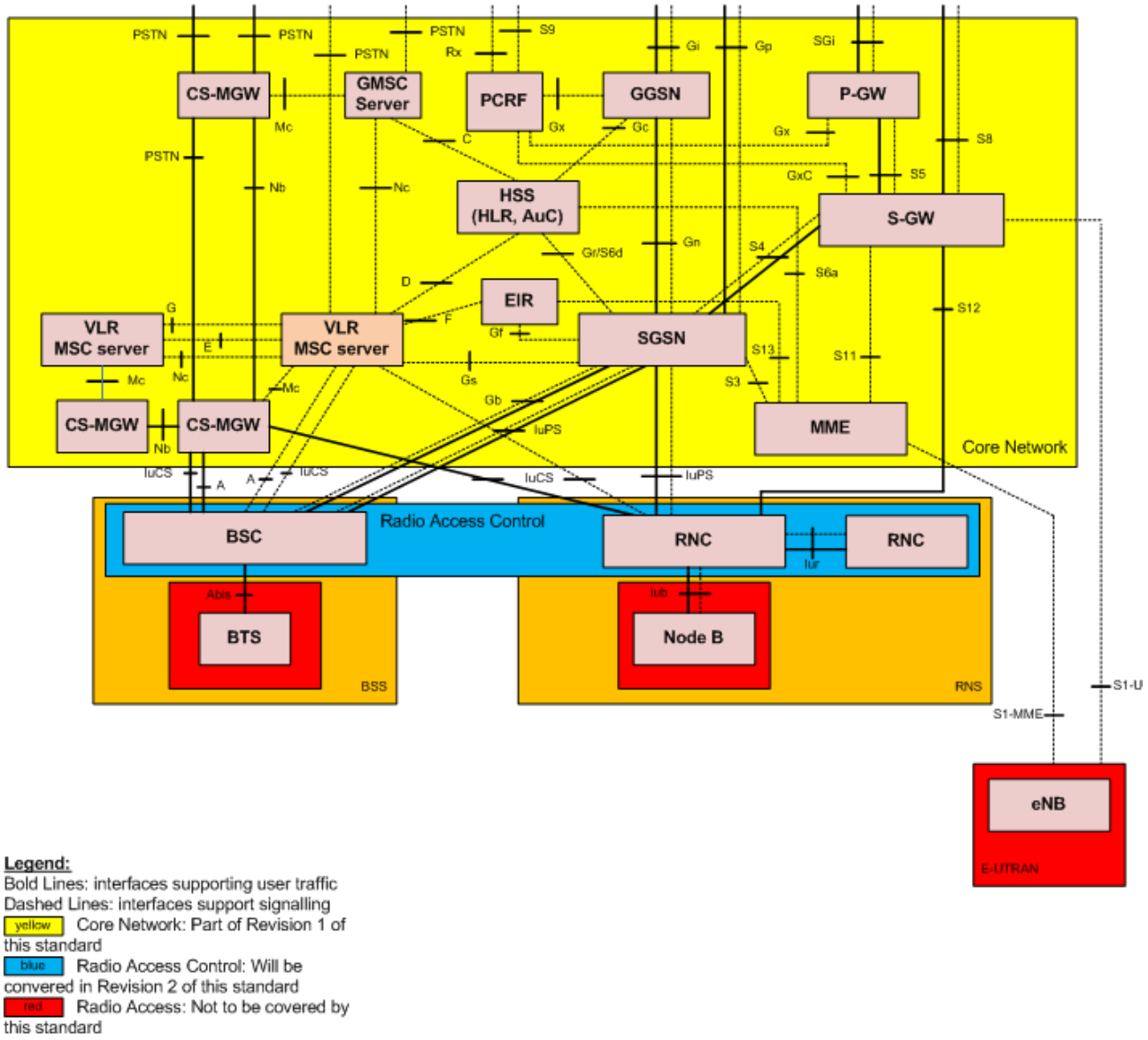
The present document defines energy efficiency metrics and measurement methods for mobile core equipment. In later revisions Base Station Controller (BSC) and IMS core will be added. Energy efficiency is defined as useful output normalized to energy consumption, and the assumption is that an energy efficient system handles more calls, subscribers, etc., with less energy. The present document promotes energy saving features as the traffic profile is a representation of the expected behaviour of the equipment in operation, i.e. the power consumption is measured at different load levels when processing traffic mimicking a typical usage of the equipment. The defined metrics can be used for comparing energy efficiency of different implementations (HW and SW) of the same function only. Energy efficiency of co-located functions can however not be compared using the methodology defined in the present document.

1 Scope

The present document defines metrics and measurement methods applicable for the following systems and nodes defined in TS 123 002 [i.3]:

- Mobile core functions (GGSN, HLR, MGW, MME, MSC, SGSN and PGW/SGW).
- Radio Access Controller (RNC).

Later revisions of the present document will include Base Station Controller (BSC) and IMS core functions (BGCF, CSCF, HSS, IBCF, MRFC, MRFP, SLF and LRF).



Legend:
Bold Lines: interfaces supporting user traffic
Dashed Lines: interfaces support signalling
yellow Core Network: Part of Revision 1 of this standard
blue Radio Access Control: Will be convered in Revision 2 of this standard
red Radio Access: Not to be covered by this standard

Figure 1: Illustrative view of the scope

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are necessary for the application of the present document.

[1] ETSI EN 300 132-2: "Environmental Engineering (EE); Power supply interface at the input to telecommunications and datacom (ICT) equipment; Part 2: Operated by -48 V direct current (dc)".

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] IEEE (05 June 2009): "Traffic Analysis for GSM Networks", Boulmalf, M. Abrache, J. Aouam, T. Harroud, H. Al Akhawayn Univ. in Ifrane, Ifrane.

[i.2] ISO/IEC 17025:2005: "General requirements for the competence of testing and calibration laboratories".

[i.3] ETSI TS 123 002 (V9.2.0): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Network architecture (3GPP TS 23.002 version 9.2.0 Release 9)".

[i.4] ETSI TR 121 905: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Vocabulary for 3GPP Specifications (3GPP TR 21.905)".

[i.5] Sandvine: "Fall 2010 Global Internet Phenomena Report".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

energy consumption: amount of consumed energy

NOTE: It is measured in Joule or kWh (where 1 kWh = $3,6 \times 10^6$ J) and corresponds to energy use.

energy efficiency: relation between the useful output and energy consumption

erlang: average number of concurrent calls carried by the circuits

function: logical representation of a network element defined by 3GPP

node: physical representation of one or more functions

power consumption: amount of consumed power

NOTE: It is measured in W and corresponds to the rate which energy is converted.

power saving feature: feature which contributes to decreasing power consumption compared to the case when the feature is not implemented

system under test: node being measured

test suite: complete sequence of measurements including low, medium, and high load levels as individual test steps

useful output: maximum capacity of the system under test which is depending on the different functions

NOTE 1: It is expressed as the number of Erlang (Erl), Packets/s (PPS), Subscribers (Sub), or Simultaneously Attached Users (SAU).

NOTE 2: It is expressed as maximum instantaneous traffic Erling (CS) and bits/s (PS).

3.2 Symbols

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

A Ampere

NOTE: SI unit of electric current.

h Hour

NOTE: SI unit of measurement of time.

J Joule

NOTE: SI unit of energy or work, J = W × s.

s Second

NOTE: SI unit of measurement of time.

V Volt

NOTE: SI unit for electric potential difference (voltage).

W Watt

NOTE: W = V × A.

3.3 Abbreviations

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

NOTE: Additional abbreviations may be found in TR 121 905 [i.4].

2G Second-Generation wireless telephone technology

EXAMPLE: GSM.

3G Third-Generation mobile telecommunications

EXAMPLE: WDCMA.

AC Alternating Current

NOTE: Bidirectional flow of electric charge.

AS Application Server
AUC AUthentication Centre

BGCF	Breakout Gateway Control Function
BICC	Bearer Independent Call Control
BSC	Base Station Controller
BTS	Base Transceiver Station
CS	Circuit Switched
CSCF	Call Session Control Function
DC	Direct Current

NOTE: Unidirectional flow of electric charge.

EIR	Equipment Identity Register
GGSN	Gateway GPRS Support Node
GPRS	General Packet Radio Service
GSM	Global System for Mobile communication
GUTI	Globally Unique Temporary Identity
HLR	Home Location Register
HO	HandOver
HSS	Home Subscriber Service
HW	HardWare
IBCF	Interconnect Border Control Function
IMEI	International Mobile Equipment Identity
IMS	IP Multimedia Subsystem
IMSI	International Mobile Subscriber Identity
IP	Internet Protocol
ISUP	Integrated Services digital network User Part
LRF	Location Retrieval Function
LU	Location Update
MGW	Media GateWay
MHT	Mean Holding Time
MME	Mobility Management Entity
MO	Mobile Originated
MRFC	Media Resource Function Controller
MRFP	Media Resource Function Processor
MSC	Mobile Switching Centre
MSS	Mobile Switching centre Server
MT	Mobile Terminated
Node B	eq Base Transceiver Station
PDN	Public Data Network
PDP	Packet Data Protocol
PGW	PDN Gateway
PLMN	Public Land Mobile Network
POI	Point of Interface
PPS	Packets Per Second
PSTN	Public Switched Telephone Network
RNC	Radio Network Controller
SAU	Simultaneously Attached Users
SGSN	Serving GPRS Support Node
SGW	Serving Gateway
SI	International System of units
SIP	Session Initiation Protocol
SLF	Subscriber Location Function
SMS	Short Message Service
SW	SoftWare
TDM	Time Division Multiplexing
USSD	Unstructured Supplementary Service Data
VLR	Visitor Location Register
WCDMA	Wideband Code Division Multiple Access

4 Definition of Power consumption and metrics for Core networks

4.1 Black box

The system under test is seen as a "black box", i.e. only the total power consumed by the device or shelf/shelves is/are measured and not different parts of the device or shelf/shelves. A "black box" can be viewed solely in terms of its input, output and transfer characteristics without any knowledge of its internal workings.

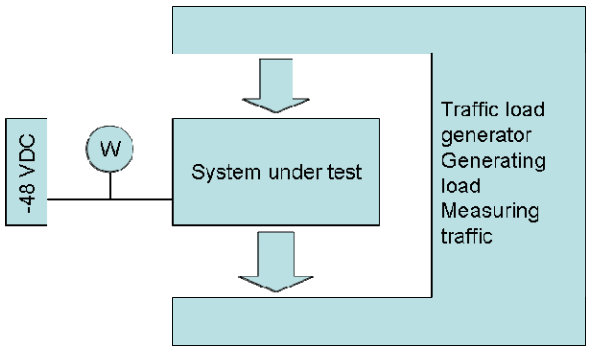


Figure 2: Measurement set-up of system under test

4.2 Site energy consumption

Energy consumption at site includes also climate units, losses, auxiliary equipment, etc. These aspects are not observed in the present document.

4.3 Power consumption

The defined traffic profile mimics the behaviour of a function in operation (i.e. with load level variations) and the resulting performance indicators constitutes of a weighted average of multiple measurements.

The load levels are defined as:

- Specification: T_S - the maximum capacity according to the vendor's specification of the specific implementation of the function
- High: $T_H = 1,0 \times T_S$
- Mid: $T_M = 0,7 \times T_S$
- Low : $T_L = 0,1 \times T_S$

As the present document defines metrics and measurements for a wide variety of implementations of functions - operating in control and/or user planes as well as circuit switched and/or packet switched domains - further details on the traffic models are specified per function in annexes A to G.

The power consumption levels associated with the above load levels are defined as:

- High: P_H = average power consumption [W] measured at T_H
- Mid: P_M = average power consumption [W] measured at T_M
- Low: P_L = average power consumption [W] measured at T_L

The average power consumption is defined as:

$$P_{avg} = \alpha \times P_L + \beta \times P_M + \gamma \times P_H \text{ [W]} \quad (1a)$$

Where α, β, and γ are weight coefficients selected such as $(\alpha + \beta + \gamma) = 1$.

The inclusion of power consumption at T_M, and T_L highlights the importance of Power saving features.

See annexes A to G for further details.

4.4 Shaping of weight coefficients

Although the functions included in the present document are heterogeneous in the sense that they operates in control and/or user planes as well in circuit switched and/or packet switched domains, it is possible to distinguish three normalized traffic profiles:

- Voice
- Data
- Subscriber

The weight coefficients for the normalized traffic profiles are derived by mapping the defined load levels (low, medium, and high) to the following analysis of live networks; IEEE (05 June 2009): "Traffic Analysis for GSM Networks" [i.1], Sandvine: "Fall 2010 Global Internet Phenomena Report" [i.5], respectively.

Table 1

Profiles	KPI (Key Performance Indicator)	P_{avg} weight coefficients		
		α	β	γ
Subscriber	Subscriber	0,1	0,4	0,5
Data	PPS or SAU	0,2	0,45	0,35
Voice	Erlang or Subscriber	0,4	0,4	0,2

The mapping of load levels to the analysis of live networks are illustrated in figures 3, 4 and 5, respectively.

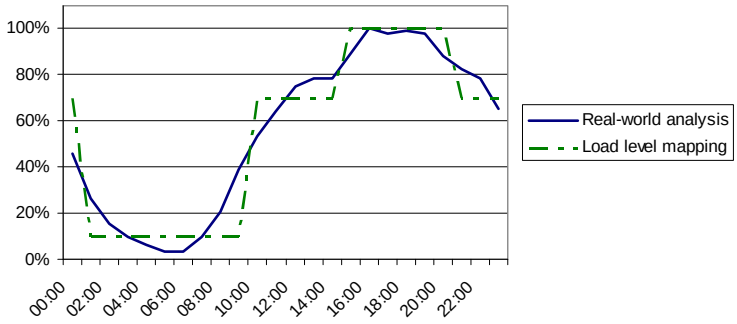


Figure 3: Working states for voice centric function

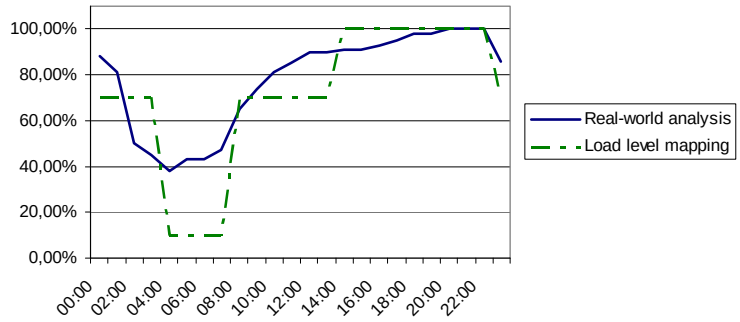


Figure 4: Working states for data centric functions

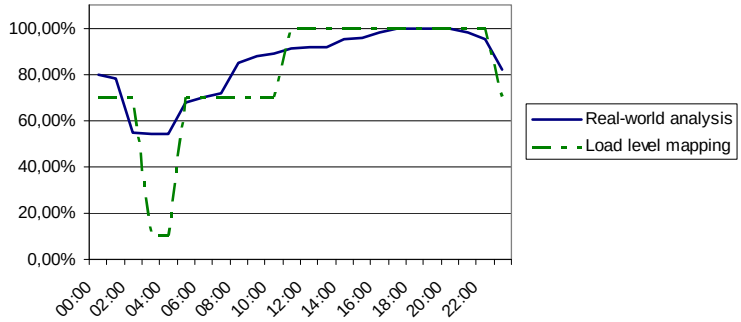


Figure 5: Working states for subscriber centric functions

4.5 Energy efficiency

The Energy Efficiency Ratio metric, the comparable performance indicator, for Core networks is defined as:

$$EER = Useful\ Output / P_{avg}\ [\text{Erlang/W} \mid \text{PPS/W} \mid \text{Subscribers/W} \mid \text{SAU/W}] \quad (1b)$$

Where Useful Output is the maximum capacity of the system under test (T_S) which, depending on the different functions, is expressed as the number of Erlang (Erl), Packets/s (PPS), Subscribers (Sub), or Simultaneously Attached Users (SAU). By using the defined traffic models, Useful Output can be translated to Subscribers (Sub) or Simultaneously Attached Users (SAU) also for functions which normally have the maximum capacity expressed in Erlang (Erl) or Packets/s (PPS).

5 Measurement methods

5.1 Measurement basics

5.1.1 General

Void.

5.1.2 Measurement and test equipment requirements

The power consumption shall be measured by either measuring the power supply voltage and true effective current in parallel and calculate the resulting power consumption (applicable only for DC) or with a wattmeter (applicable for both AC and DC). The measurements can be performed by a variety of measurement equipment, including power clamps, or power supplies with in-built power measurement capability.

All measurement equipments shall be calibrated and shall have data output interface in order to allow long term data recording and calculation of the complete power consumption over a dedicated time.

The measurement equipment shall comply with following attributes:

- Resolution: ≤ 10 mA; ≤ 100 mV; ≤ 100 mW
- DC current: ±1,5 %
- DC voltage: ±1 %
- Wattmeter: ±1 %
- Capable of accurate reading of waveforms having a crest factor of up to at least 5

All nodes shall be stimulated via the standard interfaces by the emulation of the test-models in conjunction with the traffic models and reference parameters given in annexes A to G.

5.2 Measurement conditions

5.2.1 Configuration

All equipment part of the system under test shall be generally available and orderable by customers. All configurations shall be done before the test and shall not be changed or updated during the test suite.

Only Power saving features considered as generally available may be used during the measurement. All used Power saving features shall be listed in the measurement report.

The equipment shall be measured and tested under - according to the information accompanying the equipment - normal operational conditions. Used versions of SW, firmware, HW and other test configurations shall represent the normal intended usage and be listed in the measurement report.

All signalling requested for normal operation shall be activated. Traffic profile data needed in addition to the traffic models specified in the present document, shall be listed in the measurement report.

5.2.2 Environmental conditions

For the power consumption measurements the environmental conditions under which the nodes have to be tested are defined as follows.

Table 2

Condition	Minimum	Maximum
Barometric pressure	86 kPa (860 mbar)	106 kPa (1 050 mbar)
Relative Humidity	20 %	85 %
Vibration	Negligible	
Temperature	+25 °C	
Temperature accuracy	±2 °C	

5.2.3 Power supply

For measurements of the nodes power consumption the operating voltage value in table 3 shall be used (for non standard power supply voltages one should use operating voltage with ±2,5 % tolerances).

Table 3

Type	Standard	Nominal value	Operating value for testing
DC	EN 300 132-2 [1]	-48 V	-54,5 V ± 1,5 V

5.3 Measurement procedure

5.3.1 Tests to be performed

The power consumption measurements shall be performed when stable temperature conditions inside of the equipment are reached. For this purpose, all equipment shall be placed in the environmental conditions for two hours minimum. Measurement results shall be captured earliest when the equipment including the selected load level is in stable operating conditions with a constant outlet temperature for at least 30 minutes.

The average power consumptions, P_H, P_M and P_L, shall be calculated as the arithmetic mean of samples made at least one sample per minute during 30 minutes.

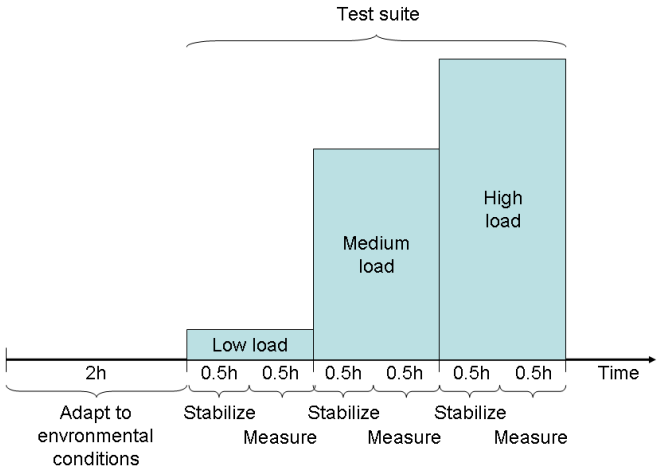


Figure 6: Test suite and its corresponding timing

The power consumption of the equipment shall be given in watts with a sufficient number of digits and in accordance with the accuracies and the resolutions given in clause 5.1.2.

Stimulation shall be realized via the equipment's standard interfaces.

The equipment shall be measured for the following load levels, see annexes A to G for details:

- High: T_H
- Mid: T_M
- Low : T_L

5.3.2 Measurement report

The results of the assessments shall be reported accurately, clearly, unambiguously and objectively, and in accordance with any specific instructions in the required method(s).

Reference parameters, measurement conditions, test results and derived calculation results shall be reported.

Measurement that are based on experimental equipment or estimated/declared values shall be clearly marked.

In addition, the measurement report shall include the following information:

- Date and location of the test
- Name(s) of the responsible(s)
- Version of the present document (in case of future changes of the traffic profiles)
- Functions and sub-functions (co-located scenario)

- The maximum capacity T_S
- Redundancy level
- Model(s) and serial/version number(s) of the equipment/modules (HW/SW)
- Data of the used measurement equipment (type, serial number, calibration information)
- Samples of measurements of P_H, P_M and P_L, respectively
- Calculations of P_H, P_M, P_L and P_{avg}, respectively
- The calculated Energy Efficiency Ratio, EER
- Error statistics

Further guidelines on the test report can be found in clause 5.10 of ISO/IEC 17025 [i.2].

Annex A (normative): Reference parameters for MGW

Table A.1: Key Performance Indicator(s) and specific energy efficiency calculation parameters

Equipment	KPI (Key Performance Indicator)	Profile (see clause 4.4)
MGW	Erlang or Subscriber, where maximum capacity = MIN(maximum Sub, maximum throughput /16mErl)	Voice

Table A.2: Interfaces

Label	Description
A	Interface between MGW and BSC. TDM and IP transport bearers supported. A over IP assumed as the default.
Iu	Interface between MGW and RNC. ATM and IP transport bearers supported. Iu over IP assumed as the default.
Nb	Interface between two MGWs. ATM, TDM and IP transport bearers supported. Nb over IP assumed as the default.
POI	Interface between MGW and PSTN/PLMN network. TDM and IP transport bearers supported. POI (PSTN and PLMN) over TDM assumed as the default.
Mb	IP based interface between MGW and IMS network.
Mc	Signalling (H.248) interface between MSC and MGW. Mc over IP is assumed.
IuCS	Signalling MGW and RNC. IuCS over IP is assumed.

Reference parameters for the traffic model shall be applied as defined in table A.3.

Table A.3: Reference parameters for the traffic model

Parameter	Description	Unit	Value
	Proportion of WCDMA subscribers	%	50
	Proportion of GSM subscribers	%	50
	Voice traffic (WCDMA)	mErl/Sub	16
	CS data traffic (WCDMA)	mErl/Sub	0,55
	Voice traffic (GSM)	mErl/Sub	16
	CS data traffic (GSM)	mErl/Sub	0,016
	Originating traffic	%	60
	Terminating traffic	%	40
	MHT of calls (speech and data included)	s	60
	Echo Cancelling, POI originating and POI terminating	%	50

Reference traffic distribution shall be applied as defined in table A.4.

Table A.4: Reference traffic distribution

Parameter	Description	Unit	Value
	Access -> Access (node internal)	%	10
	Access -> Nb	%	32
	Access -> POI	%	42,4
	Access -> Mb	%	0,9
	Nb -> POI	%	11,2
	Nb -> Mb	%	1,3
	POI -> POI (node internal)	%	1,8
	Mb -> POI	%	0,4

Annex B (normative): Reference parameters for HLR, AUC and EIR

B.1 Reference parameters for HLR and AUC

However TS 123 002 [i.3] considers HLR and AUC as separate NEs these functions are usually integrated into one network element and both of them are considered as a subset of HSS in TS 123 002 [i.3]. Therefore they are considered here together.

Table B.1: Key Performance Indicator(s) and specific energy efficiency calculation parameters

Equipment	KPI (Key Performance Indicator)	Profile (see clause 4.4)
HLR	Subscriber	Subscriber

Table B.2: Interfaces

Label	Description
C	Interface between MSS and HLR
D	Interface between VLR and HLR
H	Interface between MSS and AUC

Reference parameters for the traffic model shall be applied as defined in table B.3.

Table B.3: Reference parameters for the traffic model

Parameter	Description	Unit	Value
MT calls	Routing inquiries for MT calls	Attempt/h/Sub	0,6
MT SMS	Routing inquiries for MT SMS	Attempt/h/Sub	1,12
Authentication requests	Authentication triplet or quintuplet request	Attempt/h/Sub	2,6
Location updates	Location updates or GPRS location updates	Attempt/h/Sub	0,6
Cancel location	Cancel location	Attempt/h/Sub	0,6
USSD	USSD	Attempt/h/Sub	0,009
Black list	Number of entries in EIR Black list	Equipments/Sub	2
Grey list	Number of entries in EIR Grey list	Equipments/Sub	0,8
White list	Number of entries in EIR White list	Equipments/Sub	0,04
IMEI checking	IMEI checking	Attempt/h/Sub	2,4

Reference traffic distribution shall be applied as defined in table B.4.

Table B.4: Reference traffic distribution

Parameter	Description	Unit	Value
TDM subscribers	Percentage of subscriber profiles reached via TDM	%	50
IP subscribers	Percentage of subscriber profiles reached via SIGTRAN	%	50

Reference subscriber profile shall be applied as defined in table B.5.

Table B.5: Reference subscriber profile

Parameter	Description	Unit	Value
	GPRS subscribers	%	100
	IN subscribers	%	50
	WCDMA subscribers	%	20
	GSM subscribers	%	80

B.2 Reference parameters for EIR

It is a common solution to integrate EIR, AUC and HLR into one network element. As these integrated network elements provide better energy efficiency and better hardware utilization the current document provides support to measure the power consumption of these network elements against not integrated network elements.

Basic assumptions of these measurements are the following:

- Network Element A provides HLR and AUC functionality.
- Network Element B provides EIR functionality.
- Network Element C provides HLR, AUC and EIR functionality.

The measurement steps shall be:

1) Measure of the power consumption of network element A as it is described in clause B.1. This will result in P_{AH}, P_{AM} and P_{AL}.

2) A ratio shall be defined between EIR equipments and HLR users. This ratio shall be agreed upon prior to the measurements and shall be documented.

3) Measure of the power consumption of network element B. Define the number of equipments based on the measured maximum amount of subscribers from step 1 and the agreed ratio. This will result in P_{BH}, P_{BM} and P_{BL}.

4) Measure the power consumption of network element C as it is described in clauses B.1 and B.2. The measurement shall result in P_{CH}, P_{CM} and P_{CL}.

5) When comparing the results, the sum of Pa and Pb shall always be compared to Pc.

Table B.6: Key Performance Indicator(s) and specific energy efficiency calculation parameters

Equipment	KPI (Key Performance Indicator)	Profile (see clause 4.4)
EIR	Equipments	Subscriber

The total number of equipments stored in the EIR (Black List + Grey List + White List).

Table B.7: Interfaces

Label	Description
F	Interface between MSS and EIR

Reference parameters for the traffic model shall to be applied as defined in table B.8.

Table B.8: Reference parameters for the traffic model

Parameter	Description	Unit	Value
Black list	Number of entries in EIR Black list	Percentage of all equipments	70
Grey list	Number of entries in EIR Grey list	Percentage of all equipments	25
White list	Number of entries in EIR White list	Percentage of all equipments	5
IMEI checking	IMEI checking	attempt/h/equipment	0,85

Reference traffic distribution shall be applied as defined in table B.9.

Table B.9: Reference traffic distribution

Parameter	Description	Unit	Value
TDM queries	Percentage of IMEI checks via TDM	%	50
IP queries	Percentage of IMEI checks via SIGTRAN	%	50

Annex C (normative): Reference parameters for MSC

Table C.1: Key Performance Indicator(s) and specific energy efficiency calculation parameters

Equipment	KPI (Key Performance Indicator)	Profile (see clause 4.4)
MSC	Subscriber	Voice

Table C.2: Interfaces

Label	Description
A	Interface between MSC and BSC. SIGTRAN transport assumed as the default.
Iu	Interface between MSC and RNC. SIGTRAN transport assumed as the default.
C	Interface between MSC and HLR. SIGTRAN transport assumed as the default.
D	Interface between VLR and HLR. SIGTRAN transport assumed as the default.
F	Interface between MSC and EIR. SIGTRAN transport assumed as the default.
H	Interface between MSC and AUC. SIGTRAN transport assumed as the default.
Mc	Signalling (H.248) interface between MSC and MGW.

Reference parameters for the traffic model shall to be applied as defined in table C.3.

Table C.3: Reference parameters for the traffic model

Parameter	Description	Unit	Value
Proportion of WCDMA subscribers in the VLR	Proportion of WCDMA subscribers	%	50
Proportion of GSM subscribers in the VLR	Proportion of GSM subscribers	%	50
Mobile call attempts	Amount of switched calls. At least one participant is mobile subscriber	Attempt/h/Sub	0,85
Transit call attempts	Transit call (50 % with HLR enquiry)	Attempt/h/Sub	0,15
MO Short Messages	Mobile originating SMS per subs	Attempt/h/Sub	0,33
MT Short Messages	Mobile terminating SMS per subs	Attempt/h/Sub	0,67
mErl	Traffic per subscriber	mErl/Sub	16
LU without HLR interworking	Location Updates without HLR interworking	Attempt/h/Sub	1,3
IMSI Detach	IMSI Detach per sub	Attempt/h/Sub	0,3
Inter VLR LU	LU with HLR interworking	Attempt/h/Sub	0,4
Intra BSC/RNC handovers	Intra BSC/RNC handovers per call	Attempt/h/Sub	1
Inter BSC/RNC handovers	Inter BSC/RNC handovers per call	Attempt/h/Sub	0,2
Inter MSS handovers	Inter MSS handovers per call	Attempt/h/Sub	0,05
IMEI checking	IMEI checking	Attempt/h/Sub	1,7
Authentication	Authentication	Attempt/h/Sub	2,3
Cancel location	Cancel location	Attempt/h/Sub	0,4
Max average processor unit load	Max unit load	%	70
Success rate	Success rate for each traffic type	%	> 99,99 %

Prepaid used for 100 % of originating calls (2 ACR per call).

CDRs are generated and transferred to Billing Centre for all calls and SMSs.

Each Inter VLR LU includes four Insert Subscriber Data messages.

Typically used traffic measurements in use.

Reference traffic distribution shall be applied as defined in table C.4.

Table C.4: Reference traffic distribution

Parameter	Description	Unit	Value
MSC internal traffic	Mobile to mobile intra node traffic rate of total call attempts	%	10
Incoming terminating	Terminating traffic from other network elements	%	30
Originating outgoing	Originating traffic to other network elements	%	45
Transit	Transit traffic (50 % with HLR interworking)	%	15
SIP-I signalling	Proportion of trunk calls using SIP-I signalling	%	40
BICC signalling	Proportion of trunk calls using BICC signalling	%	40
ISUP signalling	Proportion of trunk calls using ISUP signalling	%	20

Annex D (normative): Reference parameters for GGSN

Table D.1: Key Performance Indicator(s) and specific energy efficiency calculation parameters

Equipment	KPI (Key Performance Indicator)	Profile (see clause 4.4)
GGSN	PPS or SAU, where maximum capacity = MIN(maximum SAU, maximum throughput /1 PPS)	Data

Table D.2: Interfaces

Label	Description
Gc	Interface between GGSN and HLR
Gn	Interface between GGSN and SGSN

Reference parameters for the traffic model shall be applied as defined in table D.3.

Table D.3: Reference parameters for the traffic model

Parameter	Description	Unit	Value
PDP Context Activation		Requests/h/PDP context	1
PDP Context Deactivation		Requests/h/PDP context	1
Throughput	Number of packets forwarded by the node	Packets/s/PDP context	1
PDP contexts	Number of PDP contexts in the node	PDP contexts/SAU	1

Annex E (normative): Reference parameters for SGSN

Table E.1: Key Performance Indicator(s) and specific energy efficiency calculation parameters

Equipment	KPI (Key Performance Indicator)	Profile (see clause 4.4)
SGSN	SAU	Data

Table E.2: Interfaces

Label	Description
Gn	Interface between SGSN and GGSN
IuPS	Interface between SGSN and RNC
Gs	Interface between SGSN and MCS
Gf	Interface between SGSN and EIR
Gr	Interface between SGSN and HLR
S4	Interface between SGSN and SGW
S3	Interface between SGSN and MME

Reference parameters for the traffic model shall to be applied as defined in table E.3.

Table E.3: Reference parameters for the traffic model

Parameter	Description	Unit	Value
Attach rate		Requests/h/SAU	0,33
Detach rate		Requests/h/SAU	0,33
PDP Context Activation		Requests/h/SAU	0,5
PDP Context Deactivation		Requests/h/SAU	0,5
Service Request		Requests/h/SAU	2
Release		Requests/h/SAU	2
Paging Request		Requests/h/SAU	0,66
Throughput	Number of packets forwarded by the node	Packets/s/PDP context	1
PDP contexts	Number of PDP contexts in the node	PDP contexts/SAU	0,5

Measurement set-up

For a combined 2G and 3G SGSN, only the 3G interfaces and procedures are used.

Annex F (normative): Reference parameters for MME

Table F.1: Key Performance Indicator(s) and specific energy efficiency calculation parameters

Equipment	KPI (Key Performance Indicator)	Profile (see clause 4.4)
MME	SAU	Data

Table F.2: Interfaces

Label	Description
S3	Interface between MME and SGSN
S13	Interface between MME and EIR
S6a	Interface between MME and HLR
S11	Interface between MME and SGW
S1	Interface between MME and eNB

Reference parameters for the traffic model shall to be applied as defined is table F.3.

Table F.3: Reference parameters for the traffic model

Parameter	Description	Unit	Value
Attach rate	GUTI attach including default bearer activation	Requests/h/SAU	0,33
Detach rate		Requests/h/SAU	0,33
Inter eNodeB HO	X2 based HO	Requests/h/SAU	
Dedicated Bearer Activation		Requests/h/SAU	0,67
Dedicated Bearer Deactivation		Requests/h/SAU	0,67
Service Request		Requests/h/SAU	4
Release		Requests/h/SAU	4
Paging Request		Requests/h/SAU	0,66
Bearers	Number of Bearers in the node	Bearers/PDN connection	1,5
PDN connections	Number of PDN connections in the node	PDN connections/SAU	1

Annex G (normative): Reference parameters for SGW and PGW

Table G.1: Key Performance Indicator(s) and specific energy efficiency calculation parameters

Equipment	KPI (Key Performance Indicator)	Profile (see clause 4.4)
PGW	PPS or SAU, where maximum capacity = MIN(maximum SAU, maximum throughput/15 PPS)	Data

Table G.2: Interfaces

Label	Description
S4	Interface between SGW and SGSN
S5	Interface between PGW and SGW
S11	Interface between SGW and MME
S12	Interface between SGW and RNC
S1U	Interface between SGW and eNB

Reference parameters for the traffic model shall to be applied as defined in table G.3.

Table G.3: Reference parameters for the traffic model

Parameter	Description	Unit	Value
Bearer Activation		Requests/h/PDN connection	1
Bearer Deactivation		Requests/h/PDN connection	1
Modify Bearer	(only for SGW)	Requests/h/PDN connection	4
S1 Release	(only for SGW)	Requests/h/PDN connection	4
Throughput	Number of packets forwarded by the node	Packets/s/Bearer	10
Bearers	Number of Bearers in the node	Bearers/PDN connection	1,5
PDN connections	Number of PDN connections in the node	PDN connections/SAU	1

Measurement set-up

There may be combined SGW and PGW. These may then be measured as one entity.

Annex H (normative): Reference parameters for RNC

Table H.1: Key Performance Indicator(s) and specific energy efficiency calculation parameters

Equipment	KPI (Key Performance Indicator)	Profile (see clause 4.4)
RNC	Subscriber	Subscriber

Table H.2: Interfaces

Label	Description
Iub	3GPP specified interface between Node B and RNC. ATM and IP transport bearers supported. Iub over IP assumed as the default.
Iu	3GPP specified interface between WCDMA RAN and the Core Network. ATM and IP transport bearers supported. Iu over IP assumed as the default.
Iur	3GPP specified interface between WCDMA RAN networks. ATM, and IP transport bearers supported. Iur over IP assumed as the default.

Reference parameters for a Pragmatic Smartphone Centric Traffic Model shall be applied as defined in table H.3.

Table H.3: Reference parameters for a Pragmatic Smartphone Centric Traffic Model

User and control data 1	User and control data 2	Location update	Paging
1 time per hour starting from state Idle	9 times per hour starting from state Idle	27 times per hour starting from state Idle	12 times per hour starting from state Idle
repeat 7 times loop {repeat 8 times loop [send 4,3 kB UL (PS EUL) and 72,9 kB DL (PS HS), wait 4,5 s (incl. transition to FACH or URA state)], wait 25 s (incl. transition to URA or Idle state)}, return to Idle	send 4,3 kB UL (PS EUL) and 72,9 kB DL (PS HS), wait 146 s, return to Idle	Location Area / Routing Area Update, return to Idle	Paging, return to Idle

A traffic model resembling Smartphone behaviour simplified for the purpose of Energy Efficiency measurements. Load generation by setting up and releasing Radio Access Bearers with predefined byte length and some core network signalling.

The traffic model is defined for one (1) subscriber and consists of four sequences that together mirror different aspect of the network load.

Annex I (informative): Bibliography

ETSI TR 102 530: "Environmental Engineering (EE); The reduction of energy consumption in telecommunications equipment and related infrastructure".

History

Document history		
V1.1.1	April 2012	Publication
V1.2.0	May 2014	Membership Approval Procedure MV 20140718: 2014-05-19 to 2014-07-18