

International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.1034

(01/2020)

SERIES G: TRANSMISSION SYSTEMS AND MEDIA,
DIGITAL SYSTEMS AND NETWORKS

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Quality of experience metrics for mobile telephony communication during rail travel

Recommendation ITU-T G.1034



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Recommendation ITU-T G.1034

Quality of experience metrics for mobile telephony communication during rail travel

Summary

Recommendation ITU-T G.1034 presents a novel high-level end-to-end key performance indicator (KPI) for telephony intended to be used in rail and other route-based public transport scenarios where movement is a constituting factor. The methodologies and metrics described in this Recommendation will allow generation of a holistic view of the end-user experience and solid predictions for a wide range of use case parameters based on measurement data, while at the same reducing resources and efforts needed to collect this measurement data. It will extend the existing range of quality of service (QoS) metrics by leveraging the particular properties of public transport scenarios that are defined by repeatability and reproducibility. While the described methodology focuses on telephony, it is easily possible to extend it to cover other types of service tests. This Recommendation will benefit all stakeholders in public transport: rail passengers who will encounter a high QoE, railway operators who will be enabled to provide competitive and attractive services and last but not least the network operators, who will be able to optimize their efforts and resources.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T G.1034	2020-01-13	12	11.1002/1000/14150

Keywords

Call stability, end-to-end, mobile communication, QoE, QoS, spatially resolved information.

* 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>.

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Introduction

Accessing mobile network services while using public transport has become a popular way to use travel time, and can also be a motivation in selecting a specific transport system. A good usage experience is a prerequisite to that; however, especially in the case of railway travel, mobile network coverage or quality still has, in many places, considerable room for improvement, due to several factors such as inadequate trackside coverage or capacity-related issues when providing services to a train with a large number of passengers.

In order to improve mobile network service quality, quality of service (QoS) metrics provide guidance for efficient resource usage e.g., for network optimization or expansion of network capabilities. This Recommendation defines novel metrics which are utilizing specific characteristics of route-based travel, namely the high degree of spatial and temporal repeatability of individual journeys.

The root of the considerations leading to the definition of these metrics is the use case of a mobile telephone subscriber on board a public transport vehicle (for the sake of simplicity, in the following descriptions railway travel is used, with the understanding that other route-based forms of travel can be seen as equivalent).

If there are places with poor or no network coverage or other issues along the track, users will experience dropped calls. Typically such effects will be localized, so the user experience will also depend on the distribution of such locations. This is visualized in subsequent figures. Figure 1 shows a case where such 'drop points' are evenly distributed, while Figure 2 shows a case where these points are clustered.

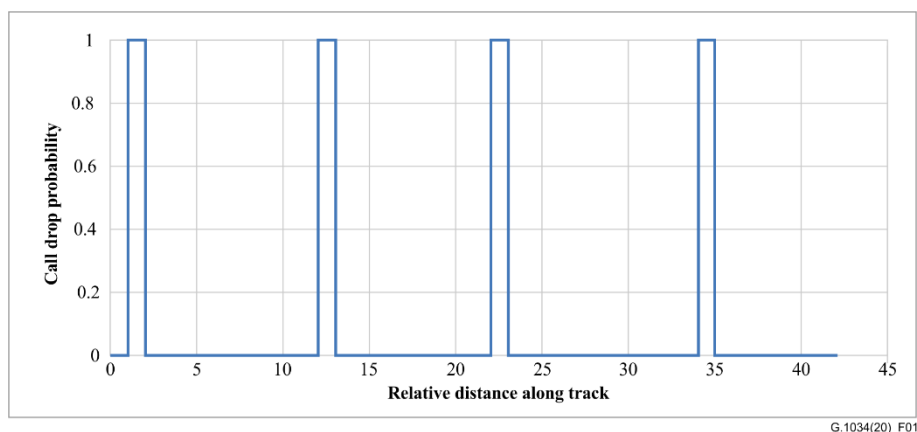


Figure 1 – Idealized situation with even distribution of problematic points where a telephone call may drop along a route

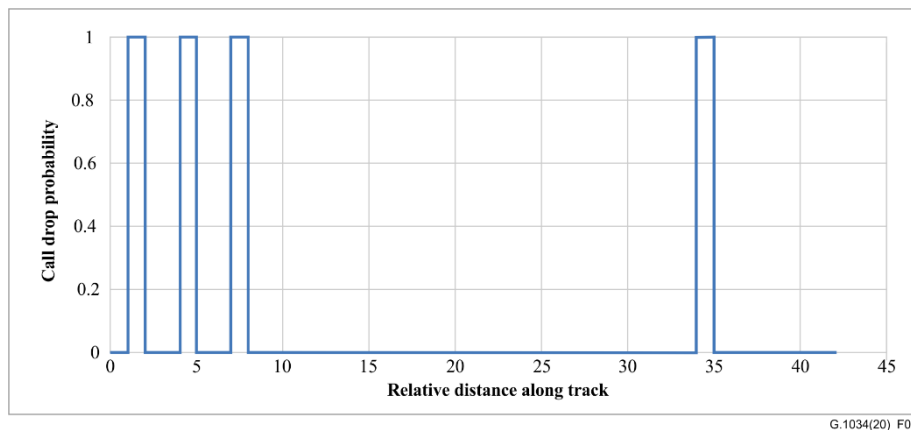


Figure 2 – Idealized situation for a telephone call drop probability along a route with clustered problematic points

A standard key performance indicator (KPI) such as a call drop rate (CDR), which is calculated over the entire route, would yield the same value in both cases. From the perspective of a user actually travelling along one of these routes, the experience would, however, be significantly different. With evenly distributed 'drop points', no uninterrupted call with a duration longer than the travel time between two such points would be possible. In a mobile network with clustered 'drop points', uninterrupted longer phone calls would be possible for a large part of the journey. It follows that there is a need for a QoS metric which is able to express such differences.

This Recommendation defines two metrics, after establishing the required definitions and conventions in clauses 3, and 5. The first metric, termed local drop probability (LDP), which is computed directly from measurement data, provides spatially resolved information about call stability along a route and provides information about the location and severity of problematic places along a track. LDP is described in detail in clause 6.

The second metric, termed call completion probability (CCP), uses this data to compute indicators which express the probability that a telephone call of a given duration can be completed successfully. The basic use case for this indicator is that of a subscriber seated in a rail or street vehicle, conducting a telephone call while travelling along a pre-defined route from A to B. CCP is described in detail in clause 7.

An important property of CCP is that the assumed call duration is a parameter in the calculation process; therefore the methodology not only provides a single indicator for one particular call duration, but can produce a range of indicator values covering an entire range of call durations.

In that sense, the methodology goes beyond standard KPIs describing telephony-call stability by utilizing specific properties of use cases which include a high degree of temporal and spatial repeatability of movement, which is a typical property of rail-based travel in particular, but also other means of public transport. One of the consequences is that network structure or topology becomes a macroscopic property of the use case as randomness of use cases is effectively reduced.

The methodology is a two-step process which is rooted in actual measurement data. The result of the first step can be seen as an abstraction layer for subsequent processing, but also constitutes robust spatially resolved information of key network performance properties. Overall, the methodology is able to generate robust predictions of end-to-end experience for a wide range of use case parameters, solidly based on measurement data.

The methodology and related KPIs provide a holistic view of mobile telephony communication availability and QoE metrics for corresponding use cases.

QoE indicators generated by this methodology can be used to improve resource utilization in network optimization in a targeted way, by focusing on the use cases typical for rail travel in parts

of the network dedicated to respective mobile network coverage. This can support the achievement of high levels of QoE for such use cases at a significantly lower effort than by less targeted measures which may lead to overprovisioning. This will be beneficial for all stakeholders, rail passengers encountering high QoE, railway operators being enabled to provide competitive and attractive services and last but not least the network operators, who can optimize their efforts and resources.

The recommended methodology provides an intuitive view on those use cases, with KPIs that are easy to adapt and to communicate for a wide range of conditions. It also is modular and scalable in the sense that indicators can be generated from a basic set of data for a wide range of travel situations and routes.

The methodology is not limited to the telephony use case, or the call stability aspect. Using the same process, it is possible to also create QoE indicators for other types of usage. Respective definitions are for further study.

Recommendation ITU-T G.1034

Quality of experience metrics for mobile telephony communication during rail travel

1 Scope

This Recommendation provides the methodology for the assessment of metrics for the end-to-end quality of service (QoS) of mobile communication services on board vehicles moving along a defined route, i.e., trains as well as road vehicles, and in particular public transport. This metric is a measure for call stability or retainability, i.e., it represents the probability that a telephone call with a pre-defined duration can be completed successfully.

The metric exploits specific properties of respective use cases and allows for a holistic, end user centric point of view on related mobile network performance characteristics. The underlying model consists of two parts:

- a computation methodology which derives spatially resolved information from measurement data acquired by conventional mobile network testing, and
- a methodology which uses the data created to compute respective high-level QoS indicators.

The methodology also produces spatially resolved information about local call stability and is therefore useful for network optimization.

The recommended methodology focuses on aspects of voice telephony. However, an extension of this methodology to aspects of mobile data communication is possible and will be taken into account in a future revision of the present Recommendation.

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 G.113] | Recommendation ITU-T G.113 (2007), <i>Transmission impairments due to speech processing</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.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

This Recommendation uses the following terms defined elsewhere:

3.1.1 quality of experience (QoE) [b-ITU-T P.10]: The degree of delight or annoyance of the user of an application or service.

3.1.2 quality of service (QoS) [b-ITU-T E.800]: The totality of characteristics of a telecommunications service that bear on its ability to satisfy stated and implied needs of the user of the service.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 geographical unit (GU): A segment of road or railway track, or a square or rectangular shaped area, with given coordinates on a map. Used to aggregate measurement data based on their geographical coordinates.

3.2.2 route profile: A data object, based on an ordered list of geographical units (GUs). A route profile provides spatially resolved information about mobile communication related properties for a given route. One example of data contained in a route profile is the local drop probability (LDP).

3.2.3 local drop probability (LDP): An indicator, computed from drive test data, to indicate the call-drop probability for a given geographical unit (GU).

3.2.4 call completion probability (CCP): The probability that a telephone call started at a given location can be completed as intended (i.e., without being dropped).

3.2.5 virtual call: A concept using the local drop probability (LDP) values in a route profile to compute the call completion probability (CCP) for a call of given duration.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

CCP	Call Completion Probability
CDR	Call Drop Rate
GNSS	Global Navigation Satellite System
GU	Geographical Unit
KPI	Key Performance Indicator
LDP	Local Drop Probability
QoE	Quality of Experience
QoS	Quality of Service
RAT	Radio Access Technologies
VC	Virtual Call

5 Conventions

5.1 Chosen variant for call drop rate (CDR)

For the purpose of this Recommendation, the following applies:

The primary definition is being the inverse of an end-to-end call success ratio, with reference to Figure 8-1 in [ITU-T E.804].

The definition of CDR therefore combines the key performance indicators (KPIs) **Telephony service non-accessibility** and **Telephony cut-off call ratio** as defined in [ITU-T E.804]. This corresponds to an end-user perspective where call attempts are made without previously checking if the mobile device is camped on a network (i.e., network coverage and service availability agnostic).

In that sense, the call set-up phase is subsumed in the definition.