INTERNATIONAL TELECOMMUNICATION UNION

CCITT

E.711

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

(10/92)

TELEPHONE NETWORK AND ISDN

**QUALITY OF SERVICE,
NETWORK MANAGEMENT AND TRAFFIC
ENGINEERING**

USER DEMAND MODELLING

Recommendation E.711

FOREWORD

The CCITT (the International Telegraph and Telephone Consultative Committee) is a 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.711 was revised by Study Group II and was approved under the Resolution No. 2 procedure on the 30th October 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.

Recommendation E.711

USER DEMAND MODELLING

(revised 1992)

1 Introduction

ISDN users have various needs for information transfer. The user demand, as manifested in the user/CPE interface [see figure 1a)/E.711], is characterized by an arrival process and by a call duration and/or a quantity of information attached to each arrival.

Through the mediation of the Customer Premises Equipments (CPEs), user demands are translated into call demands for specific telecommunication services in the user-network interface. These call demands are modelled in this Recommendation to allow the characterization of the traffic offered to the layers 1 to 3 of the ISDN.

Based on the call demand modelling, users will be characterized by the generating process of their originating and terminating call demands.

2 Modelling of a call demand

2.1 *General*

The traffic offered to the layers 1 to 3 at the user-network interface is modelled by the call demand [see Figure 1b)/E.711]. For traffic engineering purposes, a call demand is defined by a set of connection characteristics and by a call pattern:

- The connection characteristics are described by the values of certain attributes given by Recommendation I.210. Only some of the low layer and general attributes are significant. The values of each attribute can be:
  - selected by the user;
  - prescribed by the service provider;
  - negotiated between them.

  This set of attributes must be sufficient to identify precisely the resources needed by the call demand in the network, both in the user and control planes.

- The call pattern of a call demand is described in terms of sequences of events at the user-network interface and of the times between events.

  The call pattern, associated with the connection characteristics, must be sufficient to quantify the traffic offered to the network resources by the call demand, in the user plane and in the control plane.

2.2 *Connection characteristics*

As mentioned in § 2.1, the connection characteristics of a call demand are defined by a set of low layer and general attribute values, defined in Recommendation I.210, which are significant for traffic engineering. The low layer attributes are:

- information transfer mode;
- information transfer rate;
- information transfer capability;

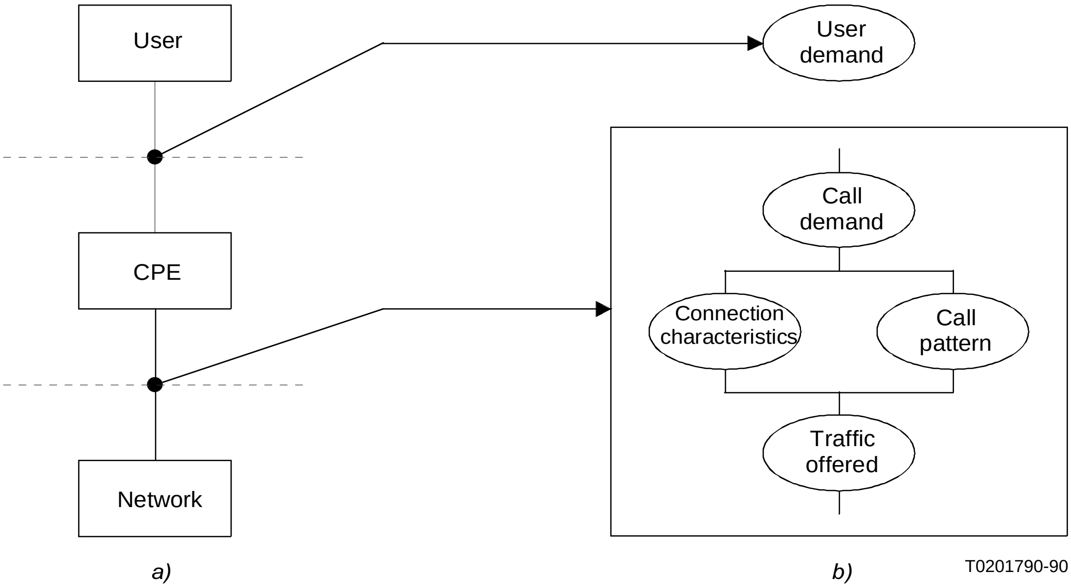


FIGURE 1/E.711

User demand modelling by call demands

– establishment of communication;

– symmetry;

– communication configuration;

– access channel and rate;

– signalling access protocol layers 1 to 3;

– information access protocol layers 1 to 3.

Among the general attributes, which are still under study, the attribute "Supplementary services" is of particular significance for traffic engineering. The list of other traffic significant general attributes is for further study.

In practice, when the connection characterization is made for a specific traffic engineering task, only some of the above-mentioned attributes are significant.

On the other hand, some of the values of the attributes given in the I-Series Recommendations are not sufficient for traffic engineering purposes. As an example, the defined values of the communication configuration attributes are point-to-point, multipoint and broadcast. For traffic engineering purposes, the number and position of the points and the identification of the originating and terminating points have to be specified as well.

The definition of other connection characteristics significant from the traffic engineering point of view is for further study.

Note – High layer attributes, such as high layer protocols, are not considered as connection characteristics since, from the viewpoint of traffic offered to layers 1 to 3 of the ISDN, high layer protocol messages should be considered as user information and thus modelled by means of the call pattern.

2.3 *Call pattern and traffic variables*

As mentioned in § 2.1, the call pattern of a call demand is defined in terms of sequences of events at the user-network interface and of the times between events.

The call pattern is defined by a set of traffic variables. These traffic variables are expressed as statistical variables described by some parameters related to their distribution. This allows a large variety of call demands to be modelled by the same call pattern. Call demands with the same types of events, but different numbers of such events (e.g. different number of re-attempts), or different times between them (e.g. different holding times), could be modelled by the same call pattern.

Two kinds of traffic variables can be distinguished:

– call variables, describing events occurring during the call set-up and release phases and the times between these events;

– transaction variables, describing events occurring during the information transfer phase and the times between these events.

In the following, these two kinds of traffic variables are described, as well as the parameters to characterize them. Nevertheless, it must be observed that, when the call demand modelling is made for a specific traffic engineering task, only some of the following traffic variables are needed.

2.3.1 *Call variables*

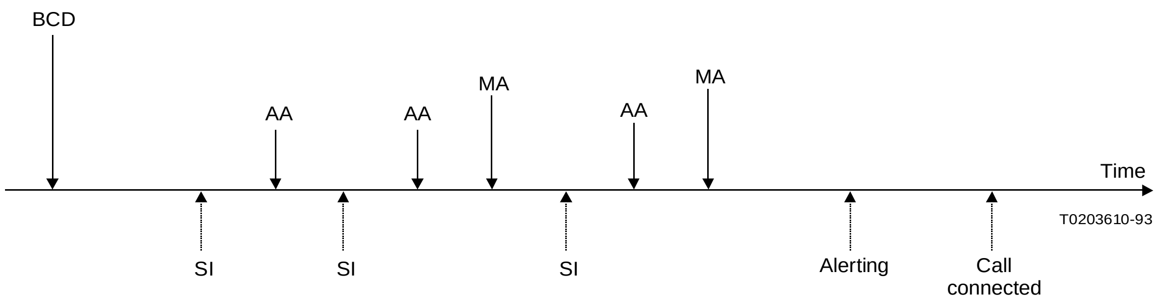
2.3.1.1 *Call attempt arrival process*

This is the process of manual or automatic attempts in which a call demand can result (see Figure 2/E.711). These attempts are recognized by the system as layer 3 set-up messages. This process may be characterized, in particular, by:

– mean number of re-attempts in case of non-completion;

– mean time between the call attempts.

A more detailed characterization of the call attempt arrival process is for further study.



BCD Beginning of call demand (manifested by the first manual attempt)
MA Manual attempt
AA Automatic attempt
SI Status indication, indicating call no completion

FIGURE 2/E.711
Call attempt sequence

2.3.1.2 *Call attempt holding times*

For a call demand, several call attempt holding times, delimited by layer 3 messages, are of interest, e.g. dialling time, ringing time and conversation time. The definition of the holding times and of the parameters of their distributions which characterize them is for further study.

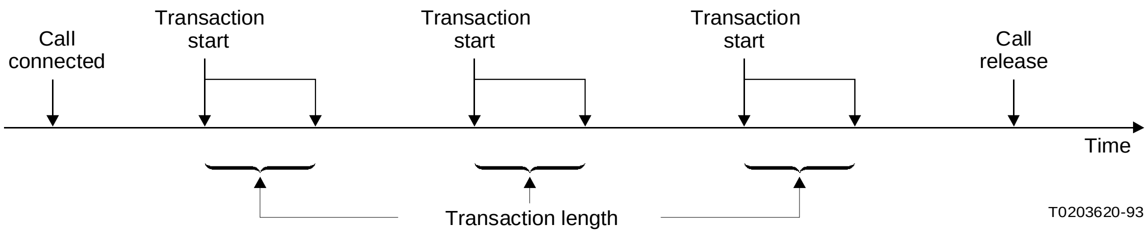
As a first step, it may be sufficient to consider the mean total holding time.

2.3.2 *Transaction variables*

The information contents at the user plane during a call may be produced in discrete transactions, i.e. intervals during which a user is continuously producing information (see Figure 3/E.711). This subdivision may be significant from a traffic point of view in packet switched services and in some cases in circuit switched services, e.g. when Digital Circuit Multiplication Equipment (DCME) is used.

Note 1 – 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.

Note 2 – In the definition of transaction variables, the high layer protocol messages should be considered as user information.



Note – Information transfer only occurs during the transactions.

FIGURE 3/E.711

Transactions of a call

2.3.2.1 *Transaction arrival process*

The arrival process for transactions within a call is for further study. Nevertheless, as a first step it may be sufficient to consider the mean number of transactions per call.

2.3.2.2 *Transaction length*

The transaction length, expressed in bits, represents the workload offered by the transaction through the user-network interface. The distribution of transactions lengths is for further study. The mean transaction length may be considered, as a first step.

2.4 *Illustration of call demand modelling*

Sets of connection characteristics can be defined for each telecommunications service. For a given traffic engineering task, a limited number of call patterns can be associated with each telecommunication service/connection characteristics combination. The range of possible call patterns to consider could be assumed *a priori* or derived from the user characterization. Table 1/E.711 gives a structured format for listing connection characteristics and call patterns.

TABLE 1/E.711

List of telecommunication services, connection characteristics and call patterns defined in the call demand modelling

Telecommunication services (names)	Connection characteristics (sets)	Call patterns
TS 1	XC 1,1	CP 1,1,1 CP 1,1,2 CP 1,1,3 . . .
	XC 1,2	CP 1,2,1 CP 1,2,2 . . .
	XC 1,3	CP 1,3,1 CP 1,3,2
	. . .	. . .
TS 2	XC 2,1	CP 2,1,1
	XC 2,2	CP 2,2,1 . . .
	. . .	. . .
. . .	. . .	. . .

Call patterns listed in association with a telecommunications service/connection characteristics combination must be described in terms of traffic variables appropriate for that combination. Table 2/E.711 gives examples of both connection characteristics and call pattern descriptions.

TABLE 2/E.711

Example of connection characteristics and call pattern descriptions

Telecommunication services	Connection characteristics	Call patterns
Telephony	Circuit switched 64 kbit/s Speech On-demand Bidirectional symmetric Point-to-point Points in different districts of the same city	*Call variables* Mean number of re-attempts Mean holding time *Transaction variables* Mean number of messages for user-to-user signalling Mean message length
Data communication	Packet switched 64 kbit/s Unrestricted digital On-demand Unidirectional Point-to-two points Points in the same district Access channel: B Access protocol: Recommendation Q.931	*Call variables* Mean number of re-attempts Both connections established and released simultaneously Mean holding time *Transaction variables* Mean number of messages for user-to-user signalling Mean message length Mean number of transactions per call Mean transaction length

3 User characterization

3.1 *General*

From a traffic engineering point of view users sharing the same CPE should not be characterized individually, but rather as an ensemble which is called the *CPE user set*. The CPE user set is taken to be the user, or set of users, accessing the network through a single CPE (regardless of the number of ISDN accesses from the CPE).

A CPE user set is characterized by the generating process of its originating and terminating call demands. In the initial phase this process may be approximated by the mean rate of call demands of each type during a reference period. A more detailed characterization of this process, which includes higher order statistical moments, is for further study.

User characterization has to be done for each CPE user set, in order to dimension the user set ISDN accesses, and for each population of CPE user sets which could share network resources.

3.2 *Characterization of a CPE user set*

The characterization of a CPE user set can be achieved by the following steps:

– determine the call demand rate, $rt(i)$, for each telecommunication service i, under the reference conditions;

– determine which sets of connection characteristics (i,j) are requested by the CPE user set, for each telecommunication service, i;

– determine the proportion, $px(i,j)$, of each of these sets of connection characteristics;

– derive the rates, $rx(i,j)$, of each set of connection characteristics, by the following formula:

$$rx(i,j) = rt(i) \times px(i,j)$$

– determine the call patterns (i,j,k) used by the CPE user set for each set of connection characteristics (i,j);

– determine the proportion, $pc(i,j,k)$, of each of these call patterns (i,j,k);

– finally, derive the call pattern rates, $rc(i,j,k)$, by the following formula:

$$rc(i,j,k) = rx(i,j) \times pc(i,j,k)$$

3.3 *Characterization of a population of CPE user sets*

The demand of a population of CPE user sets is characterized by the mean value per CPE user set in the population of the rates defined in § 3.2.

A practical procedure to obtain these values is to divide the population of the CPE user sets into CPE user set classes, each class consisting of CPE user sets for whom similar traffic behavior can be expected. This classification can be based on the nature of the users (e.g. residential, small business, etc.) and/or their CPEs.

Once the CPE user set classes have been specified, each class is characterized by its proportion in the population of CPE user sets, and by the variables (proportions and rates) defined in § 3.2.

Finally, the mean value of each rate per CPE user set in the whole population is calculated as the weighted average of its mean value in each class.

An example of this procedure is provided in Annex A.

4 Recommendation history

First published in 1988, entitled "User Demand".

Revised and republished in 1991.

ANNEX A

(to Recommendation E.711)

Example of the characterization of a population of CPE user sets according to their call demands

Table A-1/E.711 shows the break-down of the population into classes of CPE user sets. The telecommunication services used by each class are defined, as well as the corresponding call demand rates.

TABLE A-1/E.711

Examples of classes of CPE user sets and their demand rates for telecommunication services

CPE user set classes	Proportion of the class in the total CPE user set population	Mean number of access unit (B-channels) per CPE	Telecommunication service	Busy hour call demand rate per CPE user set
Residential	22%	2	Telephone Interactive videotex Data	3.5 0.06 0.8
Small business	65%	2	Telephone Interactive videotex Fax Teletex Data	4 0.15 0.08 0.15 4
Medium business	12%	3	Telephone Interactive videotex Fax Teletex Data	22 0.35 1.15 2 20
Large business	1%	92	Telephone Interactive videotex Fax Teletex Data	920 8 18 25 210

For each class of CPE user sets and each telecommunication service, the proportion of each set of connection characteristics and of each call pattern should be determined, in the manner explained in § 3.

Table A-2/E.711 shows the result of the process for one particular class of CPE user sets and one particular telecommunication service of Table A-1/E.711.

TABLE A-2/E.711

Call demands for the telecommunication service "Data" for the class of CPE user sets "Large business"

Call demand rate (per hour)	210		
Sets of connection characteristics	Circuit switched, point-to-point, 64 kbit/s, user information via B-channel (Both originating and terminating calls are included)		Packet switched point-to-point 64 kbit/s, user information via D-channel (Both originating and terminating calls are included)
Proportion	50%		50%
Call demand rate (per hour)	105		105
Call pattern	t_m = 60 s (interactive)	t_m = 1.5 s (file transfer)	t_m = 60 s 20 transactions per call Transaction length = 1000 bits
Proportion	22%	78%	100%
Call demand rate (per hour)	23.1	81.9	105

Note that the number of different sets of connection characteristics and the number of different call patterns to be considered depend on the type of the traffic engineering task. In the example, a traffic engineering task is assumed that requires only a limited number of parameters for the description of the call demand.

It should be noted that this annex gives an illustrative example only. Additional examples related to particular countries and networks can be found in the papers listed in the bibliography.

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