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Okoljski inženiring (EE) - Ocenjevanje energijske učinkovitosti mobilnega omrežja

Environmental Engineering (EE) - Assessment of mobile network energy efficiency

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Foreword

This ETSI Standard (ES) has been produced by ETSI Technical Committee Environmental Engineering (EE).

The present document was developed jointly by ETSI TC EE and ITU-T Study Group 5. It will be published respectively by ITU and ETSI as Recommendation ITU-T L.1330 [i.4] and ETSI ES 203 228 (the present document), which are technically-equivalent.

Moreover the present document has been developed in collaboration with 3GPP SA5 and RAN3; GSMA has also given valuable suggestions and contributions.

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).

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Introduction

The present document deals with the definition of metrics and methods to measure energy efficiency performance of Mobile Radio Access Networks and adopts an approach based on the measurement of such performance on small networks, for feasibility and simplicity purposes. Such simplified approach is proposed for approximate energy efficiency evaluations and cannot be considered as a reference for planning evaluation purposes throughout the network operation process. The same approach was introduced also in ETSI TR 103 117 [i.1]; the measurements in testing laboratories of the efficiency of the Base Stations is the topic treated in ETSI ES 202 706 [i.2].

The measurement of this performance is useful for many reasons, and an implementation guidelines clause is given (clause 9) to help using the present document in the most convenient way.

The present document provides also an extrapolation method to extend the applicability of the assessment of energy efficiency to wider networks (clause 7).

The general outcome of the application of the method specified in the present document is based on the "Assessment report" introduced in clause 8. An example of application of the method is given for better readability and ease of use in annex A.

1   Scope

The present document is aimed at defining the topology and level of analysis to assess the energy efficiency of mobile networks. Within the scope of the present document there is the radio access part of the mobile networks, and namely there are radio base stations, backhauling systems, radio controllers and other infrastructure radio site equipment. The covered technologies are GSM, UMTS and LTE (including LTE-A). In particular the present document defines metrics for mobile network energy efficiency and methods for assessing (and measuring) energy efficiency in operational networks. The purpose of the present document is to allow better comprehension of networks energy efficiency.

The present document deals with both a homogeneous and heterogeneous "network" considering a network whose size and scale could be defined by topologic, geographic or demographic boundaries. For networks defined by topologic boundaries, a possible example of a network covered by the present document consists of a control node (whenever applicable), its supported access nodes as well as the related network elements. Networks could be defined by geographic boundaries, such as city-wide, national or continental networks and could be defined by demographic boundaries, such as urban or rural networks.

The present document applies to the so-called "partial" networks where energy efficiency is measured in standardized way. The specification extends the measurements in partial networks to wider so-called "total" networks energy efficiency estimations (i.e. the network in a geographic area, the network in a whole country, the network of a MNO, etc.).

Terminal (end-user) equipment is outside the scope of the present document and is not considered in the energy efficiency measurement.

2   References

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2.1   Normative 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 referenced 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.

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

[1]   ETSI TS 125 104: "Universal Mobile Telecommunications System (UMTS); Base Station (BS) radio transmission and reception (FDD) (3GPP TS 25.104)".

[2]   ETSI TS 136 104: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception (3GPP TS 36.104)".

[3]   ETSI TS 132 425 (V12.0.0): "LTE; Telecommunication management; Performance Management (PM); Performance measurements Evolved Universal Terrestrial Radio Access Network (E-UTRAN) (3GPP TS 32.425 version 12.0.0 Release 12)".

[4]   ETSI TS 132 412 (V11.1.0): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Telecommunication management; Performance Management (PM) Integration Reference Point (IRP): Information Service (IS) (3GPP TS 32.412 version 11.1.0 Release 11)".

[5]   ETSI TS 123 203 (V12.7.0): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Policy and charging control architecture (3GPP TS 23.203 version 12.7.0 Release 12)".

[6]   ETSI TS 136 314: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Layer 2 - Measurements (3GPP TS 36.314)".

[7]   ETSI TS 152 402 (V11.0.0): "Digital cellular telecommunications system (Phase 2+); Telecommunication management; Performance Management (PM); Performance measurements - GSM (3GPP TS 52.402 version 11.0.0 Release 11)".

[8]   ETSI TS 132 405 (V11.1.1): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Telecommunication management; Performance Management (PM); Performance measurements; Universal Terrestrial Radio Access Network (UTRAN) (3GPP TS 32.405 version 11.1.1 Release 11)".

[9]   ETSI ES 202 336-12: "Environmental Engineering (EE); Monitoring and control interface for infrastructure equipment (power, cooling and building environment systems used in telecommunication networks); Part 12: ICT equipment power, energy and environmental parameters monitoring information model".

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

2.2   Informative 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 referenced document (including any amendments) applies.

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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]   ETSI TR 103 117: "Environmental Engineering (EE); Principles for Mobile Network level energy efficiency".

[i.2]   ETSI ES 202 706: "Environmental Engineering (EE); Measurement method for power consumption and energy efficiency of wireless access network equipment".

[i.3]   ETSI GS NFV 003: "Network Functions Virtualisation (NFV); Terminology for Main Concepts in NFV".

[i.4]   Recommendation ITU-T L.1330: "Energy efficiency measurement and metrics for telecommunication networks".

[i.5]   FAO Soils Portal.

NOTE: Available at http://www.fao.org/soils-portal/soil-survey/soil-maps-and-databases/harmonized-world-soil-database-v12/en/.

[i.6]   Jürgen Grieser, René Gommes, Stephen Cofield and Michele Bernardi: "Data sources for FAO worldmaps of Koeppen climatologies and climatic net primary production", 2006.

NOTE: Available at: http://www.fao.org/nr/climpag/globgrids/KC_commondata_en.asp.

3   Definitions and abbreviations

3.1   Definitions

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

backhaul equipment: equipment used to connect base stations to the core network, or to other BSs (like X2 in LTE)

Base Station (BS): generic term used for network component which serves one cell or more cells and interfaces the user terminal (through air interface) and a radio access network infrastructure

distributed RBS: BS architecture which contains radio heads (RRH) close to the antenna element and a central element connecting BS to network infrastructure

Energy Efficiency (EE): relation between the useful output and energy/power consumption

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

integrated BS: BS architecture in which all BS elements are located close to each other for example in one or two cabinets

   NOTE: The integrated BS architecture may include TMA close to antenna.

Mobile Network (MN): set of equipment from the radio access network or sub-network that are relevant for the assessment of energy efficiency

mobile network coverage energy efficiency: ratio between the area covered by the network in the Mobile Network under investigation and the energy consumption

mobile network data energy efficiency: ratio between the performance indicator based on Data Volume and the energy consumption when assessed during the same time frame

mobile network energy consumption: overall energy consumption of equipment included in the MN under investigation

mobile network energy efficiency: Energy Efficiency of a Mobile Network

Mobile Network Operator (MNO): operator that manages one or more Mobile Networks

mobile network operator penetration ratio: percentage of traffic served by an MNO in the area where it is active

mobile network performance delivered: performance indicator of the MN under investigation, defined as the data volume delivered by the mobile network under investigation during the time frame of the energy consumption assessment

power consumption: power consumed by a device to achieve an intended application performance

radio access network: telecommunications network in which the access to the network (connection between user terminal and network) is implemented without the use of wires and that is part of GERAN, UTRAN or E-UTRA networks defined by 3GPP

Site Energy Efficiency (SEE): metric used to determine the energy efficiency of a telecom site

   NOTE: SEE is defined by the ratio of "IT equipment energy" and "Total site energy", which generally includes
                    rectifiers, cooling, storage, security and IT equipment. For datacentres, the "Total site energy" more
                    globally includes building load, powering equipment (e.g. switchgear, uninterruptible power supply
                    (UPS), battery backup), cooling equipment (e.g. chillers, computer room air conditioning unit (CRAC))
                    and IT equipment energy.

telecommunication network: network operated under a license granted by a national telecommunications authority, which provides telecommunications between Network Termination Points (NTPs)

Virtualized Network Function (VNF): See ETSI GS NFV 003 [i.3].

3.2   Abbreviations

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

3GPP	3G (mobile) Partnership Project
BH	Backhaul
BS	Base Station
CC	Central Cloud
CoA	Coverage Area
CoA_des	designated coverage area as designed by network planning
CoA_geo	total geographical area under investigation and within the operator's license agreement
CoA_Qdes	quality factor describing how well users are covered within the coverage area
CRAN	Cloud Radio Access Network
CS	Circuit Switched
CS/PS	Circuit Switched/Packet Switched
DC	Data Center
DCA	Designed Coverage Area
DL	DownLink
DP	Dominant Penetration
DU	Dense Urban
DV	Data Volume
DV_{MN}	Data Volume of the Mobile Network
EC	Energy Consumption
EC_{MN}	Energy Consumption of the Mobile Network
EC_{SI}	Energy Consumption of the Site
EDC	Edge Cloud
EECRAN	Energy Efficiency of the Cloud RAN
EE_{MN}	Energy Efficiency of the Mobile Network
E-UTRA	Evolved UMTS Terrestrial Radio Access
FAO	Food and Agriculture Organization
GERAN	GSM/EDGE Radio Access Network
GHG	GreenHouse Gas
GSM	Global System for Mobile communication
GSMA	GSM Association
ICT	Information Communications Technology
IP	Internet Protocol
ITU	International Telecommunications Union
ITU-T	International Telecommunications Union - Telecommunication
LTE	Long Term Evolution
MDT	Minimization of Drive Tests
MJ	MegaJoule
MN	Mobile Network
MNO	Mobile Network Operator
MP	Minor Penetration
NA	Not Applicable
NDP	Non Dominant Penetration
O&M	Operation & Maintenance
PDF	Probability Distribution Function
PS	Packet Switched
PSL	Packet Switched Large packages dominating
PSS	Packet Switched Small packages dominating
QCI	QoS Class Identifier
QoS	Quality of Services
RA	Radio Access
RAB	Radio Access Bearer
RAN	Radio Access Network
RAP	Radio Access Point
RAT	Radio Access Technology
RC	Remote Controller
RF	Radio Frequency
RNC	Radio Network Controller

RRC   Radio Resource Control
RRH   Remote Radio Head
RU   Rural
SE   Switching Equipment
SEE   Site Energy Efficiency
SEE$_{CC}$ SEE for Central Cloud
SEE$_{EDC}$ SEE for Edge Cloud
SEE$_{RAP}$ SEE for Radio Access Point
SI   Site Infrastructure
SINR   Signal to Interference plus Noise Ratio
SU   Sub Urban
TCO   Total Cost of Ownership
TE   Telco Equipment
TMA   Tower Mounted Amplifier
U   Urban
UE   User Equipment
UE-BS   User Equipment to Base Station
UL   UpLink
UMTS   Universal Mobile Telecommunication Service
UN   United Nations
USA   United States of America
UTRAN   UMTS Terrestrial Radio Access Network
VNF   Virtualized Network Function
VNFS   Virtualized Network Function Servers
X2   Interface allowing to interconnect eNBs with each other

4   Network under test definition

4.1   Introduction

The Mobile Radio Access Network (MN) under investigation shall include all the equipment that is necessary to run a
radio access network or sub-network. Equipment to be included in the Mobile Network under investigation:

- Base Stations (see ETSI TS 125 104 [1] and ETSI TS 136 104 [2]):

    - Wide area BS.

    - Medium range BS.

    - Local Area BS.

    - Home BS.

NOTE: Home BS (and Wi-Fi access points) are not dealt with in the present document, being possibly considered
         for future versions.

- Site equipment (air conditioners, rectifiers/batteries, fixed network equipment, etc.).

- Backhaul equipment required to interconnect the BS used in the assessment with the core network.

- Radio Controller (RC).

Power consumption and energy efficiency measurements of individual mobile network elements are described in
several standards (for example ETSI ES 202 706 [i.2] for radio base stations). The present document describes energy
consumption and MN energy efficiency measurements in operational networks.

As a complete and detailed energy consumption measurement of the complete network of a country or MNO is in most
cases impossible or economically not viable, the total network is split into a small number of networks with limited size
("sub-networks").