INTERNATIONAL TELECOMMUNICATION UNION

# CCITT

# E.432

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

## TELEPHONE NETWORK AND ISDN

## QUALITY OF SERVICE, NETWORK MANAGEMENT AND TRAFFIC ENGINEERING

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# CONNECTION QUALITY

## Recommendation E.432

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Geneva, 1992

## FOREWORD

The CCITT (the International Telegraph and Telephone Consultative Committee) is the permanent organ of the International Telecommunication Union (ITU). CCITT 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 Plenary Assembly of CCITT which meets every four years, establishes the topics for study and approves Recommendations prepared by its Study Groups. The approval of Recommendations by the members of CCITT between Plenary Assemblies is covered by the procedure laid down in CCITT Resolution No. 2 (Melbourne, 1988).

Recommendation E.432 was prepared by Study Group II and was approved under the Resolution No. 2 procedure on the 16th of June 1992.

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CCITT NOTE

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

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**Recommendation E.432**

## CONNECTION QUALITY

## 1 Introduction

This Recommendation suggests parameters, measurements and standards to capture the customer perception of connection quality for all services on the public switched telephone network (PSTN) and the evolving integrated services digital network (ISDN).

In principle, when a new service is to be implemented, a market analysis has to be undertaken to gain information on the service quality that has to be offered to the users at a given tariff. Here a problem appears to arise: users show their satisfaction in a non-technical way: they judge connection quality ranging from poor to excellent. The same problem applies to existing services.

The intention of the Recommendation is to provide a guideline to obtain end-to-end connection of acceptable quality, that satisfies the end users.

## 2 Scope

In considering "connection quality", it is important to recognize that the "user" must already have a complete end-to-end connection, i.e. a distant end answer signal has been received before the connection quality can be assessed. "Connection quality" does not include call set-up delays, etc.

The "connection quality" has to be considered from the users perspective and will be influenced by the subjective perception of the user, the destination and route chosen, the transmission media used and the total ressources available and applicable to the end-to-end connection.

As a result, this Recommendation considers the user perspective first, and then develops the network parameters and objectives.

## 3 Definitions

**connection quality**

The degree to which a connection reproduces the offered signal under stated conditions, as a sum of transmission performance, service integrity, service retainability performance, propagation performance.

**connection transmission quality**

The level of reproduction of a signal offered to a telecommunication system, under given conditions, when this system is in an up-state.

## 4 User perspective

4.1 The user perspective is the key issue in connection quality. User's opinions are subjective but by appropriate methods, a service can assess user's satisfaction in a quantitative and reproducible way.

During an established call the user(s) may notice degradation of the intelligibility. The cause of this may be increased attenuation, inadmissible distortion, strong noise, etc.

The speech quality is influenced by ther performance and the user conditions applicable to the complete connection from speaker to listener. In general, speech quality is treated by dividing it into sending quality, transmission quality and receiving quality. Among them, the transmission quality is the main factor which can be controlled by the Administration. The other two factors vary widely with the ability of speakers, listeners and the conditions under which speech is sent and received.

Low level pulsive noise, produced in a switching system, and group delay distorsion on a transmission line, do not cause any substantial trouble for the telephony service. These impairments are more likely to impact non-telephony applications, such as data and facsimile. It should be noted that there are many other impairments factors that affect non-telephony applications.

For most services, it is the network and terminal equipement that have the major impact on user opinion. Figure 1/E.432 illustrates the general network arrangement required to provide international voiceband services.

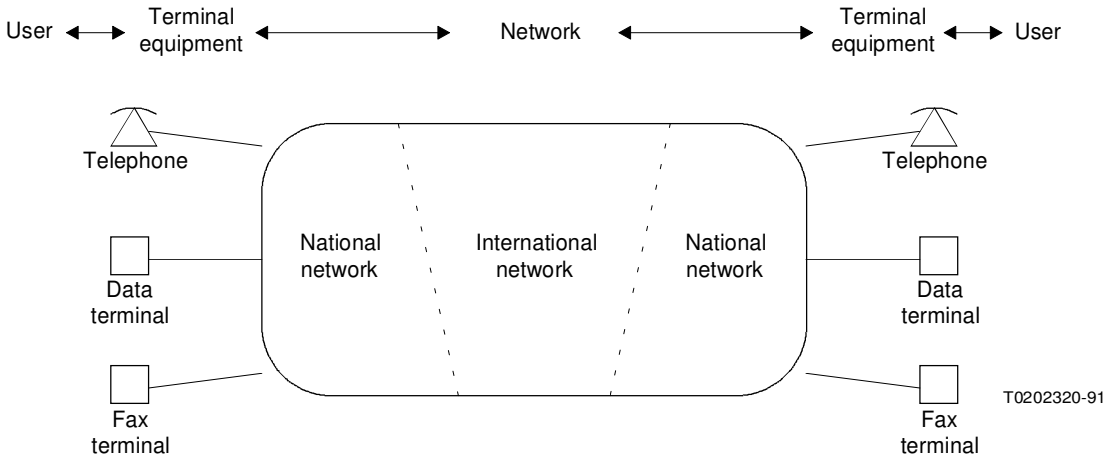


FIGURE 1/E.432

**General network arrangement required to provide international voice-band services**

The next step is to relate user of the connection quality to the relevant network or terminal conditions that can be studied or monitored by the service provider.

## 5 Customer perceived parameters in relation to network parameters and terminal equipement transmission parameters

The Table 1/E.432 gives, for general information, *examples* of relationships between user-perceived quality and technical aspects of network/or terminal equipment. *This is not intended to be an exhaustive list.*

TABLE 1/E.432

**Relationship of customer/network/terminal parameters**

| Customer perceivable parameters | Network parameters | Terminal equipement parameters |
|---|---|---|
| VOICE | | |
| Loudness | Circuit loss | Telephone design |
| Noise<br>Interruptions | Circuit noise, impulse noise,<br>crosstalk (unintelligible) | Noise acoustic environment |
| Echo (talker and listener) and singing | Terminal balance, echo control devices,<br>delay, loss, stability | Terminal balance<br>Impedance |
| Delay | Propagation time, digital processing | Digital processing |
| Sidetone | Impedance | Telephone design |
| Fidelity | Quantization, non-linear and attenuation distortions and bandwidth | Local distortion<br>Bandwidth |
| Chopped speech | Speech detectors parameters, switched loss clipping, interruptions, freeze-out, fading | – |
| Crosstalk (intelligible) | Power loads on cables and carriers,<br>leakage, imbalances | – |
| NON-VOICE | | |
| Lost-errored data | Impulse noise, frame slips, jitter,<br>hits, drop-outs, distortion, circuit loss,<br>crosstalk, interruptions, etc.,<br>burst errors, echo | Frame slips, drop-outs, distorsion,<br>degradation due to compression algorithms |
| Throughput | Delay (and above impairments) | – |
| Response time | Delay | Delay |
| Fax image quality | Above impairments,<br>out of synchronism | Above<br>plus out of synchronism |
| Retransmission | Noise, interruptions, out of synchronism,<br>group delay distortion, impulsive noise | Echo control devices,<br>out of synchronism |

## 6 Measuring methods

The following methods of measuring the connection quality are available:

1) service observations on live traffic;

2) test calls;

3) customers interviews;

4) trouble reports;

5) transmission quality index (TQI).

Measures using test calls on live traffic can be taken manually or by automatic means.

The automatic methods are considered as objective measurements, for example, the non-intrusive methods on live traffic and the envelope methodology for speech quality on test calls.

TQI, model to assess the global user perception of the level of transmission quality, is described in Recommendation P.11. This model expresses the resulting effect by an overall index, which can be directly derived from the objective measurements on the network of elementary transmission quality parameters.

Measures using customer interviews and trouble reports are considered to be subjective measurements along with the manual methods for service observations and test call categories.

The following method is available for the assessment of subjective measurements:

Mean opinion score (MOS) Users of the observers – in a sufficiently large sample – express their satisfaction about connection quality according to a five-category scale frome 4 to 0: excellent, good, fair, poor and bad. The MOS value is obtained by averaging scores.

*As an example:* from Figure 2/E.432, it can be seen that an MOS of 2.5 relates to 90% satisfaction in the fair or better curve. It also means that 50% of the users are considering the quality as good or excellent. If the target for "good or excellent" quality is 75%, then the MOS should be 3.

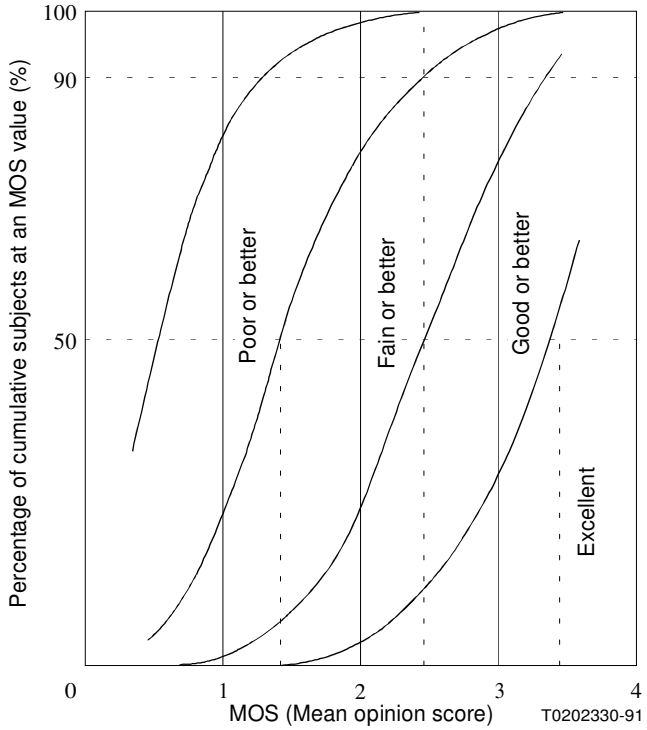


FIGURE 2/E.432
**Cumulative MOS characteristics**

The modern trend is to carry out automatic measurements for the following reasons:

– operating cost is minimized (staff reduction);

– continuous observation is possible;

– it is possible to take a larger sample;

– human error is eliminated;

– automatic processing of data is facilitated;

– conversational privacy is ensured;

– the time at which observations are made can be recorded.

On the other hand, manual observations can permit the detection of a number of abnormalities which cannot easily be detected automatically, and whose assessment is largely subjective, e.g. voice clipping.

## 7 Objectives and CCITT Recommendations

Objectives provide an effective means for managing Quality of Service. The use of objectives will guide actions to be taken to ensure that Quality of Service is consistent with the requirements and perceptions of end users. Objectives need to be reviewed and revised periodically as networks and technologies evolve and user expectations for Quality of Service change.

Guidance in setting objectives for specific aspects of Quality of Service can be found in various CCITT Recommendations, including those listed below.

Recommendations on transmission quality, including both network and terminal equipment aspects, may be found in Volume V (P-Series) and III.1 (G-Series, Fascicle 1); and the Handbook of Telephonometry, Recommendations P.11 and G.113 are especially helpful regarding transmission impairments.

Page XI of the G-Series, Fascicle III.1, gives a useful index of transmission performance Recommendations, grouped by the type of impairment (e.g. noise, level, delay).

The Q-Series of Recommendations give Recommendations for *exchanges* (Fascicle VI.1).

The M-Series of Recommendations give Recommendations for *leased circuits* (Fascicle IV.2).

Recommendations G.821 and G.921 give requirements for *bit error ratios* in digital circuits and sections.

Finally, the Hadbook on Quality of Service and Network Performance (1992), contains comprehensive tables for cross-referencing Network Performance and Quality of Service parameters to Recommendations.