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SERIES E: OVERALL NETWORK OPERATION,
TELEPHONE SERVICE, SERVICE OPERATION AND
HUMAN FACTORS

Quality of service, network management and traffic
engineering – Traffic engineering – ISDN traffic
engineering

**Network grade of service parameters and target
values for circuit-switched services in the
evolving ISDN**

ITU-T Recommendation E.721

(Previously CCITT Recommendation)

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ITU-T RECOMMENDATION E.721

NETWORK GRADE OF SERVICE PARAMETERS AND TARGET VALUES FOR CIRCUIT-SWITCHED SERVICES IN THE EVOLVING ISDN

Summary

This Recommendation provides network Grade of Service (GOS) parameters for circuit-switched services in ISDN, based on the ISDN Grade of Service concept and guidelines for selecting GOS parameters provided in Recommendation E.720. The parameter values assume that the network and the components are fully operational and take account of the evolving nature of the ISDN and Signalling System No. 7 capabilities.

This version of this Recommendation includes revised parameters for GOS target values for circuit-switched services in the evolving ISDN.

Source

ITU-T Recommendation E.721 was revised by ITU-T Study Group 2 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on the 10th of May 1999.

FOREWORD

ITU (International Telecommunication Union) is the United Nations Specialized Agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the ITU. The 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 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

In this Recommendation the term *recognized operating agency (ROA)* includes any individual, company, corporation or governmental organization that operates a public correspondence service. The terms *Administration*, *ROA* and *public correspondence* are defined in the *Constitution of the ITU (Geneva, 1992)*.

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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.

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Recommendation E.721

NETWORK GRADE OF SERVICE PARAMETERS AND TARGET VALUES FOR CIRCUIT-SWITCHED SERVICES IN THE EVOLVING ISDN

(revised in 1999)

1 Introduction

This Recommendation provides network Grade of Service (GOS) parameters for circuit-switched services in ISDN, based on the ISDN Grade of Service concept and guidelines for selecting GOS parameters provided in Recommendation E.720. The parameter values assume that the network and the components are fully operational and take account of the evolving nature of the ISDN and Signalling System No. 7 capabilities.

NOTE – GOS parameters and their target values for such services as point-to-multipoint, multislot services and reservation services require further study.

Besides the E.700-series of Recommendations (ISDN traffic engineering) and Recommendations E.500 and E.502 (Measurement and recording of traffic), the following Recommendations also contain material that either provide background for or is relevant to this Recommendation:

- CCITT Recommendation E.172 (1992), *ISDN routing plan*.
- ITU-T Recommendation G.101 (1996), *The transmission plan*.
- CCITT Recommendation I.324 (1991), *ISDN network architecture*.
- ITU-T Recommendation I.325 (1993), *Reference configurations for ISDN connection types*.
- ITU-T Recommendation I.350 (1993), *General aspects of quality of service and network performance in digital networks, including ISDN*.
- ITU-T Recommendation I.352 (1993), *Network performance objectives for connection processing delays in an ISDN*.
- ITU-T Recommendation Q.543 (1993), *Digital exchange performance design objectives*.
- ITU-T Recommendation Q.706 (1993), *Message transfer part signalling performance*.
- ITU-T Recommendation Q.709 (1993), *Hypothetical signalling reference connection*.
- ITU-T Recommendation Q.766 (1993), *Performance objectives in the integrated services digital network application*.
- ITU-T Recommendation Q.921 (1997), *ISDN user-network interface – Data link layer specification*.
- ITU-T Recommendation Q.931 (1998), *ISDN user-network interface layer 3 specification for basic call control*.

The relation with Recommendation I.352 is particularly important. The major distinctions between this Recommendation and Recommendation I.352 are:

- The GOS values of this Recommendation are intended to be used for network dimensioning and thus consider the network to be in a state where all components are fully operational. Recommendation I.352 identifies network performance objectives observable at specified network boundaries and includes the effects of both congestion and network failures.

- Since the parameters of this Recommendation are used for network dimensioning, traffic weighted averages of connection types are employed. On the other hand, I.352 performance objectives characterize the performance any connection should achieve and thus are upper bounds.
- The recommended values of this Recommendation allow for additional delays from connections that may include PSTN components which may be present during ISDN evolution. I.352 values apply for an exclusively ISDN connection.

2 Circuit-switched services

In the current ISDN specifications, call establishment and release for all circuit-switched services provided via B-channels (voice, data, image) will use the out-of-band call control procedures defined by Recommendation Q.931 and Signalling System No. 7 signalling protocols.

The following traffic GOS parameters are recommended for circuit-switched calls in ISDN:

- 1) pre-selection delay (overlap sending);
- 2) post-selection delay (overlap sending);
- 3) post-selection delay (en-bloc sending);
- 4) answer signal delay;
- 5) call release delay; and
- 6) probability of end-to-end blocking.

The definitions of these traffic GOS parameters are given below. The delay GOS parameters are based on the message flows in Recommendation Q.931 and Signalling System No. 7 (ISUP) protocols as indicated, for example, in Figure A-1/E.713. Further, delays or blocking within the customer premises equipment or subscriber terminal are not part of the following definitions for GOS parameters.

2.1 pre-selection delay (overlap sending)

Pre-selection delay (overlap sending) is defined as the time interval from the instant the first bit of the SABME message is passed by the calling terminal to the access signalling system until the last bit of the SETUP ACK message is received by the calling terminal.

2.2 post-selection delay

a) post-selection delay (overlap sending)

Post-selection delay (overlap sending) is defined as the time interval from the instant the first bit of the INFORMATION message containing the last selection digit is passed by the calling terminal to the access signalling system until the last bit of the first message indicating call disposition is received by the calling terminal (ALERTING message in case of successful call).

b) post-selection delay (*en bloc* sending)

Post-selection delay (*en bloc* sending) is defined as the time interval from the instant the first bit of the initial SETUP message containing all the selection digits is passed by the calling terminal to the access signalling system until the last bit of the first message indicating call disposition is received by the calling terminal (ALERTING message in case of successful call).

NOTE – In case of automatic answering terminals the ALERTING message is replaced by the CONNECT message.

2.3 answer signal delay

Answer signal delay is defined as the time interval from the instant that the called terminal passes the first bit of the CONNECT message to its access signalling system until the last bit of the CONNECT message is received by the calling terminal.

2.4 call release delay

Call release delay is defined as the time interval from the instant the first bit of the DISCONNECT message is passed by the user terminal which terminated the call to the access signalling system, until the last bit of the RELEASE message is received by the same terminal (indicating that the terminals can initiate/receive a new call).

2.5 probability of end-to-end blocking

The probability of end-to-end blocking is the probability that any call attempt will be unsuccessful due to a lack of network resources.

NOTE 1 – Blocking because of lack of B-channels between the customer premises equipment and the network is not part of this definition.

NOTE 2 – The lack of control plane resources during the call setup phase may also contribute to end-to-end blocking. This aspect is for further study.

3 Target values for GOS parameters

The target values will be specified at the normal and high loads in the same sense as Recommendation E.500. However, additional study is required to ensure their suitability for ISDN. The delay target values will be specified by the mean and percentile levels for both normal and high loads.

3.1 PSTN users distinguish the following three types of service in their performance expectations:

- local service;
- toll (trunk) service within a country; and
- international service.

Local service is provided by networks of one node in the simplest case, two nodes and one inter-office link in the most common case but up to six nodes in extreme and very rare cases. Typical local service can be represented by connections ranging from one to four nodes.

Toll (or trunk) service is normally provided by a connection involving at least four nodes (two local exchanges and two toll exchanges). Much longer connections are possible for the very small portion of traffic that would follow the all final route path in a multilevel hierarchical network. Both unusually short (e.g. combined local-toll exchanges) and unusually long connections should be ignored leading to toll service being represented by connections with five to seven nodes.

Recommendation G.101 gives connections for international service and identifies the extreme cases as a 14-node connection. Recommendation G.101 also provides distributions of connection lengths based on measurements taken a number of years ago. In these measurements, 93% of calls used seven or less nodes and 99.98% used 11 or less nodes. Based on these distributions, connections for international service can be considered to include eight to ten nodes.

The typical connections for ISDN circuit switched calls that have been used to establish the end-to-end GOS targets are summarized in Table 1.

Table 1/E.721 – Number of switching nodes in typical end-to-end connections for ISDN circuit-switched calls

	Local connection	Toll connection	International connection
Number of nodes	1-4	5-7	8-10

3.2 The GOS parameters defined in clause 2 can be partitioned into two categories. Parameters like Pre-Selection Delay and Call Release Delay are essentially determined by the local exchange performance, i.e. they are not "network" parameters, although these parameters contribute to the end-to-end performance of international connections. On the other hand, Post-Selection Delay, Answer Signal Delay and probability of end-to-end blocking are network parameters and their target values need to be specified for the local, toll and international connections given in 3.1.

The GOS target values for international connections apply to each international traffic relation. The GOS target values for local and toll connections can be applied by individual Administrations as appropriate. For each connection type, the GOS target value is for the weighted average of the GOS of all pairs of originating and terminating nodes (whose connection length is within the typical values of Table 1) weighted by the traffic between them.

In the case of single node connections, the GOS is taken to be internal to the node.

The targeted values for the GOS parameters for ISDN circuit-switched services are given in Table 2.

These target values take account of the evolving nature of the ISDN and SS No. 7 capabilities, user expectation of service quality, technology and network constraints and existing Q-series Recommendations on ISDN exchange and SS No. 7 performance. These factors are taken into account by means of an allowance in the derivation of target values. Some additional assumptions are identified as "Notes" with Table 2.

Table 2/E.721 – Target values for GOS parameters for circuit-switched services in the evolving ISDN

GOS parameter	Normal load		High load	
	Mean	95%	Mean	95%
Pre-selection delay	0.6 sec	1.0 sec	1.0 sec	2.0 sec
Call release delay	0.4 sec	0.6 sec	0.6 sec	1.0 sec
Post-selection delay (<i>en bloc</i> sending)				
• Local connection	3.0 sec	6.0 sec	4.5 sec	9.0 sec
• Toll connection	5.0 sec	8.0 sec	7.5 sec	12.0 sec
• International connection	8.0 sec	11.0 sec	12.0 sec	16.5 sec
Answer signal delay				
• Local connection	0.75 sec	1.5 sec	1.0 sec	2.0 sec
• Toll connection	1.5 sec	3.0 sec	2.0 sec	4.0 sec
• International connection	2.0 sec	5.0 sec	3.3 sec	6.5 sec
Probability of end-to-end blocking				
• Local connection	2%	NA	3%	NA
• Toll connection	3%	NA	4.5%	NA
• International connection	5%	NA	7.5%	NA
NA Not applicable.				

NOTE 1 – Except for mean delay at normal load, all other target values are provisional and require further review.

NOTE 2 – The concept of "normal load" and "high load" in a network that may be geographically distributed with non-coincident busy hours needs further study.

NOTE 3 – International connections are assumed to include one satellite link in the user as well as the control (SS No. 7) plane.

NOTE 4 – For calls requiring database lookup, an additional delay will need to be added to the post-selection delay for each database lookup. This additional delay will depend on the type of connection used for database lookup.

NOTE 5 – The subject of allowable end-to-end blocking for the worst treated traffic relations, for instance an all final route path, is for further study.

NOTE 6 – The target values in this table are to be interpreted as design objectives.

4 Recommendation history

Recommendation E.721 – First issue 1988.

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- Series I Integrated services digital network
- Series J Transmission of television, sound programme and other multimedia signals
- Series K Protection against interference
- Series L Construction, installation and protection of cables and other elements of outside plant
- Series M TMN and network maintenance: international transmission systems, telephone circuits, telegraphy, facsimile and leased circuits
- Series N Maintenance: international sound programme and television transmission circuits
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