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SECTION 7

ISDN TRAFFIC ENGINEERING

Recommendation E.700

FRAMEWORK OF THE E.700 SERIES OF RECOMMENDATIONS

1 Introduction

The E.700 Series of Recommendations are intended to provide guidance on traffic engineering for the ISDN. They are organized in sections to deal with various aspects of traffic engineering.

2 General: Recommendations E.700 to E.709

This section deals with general topics applicable throughout the E.700 Series.

3 Traffic modelling: Recommendations E.710 to E.719

This section provides guidance on how to characterize the traffic that will be offered in ISDNs.

4 Grade of Service: Recommendations E.720 to E.729

This section defines Grade of Service (GOS) concepts and parameters that will be significant in ISDNs and sets objectives for these parameters.

5 Dimensioning methods: Recommendations E.730 to E.739

This section provides methods to relate the offered traffic and Grade of Service objectives in order to allocate sufficient resources for planning and design purposes.

6 Traffic measurements: Recommendations E.740 to E.749

This section describes traffic measurement and performance monitoring requirements.

Recommendation E.701

REFERENCE CONNECTIONS FOR TRAFFIC ENGINEERING

1 General

The goal of this Recommendation is to give the E.700 Series of Recommendations a base to define ISDN Grade of Service (GOS) and traffic parameters.

In § 2, two reference connections are defined. Definition of other reference connections is for further study.

2 Reference connections

2.1 *Reference connection for point-to-point circuit switched services*

See Figure 1/E.701.

Figure 1/E.701, p.

2.2 *Reference connection for point-to-point packet switched services*

See Figure 2/E.701.

Figure 2/E.701, p.

Recommendation E.710

ISDN TRAFFIC REQUIREMENTS OVERVIEW

1 Introduction

This Recommendation outlines the general consideration in modelling traffic flows in ISDNs. More detailed descriptions for specific services and significant points in the network are given in Recommendations of the E.710 Series as follows:

E.711 — User Demand

E.712 — User Plane Traffic Models

E.713 — Control Plane Traffic Models

E.714 — Management Plane Traffic Models.

Additional Recommendations in this Series will be developed in the future to reflect ISDN developments.

Note — Recommendations E.712 and E.714 are for further study.

2 Context

ISDN concepts, services and networks are described in the Series I Recommendations. The E.710 Series of Recommendations have been developed consistent with the approach. However, the grouping of material in the E.710 Series concentrates on the important aspects from a traffic point of view of ISDN operations in the immediate future.

An important modelling technique used to represent ISDN capabilities is the layered architecture described in Recommendations I.310 and I.320. The E.710 Series have been developed using this approach. At present the E.710 Series concentrates on lower layer (1-3) traffic flows. Higher layer traffic flows are for further study.

The user plane/control plane perspectives described in Recommendation I.320 have been used to provide two separate traffic models in Recommendations E.712 and E.713. Nevertheless, it should be kept in mind that

many traffic engineering procedures described in subsequent E.700 Recommendations require incorporating traffic loads from both planes using the same resources. The influence of the management plane is for further study.

The ISDN reference connections used in the E.710 Series are those given in Recommendation E.701.

3 User demand

ISDN users have various needs for information transfer. The user and his terminal equipment transform these needs into a series of call demands for available ISDN services. These transformations involve many functions including coding, and peer-to-peer and inter-layer protocols. The higher layer functions are not analysed in the E.710 Series.

Recommendation E.711 starts from the expression by the user of a call demand to use the ISDN services defined in Recommendations I.230 and I.240. Corresponding traffic variables including the number of attempts per call demand

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significant points are points in the network where traffic flows and grades of service should be evaluated.

are derived for the relevant attributes of each service.

4 User plane

In the user plane the attributes of some ISDN services give rise to additional traffic parameters beyond those used in telephony. Based on the user models of Recommendation E.711, Recommendation E.712 will be developed in the future to derive traffic models for each basic ISDN service using a common set of parameters that applies to all services.

5 Control plane

Each attempt from a terminal will result in signalling messages in the control plane. The number of messages and their length are highly dependent on:

— protocols (S.S. No. 7 and Q.931 digital access);

— call disposition (including user facilities);

— originating and terminating subscriber equipment configurations (e.g. overlap sending).

Control plane traffic models given in Recommendation E.713.

6 Further developments

The preceding sections of this Recommendation and the Recommendations of the E.710 Series concentrate on those services and facilities which will predominate in the first ISDNs to be implemented.

However, the ISDN concepts include the inherent possibility of developing completely new services and functions in response to changing user needs. This will result in new traffic situations that will need to be covered in the E.710 Series. Some of the situations which can be anticipated are:

— the impact of supplementary services, such as call waiting, on control plane traffic;

— new ISDN capabilities such as statistical switching and dynamic allocation;

— connectionless communications;

— the impact of user-to-user signalling;

— the impact of multipresentation type calls, and simultaneous use of different interactive and distribution services, involving multi-slot and multipoint connections, and broadcast mode.

Recommendation E.711

USER DEMAND

1 Introduction

1.1 Traffic offered to layers 1-3 of the ISDN can be modelled by distributions of arrival times and holding times (traffic variables). This Recommendation describes how these traffic variables are related to user demands at higher levels.

2 General structure

2.1 This section describes the general process by which the distributions of arrival times and holding times (traffic variables) which determine the offered traffic to layers 1-3 may be derived from user demands. The process is illustrated in Figure 1/E.711 and described in detail in Annex B.

2.2 Through the mediation of Customer Premises Equipment (CPE), user demands are translated into sequences of requests for applications, teleservices, and bearer services.

2.3 An **application in an ISDN** is a sequence of teleservice and bearer service requests, predefined in order to satisfy a global communications need.

2.4 A **call pattern** is a specific sequence of events and inter-event times generated by a call demand and modelled by traffic variables as described in § 3 of this Recommendation. Each teleservice class can be modelled by a mix of call patterns, each corresponding to a set of teleservice attributes.

2.5 A **connection pattern** is a specific set of information transfer and general attributes which are significant for traffic engineering. Information transfer and general attributes are described in Recommendation I.210. Each call pattern can be served by one or more connection patterns.

Figure 1/E.711, p.3

2.6 A teleservice has attributes that can be selected by the user, negotiated or selected by the service provider. The result of this selection procedure is a sequence of requests for connection patterns.

2.7 Annex A outlines the relations between user demands, applications, teleservices, bearer services and traffic significant attributes.

2.8 The mix of connection patterns determined by the process in turn determines the distributions of arrival times and holding times.

3 Traffic variables

3.1 Traffic variables are expressed as distributions of arrival times and holding times. For traditional circuit switched services, the shapes of some distributions are such that they can be represented by the mean values. A discussion of traffic variables in the ISDN context is given in the following sections.

3.2 *Call variables*

3.2.1 *Arrival process*

For traditional circuit switched services, the call attempt rate has, for practical purposes, been considered equivalent to the call demand rate. In the ISDN, on the contrary, this equivalence can no longer be assumed. Many teleservices will have attributes such that complex call attempt sequences are generated for each call demand. This will require the introduction of additional considerations such as:

— number of call attempts per call demand;

— number of negotiations per call demand;

— number of call demands requiring reservation.

The entire subject of call attempts sequences requires further study.

3.2.2 *Holding times*

For traditional circuit switched services, call holding time t_1 is the only variable of interest. For reservation services, additional variables are needed to characterize reservation time t_2, completion time t_3 and request time t_4. See Figure 2/E.711. (New holding times require further study.)

Figure 2/E.711, p.

3.3 *Transaction variables*

Additional information beyond § 3.2 is needed for packet switching services.

For packet-switched services, the information content at the user level during a call may be produced in discrete transactions (intervals during

which a user is continuously producing information). This subdivision is significant from a traffic point of view. See Figure 3/E.711.

3.3.1 *Arrival process*

The arrival process for transactions within a call is for further study.

3.3.2 *Transaction length*

The transaction length as expressed in bits represents the workload offered by the transaction through the user/network interface. The distribution of transaction lengths is for further study.

Note — For transport purposes, the workload as related to single transactions within a specific call may undergo one or more segmentation stages. The entire subject of workload segmentation is for further study.

Figure 3/E.711, p.

4 Examples

4.1 Traditional telephone service with lost calls cleared is usually characterized by mean arrival rate and mean holding times.

4.2 Telephone service in the ISDN, with a fast signalling system (Signalling System No. 7) and capabilities for automatic repetition, needs the introduction of a supplementary variable, namely the repetition rate, to evaluate the number of call attempts per call demand.

4.3 Personal computer communication using reservation services, associated with the supplementary services of automatic repetition and call waiting, is a teleservice giving rise to a complex call attempt sequence as illustrated in Figures 4/E.711 and 5/E.711.

In relating this service to user demand, many additional variables are needed as discussed in § 3. The control and user plane traffics must take into account not only the mean values but also other parameters characterizing the distributions.

Figure 4/E.711, p.6

Figure 5/E.711, p.7

ANNEX A
(to Recommendation E.711)

Relation between user demands and attributes

A.1 *Introduction*

This Annex provides concrete examples relating user demands (applications, teleservices and bearer services) to attributes which are important for traffic engineering purposes. Tables are provided for illustrative purposes but it must be noted that these are based on a selective summarization of key attributes related to the I.200 Series of Recommendations. Thus they should be only interpreted as illustrations of the process.

A.2 *User demand attributes*

User demands are described by the following attributes:

— user service selections;

— access channels and rates (see Figure A-1/E.711);

— layer 7 to 1 protocols.

A.3 *Application characteristics*

Applications are described by the following characteristics:

— teleservices supporting the application;

— bearer services supporting the application;

— bearer capabilities supporting teleservices and bearer services.

Table A-1/E.711 gives the teleservices recommended in Recommendation I.240 together with the attributes which are important from a traffic engineering point of view. These comprise:

— information transfer mode;

— information transfer rate;

— information transfer capability;

— establishment of communication;

— symmetry;

— communication configuration.

As other teleservices are introduced into ISDN (e.g. electronic shopping) in the future, the traffic engineering attributes may expand (e.g. information handling processes).

Table A-2/E.711 lists representative bearer services from which those required to support an application may be chosen.

A.4 *Teleservices*

According to Recommendation I.210, a teleservice is the result of one of the following combinations:

— one basic teleservice;

— one basic teleservice plus one or more supplementary services.

Furthermore, a teleservice is implemented using bearer capabilties.

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Figure A-1/E.711, p.

H.T. [T1.711]

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TABLE A-1/E.711

Examples of teleservices and their attributes

}

{ Information transfer mode } Circuit mode | ua)		

{						Bidirectional Symmetric	Asymmetric	Point-to- point	Multipoint	Broadcast	
Telephony	64 (max.)		×	×			×		×	×	
Teletex	64 (max.)	| ub) × | ub)									
Telefax 4	64 (max.)	×		×		×			×	×	
Mixed mode	64 (max.)	×		×		×			×		
Videotex	64 (max.)	×		×				×	×		

a) Packet mode is for further study.

b) Presently this service is provided by 3.1 kHz audio.

Tableau A-1/E.711 [T1.711] ITALIENNE, p.9

H.T. [T2.711]

TABLE A-2/E.711

Bearer services

{ *Circuit mode* (Recommendation I.231) } { 64 kbit/s, unrestricted, 8 kHz structured } { 64 kbit/s, 8 kHz structured, usable for speech information transfer } { 64 kbit/s, 8 kHz structured, usable for 3.1 kHz audio information transfer } { Alternate speech / 64 kbit/s unrestricted, 8 kHz structured } { 2 × 64 kbit/s unrestricted, 8 kHz structured } { 384 kbit/s unrestricted, 8 kHz structured } { 1536 kbit/s unrestricted, 8 kHz structured } { 1920 kbit/s unrestricted, 8 kHz structured }
{ *Packet mode* (Recommendation I.232) } { Virtual call and permanent virtual circuit } Connectionless User signalling

Tableau A-2/E.711 [T2.711], p.10

ANNEX B

(to Recommendation E.711)

Traffic characterization

B.1 *Introduction*

B.1.1 This Annex describes a methodology for relating user demands to the traffic offered to layers 1-3 of the ISDN. The basic approach is to relate the mix of user demands to *call patterns* and *connection patterns* latter concepts are defined in §§ 2.4 and 2.5 and repeated below; between them, they contain all of the information needed to derive the distributions of arrival times and holding times.

B.1.2 Call patterns and connection patterns are the means by which the effects of user demands are described as they affect layers 1-3 of the ISDN network.

A call pattern is a specific sequence of events and inter-event times generated by a call demand and modelled by traffic variables as described in § 3 of this Recommendation.

A connection pattern is a specific set of information transfer and general attributes which are significant for traffic engineering. Information transfer and general attributes are described in Recommendation I.210.

Call patterns describe what happens at the user-network interfaces. Connection patterns describe what types of resources are used. Each call pattern can be served by one or more connection patterns.

B.2 *User/customer premises equipment characterization*

B.2.1 *User classes*

The population of users can be divided into user classes characterized by the user selections of applications, teleservices and bearer services, and their rates of occurrence. Each class is associated with a penetration in the population.

B.2.2 *Customer premises equipment (CPE) classes*

The actual application, teleservice and bearer service requests presented to the network as a result of user selections are determined by the user's CPE type. Each user class can be subdivided into CPE classes characterized by the penetration of CPE types in that user class.

B.3 *Application characterization*

For further study.

B.4 *Teleservice characterization*

B.4.1 *Teleservice classes*

The population of teleservices requested by user/CPE combinations may be subdivided into classes defined by the values of attributes significant for traffic engineering.

Teleservices, as defined in Recommendation I.240, are teleservice classes from the traffic point of view.

Of the attributes defined in Recommendation I.210, the following are significant for traffic engineering:

— information transfer mode;

— information transfer rate;

— information transfer capability;

— establishment of communication;

— symmetry;

— communication configuration.

Each combination of attribute values defines a single teleservice class.

B.4.2 *Teleservices*

Within each teleservice class, individual teleservices are defined by values of general attributes which are still under study in Study Group XVIII. Of particular significance for traffic engineering is the attribute ''Supplementary services''.

B.4.3 *Demands for teleservice classes*

Each user class/CPE class combination is characterized by rates of demand for teleservice classes. This characterization may be represented as shown in Table B-1/E.711. The contents of Table B-1/E.711 must be estimated by statistical studies.

B.4.4 *Teleservice demands*

Combining the concepts of §§ B.4.1 and B.4.2, the total request rate for each teleservice class can be subdivided as shown in Table B-2/E.711.

The entries of Table B-2/E.711 must be estimated by statistical means.

B.4.5 *Call patterns*

For each individual teleservice there is one and only one corresponding call pattern. However, the same call pattern may be representative of several teleservices.

Multiplying the total rates in Table B-1/E.711 by the proportions shown in Table B-2/E.711, rates for each call pattern are obtained as shown in Table B-3/E.711.

H.T. [T3.711]

TABLE B-1/E.711

Demands for teleservice classes

User class	CPE class (Note 1)	Teleservice class							
		1	2	3	.	.	.	.	.
1	X Z	Y							
2	t	Z							
. . .	. . .								
Totals									

Note 1 — A given user class will not necessarily use all CPE classes.

Note 2 — Table entries are the rates at which the user/CPE combinations originate requests for each teleservice class.

Tableau B-1/E.711 [T3.711], p.11

H.T. [T4.711]

TABLE B-2/E.711

Demand for individual teleservices

Teleservice class	{							
	1	2	3	.	.	.	.	.
1								
2								
. . .								
Total								

Note — Table entries are the proportions of total requests for each teleservice class for each general attribute combination (defining an individual teleservice). Each row adds to unity.

Tableau B-2/E.711 + Note [T4.711], p.12

H.T. [T5.711]

TABLE B-3/E.711

Call pattern demands

Teleservice class	Call pattern 1	2	3	.	.	.	.	.
1								
2								
. . .								
Total								

Note — Table elements are the rates at which each teleservice class creates a demand for each call pattern.

Tableau B-3/E.711 + Note [T5.711], p.13

B.5 *Connection pattern characterization*

Each call pattern can be served by one or more connection patterns. A specific connection pattern corresponds to each set having as elements one value for each applicable bearer service attribute.

The breakdown in Table B-4/E.711 of the call patterns on the connection patterns is needed.

H.T. [T6.711]

TABLE B-4/E.711

Breakdown of the call pattern on the connection patterns

{	1 i	.||	1	.|| .||	j	.||	1	.||	k	.||		
CP1												
.||												
CPn												
Total												

Note 1 — Table entries are the proportions of the *n* th call pattern served by the different connection patterns.

Note 2 — The total on the columns gives the total rate on each connection pattern.

Note 3 — The sums on the rows may be useful for designing priority classes.

Table B-4/E.711 [T6.711], p.

Using Tables B-3/E.711 and B-4/E.711, Table B-5/E.711 can be obtained.

H.T. [T7.711]

TABLE B-5/E.711

Rate of the call demands requiring a specific connection pattern

Connection patterns	Rate
XP1	
XP2	
. . .	
XPn	
Total	

Table B-5/E.711 [T7.711], p.

Bibliography

BONATTI (M.), GIACOBBO SCAVO (G.), ROVERI (A.), VERRI (L.): Terminal exchange access system for NB-ISDN: Key issues for a traffic reference model. *Proc. 12th ITC* , paper 4.1A.3, Turin, 1988.

Recommendation E.713

CONTROL PLANE TRAFFIC MODELS

1 Control plane traffic

For the purposes of teletraffic engineering, the control plane traffic load is assumed to be generated by call attempts on the network. These call attempts are part of the call pattern described in Recommendation E.711.

This Recommendation considers traffic loads at the lower three layers of the CCITT 7-layer reference models (Recommendation I.310 and I.320) described for ISDN in Recommendation Q.931 and in Signalling Sytem No. 7.

The control plane traffic of an ISDN network includes all the control signals sent through the ISDN network. The types of control signals are:

1) signals for user call attempts

a) to set up the connection paths in the user plane (reservation of time slots for circuit switched connections or control for the virtual calls of packet-switched connections),

b) to release the connection paths in the user plane,

c) if required, to order additional communication facilities or change of service by the users during the time of user information transfer,

d) possibly to send charging information during the time of user information transfer.

2) User-to-user information messages

Because control plane traffic due to user-to-user messages is left for further study, this Recommendation will consider only signals for user call attempts.

The control plane traffic uses two types of channels in the network:

a) the 16 kbit/s or 64 kbit/s D-channels in the user access, and

b) the 64 kbit/s Signalling System No. 7 channels connecting two different signalling points.

2 Signalling traffic

The end-to-end ISDN signalling traffic depends on the call pattern arrival process defined in Recommendation E.711 and on the signalling protocol.

The basis for the estimation of the signalling traffic is the information given in the Recommendations of the I- and Q-Series dealing with the number and structure of the signals in the D- and Signalling System No. 7 channels for any type of attempt. The total signalling traffic is composed of these signals. The number of signals may be different for each different type of attempt.

3 Estimation of the signalling traffic for a single call attempt

In Figure 1/E.713 the network components supporting the control plane of the ISDN reference connection of Figure 1/E.701 are considered. In each section, a significant point is defined:

DA (D-channel, A user side): S/T interface at an A user side

DB (D-channel, B user side): S/T interface at a B user side

CA (S.S. No. 7 channels, A user side): outgoing side of the local exchange LE(A).

CB (S.S. No. 7 channels, B user side): incoming side of the local exchange LE(B).

The analysis of user-to-user messages in the control plane is left for further study.

Figure 1/E.713, p.

The signal flow which is necessary to perform the control functions of a particular call attempt may be represented by a signal flow diagram. It contains all the signals passing the significant points in the control plane for the considered attempt. Figure 2/E.713 shows the basic scheme of this signal flow diagram. The arrows represent the layer 2 signals in the three connection phases: call establishment, user information transfer, and call release.

An example of a signal flow diagram for a successful circuit switched call attempt is given in Annex A.

The signal flow diagram is the basis for the estimation of the amount of signalling traffic caused by the considered attempt using the reference connection. The signalling traffic of a single attempt in a given section of the control plane associated with a significant point can be described by two sets of parameters:

1) the total number of signals passing the significant point in the three call-connection phases in the A-to-B direction and in the B-to-A direction, as in Figure 2/E.713;

2) the length of each signal type passing the significant point in the A-to-B and the B-to-A direction.

Figure 2/E.713, p.

4 Estimation of the total signalling traffic

The total number of signals in the control plane over a reference period is determined by summing the number of signals caused by call attempts handled in the associated user plane during the reference period. Therefore the estimation of the number of signals is based on the estimation of the amount and types of attempts in the user plane.

In order to estimate the amount of signals, it is necessary to accept a traffic model for the traffic in the user plane assuming the total number of attempts over the reference period and the breakdown of these attempts into the different types of attempts, such as successful call attempts, unsuccessful call attempts and calls to busy tone.

The total traffic load of a section caused by the signals is expressed by the total amount of bits crossing its significant point.

In order to estimate the amount of this traffic load it is necessary to multiply the length of each particular type of signals by the number of signals of each type occuring during the reference period and summing over all types of signals occuring during the reference period.

Since the number and length of the signals do not vary widely for most types of attempts, initially this traffic model will be adequate by taking into consideration only the most frequently experienced types of attempts.

The characteristic of the signalling traffic in a particular section of the control plane will depend on such factors as:

a) the total traffic load caused by layer 2 and 3 signals for the attempts.

b) the distribution of call attempts and release arrivals.

The impact on teletraffic engineering caused by a full characterization of the arrival process is left for further study.

Using Figure 2/E.713, the signalling traffic load at a significant point can be estimated.

If, over the reference period:

i is the call phase,

j is the signal type,

$n_{ij}(u)$ is the average number of signals of type j in call phase i in the A-to-B direction,

$n_{ij}(d)$ is the average number of signals of type j in call phase i in the B-to-A direction,

l_j is the length of signal of type j,

T is the total number of signals types,

$L(u)$ is the total load in the A-to-B direction,

$L(d)$ is the total load in the B-to-A direction,

then:

Each $n_{ij}(u)$ and $n_{ij}(d)$ must be estimated from the number of call attempts and the call attributes in the user plane over the reference period. An example of this procedure is given in Annex A.

The proper reference period to use for dimensioning is for further study.

ANNEX A

(to Recommendation E.713)

Example of procedure for estimating

the total signalling traffic in a D-channel

A.1 *Signalling traffic for one call attempt*

A call attempt of the following type is considered:

— effective call attempt,

— circuit switched connection,

— en-bloc sending of dialled information,

— call to an appointed terminal,

— no additional control signals during the information transfer phase,

— installation of data link in the D-channels required for establishment and release of the connection,

— manual answering terminal.

The signal flow diagram for this type of call attempt is given in Figure A-1/E.713 and Figure A-2/E.713. Three kinds of signals are indicated in Figure A-1/E.713:

— layer 3 signals,

— layer 2 signals for the activation and deactivation of the data links,

— end-to-end signals via the S.S. No. 7 network.

Figure A-2/E.713 presents the breakdown of the D-channel signals into layer 2 for the case of multiple terminals on the terminating side. The breakdown of the S.S. No. 7 messages and the total length of signal in the considered call attempt is for further study.

A.2 *Signalling traffic for additional types of call attempts*

For further study.

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Figure A-1/E.713, p.18

Figure A-2/E.713, p.19

Recommendation E.720

ISDN GRADE OF SERVICE CONCEPT

1 Introduction

This Recommendation outlines the general considerations for the ISDN Grade of Service (GOS) concept and provides guidelines for selecting GOS parameters. In this Series of Recommendations, the term GOS always refers to traffic Grade of Service parameters as defined in Recommendation E.600.

ISDN GOS parameters are given in subsequent Recommendations in the E.720 Series.

2 GOS concept

GOS uses a number of traffic engineering parameters to provide a measure of adequacy of plant under specified conditions; these GOS parameters may be expressed as probability of blocking, probability of delay, etc. Blocking and delay are caused by the fact that the traffic handling capacity of a network/network component is finite and that the demand traffic is stochastic by nature.

The users of telecommunication services can experience the effects of GOS parameters depending on their perception of events such as:

1) failure of a call demand or excessive delay to satisfy a call demand;

2) failure of call attempts or excessive delay to satisfy call attempts;

3) failure of automatic re-attempts or excessive delay to satisfy automatic re-attempts.

Events of the first class are always perceived by the user. Events of the other two classes may be perceived by the user depending on the capability of the terminal equipment to transmit signalling information to the calling user.

In all three classes the ability to distinguish GOS depends on having distinct indications of called user conditions and network conditions.

GOS may be distinguished as the user GOS , network GOS and network component GOS as shown in Figure 1/E.720. User GOS relates to user call demands. Network GOS relates to any call attempts including both user generated call attempts and terminal generated automatic reattempts. Network component GOS relates to bids for the utilization of a specific network component including both bids generated by call attempts and bids generated by call attempts and bids generated by internal retrials in the network. Parameters related to user GOS and network component GOS are for further study.

Recommendation E.721 defines network GOS parameters based on any call attempt. Subsequent Recommendations in the E.720 Series will define other GOS parameters. Recommendations in the E.740 series will define traffic measurement and performance monitoring requirements.

User GOS performance effects and other traffic-independent, user-perceived effects such as availability and service integrity contribute to Quality of Service (QOS). Network GOS parameters and their values provide information on the traffic aspects of the QOS.

3 Principles to select ISDN GOS parameters

3.1 *ISDN traffic characteristics*

ISDN has many characteristics different from the existing dedicated networks such as Public Switched Telephone Network (PSTN), Circuit Switched Public Data Network (CSPDN), Packet Switched Public Data Network (PSPDN), etc. The following characteristics are taken into account when defining GOS parameters for ISDN:

— ISDN provides integrated access to a wide variety of telecommunication services through a small set of standardized user-network interfaces.

— Services have heterogeneous traffic demand profiles and diverse performance requirements.

— The traffic streams generated by user demands for bearer services and teleservices utilize layer 1, 2 and 3 resources.

— The configuration and implementation of a user's terminal and its man-machine interface may vary from one service to another service and one user to another user.

— Out-of-band signalling and call control capability, based on D-channel and Signalling System No. 7 (S.S. No. 7) are provided.

Figure 1/E.720, p.20

3.2 *Parameter selection principles*

The GOS parameters defined in the E.720 series of Recommendations applies to the first phase of ISDN. The definitions of these parameters may be expanded or additional GOS parameters defined to accomodate future evolution of ISDN architecture and services. Considering the above characteristics in ISDN, the following principles are recommended for selecting GOS parameters in ISDN:

i) A minimum common set of GOS parameters is defined for attempts on layers 1, 2 and 3 — such attempts belonging to different services may or may not share the same out-of-band call set-up and release procedures. (See Note.)

ii) The GOS parameters are defined and specified in such a way that the GOS can be derived at well-defined reference points (traffic significant points).

iii) The GOS parameters should be specified with reference to traffic load conditions in the sense of Recommendation E.500.

iv) Blocking GOS parameters may in the future need to take account of repetitions due to network status, but are presently based on lost-call-cleared assumptions.

v) GOS parameters related to the user plane information transfer phase are for further study.

Note — To assess the performance directly perceived by a user, other additional parameters which are specific to the user's terminal equipment may also be necessary.

3.3 *GOS standard setting principles*

GOS standard setting principles will take into account the current standards for voice and data services so that when the user migrates from a dedicated network to the ISDN, the user does not encounter a marked undesirable contrast.

Recommendation E.721

NETWORK GRADE OF SERVICE PARAMETERS IN ISDN

1 Introduction

This Recommendation proposes network Grade of Service (GOS) parameters for circuit-switched and packet-switched services in ISDN, based on the ISDN Grade of Service concept and guidelines for selecting GOS parameters provided in Recommendation E.720. These parameters are defined assuming that the network and the network components are fully operational.

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 S.S. No. 7 (ISUP) signalling protocols. Thus, for the traffic GOS parameters that relate to call establishment and release phases, a single set of parameters can be used for all circuit-switched services provided by the ISDN.

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

1) pre-selection delay (overlap sending) ,

2) post-selection delay ,

3) call release delay , and

4) 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 S.S. No. 7 (ISUP) protocols as indicated, for example, in Figure A-1/E.713.

2.1 *Pre-selection delay (overlap sending)*

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

2.2 *Post-selection delay*

post-selection delay is defined as the time interval from the instant the INFO message containing the last selection digit (in the case of overlap sending or the SETUP message in the case of en-bloc sending) is passed by the calling terminal to the access signalling system until the first message indicating call disposition is received by the calling terminal.

Note — In the ISDN the called user can choose to delay the sending of the ALERTING signal to the calling user. This definition does not include such user-induced delays.

2.3 *Call release delay*

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

2.4 *Probability of end-to-end blocking*

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

Note — Resources in the access network are not part of this definition.

3 Packet-switched services

The ISDN user has a choice of two types of packet-switched data services. The B-channel provides 64 kbit/s packet access, while the D-channel can also be used to provide packet data access at 16 kbit/s (64 kbit/s in the case of primary access). For packet-switched services, the current call control procedures are based on X.25 (inband) protocols, except during the initial B-

or D-channel set-up between the DTE (Data Terminating Equipment) and the PH (Packet Handler). Thus a certain number of messages will be exchanged between the TE (Terminal Equipment) and the LE (Local Exchange) over the D-channel during the initial establishment phase of a packet-switched call. The messages will have to compete with other signalling (SAPI 0) and data (SAPI 16) traffic on the D-channel.

Thus, the traffic GOS parameters for the current specification of ISDN packet-switched services will have to be based on the Q.931 as well as on the X.25 call control procedures.

The selection and definition of traffic GOS parameters for packet-switched services in ISDN are for further study.

4 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. The delay target values will be specified by the mean and percentile levels for both normal and high loads.

The actual target values are for further study.

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