INTERNATIONAL TELECOMMUNICATION UNION

CCITT E.502 (rev.1)

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

TELEPHONE NETWORK AND ISDN

QUALITY OF SERVICE, NETWORK MANAGEMENT AND TRAFFIC ENGINEERING

TRAFFIC MEASUREMENT REQUIREMENTS FOR DIGITAL TELECOMMUNICATION EXCHANGES

Recommendation E.502 (rev.1)

Geneva, 1992

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

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.502

TRAFFIC MEASUREMENT REQUIREMENTS FOR DIGITAL TELECOMMUNICATION EXCHANGES

(*revised 1992*)

1 Introduction

This Recommendation applies to all digital telecommunications exchanges operating in a switched telephone network and ISDN.

Traffic measurements on exchanges and surrounding network provide the data base from which the dimensioning, planning, operation and management of the network are carried out.

Information gathered from these measurements can be used for:

– identifying traffic patterns and distributions on a route and destination basis;

– determining the amount of traffic in the exchange and the network;

– monitoring the continuity of service and the grade of service.

The above data and information are gathered with the purpose of supporting the following fundamental activities:

a) dimensioning, planning and administration of the exchange and surrounding network;

b) performance monitoring of the exchange and surrounding network;

c) network management;

d) operation and maintenance of the exchange and surrounding network;

e) tariff and marketing studies;

f) forecasting;

The information generated by the exchange (see Recommendation Q.544) can be provided to the end user in either real-time or non real-time (post processed). The activities being performed by the end user will dictate the speed of this response: for example, operation and maintenance will require real-time information while the forecasting and planning information can be provided after the event in non real-time.

For these activities, the following major processing steps can be identified:

– generation, collection and storage of data;

– analysis and processing of data;

– presentation and use of the analysis results.

The generation, collection and output of raw data is achieved by continuous as well as periodic and non-periodic measurements carried out in the exchange.

The data analysis may be performed by the exchange itself or by another system depending on the following:

– total amount of data;

– need for analysis of data from multiple exchange;

– processor load constraints.

For further information see Recommendation E.503.

2 Traffic measurement

2.1 *Traffic measurement model*

This section establishes the basic structure for a traffic measurement model that can be applied to measurements of traffic generated by the telephony service and ISDN.

A measurement is identified by three basic elements: time, entities, objects. Time includes all the necessary information to define the start, the duration and periodicity of a certain measurement. Entities describe the quantities for which data collection must be performed with a certain measurement. Objects are individual items on which the measurements are performed. Some examples of entities and objects are given below:

Entities:

– traffic volume;

– number of call attempts;

– number of seizures;

– number of successful call attempts;

– number of call attempts for which a delay exceeds a predetermined threshold value.

Objects:

– subscriber line groups;

– circuit groups;

– common control units;

– auxiliary devices;

– destinations;

– common channel signalling links;

– signal transfer points (STP);

– common channel signalling points;

– common channel user/application part.

The measurements are classified into different measurement types on the basis of a measurement matrix in which each row represents an entity and each column represents an object (see Figure 1/E.502).

A measurement type is a particular combination of entities and objects corresponding to certain entries in the measurement matrix. Part of these measurement types may be standardized while the rest of them seem to be system- and/or Administration-dependent. It should be noted that all the entries in the measurement matrix cannot be used because some of them will be impossible and some others may be meaningless. In all measurement types, the entities are fixed although some entities may not be measured for some applications. Selected objects form an object list. In some measurement types, the object list is fixed. In other types one can choose for the actual measurement some or all of the allowed objects. A measurement set is a collection of measurement types.

2.2 *Traffic measurement structure*

A traffic measurement consists of:

– measurement set information;

– time information;

– output routing and scheduling information (output parameters).

Measurement set information, time information and output routing and scheduling information may be predefined as well as object lists. It should be noted that predefinition characteristic are system-dependent. Time data routing and the schedule may be fixed.

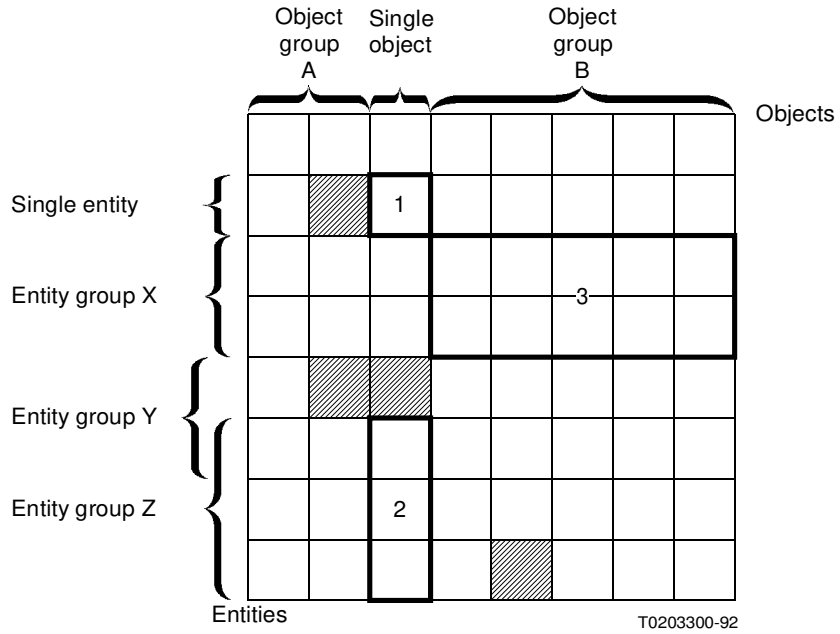

FIGURE 1/E.502
Measurement matrix

2.2.1 *Measurement set information*

Measurement set information consists of one or several selected measurement types with defined object (object lists) and measurement-type-dependent parameters (e.g. sampling interval, number of events in a certain category, destination codes, etc.).

2.2.2 *Time information*

Measurements may have an undetermined duration (stop date is not prespecified), or a predetermined duration, or be taken all the time. In addition, measurements may be performed continuously or on a non-continuous basis.

For measurements of undetermined duration and performed non-continuously, the recording days must be determined on a periodic basis (periodicity pattern within a calendar week). For measurements of predetermined duration, the recording days may be determined on a periodic basis or by defining the dates of the recording days (see Figure 2/E.502).

As shown in Figure 3/E.502, time data are measurement level, recording day level and recording period level.

Measurement level: Contains information about dates of recording days for non-periodic measurements or periodicity pattern for periodic measurements.

Recording day level: Contains information about the start and stop time for recording periods within a recording day.

Recording period level: Contains information about the periodicity of the data collection, controlled by the result accumulation period. The result accumulation period can be shorter than the recording period; in that case, more than one set of data is collected for each of the recording periods, to be routed toward the output media according to the results output schedule.

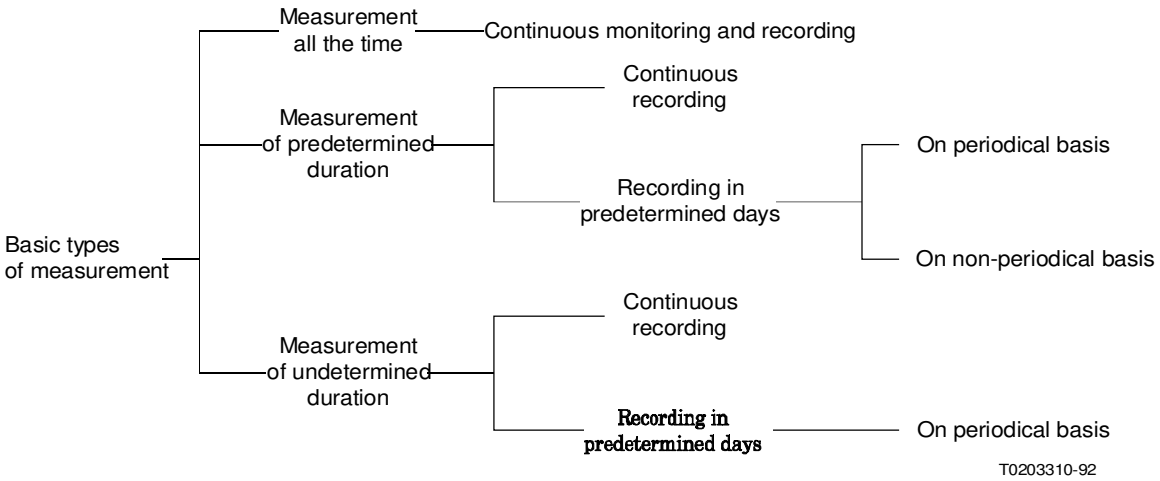

FIGURE 2/E.502

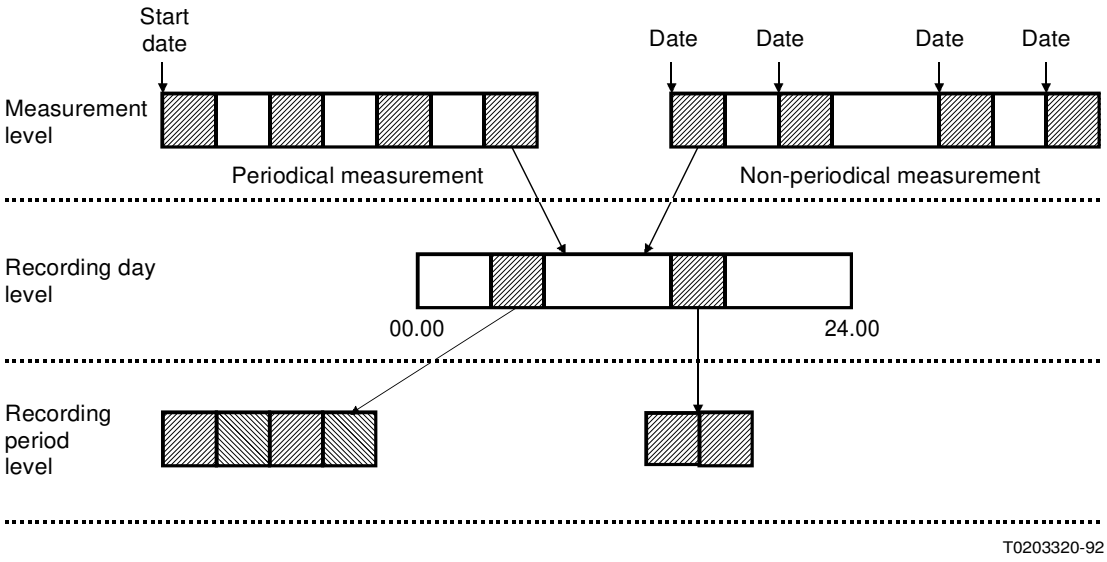

FIGURE 3/E.502

2.2.3 *Output routing and scheduling information*

Output routing information defines to what destination the produced measurement results should be routed for the recording; the output routing may be toward either a physical medium (e.g. printer) or a logical medium (e.g. file).

Output scheduling information defines when (days and time) the output of the results is to be made. The output of results may be related to the end of the result accumulation period.

3 Traffic flows

Each type of traffic flow occurring in/through the exchange can be distinguished by association with an inlet[1] or outlet[2] of the exchange, or both. The different types of traffic flow for a generalized exchange, viz. one that combines both local and transit functions and that provides operator (telephonist) service, are illustrated as shown in Figure 4/E.502.

From Figure 4/E.502 the following relations apply:

$$A = E + F + G + H + Z_1$$

$$B = I + J + K + L + Z_2$$

$$C = O + P$$

$$D = M + N + Z_3$$

where Z_1, Z_2 and Z_3 account for traffic flows corresponding to calls with incomplete or invalid dialling information, and

$$Q = M + F + K + O - d_1$$

$$R = N + G + L + P - d_2$$

$$S = H + J - d_3$$

$$T = E + I - d_4$$

where d_1, d_2, d_3 and d_4 account for traffic flows corresponding to calls that fail within the exchange owing to any of the following reasons:

a) all suitable outlets are busy or unavailable;

b) internal congestion;

c) incomplete dialling;

d) invalid destination code;

e) service barring/blocking (as a result of network management controls, for instance, or the operation of some supplementary service (e.g. absentee service), or because the calling/called party is disallowed such service).

The types of calls, viz. *system-originating* call and *system-terminating* calls, result from the operation of some of the supplementary services that exchanges offer in addition to conventional telephone service. In the traffic flow diagram of Figure 4/E.502, system-originating and system-terminating calls are identified by the aggregate traffic flows *C* and *S* respectively.

4 Basic measurement types

4.1 *General*

4.1.1 Depending on the activities listed in § 1, a different degree of detail may be needed.

In order to provide bulk data for each of the above-mentioned traffic categories, overall measurements can be performed on the totality of subscriber lines and/or circuits.

Such overall measurements have been taken into account in this Recommendation only for the traffic items from *A* to *P* in Figure 4/E.502, while they have not been considered for items *Q*, *R*, *S* and *T* since, with the assumptions made above, it is possible to achieve the relevant information by taking into account the relationship

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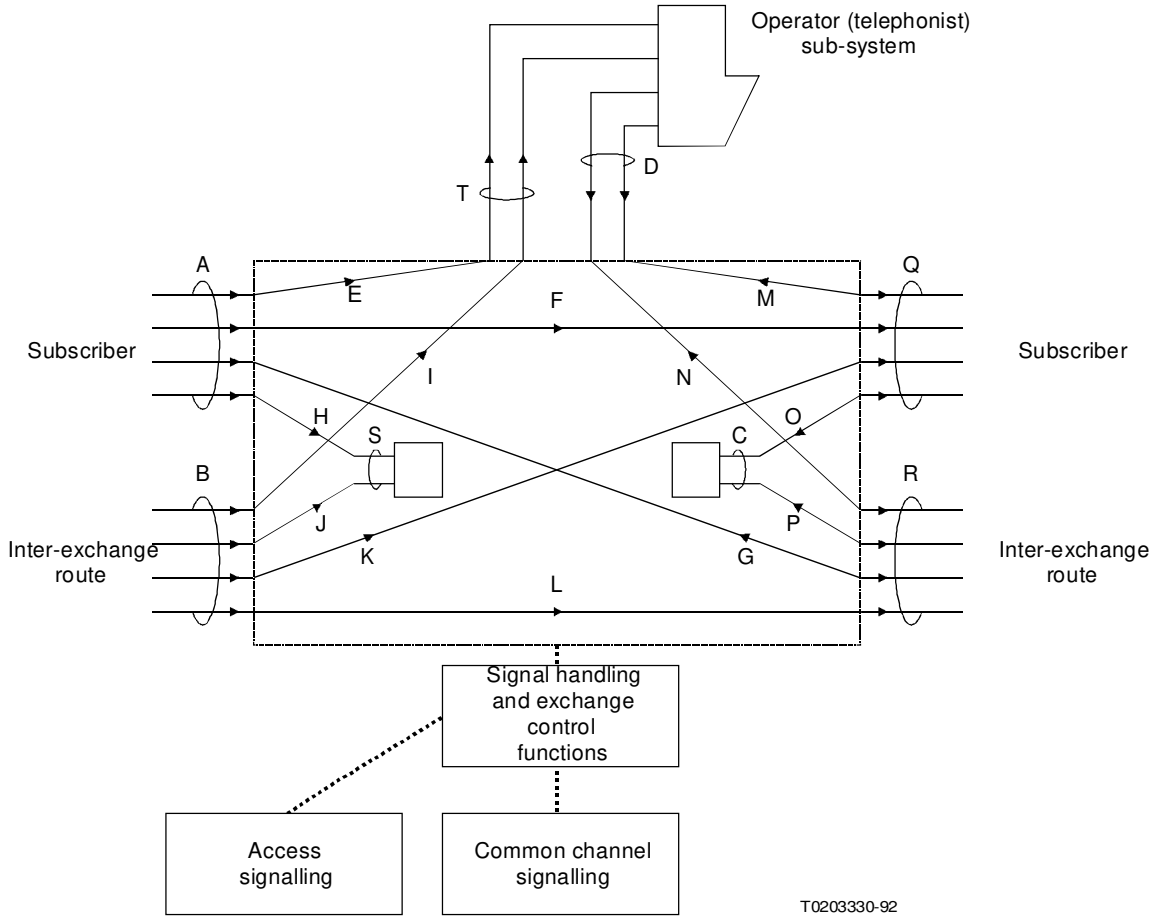
1) Inlet is the point on or within the boundary of the exchange system where a call attempt arrives or arises.

2) Outlet is the point on or within the boundary of the exchange system to which a call attempt bearing adequate and valid dialling information would tend to be routed.

between these items and the measured ones. It is recognized that the overall measurement results might be partitioned to cover various Administrations' needs. As an example, in an international transit exchange, the traffic data measured on the totality of incoming circuits should be split into data measured on national incoming circuits and international incoming circuits, and these, in turn, could be differentiated according to the relevant country.



A Originating traffic
B Incoming traffic
Q Terminating traffic
R Outgoing traffic
F Internal traffic
G Originating outgoing traffic
H Originating system terminating traffic
J Incoming system terminating traffic
K Incoming terminating traffic
L Transit traffic

O System originating terminating traffic
P System originating outgoing traffic
S System terminating traffic
C System originating traffic
T Operator terminating traffic
D Operator originating traffic
E Originating operator terminating traffic
I Incoming operator terminating traffic
M Operator originating terminating traffic
N Operator originating outgoing traffic

FIGURE 4/E.502
Main traffic flow diagram

More detailed information on traffic data relevant to the exchange and surrounding network performance can be provided by means of measurements on selected sets of circuit groups, subscriber line groups, auxiliary and control units.

Very detailed traffic data can be obtained by the analysis of call records.

These call records should be produced by the exchange, containing all data (e.g. time of occurrence of signalling event, dialled digits, etc.) characterizing each individual call attempt.

The basic measurement types are given in § 4.2 below.

Their applicability will depend on the function of the exchange (local, transit, international, etc.).

Manufacturers and Administrations are to note that the list of basic measurement types is derived from the traffic model given in Figure 4/E.502. It is not intended that every exchange system should contain all the different measurement types. The measurement types are exchange- and system-dependent, and are intended as a guide to the type of measurements required to fulfil various functions. Measurement types may be combined into a few sets to enable requirements to be met for specific exchange types, e.g. local. In particular Administrations may consider that by the use of a few measurement types it is possible to satisfy the majority of their requirements.

No single measurement type can be assumed to be exclusive to a single user or to satisfy a single requirement. More than one user may require the same information presented in different ways at the same time. As an example, measurement type 21 is required for both network management and traffic engineering purposes.

4.1.2 *Network management considerations*

4.1.2.1 Information on network management is contained in the E.410-Series Recommendations. Network management requires "real-time" monitoring and measurement of network status and performance and the ability to take prompt action to control the flow of traffic when necessary.

4.1.2.2 *Performance reports*

Performance reports can be provided by the exchange and/or its network management operations system (OS) in the following ways, as required by the Administration:

i) automatic data – this data is provided automatically as specified in the exchange or OS program;

ii) scheduled data – this data is provided according to a schedule established by the network manager;

iii) demand data – this data is provided only in response to a specific request by the network manager. In addition to performance data, demand data includes reference data, such as the number of circuits provided or available for service, routing information, assigned threshold values, numbers of installed switching system components, etc.;

iv) exception data – this data is provided when a data count for calculation exceeds a threshold established by the network manager.

Data reports can be provided for example on a 5-minute, 15-minute or 30-minute basis. The specific interval for any data report will be determined by the network manager. Historic data relating to the previous two or three periods (5, 15 or 30-minute) must also be available.

Data report for certain events of critical significance to network operations may be provided upon occurrence.

4.1.2.3 In order to obtain information and apply controls which may be instrumental in reducing exchange congestion, Administration should ensure that network management terminals and functions should have the highest possible priority, so that network management operations can continue uninterrupted.

4.1.2.4 Information as to which network management controls, detailed in Recommendation E.412, are currently activated and whether the controls were activated by manual or automatic means should be available to all necessary points (for example, the network management centre, exchange staff).

4.1.3 *Traffic engineering*

Information on measurements for planning purposes is given in Recommendation E.500. For further details about requirements on measurement lengths over the year and the day, data reporting intervals, etc., reference should be made to that Recommendation.

4.2 *Measurements*

In this section measurement types 1 to 22 relate to the telephone network while measurement types starting with 23 relate to ISDN.

4.2.1 *Overall measurements*

Type 1: Overall measurements on originating traffic (*A*).

Object: Totality of subscriber lines.

Entities:

a) number of originating seizures;

b) number of call attempts not routed due to:

   i) no dialling (including permanent signal),

   ii) incomplete dialling[3)],

   iii) invalid address;

c) number of call attempts lost due to internal congestion[4)].

Type 2: Overall measurements on internal traffic (*E* + *F* + *H*)[5)].

Object: Totality of subscriber lines.

Entities:

a) number of internal seizures;

b) number of call attempts lost due to internal congestion;

c) number of call attempts:

   i) with called-party busy,

   ii) with called-party free/no answer[6)],

   iii) answered;

   iv) line out of order,

   v) vacant national number,

   vi) transferred subscriber;

d) number of unsuccessful call attempts due to incomplete dialling[5)].

Type 3: Overall measurements on originating outgoing traffic (*G*).

Object: Totality of subscriber lines.

Entities:

a) number of outgoing seizures;

b) number of call attempts lost due to internal congestion;

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3) Not enough digits to discriminate if internal or outgoing call.

4) When possible, broken down by reason of congestion, e.g. c-1, blocking through the switching network, c-2, unavailability of common resources, c-3, system faults.

5) Entities may be broken down according to relevant traffic flows.

6) Expiring of time-outs calling-party's abandon.

c) number of call attempts in overflow on the last choice route;

d) number of successful call attempts getting:

   i) no answer[7)],

   ii) answer or metering pulse(s);

e) number of unsuccessful call attempts due to incomplete dialling[8)].

Type 4: Overall measurements on incoming traffic (*B*).

Object: Totality of incoming circuits and both-way circuits.

Entities:

a) number of incoming seizures;

b) number of call attempts not routed due to:

   i) incomplete dialling[8)],

   ii) invalid address;

c) number of call attempts lost due to internal congestion.

Type 5: Overall measurements on incoming terminating traffic (*I* + *J* + *K*)[9)].

Object: Totality of incoming circuits and both-way circuits.

Entities:

a) number of incoming terminating seizures;

b) number of call attempts lost due to internal congestion;

c) number of successful call attempts:

   i) with called-party busy,

   ii) with called-party free/not answered,

   iii) answered or metering pulse(s);

d) number of unsuccessful call attempts due to incomplete dialling.

Type 6: Overall measurements on transit traffic (*L*).

Object: Totality of incoming circuits and both-way circuits.

Entities:

a) number of incoming transit seizures;

b) number of call attempts lost due to internal congestion;

c) number of call attempts in overflow on the last-choice route;

d) number of successful call attempts obtaining:

   i) no answer[10)].

   ii) no answer or metering pulse(s);

e) number of unsuccessful call attempts due to incomplete dialling[8)].

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7) Due to time-out expiring or calling-party's abandon or called-party busy.

8) Not enough digits to discriminate if internal or outgoing call.

9) Entities may be broken down according to relevant traffic flows.

10) Expiring of time-out or receiving a release forward.

Type 7: Overall measurements on system originating traffic ($O + P$)[11].

Object: Exchange system.

Entities:

a) number of system originating seizures;

b) number of call attempts lost due to internal congestion;

c) number of successful call attempts:

   i) with called party busy or no free outlet,

   ii) with called party free/not answered (for O),

   iii) answered.

Type 8: Overall measurements on operator-originating traffic ($M + N$)[11].

Object: Totality of operator board trunks.

Entities:

a) number of operator originating seizures;

b) number of unsuccessful call attempts due to:

   i) incomplete dialling,

   ii) invalid address,

   iii) internal congestion;

c) number of successful call attempts:

   i) with called party busy or no free outlet,

   ii) with called party free/not answered (for M),

   iii) answered.

4.2.2 *Measurement on selectable objects*

Type 9: Incoming traffic measurements.

Object: Each incoming circuit group and both-way circuit group.

Entities:

a) number of incoming seizures;

b) traffic volume;

c) number of call attempts lost due to internal congestion[12];

d) number of circuits in service;

e) number of circuits out of service.

Type 10: Outgoing traffic measurements.

Object: Each outgoing circuit group and both-way circuit group.

Entities:

a) number of outgoing seizures;

b) traffic volume;

c) number of call attempts in overflow;

d) number of call attempts blocked by trunk reservation;

e) number of seizures obtaining answer;

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[11] Entities may be broken down according to relevant traffic flows.

[12] When possible, broken down by reason of congestion, e.g. c-1, blocking through the switching network, c-2, unavailability of common resources, c-3, system faults.

f) number of circuits in service;

g) number of circuits out of service;

h) number of dual seizures (both-way circuits only).

Type 11: Route destination traffic measurements.

Object: For destinations on each outgoing circuit group and both-way circuit group.

Entities:

a) number of outgoing seizures;

b) number of effective call attempts;

c) traffic volume;

d) number of call attempts, lost due to congestion on the circuit group;

e) number of call attempts blocked by trunk reservation;

f) source (identity of incoming circuit group) if available.

Type 12: Measurements on subscriber line groups.

Object: Set of lines composing a functional unit.

Entities:

a) originating traffic volume;

b) terminating traffic volume;

c) number of originating seizures;

d) number of terminating seizures;

e) number of terminating call attempts.

Type 13: Measurements on auxiliary units[13)].

Object: Selected groups of auxiliary units.

Entities:

a) number of seizures;

b) traffic volume;

c) numbers of non-serviced call attempts;

d) number of units in service;

e) number of units out of service.

4.2.3 *Measurements on control unit(s)*

Type 14: Measurements on control unit(s).

Object: Control unit(s).

These measurements are highly system-dependent and therefore no specific recommendations on relevant entities can be made. However, it is essential that systems have provisions for determining the utilization of control units as required for dimensioning, planning, and grade of service monitoring of the exchange.

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13) By auxiliary units it is meant multifrequency code (MFC) receivers, tone circuits, etc.

4.2.4 *Measurements on call records*[14)]

Type 15: Traffic dispersion and duration.

Object: Originating (by subscriber, exchange system, operator) and/or incoming seizures ($A + B + C + D$).

Entities:

a) source or inlet (local subscriber, exchange system or incoming/both-way circuit group);

b) time of seizure of inlet;

c) dialled digits;

d) service characteristic of call attempt[15)] for successful call attempt;

e) identity of exchange outlet;

f) time of seizure of outlet;

g) time of occurrence of call attempt at exchange outlet;

h) time of address-complete signal (if available);

i) time of answer signal;

j) time of release of outlet;

k) time of release of inlet.

Type 16: Quality-of-service assessment.

Object: Originating (by subscriber, exchange system, operator) and/or incoming seizures ($A + B + C + D$).

Entities:

a) source or inlet (local subscriber, exchange system or incoming/both-way inter-office circuit group);

b) time of seizures of inlet;

c) dialled digits.

For unsuccessful call attempt, specify causes of failure:

d) no dialling;

e) incomplete dialling;

f) invalid address;

g) no free outlet;

h) internal congestion;

i) due to network management action.

For successful call attempt:

j) order of routing choice (first, second, . . ., last) (when considering the automatic repeated attempts and/or rerouting);

k) time of address-complete signal (undifferentiated subscriber free, subscriber busy, backward congestion) (if available);

l) result of call attempt (answer, release due to abandon, release due to congestion).

[14)] The collection of the totality of call attempts could cause an excessive load for the system resources, therefore such measurements might be performed on a sampling basis.

[15)] Whether the call attempt uses or seeks to use any of the supplementary facilities of the exchange; if so, the supplementary facility concerned shall be specifically indicated.

4.2.5 *Delay grade-of-service (GOS) monitoring*

Measuring delays on a per call basis could produce severe cost penalties to the exchange. Since the accuracy requirements from the statistical viewpoint are not very high, call sampling procedures or test calls are normally sufficient for GOS monitoring purposes.

4.2.5.1 *On a per exchange basis*

Type 17: Overall originating delay grade-of-service parameters monitoring.

Object: Totality of subscriber lines.

Entities:

a) total number of originating seizures;

b) total number of originating seizures for which the required information for setting up a through connection is available for processing in the exchange;

c) total number of originating seizures for which sufficient address information has been received, which are addressed to a certain outgoing circuit group and for which the seizing signal or the corresponding address information is sent to the subsequent exchange;

d) total number of originating seizures for which the dial tone delay exceeds a predetermined threshold value;

e) seizures already counted in b) for which the through-connection delay exceeds a predetermined threshold value;

f) seizures already counted in c) for which the call set-up delay exceeds a predetermined threshold value.

Type 18: Overall incoming delay grade-of-service parameters monitoring.

Object: Totality of incoming or both-way circuit groups.

Entities:

a) total number of incoming seizures;

b) total number of incoming seizures for which the required information for setting up a through connection is available for processing in the exchange for a certain circuit group;

c) total number of incoming seizures for which sufficient address information has been received, which are addressed to a certain outgoing circuit group and for which the seizing signal or the corresponding address information is sent to the subsequent exchange;

d) total number of incoming seizures for which the incoming response delay exceeds a predetermined threshold value;

e) seizures already counted in b) for which the through-connection delay exceeds a predetermined threshold value;

f) seizures already counted in c) for which the call set-up delay exceeds a predetermined threshold value.

4.2.5.2 *On per circuit group basis*

Type 19: Delay grade-of-service parameters monitoring.

Object: Each incoming or both-way circuit group.

Entities:

a) total number of incoming seizures;

b) total number of incoming seizures for which the required information for setting up a through connection is available for processing in the exchange for a certain circuit group;

c) total number of incoming seizures for which sufficient address information has been received, which are addressed to a certain outgoing circuit group and for which the seizing signal or the corresponding address information is sent to the subsequent exchange;

d) total number of incoming seizures for which the incoming response delay exceeds a predetermined threshold value;

e) seizures already counted in b) for which the through-connection delay exceeds a predetermined threshold value;

f) seizures already counted in c) for which the call set-up delay exceeds a predetermined threshold value.

4.2.6 *Network performance monitoring*[16)]

Type 20: Exchange performance monitoring.

Object: Total exchange and its major components, e.g. processor.

Entities:

a) bids;

b) incoming call queue length and overflows;

c) number and percentage of bids encountering switching delays;

d) percentage of processor capacity available or in use;

e) cross exchange delay measurements;

f) switching loss;

g) counts of calls blocked by automatic load shedding actions.

Type 21: Circuit group performance monitoring.

Object: Each circuit group.

Entities:

a) bids;

b) seizures - outgoing and incoming;

c) answer signals received;

d) overflows;

e) traffic carried;

f) number of circuits made busy to traffic;

g) transit bids;

h) incoming transit seizures;

i) counts of calls affected by network management control, by type of control.

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16) Network performance monitoring measurements can be used for a number of operational functions such as network management, Quality of Service assessment, etc.

Type 22: Destination performance monitoring.

Object: Destinations.

Entities:

a) bids;

b) seizures;

c) answer signals received;

d) overflows;

e) counts of calls affected by network management controls, by type of control (*Note* – This includes code block and call gap controls).

4.2.7 *Measurement of the ISDN and its services*

4.2.7.1 *Overall measurements*

Type 23: Measurement of overall originating traffic (*A*).

Object: Totality of ISDN subscriber lines (overall).

Entities:

a) number of originating call attempts;

b) originating traffic volume;

c) number of originating call attempts not routed due to:

   i) incomplete dialling,

   ii) invalid address,

   iii) Administration actions,

   iv) exchange faults,

   v) lack of exchange resources;

d) number of internal call attempts (*F*);

e) number of originating outgoing call attempts (*G*);

f) number of originating system terminating call attempts (*H*).

Type 24: Measurement of overall incoming terminating traffic (*I*, *J*, *K*).

Object: Totality of incoming and both-way ISDN circuits (overall).

Entities:

a) number of incoming terminating call attempts;

b) incoming terminating traffic volume;

c) number of incoming terminating call attempts not routed due to:

   i) invalid address,

   ii) Administration actions,

   iii) exchange faults,

   iv) lack of exchange resources;

d) number of incoming system terminating call attempts (*J*);

e) number of incoming calls not answered (*I*, *K*);

f) number of incoming calls with called party busy (*I*, *K*);

g) number of incoming call attempts to subscribers (*K*).

Type 25: Measurement of incoming transit traffic (*L*).

Object: Totality of incoming and both-way ISDN circuits (overall).

Entities:

a) number of transit call attempts;

b) transit traffic volume;

c) number of transit call attempts not routed due to:

   i) invalid address,

   ii) Administration actions,

   iii) exchange faults,

   iv) lack of exchange resources.

4.2.7.2 *Measurements on selectable objects*

Type 26: Measurement of basic rate access.

Object: Each ISDN basic rate access (selectable).

Entities:

a) number of originating call attempts;

b) number of originating call attempts – answered;

c) originating traffic volume;

d) number of terminating call attempts;

e) number of terminating call attempts – answered;

f) terminating traffic volume;

g) number of terminating calls reaching busy condition.

Type 27: Measurement of primary rate access.

Object: Each ISDN primary rate access (selectable).

Entities:

a) number of originating call attempts;

b) number of originating call attempts – answered;

c) originating traffic volume;

d) number of terminating call attempts;

e) number of terminating call attempts – answered;

f) terminating traffic volume;

g) number of terminating calls reaching busy condition.

Type 28: Measurement of multi-line hunt group.

Object: Each ISDN multi-line hunt group (selectable).

Entities:

a) number of originating call attempts;

b) number of originating call attempts – answered;

c) originating traffic volume;

d) number of terminating call attempts;

e) number of terminating call attempts – answered;

f) terminating traffic volume;

g) number of terminating call overflows;

h) number of calls originating and terminating in the same multi-line hunt group (MLHG).

Type 29: Measurement of closed user groups.

Object: Each ISDN closed user group (selectable).

Entities:

a) number of originating call attempts within the closed user group;

b) number of originating ordinary call attempts;

c) number of rejected originating call attempts (not allowed);

d) number of terminating ordinary call attempts;

e) number of rejected terminating call attempts (not allowed).

4.2.7.3 *Measurements on ISDN services*

Type 30: Measurement of circuit-switched bearer services.

Object: Each ISDN circuit-switched bearer service type (selectable).

Entities:

a) number of call attempts;

b) number of answered calls;

c) traffic volume.

Type 31: Measurement of teleservices.

Object: Each ISDN teleservice type (selectable).

Entities:

a) number of call attempts;

b) number of answered calls;

c) traffic volume.

Type 32: Measurement of supplementary services.

Object: Each ISDN supplementary service (selectable).

Entities:

a) number of invocation attempts;

b) number of successful invocations.

Note – An invocation attempt includes those that are made automatically after the customer has subscribed to the supplementary service, and those that are invoked by the customer on a per call basis. Additional measurements specific to each supplementary service are for further study.

Type 33: Measurement of packet-mode services.

Object: Each ISDN packet handler (selectable).

Entities:

a) number of call attempts;

b) number of blocked call attempts;

c) number of packets handled.

Type 34: Measurement of circuit group/bearer service traffic.

Object: Each ISDN circuit-switched bearer service on each incoming, outgoing and both-way ISDN circuit group (selectable).

Entities:

a) number of call attempts;

b) number of answered calls;

c) traffic volume;

d) number of lost attempts due to circuit congestion (outgoing and both-way only).

Type 35: ISDN user-to-user signalling (during call set-up).

Object: Each basic or primary rate access (selectable).

Entities:

a) number of originating user-to-user information elements presented to the network;

b) number of unsuccessful originating length checks;

c) number of unsuccessful originating user subscription checks;

d) number of terminating user-to-user information elements presented to the user from the network;

e) number of unsuccessful terminating user subscription checks.

Type 36: ISDN user-to-user signalling (during active call).

Object: Each basic or primary rate access (selectable).

Entities:

a) number of originating user-to-user information elements presented to the network;

b) number of times that the originating congestion control is exceeded;

c) number of unsuccessful originating length checks;

d) number of unsuccessful originating user subscription checks;

e) number of terminating user-to-user information elements presented to the user from the network;

f) number of unsuccessful terminating user subscription checks.

4.2.7.4 *Measurements on control unit*

Type 37: Measurement of exchange control and service units.

Object: Each ISDN exchange control and service unit (selectable).

These measurements are highly system-dependent, and can include such things as ISDN subscriber line units, packet handlers, packet interfaces, etc. Therefore, no specific measurement recommendation can be made. However, it is essential that the exchange have provisions for traffic measurements for these control and service units as required for dimensioning, planning and grade-of-service monitoring purposes.

4.2.7.5 *Delay grade-of-service (GOS) monitoring*

Measuring delays on a per call basis could produce severe cost penalties to the exchange. Since the accuracy requirements from the statistical viewpoint are not very high, call sampling procedures or test calls are normally sufficient for GOS monitoring purposes.

Type 38: Overall originating call set-up delay GOS (*F*, *G*).

Object: Totality of basic and primary rate ISDN access.

Entities:

a) number of Q.931 set-up messages received;

b) number of Q.931 set-up messages for which the set-up delay has exceeded a delay threshold;

c) time that the Q.931 set-up message has been received by the exchange;

d) time that the Q.931 set-up message has been sent by the exchange to the called user (*F*), or, time that the initial address message has been sent to the subsequent exchange (*G*).

Type 39: Overall incoming call set-up delay GOS (*K*, *L*).

Object: Totality of both-way, and one way incoming ISDN circuit groups.

Entities:

a) number of initial address messages received;

b) number of initial address messages for which the set-up delay has exceeded a delay threshold;

c) time that the initial address message has been received by the exchange;

d) time that the Q.931 set-up message has been sent by the exchange to the called user (*K*), or, time that the initial address message has been sent to the subsequent exchange (*L*).

4.2.8 *Measurements for B-ISDN*

For further study.

4.2.9 *Measurements for intelligent network node (IN) and universal personal telecommunication*

For further study.

5 Related Recommendations

The use of the analysed results will be dependent on the procedures in each Administration. The list of Recommendations below are those currently existing and covering many operational aspects. They are offered only as a guide rather than a comprehensive and complete set.

– Recommendation E.500 defines the traffic intensity measurement principles;

– Recommendation E.175 defines the network model for planning purposes;

– E.410-Series Recommendations provide information for network management;

– E.420-Series Recommendations describe checking the quality of the international telephone service;

– Recommendation E.506 defines the forecasting methods for international traffic;

– Recommendation E.543 defines the grade of service in digital international telephone exchanges;

– Recommendation E.503 defines the traffic measurement data analysis;

– Recommendation E.504 defines the traffic measurement administration;

– Recommendation E.505 defines the traffic measurements for common channel signalling network;

– Recommendation E.491 defines the traffic measurements by destination;

– the O-Series Recommendations outline specifications of measuring equipment;

– the M-Series Recommendations detail many maintenance aspects of international carrier and circuits;

– the Q-Series Recommendations cover all aspects relating to common channel signalling.

– Recommendation Q.544 deals with exchange measurements.

ANNEX A

(to Recommendation E.502)

The purpose of this Annex is to identify the measurements to be made at exchanges and the criteria needed to satisfy the basic measurement requirements, and is produced to assist the exchange designers to ensure that these measurements can be made.

Considering that a digital exchange is mainly composed of software with few physical entities which can be identified as specific measurement points, it is not possible to identify exactly where measurements should be taken. However, the basic measurement types given in § 4.2 require that it be possible to differentiate between events occurring:

i) from a customer/previous exchange node, arriving at an exchange.

ii) from an exchange to another exchange node/customer.

iii) within an exchange.

In the three segments indicated above it is necessary to have the ability to record the entities independently in each segment, as well as being able to associate entities between segments.

The entities recorded are:

– bids;

– seizures;

– effective calls;

– congested bids;

– traffic volume.

An exchange should categorize failed call attempts according to the reason for the failure. However, the information available to the exchange for this purpose may depend on the signalling system used and the function and position of the exchange in the network relative to the failed call attempts.

It should be noted that measurement type 15 is a call record which has to be generated wholly within an exchange system.

It shall be possible for any of the basic measurement types to be amalgamated to form a unique measurement program to meet an Administration's requirements. It shall also be possible to output measurement information to more than one user. As an example, measurements may be in progress continuously for traffic engineering purposes and, at a particular time (say for one hour), measurements of the same type may be required for maintenance purposes. The output or recording of these two measurements must not interfere with each other or with any other measurements being made at the same time, e.g. for network management.