

Recommendation

ITU-T E.813 (05/2024)

SERIES E: Overall network operation, telephone service, service operation and human factors

Quality of telecommunication services: concepts, models, objectives and dependability planning – Models for telecommunication services

Mapping and visualization strategies for the assessment of connectivity

ITU-T E-SERIES RECOMMENDATIONS

Overall network operation, telephone service, service operation and human factors

INTERNATIONAL OPERATION	E.100-E.229
OPERATIONAL PROVISIONS RELATING TO CHARGING AND ACCOUNTING IN THE INTERNATIONAL TELEPHONE SERVICE	E.230-E.299
UTILIZATION OF THE INTERNATIONAL TELEPHONE NETWORK FOR NON- TELEPHONY APPLICATIONS	E.300-E.329
ISDN PROVISIONS CONCERNING USERS	E.330-E.349
INTERNATIONAL ROUTING PLAN	E.350-E.399
NETWORK MANAGEMENT	E.400-E.489
TRAFFIC ENGINEERING	E.490-E.799
QUALITY OF TELECOMMUNICATION SERVICES: CONCEPTS, MODELS, OBJECTIVES AND DEPENDABILITY PLANNING	E.800-E.899
Terms and definitions related to the quality of telecommunication services	E.800-E.809
Models for telecommunication services	E.810-E.844
Objectives for quality of service and related concepts of telecommunication services	E.845-E.859
Use of quality of service objectives for planning of telecommunication networks	E.860-E.879
Field data collection and evaluation on the performance of equipment, networks and services	E.880-E.899
OTHER	E.900-E.999
INTERNATIONAL OPERATION	E.1000-E.1999
NETWORK MANAGEMENT	E.4000-E.4999

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

Recommendation ITU-T E.813

Mapping and visualization strategies for the assessment of connectivity

Summary

Mapping and visualizing connectivity of telecommunication services is crucial to the work of regulators, government entities and operators as it facilitates the decision-making process to reduce the digital divide. Recommendation ITU-T E.813 provides guidance, especially when it is needed to identify unserved and underserved areas. Moreover, connectivity should be understood not only as the telecommunications service's presence or absence, but also as a concept that should be built upon different perspectives.

Recommendation ITU-T E.813 defines a high-level framework for mapping and visualization strategies that include guidelines to define first how to identify and measure the level of connectivity and secondly tools and functionalities that are useful in representing the status of this connectivity.

History *

Edition	Recommendation	Approval	Study Group	Unique ID
1.0	ITU-T E.813	2024-05-29	12	11.1002/1000/15897

Keywords

Connectivity index, GIS, mapping, QoS, visualization.

* To access the Recommendation, type the URL <https://handle.itu.int/> in the address field of your web browser, followed by the Recommendation's unique ID.

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

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation 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 Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation 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 Recommendation development process.

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

© ITU 2024

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 Recommendation.....	2
4	Abbreviations and acronyms	2
5	Conventions	2
6	Connectivity of telecommunication services.....	3
	6.1 Assessment of connectivity	3
	6.2 Data tools.....	5
	6.3 In-building assessment of connectivity	7
	6.4 Requirements and characteristics of mapping and visualization tools	8
	6.5 Connectivity assessment interfaces and types of views	12
	Appendix I – Use cases.....	14
	I.1 Use case 1: Accelerating infrastructure deployment	14
	I.2 Use case 2: Resolving quality of service issues	14
	I.3 Use case 3: Providing informed choices to end users in terms of services	14
	I.4 Use case 4: Improving transparency and governance	14
	Appendix II – Characteristics of information sources	16
	Appendix III – Construction of single-number indicators and some examples.....	19
	Bibliography.....	21

Recommendation ITU-T E.813

Mapping and visualization strategies for the assessment of connectivity

1 Scope

In this Recommendation, the term "connectivity" is used with a broader meaning than the usual ones used in the telecommunication industry, including existing definitions in ITU-T Recommendations. Besides the basic meaning related to the state of being connected, without respect to a specific reason why, this Recommendation also takes into account the fact that, to be connected to a service, an end-user needs to see several, potentially many, criteria fulfilled, related to different dimensions that can be grouped into two big clusters:

- Technical elements related to the ability of a given network and a given device to share through a physical link the information and contents needed to provide access to a service. This includes network coverage and performance, as well as device performance.
- All other non-technical elements.

Taking these two clusters, this Recommendation outlines a series of toolboxes, related to the dimensions underlying connectivity, including relevant parameters. This Recommendation also proposes strategies and guidelines:

- To construct a composite connectivity index based on these toolboxes.
- To geographically map and visualize this index or any underlying relevant parameter.

These geographical mapping and visualization strategies are useful in:

- Evaluating the connectivity of users to telecommunication services, by taking all or a part of the dimensions mentioned above.
- Representing underserved as well as unserved areas, with the identification of the concerned dimensions, to determine the appropriate intervention and necessary measures needed by the end users.

Appendices to this Recommendation provide guidance on spatial analysis including stratification methodologies to classify geographical areas, data granularity, data collection and post-processing mechanisms.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- | | |
|---------------|---|
| [ITU-T E.802] | Recommendation ITU-T E.802 (2007), <i>Framework and methodologies for the determination and application of QoS parameters</i> . |
| [ITU-T E.804] | Recommendation ITU-T E.804 (2014), <i>Quality of service aspects for popular services in mobile networks</i> . |
| [ITU-T E.805] | Recommendation ITU-T E.805 (2019), <i>Strategies to establish quality regulatory frameworks</i> . |

[ITU-T E.805.1]	Recommendation ITU-T E.805.1 (2021), <i>Quality of service operational strategy for improved regulatory supervision of providers of mobile telecommunication services.</i>
[ITU-T E.806]	Recommendation ITU-T E.806 (2019), <i>Measurement campaigns, monitoring systems and sampling methodologies to monitor the quality of service in mobile networks.</i>
[ITU-T E.812]	Recommendation ITU-T E.812 (2020), <i>Crowdsourcing approach for the assessment of end-to-end quality of service in fixed and mobile broadband networks.</i>
[ITU-T E.840]	Recommendation ITU-T E.840 (2018), <i>Statistical framework for end-to-end network-performance benchmark scoring and ranking.</i>

3 Definitions

3.1 Terms defined elsewhere

None.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 connectivity: Two-way access to telecommunication services related to performance and usability.

3.2.2 connectivity index: A scalar level that represents the overall degree of connectivity, evaluated at a particular time and applicable for a specific duration and geographical area.

3.2.3 mapping: The process of illustrating values or parameters in a geographic information system (GIS).

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

GIS	Geographic Information System
H3	Hexagonal Hierarchical Spatial Index
KPI	Key Performance Indicator
MOS	Mean Opinion Score
OSS	Operations Support System
QoS	Quality of Service
RSCP	Received Signal Code Power
RSRP	Reference Signal Received Power

5 Conventions

None.

6 Connectivity of telecommunication services

6.1 Assessment of connectivity

Assessing the level of connectivity is primarily essential in order to understand the optimal telecom services needs, opportunities, and challenges of the target community in a particular location or specific geographical area. To this end, a more holistic approach to assess connectivity can be carried out to gather information on current and future needs, perform gap and risk analysis, boost investment and ensure productivity and growth in a targeted community or in a geographic area. This holistic approach consists of obtaining an index that brings an even broader view of the connectivity status, so that it can be denominated as a connectivity index.

Identifying different performance and usability levels in different geographical areas through a connectivity index can provide a better understanding for the end users service status and can lead to greater competition and investment, to the benefit of all the different stakeholders in the digital ecosystem. These connectivity index levels can provide investors with granular country-level market intelligence that highlights key intersections of telecommunication development needs. A connectivity index is a quantity that cannot be derived from a single primary measurement value. It could be represented by a group of values from different categories of data, but such a multi-dimensional array of values would be difficult to handle. Instead, a connectivity index is defined which is calculated from those values as a single number that expresses the level of connectivity available in a geographical area. Input data for this connectivity index come from multiple sources of information related to the digital ecosystem such as telecommunications infrastructure, topography, or terrain characteristics, performance indicators, regulatory aspects, demand for telecommunications services and even socio-economic statistics. It is important to emphasize that the sources of information to consider will depend on the objective of the analysis.

6.1.1 Connectivity index

A composite index can be obtained through a combination of multiple indicators identified and relevant for the target analysis using statistical methodologies. It is beneficial when a single dimensionless value is required to assess the connectivity status in simple way, so that decision makers can have a complete picture in mind. Then, concrete, targeted action plans can be derived to improve the connectivity based on an analysis of the obtained value of this composite index for the studied geographical area.

For this purpose, even if there is no universal method for constructing composite indices, their construction is mainly determined by the application or question that is going to be investigated.

In simple terms, a composite index is a single (scalar) number that is constructed from a set of input values. Typically, those input values come with their own ranges (e.g., a mean opinion score (MOS) scale from 1 to 5). In order to process them into a composite indicator, these values need to be normalized, i.e., brought to the same scale. Each input value has a given weight with which it contributes to the output quantity.

For instance, if the output quantity is calculated as a weighted sum of normalized input values, the set of set of weights is chosen such that the output value has also the desired value range, e.g., 0...100.

Also, typically, input values are not used linearly, but are transformed using some nonlinear function, expressing essentially an assessment. If this transformation is done by a function applied to the original input quantity, normalization can be integrated into this transformation already. For example, rather than using average income the input might be the percentage of households with an income below a certain threshold. Figure 1 shows an example of the construction of a composite index.