

International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Series L

Supplement 36

(11/2017)

SERIES L: ENVIRONMENT AND ICTS, CLIMATE
CHANGE, E-WASTE, ENERGY EFFICIENCY;
CONSTRUCTION, INSTALLATION AND PROTECTION
OF CABLES AND OTHER ELEMENTS OF OUTSIDE
PLANT

ITU-T L.1310 – Study on methods and metrics to evaluate energy efficiency for future 5G systems

ITU-T L-series Recommendations – Supplement 36

ITU-T

ITU-T L-SERIES RECOMMENDATIONS

**ENVIRONMENT AND ICTS, CLIMATE CHANGE, E-WASTE, ENERGY EFFICIENCY; CONSTRUCTION,
INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT**

OPTICAL FIBRE CABLES

Cable structure and characteristics	L.100–L.124
Cable evaluation	L.125–L.149
Guidance and installation technique	L.150–L.199

OPTICAL INFRASTRUCTURES

Infrastructure including node elements (except cables)	L.200–L.249
General aspects and network design	L.250–L.299

MAINTENANCE AND OPERATION

Optical fibre cable maintenance	L.300–L.329
Infrastructure maintenance	L.330–L.349
Operation support and infrastructure management	L.350–L.379
Disaster management	L.380–L.399

PASSIVE OPTICAL DEVICES

L.400–L.429

MARINIZED TERRESTRIAL CABLES

L.430–L.449

For further details, please refer to the list of ITU-T Recommendations.

Supplement 36 to ITU-T L-series Recommendations

ITU-T L.1310 – Study on methods and metrics to evaluate energy efficiency for future 5G systems

Summary

Supplement 36 to the ITU-T L-series Recommendations analyses the energy efficiency issues for future 5G systems. 5G systems are the object of standardization in 3GPP and ITU and is planned to be available from 2018 in various countries. The focus of this Supplement is on methods and metrics to measure energy efficiency in 5G systems, with a consideration of the degree of the stability of the systems known so far and the experience of the legacy systems as well as related measurement procedures for evaluating future standardization evolutions.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T L Suppl. 36	2017-11-22	5	11.1002/1000/13476

Keywords

5G, energy efficiency, metrics, key performance indicators.

* To access the Recommendation, type the URL <http://handle.itu.int/> in the address field of your web browser, followed by the Recommendation's unique ID. For example, <http://handle.itu.int/11.1002/1000/11830-en>.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this publication, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this publication is voluntary. However, the publication may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the publication is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the publication is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this publication may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the publication development process.

As of the date of approval of this publication, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this publication. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at <http://www.itu.int/ITU-T/ipr/>.

© ITU 2018

All rights reserved. No part of this publication may be reproduced, by any means whatsoever, without the prior written permission of ITU.

Table of Contents

		Page
1	Scope.....	1
2	References.....	1
3	Definitions	2
	3.1 Terms defined elsewhere	2
	3.2 Terms defined in this Supplement	2
4	Abbreviations and acronyms	2
5	Introduction of 5G systems.....	3
	5.1 The 5G systems	3
	5.2 The standardization roadmap of 5G	5
	5.3 Specific aspects of 5G that impact EE	5
6	Energy efficiency metrics and methods for existing mobile systems.....	7
	6.1 Introduction of work on energy management in ETSI.....	8
7	State of the art approaches.....	10
	7.1 Next Generation Access Technologies.....	10
	7.2 Service and system aspects.....	11
	7.3 Other references.....	11
8	Proposed metrics for 5G energy efficiency	13
	8.1 Metrics for 5G "first phase" (Release 15)	13
	8.2 Metrics for 5G "future phases" (Release 16 and beyond)	14
9	Future work.....	15
	Bibliography.....	16

Supplement 36 to ITU-T L-series Recommendations

ITU-T L.1310 – Study on methods and metrics to evaluate energy efficiency for future 5G systems

1 Scope

This Supplement analyses the energy efficiency issues for future 5G systems. 5G systems are the object of standardization in 3GPP and ITU and are planned to be available from 2018 in various countries. The focus of this Supplement is on methods and metrics used to measure energy efficiency in 5G systems, with a consideration of the degree of stability of the systems known to date and the experience of the legacy systems as well as related measurement procedures for evaluating future standardization evolutions.

In approach, this Supplement will rely on the existing standards for legacy radio systems, especially [ITU-T L.1310] for single base station measurements in a laboratory environment and [ITU-T L.1331] for access network aggregate measurements of energy efficiency. These standards are currently applied to 2G, 3G and 4G energy efficiency topics. In addition, the present Supplement also considers the state of the art in 5G energy efficiency studies to elaborate a first view on 5G, to be further agreed for possible future development towards a new standard of energy efficiency (EE) evaluation for future 5G systems.

2 References

- [ITU-T L.1310] Recommendation ITU-T L.1310 (2017), *Energy efficiency metrics and measurement methods for telecommunication equipment*.
- [ITU-T L.1331] Recommendation ITU-T L.1331 (2017), *Assessment of mobile network energy efficiency*.
- [ITU-R M.2083-0] Recommendation ITU-R M.2083-0 (2015), *IMT-Vision – Framework and overall objectives of the future development of IMT for 2020 and beyond*.
- [ITU-R M.2410-0] Report ITU-R M.2410-0 (2017), *Minimum requirements related to technical performance for IMT-2020 radio interface(s)*.
- [ETSI ES 202 706-1] ETSI ES 202 706-1(2017), *Environmental Engineering (EE); Metrics and measurement method for energy efficiency of wireless access network equipment; Part 1: Power Consumption – Static Measurement Method*.
- [ETSI ES 202 706-2] ETSI ES 202 706-2 (Final draft) *Environmental Engineering (EE); Metrics and measurement method for energy efficiency of wireless access network equipment; Part 2: Energy Efficiency – dynamic measurement method*.
- [3GPP TR 38.913] 3GPP TR 38.913 (Release 14), *Technical Specification Group Radio Access Network; Study on Scenarios and Requirements for Next Generation Access Technologies*.
- [3GPP TR 21.866] 3GPP TR 21.866 (Release 14), *Technical Specification Group Services and System Aspects; Study on Energy Efficiency Aspects of 3GPP Standards*.

3 Definitions

3.1 Terms defined elsewhere

This Supplement uses the following terms defined elsewhere:

- 3.1.1 **Virtualized Network Function (VNF)**: see [b-ETSI GS NFV 003]
- 3.1.2 **backhaul equipment**: see [b-ITU-T L.1330]
- 3.1.3 **energy efficiency (EE)**: see [b-ITU-T L.1330]
- 3.1.4 **base station (BS)**: see [b-ITU-T L.1330]
- 3.1.5 **distributed RBS**: see [b-ITU-T L.1330]
- 3.1.6 **energy saving feature**: see [b-ITU-T L.1330]
- 3.1.7 **integrated BS**: see [b-ITU-T L.1330]
- 3.1.8 **mobile network (MN)**: see [b-ITU-T L.1330]
- 3.1.9 **mobile network coverage energy efficiency**: see [b-ITU-T L.1330]
- 3.1.10 **mobile network data energy efficiency**: see [b-ITU-T L.1330]
- 3.1.11 **mobile network energy consumption**: see [b-ITU-T L.1330]
- 3.1.12 **mobile network energy efficiency**: see [b-ITU-T L.1330]
- 3.1.13 **mobile network operator (MNO)**: see [b-ITU-T L.1330]
- 3.1.14 **mobile network operator penetration ratio**: see [b-ITU-T L.1330]
- 3.1.15 **mobile network performance delivered**: see [b-ITU-T L.1330]
- 3.1.16 **power consumption**: see [b-ITU-T L.1330]
- 3.1.17 **radio access network**: see [b-ITU-T Q.1742.1]
- 3.1.18 **telecommunication network**: see [b-ITU-T L.1330]

3.2 Terms defined in this Supplement

None.

4 Abbreviations and acronyms

This Supplement uses the following abbreviations and acronyms:

3GPP	3rd Generation (mobile) Partnership Project
AMF	core Access and mobility Management Function
BS	Base Station
BH	Backhaul
BW	Bandwidth
CoA	Coverage Area
CS	Circuit Switched
DL	Down Link
DTX	Discontinuous Transmission
DU	Dense Urban