INTERNATIONAL TELECOMMUNICATION UNION

ITU-T G.109

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TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

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

International telephone connections and circuits – General definitions

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Definition of categories of speech transmission quality

ITU-T Recommendation G.109

(Previously CCITT Recommendation)

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ITU-T RECOMMENDATION G.109

DEFINITION OF CATEGORIES OF SPEECH TRANSMISSION QUALITY

Summary

This Recommendation defines five categories of end-to-end speech transmission quality for 3.1 kHz handset telephony. These categories are defined as ranges of speech transmission quality in terms of "user satisfaction", tied to the ratings given by the transmission planning tool of Recommendation G.107 which takes into account the combined effects of various transmission impairments. The definitions provided here are independent of any specific technology that may be used in different types of network scenarios under consideration.

Source

ITU-T Recommendation G.109 was prepared by ITU-T Study Group 12 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on 30 September 1999.

Keywords

E-Model, speech transmission quality, user satisfaction, voice quality.

FOREWORD

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The World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 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

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As of the date of approval of this Recommendation, the ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

Introduction

A general trend that has taken place over many decades is that end-to-end speech transmission quality in telecommunications networks has improved because of technological advances in terminal and network equipment, especially the deployment of digital technologies. In particular, digital long-haul facilities have allowed the transmission quality of very long distance calls to approach that of local calls, provided that excessive delay and echo are controlled.

In recent years, however, various new access and transport technologies have been used with these digital transport facilities to deliver new capabilities (e.g. wireless access and packet-based transport) to users and service providers, that can introduce substantial degradation to the speech transmission quality of telecommunication services, as well as other quality-of-service aspects. These new access and transport technologies may present the possibility for users and service providers to choose trade-offs between the new capabilities and the resulting speech transmission quality. While each user, service provider and/or Administration must make these trade-offs for themselves, a definition of categories of speech transmission quality is needed to provide a consistent basis for comparisons.

This Recommendation defines five categories of speech transmission quality that can be used as guidance in establishing different speech transmission quality levels in telecommunications networks.

Recommendation G.109

DEFINITION OF CATEGORIES OF SPEECH TRANSMISSION QUALITY

(Geneva, 1999)

1 Scope

This Recommendation defines five categories of speech transmission quality from mouth to ear for 3.1 kHz handset telephony across networks in terms of "user satisfaction", tied to the ratings given by the transmission planning tool of Recommendation G.107 for the combined effects of various transmission impairments. The definitions provided here are independent of any specific technology that may be used in different types of network scenarios under consideration.

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; all 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.

– ITU-T Recommendation G.107 (1998), *The E-model, a computational model for use in transmission planning.*

– ITU-T Recommendation G.108 (1999), *Application of the E-Model – A planning guide*.

– ITU-T Recommendation G.113 (1996), *Transmission impairments*.

– ITU-T Recommendation G.114 (1996), *One-way transmission time*.

– ITU-T Recommendation G.131 (1996), *Control of talker echo*.

– ITU-T Recommendation G.175 (1997), *Transmission planning for private/public network interconnection of voice traffic*.

– ITU-T Recommendation P.11 (1993), *Effect of transmission impairments*.

– ITU-T Recommendation P.311 (1998), *Transmission characteristics for wideband (150-7000 Hz) digital handset telephones*.

– ITU-T Recommendation P.341 (1998), *Transmission characteristics for wideband (150-7000 Hz) digital hands-free telephony terminals*.

3 Abbreviations

This Recommendation uses the following abbreviations:

ECD Echo Control Device

ISDN Integrated Services Digital Network

PSTN Public Switched Telephone Network

4 Key parameters affecting speech transmission quality

Speech transmission quality is an important aspect of quality-of-service for many user applications of many telecommunications services. Recommendation P.11 identifies the key speech quality parameters and gives the subjective effects of variations in the parameters. Examples of speech quality parameters are speech level, attenuation distortion, transmission delay, echo path loss and delay, circuit noise, background noise, nonlinear distortion (such as the effects of low bit-rate speech codecs, packet loss, etc) and terminal characteristics.

The G.100 series of Recommendations provides transmission planning guidance, and in particular, Recommendations G.113, G.114 and G.131 provide planning guidance on transmission impairments, delay and echo, respectively. Additionally, Recommendation G.107 provides a practical planning tool for modelling the speech transmission quality from mouth to ear for 3.1 kHz handset telephony that results from combinations of many of these impairments. While it is strongly recommended that users, Administrations, equipment designers and network planners all refer to these Recommendations for pertinent detail, the following information is provided as summary guidance on the different categories of speech quality, for use in the general assessment of the impact of various technology choices on end-to-end speech transmission quality.

5 Definition of categories of speech transmission quality

While the parameters mentioned above describe the individual factors affecting speech transmission quality, it is the combined effect of all parameters together which leads to the overall level of speech transmission quality as perceived by the user. For transmission planning purposes, the E-model (G.107) is a useful tool for assessing the combined effect of all parameters and hence differentiating between categories of speech transmission quality.

The primary output of the E-model is the Transmission Rating Factor, R. Table 1 gives the definitions of the categories of speech transmission quality in terms of ranges of Transmission Rating Factor R provided by Recommendation G.107. Also provided are descriptions of "User satisfaction" for each category.

Table 1/G.109 – Definition of categories of speech transmission quality

R-value range	Speech transmission quality category	User satisfaction
$90 \leq R < 100$	Best	Very satisfied
$80 \leq R < 90$	High	Satisfied
$70 \leq R < 80$	Medium	Some users dissatisfied
$60 \leq R < 70$	Low	Many users dissatisfied
$50 \leq R < 60$	Poor	Nearly all users dissatisfied
NOTE 1 – Connections with R-values below 50 are not recommended. NOTE 2 – Although the trend in transmission planning is to use R-values, equations to convert R-values into other metrics e.g. MOS, %GoB, %PoW, can be found in Annex B/G.107.		

It is very important to fully understand the principle recommended in this Recommendation. The R-value is a measure of a quality perception to be expected by the average user when communicating via the connection under consideration: quality is a subjective judgement such that assignments cannot be made to an exact boundary between different ranges of the whole quality scale. Rather, the quantitative terms should be viewed as a continuum of perceived speech transmission quality varying from high quality through medium values to a low quality as illustrated in Figure 1.

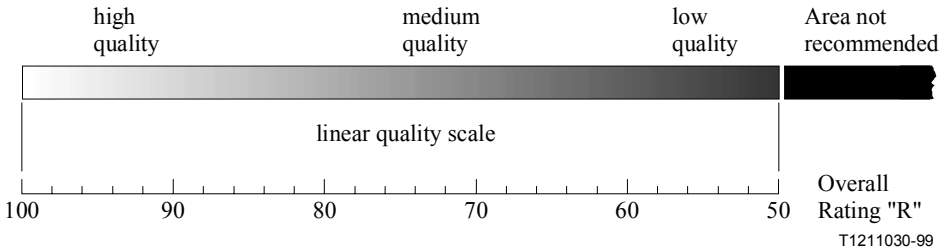

Figure 1/G.109 – Judgement of a connection on a linear quality scale

6 Examples of speech transmission quality provided in typical scenarios

To provide a practical context for the categories defined above, Table 2 gives estimates of R-values for a number of service/network scenarios. In these examples, specific parameter values follow the default values of Table 3/G.107, except as noted in column 2 of Table 2.

Table 2/G.109 – Examples of speech transmission quality provided in typical scenarios

Service/network scenario	R-value	Deviations from Table 3/G.107
ISDN subscriber to ISDN subscriber, local connection	94	Note 1
Analogue PSTN subscriber to analogue PSTN subscriber, 20 ms delay (average echo path losses; no active echo control)	82	Note 2
Mobile subscriber to analogue PSTN subscriber as perceived at mobile side	72	Note 3
Mobile subscriber to analogue PSTN subscriber as perceived at PSTN side	64	Note 4
Voice over IP connection using G.729A + VAD with 2% packet loss	55	Note 5
NOTE 1 – No deviations. NOTE 2 – TELR = 35 dB, WEPL = 50 dB, T = 20 ms, Tr = 40 ms, Ta = 20 ms. NOTE 3 – TELR = 68 dB, WEPL = 101 dB (EC with ERLE = 33 dB assumed), T = 110 ms, Tr = 220 ms, Ta = 110 ms, Ie = 20. NOTE 4 – TELR = 53 dB, WEPL = 101 dB (EC with ERLE = 33 dB assumed), T = 110 ms, Tr = 220 ms, Ta = 110 ms, Ie = 20. NOTE 5 – T = 300 ms, Tr = 600 ms, Ta = 300 ms, Ie = 19.		

7 Qualifications to the definitions provided in this Recommendation

It should be noted that the E-model captures the effects of many of the key transmission parameters, but there are impairments that the current model of Recommendation G.107 does not directly capture: for example, echo canceller behaviour under double-talk conditions; syllabic clipping caused by the use of voice activity detectors; comfort noise; etc.

Additionally, it should be emphasized that while the guidance of this Recommendation applies to 3.1 kHz handset telephony; other audio categories with better quality are possible, such as wideband (150-7000 Hz bandwidth) telephony, for which terminal specifications exist (Recommendations P.311 and P.341). Network planning guidance for such applications is under consideration, because Recommendation G.107 does not apply to wideband scenarios.

Finally, to relate the definitions provided by this Recommendation to concepts and terminology used in the past, a comment about "toll quality" is in order. "Toll quality" has been used by many different people to mean different things, but to network planners it really meant that technology being introduced into the network was robust to the effects of transmission impairments from other sources, and could thus be used in many configurations where interworking with other systems would be necessary. In this context, the term "toll quality" does not have any absolute relation to speech transmission quality today, because, for example, the impairments of systems such as wireless access or packet-based transport will have the same impact, whether on a local or on a long-distance connection. Instead, the terminology provided here is recommended.

8 Guidance for detailed transmission planning

Recommendations G.108 and G.175 provide detailed guidance for transmission planning using the E-model.

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