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

Traffic engineering – ISDN traffic engineering

USER DEMAND

Reedition of CCITT Recommendation E.711 published in the Blue Book, Fascicle II.3 (1988)

NOTES

1 CCITT Recommendation E.711 was published in Fascicle II.3 of the *Blue Book*. This file is an extract from the *Blue Book*. While the presentation and layout of the text might be slightly different from the *Blue Book* version, the contents of the file are identical to the *Blue Book* version and copyright conditions remain unchanged (see below).

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

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

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.

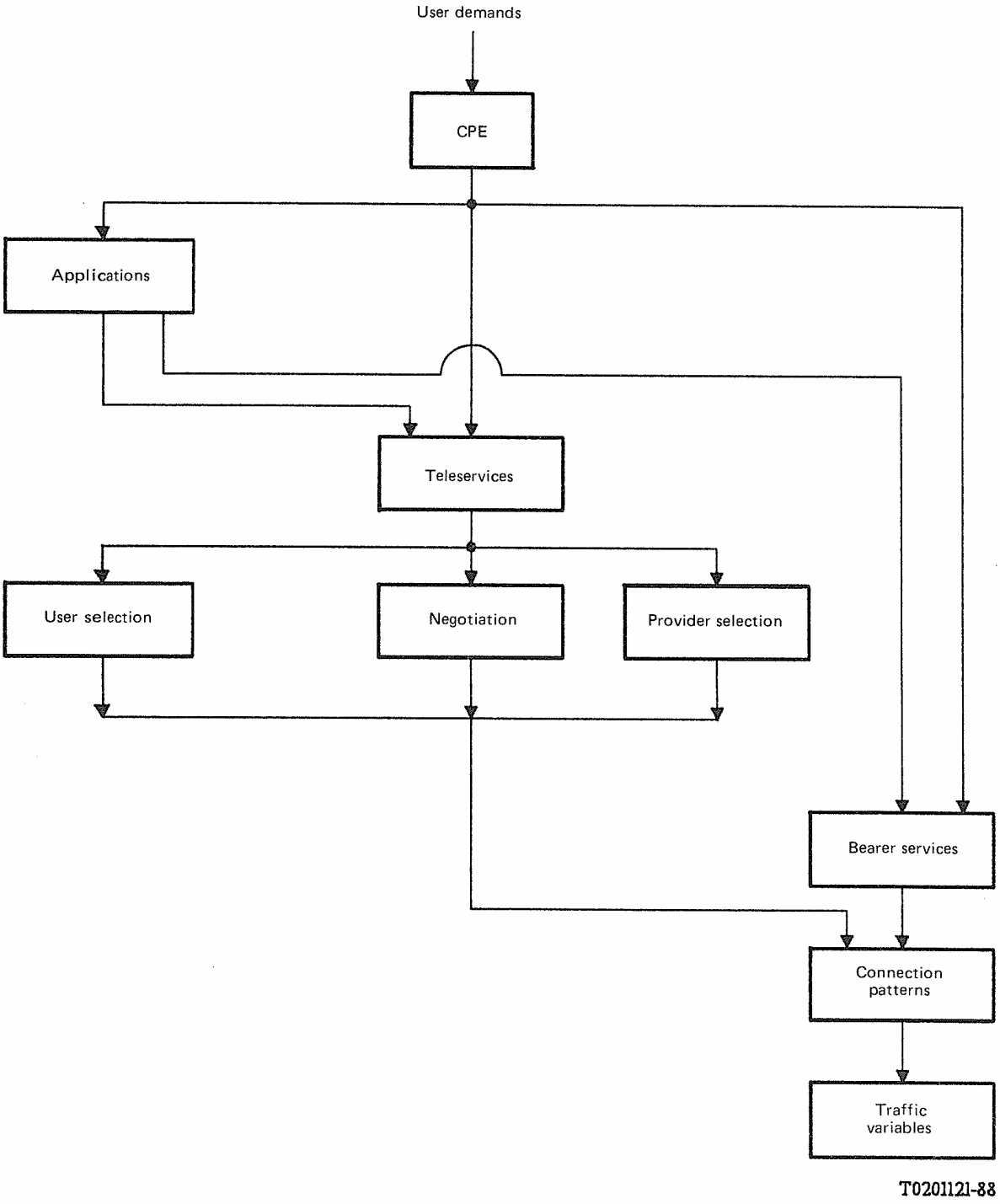
3.2 *Call variables*

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.



CPE Customer premises equipment

FIGURE 1/E.711

Relation between user demands and traffic variables

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.)

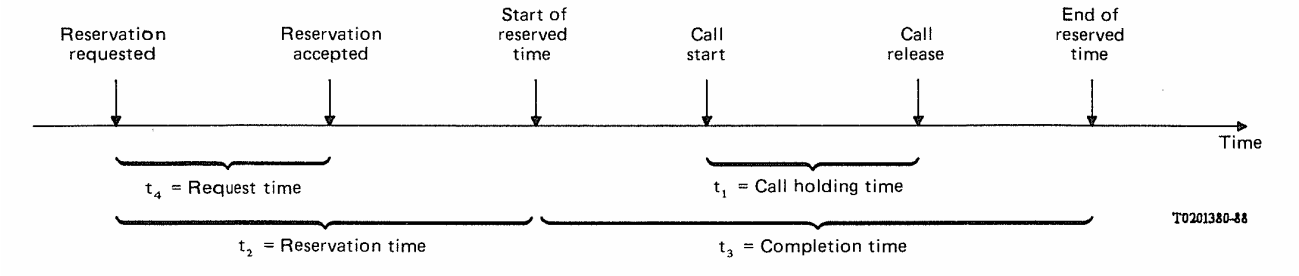


FIGURE 2/E.711

Holding times for reservation services

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.

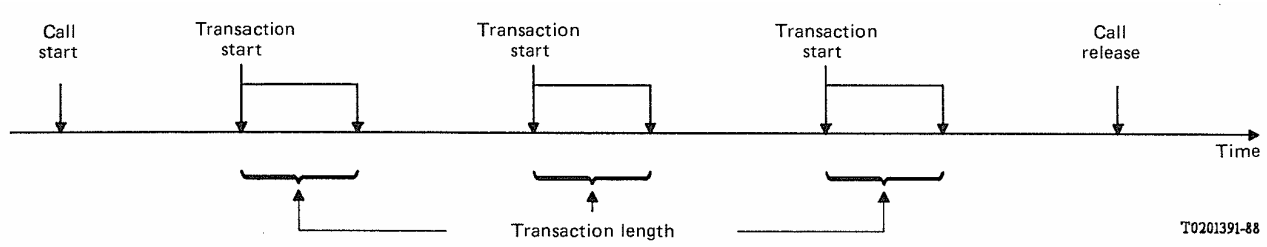
3.3.1 *Arrival process*

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.



Note – Information transfer only occurs during the transactions.

FIGURE 3/E.711

Transactions of a packet-switched service

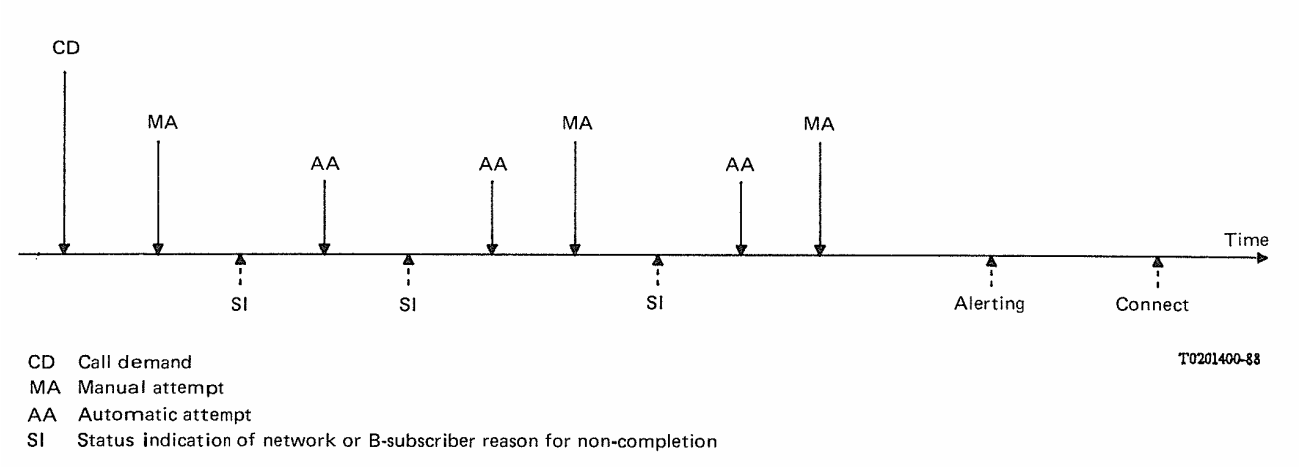
4 Examples

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.

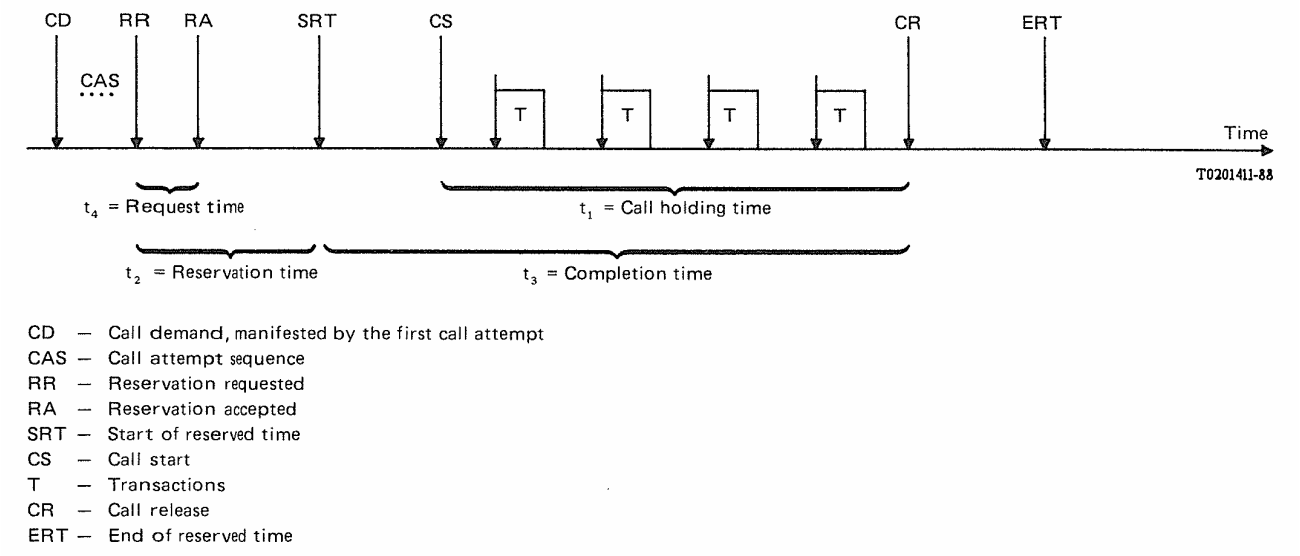
In relating this service to user demand, many additional variables are needed as discussed in § 3. The control and user plane traffics must take into account not only the mean values but also other parameters characterizing the distributions.



CD Call demand
MA Manual attempt
AA Automatic attempt
SI Status indication of network or B-subscriber reason for non-completion

FIGURE 4/E.711

Call attempt sequence



CD – Call demand, manifested by the first call attempt
CAS – Call attempt sequence
RR – Reservation requested
RA – Reservation accepted
SRT – Start of reserved time
CS – Call start
T – Transactions
CR – Call release
ERT – End of reserved time

FIGURE 5/E.711

General call pattern

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.

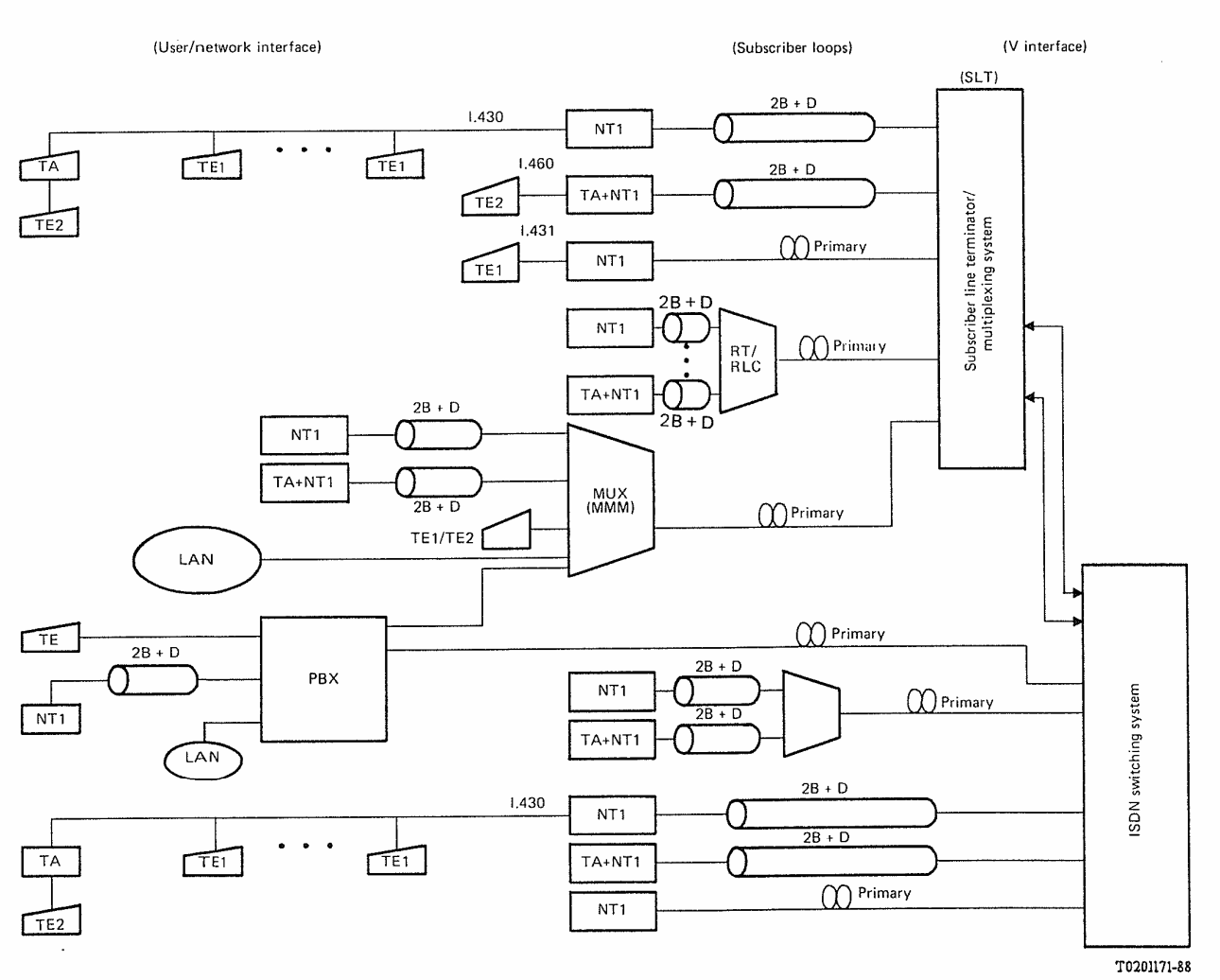
A.4 *Teleservices*

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.



Note – The equipments and channels shown in this diagram are defined in Recommendations I.411 and I.412.

FIGURE A-1/E.711

Example of ISDN user accesses

TABLE A-1/E.711

Examples of teleservices and their attributes

	Information transfer mode										
	Circuit mode[a]										
	Information transfer rate (kbit/s)	Information transfer capability		Establishment of communication		Symmetry			Communication configuration		
		Unrestriction digital	Speech	Demand	Reserved	Unidirectional	Bidirectional		Point-to-point	Multipoint	Broadcast
							Symmetric	Asymmetric			
Telephony	64 (max.)		×	×			×		×	×	
Teletex	64 (max.)	×[b]		×		×			×	×	
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.

TABLE A-2/E.711

Bearer services

Circuit mode (Recommendation 1.231)
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

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.* These 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 1.210, 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-I/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.

TABLE B-1/E.711

Demands for teleservice classes

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

TABLE B-2/E.711

Demand for individual teleservices

Teleservice class	General attribute combinations							
	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.

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.

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.

TABLE B-4/E.711

Breakdown of the call pattern on the connection patterns

Call pattern	Connexion pattern											
	Packet mode								Circuit mode (B-channel)			
	On D-channel				On B-channel							
	1	· · ·	i	· · ·	1	· · ·	j	· · ·	1	· · ·	k	· · ·
CP1												
· · ·												
CPn												
Total												

Note 1 – Table entries are the proportions of the nth 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.

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

TABLE B-5/E.711

Rate of the call demands requiring a specific connection pattern.

Connexion patterns	Rate
XP1	
XP2	
. . .	
XPn	
Total	

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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.

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