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

Traffic engineering – Measurement and recording of traffic

Traffic measurement requirements for digital telecommunication exchanges

ITU-T Recommendation E.502

ITU-T E-SERIES RECOMMENDATIONS

OVERALL NETWORK OPERATION, TELEPHONE SERVICE, SERVICE OPERATION AND HUMAN FACTORS

INTERNATIONAL OPERATION	
Definitions	E.100–E.103
General provisions concerning Administrations	E.104–E.119
General provisions concerning users	E.120–E.139
Operation of international telephone services	E.140–E.159
Numbering plan of the international telephone service	E.160–E.169
International routing plan	E.170–E.179
Tones in national signalling systems	E.180–E.189
Numbering plan of the international telephone service	E.190–E.199
Maritime mobile service and public land mobile service	E.200–E.229
OPERATIONAL PROVISIONS RELATING TO CHARGING AND ACCOUNTING IN THE INTERNATIONAL TELEPHONE SERVICE	
Charging in the international telephone service	E.230–E.249
Measuring and recording call durations for accounting purposes	E.260–E.269
UTILIZATION OF THE INTERNATIONAL TELEPHONE NETWORK FOR NON-TELEPHONY APPLICATIONS	
General	E.300–E.319
Phototelegraphy	E.320–E.329
ISDN PROVISIONS CONCERNING USERS	E.330–E.349
INTERNATIONAL ROUTING PLAN	E.350–E.399
NETWORK MANAGEMENT	
International service statistics	E.400–E.409
International network management	E.410–E.419
Checking the quality of the international telephone service	E.420–E.489
TRAFFIC ENGINEERING	
Measurement and recording of traffic	**E.490–E.505**
Forecasting of traffic	E.506–E.509
Determination of the number of circuits in manual operation	E.510–E.519
Determination of the number of circuits in automatic and semi-automatic operation	E.520–E.539
Grade of service	E.540–E.599
Definitions	E.600–E.649
Traffic engineering for IP-networks	E.650–E.699
ISDN traffic engineering	E.700–E.749
Mobile network traffic engineering	E.750–E.799
QUALITY OF TELECOMMUNICATION SERVICES: CONCEPTS, MODELS, OBJECTIVES AND DEPENDABILITY PLANNING	
Terms and definitions related to the quality of telecommunication services	E.800–E.809
Models for telecommunication services	E.810–E.844
Objectives for quality of service and related concepts of telecommunication services	E.845–E.859
Use of quality of service objectives for planning of telecommunication networks	E.860–E.879
Field data collection and evaluation on the performance of equipment, networks and services	E.880–E.899

For further details, please refer to the list of ITU-T Recommendations.

ITU-T Recommendation E.502

Traffic measurement requirements for digital telecommunication exchanges

Summary

This Recommendation applies to all digital telecommunications exchanges operating in a switched telephone network and ISDN. Traffic measurements on these exchanges are defined to provide the database from which the dimensioning, planning, operation and management of the network are carried out.

Source

ITU-T Recommendation E.502 was revised by ITU-T Study Group 2 (2001-2004) and approved under the WTSA Resolution 1 procedure on 2 February 2001.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

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

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

ITU-T Recommendation E.502

Traffic measurement requirements for digital telecommunication exchanges

1 Scope

This Recommendation defines the traffic measurements generated by digital telecommunications exchanges operating in a switched telephone network and ISDN. A generic traffic measurement model is established, based on the definition of the entities to be measured and the objects on which the measurements are performed, and the different traffic flows occurring in the exchange are identified.

Measurements are defined at different functional levels: overall measurements, measurements on selectable objects, measurements on services, measurements on control units, measurements on call records and delay GOS measurements. Services for which measurements are defined are the basic telephone service, ISDN services and IN services.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

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 as a comprehensive and complete set.

– ITU-T E.175 (1988), *Models for international network planning.*

– ITU-T E.41x series of Recommendations, *International network management.*

– ITU-T E.42x series of Recommendations, *Checking the quality of the international telephone service.*

– ITU-T E.491 (1997), *Traffic measurement by destination.*

– ITU-T E.492 (1996), *Traffic reference period.*

– ITU-T E.493 (1996), *Grade of service (GOS) monitoring.*

– ITU-T E.500 (1998), *Traffic intensity measurement principles.*

– ITU-T E.503 (1992), *Traffic measurement data analysis.*

– ITU-T E.504 (1988), *Traffic measurement administration.*

– ITU-T E.505 (1992), *Measurements of the performance of common channel signalling network.*

– ITU-T E.506 (1992), *Forecasting international traffic.*

– ITU-T E.543 (1988), *Grades of service in digital international telephone exchanges.*

– ITU-T E.721 (1999), *Network grade of service parameters and target values for circuit-switched services in the evolving ISDN.*

– ITU-T M-series Recommendations, *TMN and network maintenance: international transmission systems, telephone circuits, telegraphy, facsimile and leased circuits.*

– ITU-T O-series Recommendations, *Specifications of measuring equipment.*

– ITU-T Q-series Recommendations, *Switching and signalling.*

– ITU-T Q.544 (1988), *Digital exchange measurements.*

3 Abbreviations

This Recommendation uses the following abbreviations:

GOS Grade of Service

IN Intelligent Network

ISDN Integrated Services Digital Network

OS Operations System

SCP Service Control Point

SRP Specialized Resource Point (formerly Intelligent Peripheral – IP)

SSP Service Switching Point

4 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 database 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 ITU-T 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 ITU-T E.503.

5 Traffic measurement

5.1 Traffic measurement model

This clause 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:

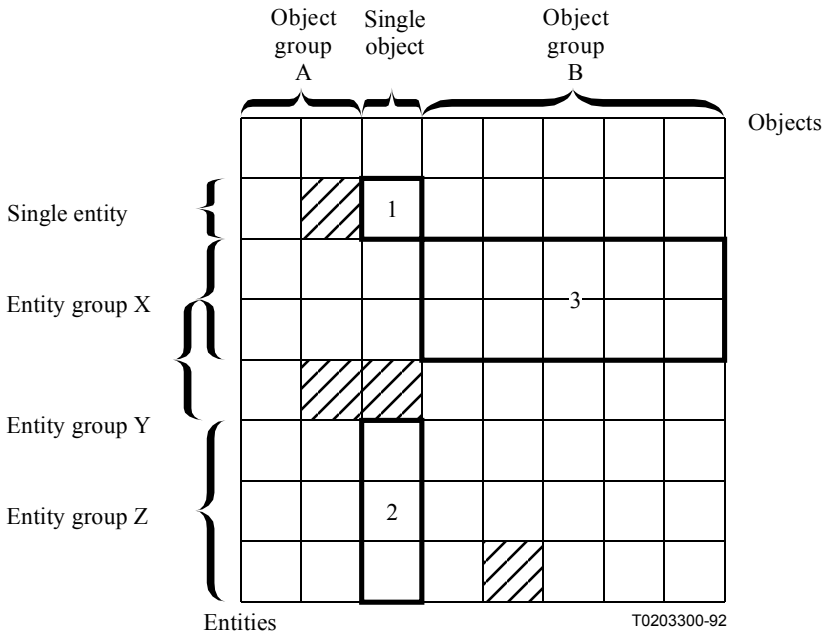
Entities:

– 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).



Measurement type 1: single object, single entity.
Measurement type 2: single object, entity group Z.
Measurement type 3: object group B, entity group X.
Impossible or meaningless

Figure 1/E.502 – Measurement matrix

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.

5.2 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.

5.2.1 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.).

5.2.2 Time information

Measurements may have an undetermined duration (stop date is not pre-specified), 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).

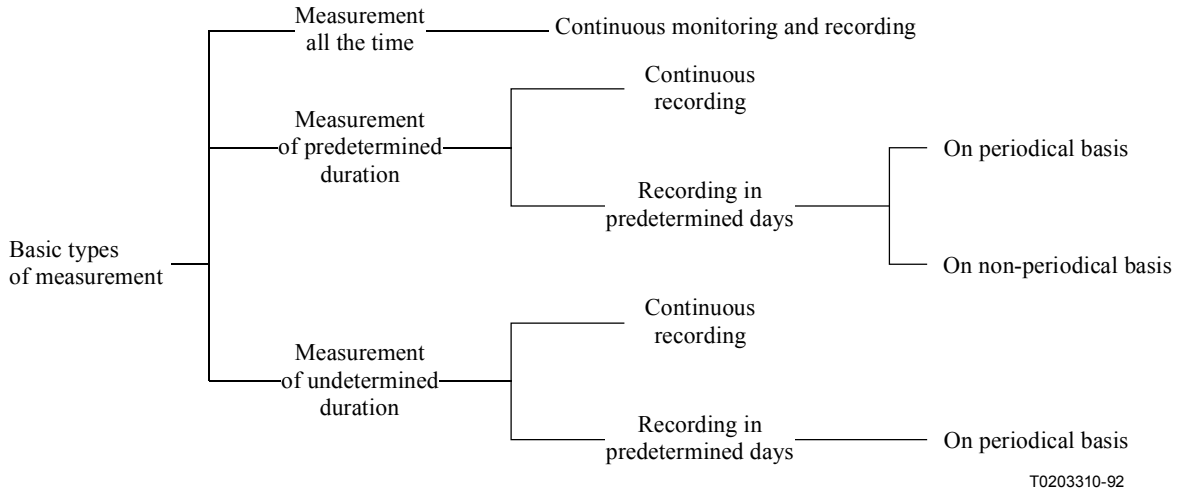


Figure 2/E.502

As shown in Figure 3, 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.

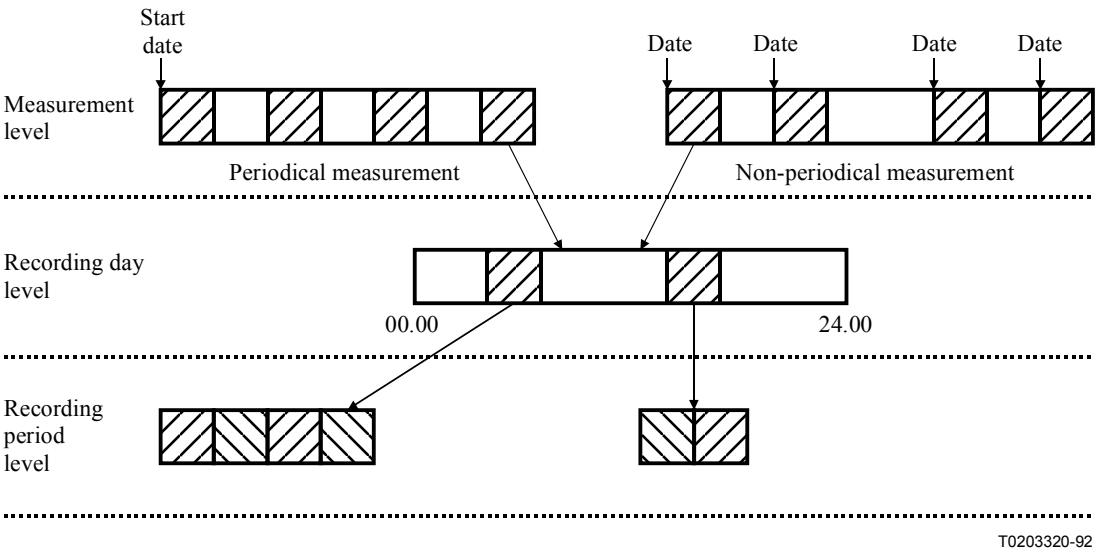


Figure 3/E.502

5.2.3 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.

6 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.

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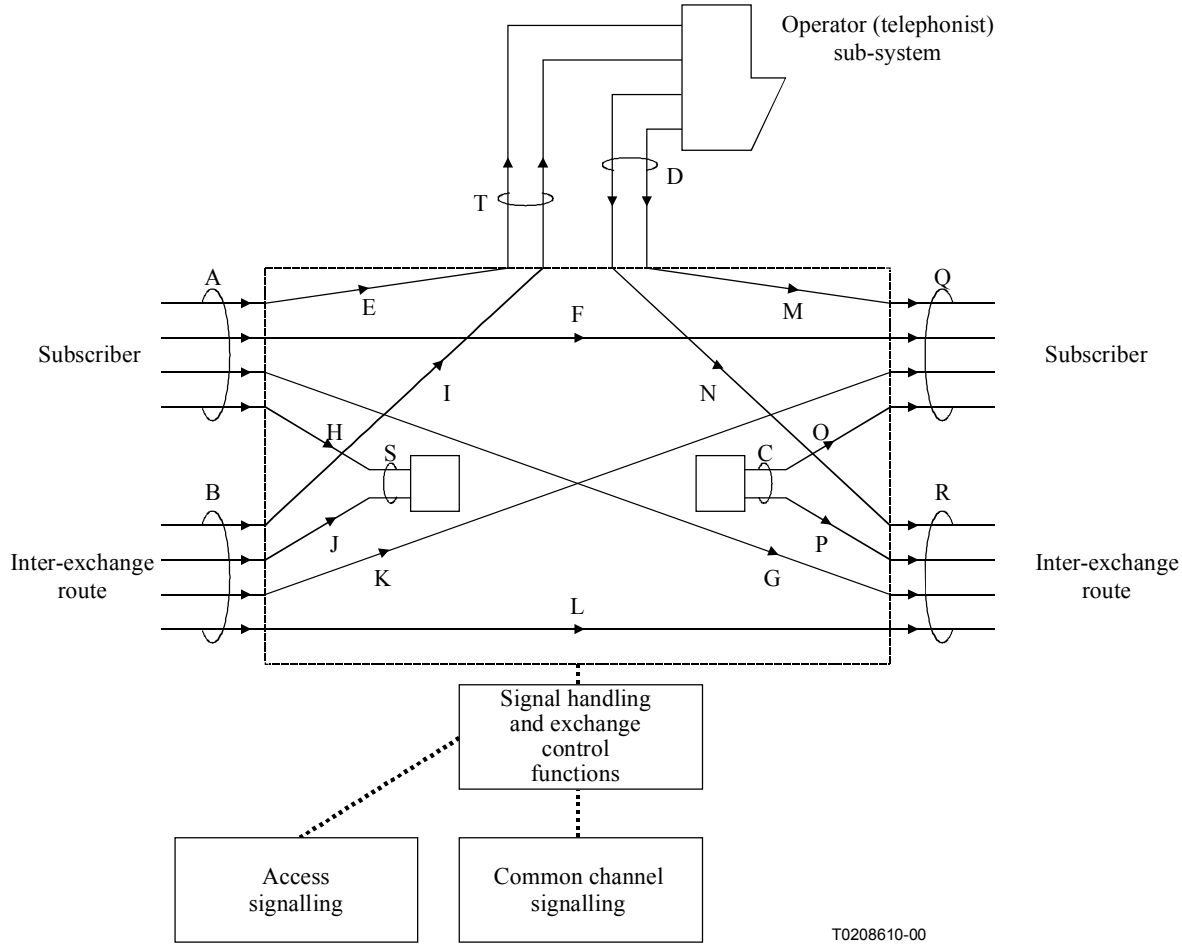
[1] Inlet is the point on or within the boundary of the exchange system where a call attempt arrives or arises.

[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.



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

From Figure 4 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, system-originating and systemterminating calls are identified by the aggregate traffic flows *C* and *S* respectively.

7 Basic measurement types

7.1 General

7.1.1 Depending on the activities listed in clause 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, 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 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.

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 7.2.

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. 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.

7.1.2 Network management considerations

7.1.2.1 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.

7.1.2.2 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.

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

7.1.2.4 Information as to which network management controls, detailed in ITU-T 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).

7.1.3 Traffic engineering

Information on measurements for planning purposes is given in ITU-T 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.

7.2 Measurements

In this clause measurement types 1 to 22 relate to the telephone network, measurement types 23 to 39 relate to ISDN and measurement types 40 to 48 relate to IN.

7.2.1 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;

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);

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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.

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

e) number of unsuccessful call attempts due to incomplete dialling[3].

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[3],

   ii) invalid address;

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

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

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[8].

   ii) no answer or metering pulse(s);

e) number of unsuccessful call attempts due to incomplete dialling[3].

Type 7: Overall measurements on system originating traffic (*O* + *P*)[5]

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,

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[8] Expiring of time-out or receiving a release forward.

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

iii) answered.

Type 8: Overall measurements on operator-originating traffic (*M* + *N*)[5]

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.

7.2.2 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[4];

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;

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[9]

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.

7.2.3 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.

7.2.4 Measurements on call records[10]

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;

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

[10] 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.

c) dialled digits;

d) service characteristic of call attempt[11] 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).

7.2.5 Delay grade-of-service (GOS) monitoring

The following measurements are to be applied in a generic digital exchange operating in a switched telephone network. ITU-T E.493 defines methods for monitoring the GOS parameters defined in ITU-T E.721 specifically for circuit switched services in ISDN. The measurements for monitoring these parameters are specified in the ISDN clause (see 7.2.7).

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.

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[11] 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.

7.2.5.1 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.

7.2.5.2 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.

7.2.6 Network performance monitoring[12]

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.

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.

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

NOTE – This includes code block and call gap controls.

7.2.7 Measurement of the ISDN and its services

7.2.7.1 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.

7.2.7.2 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).

7.2.7.3 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.

7.2.7.4 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.

7.2.7.5 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 ACK message has been sent to the calling user;

e) time that the last Q.931 INFO message has been received by the exchange;

f) time that the Q.931 ALERT message has been sent to the calling user;

g) time that the Q.931 DISC message has been received by the exchange;

h) time that the Q.931 RELEASE message has been sent to the calling user;

i) 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*);

j) time that the Q.931 ALERT message has been received from the called user *(F)*, or, time that the ACM message has been received from 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 ACM message has been sent by the exchange;

e) 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*);

f) time that the Q.931 ALERT message has been received from the called user *(K)*, or, time that the ACM message has been received from the subsequent exchange *(L)*.

7.2.8 Measurements for the Intelligent Network (IN)

The measurements described here refer only to the part of an IN related to the switching node. Measurements for other IN devices are out of the scope of this Recommendation.

Specific IN measurements are only required in those digital exchanges that contain a Service Switching Function (SSF). In other exchanges, the conventional PSTN/ISDN measurements must be applied to measure the traffic of the circuit groups that carry IN traffic to the Service Switching Points (SSP) or the traffic of the destination codes (prefixes) that identify IN services.

In this context, the Service Key parameter refers to a mandatory data item in the service request message that is triggered at an SSP towards a Service Control Point (SCP). The utilization of this parameter is operator-specific. It can be used to identify groups of data objects (e.g. segments of the subscriber database) and groups of services (e.g. service logic programs). The first approach enables a segmentation of the IN database and the corresponding IN traffic in line with the normal origin-destination traffic flow modelling and the related network design and dimensioning principles. In the case of prefix-based triggering of services, it is possible to use different Service Key values to identify service groups of different traffic or GOS characteristics, i.e. Service Key values are used to identify groups of the prefix objects. In this regard, ITU-T E.724 defines some reference topologies relevant to define the GOS parameters and GOS objectives for the IN.

A Specialized Resource Point (SRP) may be involved in the execution of IN services that require user interaction.

Type 40: Overall measurements of the IN traffic

Objects: Selected SCPs.

Entities:

a) number of calls requiring a service request to the SCP;

b) number of service requests sent to the SCP;

c) number of service requests rejected by a call gapping criterion of the SCP;

d) number of calls failed due to a timeout of a response from the SCP;

e) number of calls initiated by the SCP;

f) average transaction delay (time of receiving the first response from the SCP minus time of sending the first service request to the SCP).

Type 41: Measurements of the IN traffic components

Objects: Selected pairs of Service Key value (or value range) and SCP address.

Entities:

a) number of calls associated with the Service Key value requiring a service request to the SCP;

b) number of service requests associated with the Service Key value and sent to the SCP;

c) number of service requests associated with the Service Key value and rejected by a call gapping criterion of the SCP;

d) number of calls associated with the Service Key value and rejected due to a time-out of a response from the SCP;

e) average transaction delay (time of receiving the first response from the SCP minus time of sending the first service request to the SCP).

Type 42: Measurements of the SSP-SRP traffic

Objects: Selected SRPs.

Entities:

a) total number of calls routed from the SSP to the SRP;

b) number of calls with an SCP-instructed extension of the speech path from the SSP to the SRP without continued SCP control;

c) number of calls with an SCP-instructed extension of the speech path from the SSP to the SRP with continued SCP control;

d) number of calls coming from the SRP to the SSP;

e) number of calls encountering congestion between the SSP and SRP;

f) total traffic volume of calls routed from the SSP to the SRP;

g) traffic volume of SCP-instructed call extensions between the SSP and SRP without continued SCP control;

h) traffic volume of SCP-instructed call extensions between the SSP and SRP with continued SCP control;

i) traffic volume of calls coming from the SRP to the SSP;

j) average time for setting up the extension of the speech path from the SSP to the SRP.

Type 43: Measurements of the SSP-SRP traffic on a per SCP basis

Object: Selected pairs of SRP and SCP.

Entities:

a) number of calls with an SCP-instructed extension of the speech path from the SSP to the SRP without continued SCP control;

b) number of calls with an SCP-instructed extension of the speech path from the SSP to the SRP with continued SCP control;

c) number of calls encountering congestion between the SSP and SRP when being under the control of the SCP;

d) average time for setting up the extension of the speech path from the SSP to the SRP.

Type 44: Measurements of the announcement devices within the SSP

Objects: Pool of announcement devices within the SSP.

Entities:

a) total number of calls requiring the use of the announcement devices;

b) number of calls requiring SCP-controlled use of the announcement devices;

c) total number of announcements assigned to the announcement devices;

d) total traffic volume of the announcement devices.

Type 45: Measurements of the announcement devices within the SSP on a per SCP basis

Objects: Pool of announcement devices within the SSP.

Entities:

a) number of calls requiring the use of the announcement devices under the control of the SCP;

b) number of announcements assigned to the announcement devices under the control of the SCP.

Type 46: Measurements of the IN traffic per dialled digits

Objects: Selected dialled digits (i.e. prefixes or entire numbers).

Entities:

a) number of calls with the selected digits requiring a service request to the SCP;

b) number of calls with the selected digits and a service request sent to the SCP;

c) number of calls with the selected digits and a service request rejected by a gapping criterion of the SCP;

d) number of INAP messages sent to the SCP corresponding to calls with the selected digits;

e) number of INAP messages received from the SCP corresponding to calls with the selected digits;

f) number of calls received with the selected digits and routed to an announcement device;

g) number of calls received with the selected digits and routed to an SRP;

h) number of calls received with the selected digits and routed to elsewhere with a successful connection;

i) average transaction delay (time of receiving the first response from the SCP minus time of sending the first service request to the SCP).

Type 47: Measurements of Call Detail Records for the IN traffic components

Objects: Selected pairs of Service Key value (or value range) and SCP address.

Entities:

a) Service Key value;

b) SCP address;

c) calling number;

d) dialled digits;

e) time of sending the first service request to the SCP;

f) time of receiving the first response from the SCP;

g) routing number for the first onward routing;

h) time of receiving a B-answer signal;

i) time of receiving a call release request;

j) cause code value.

Type 48: Measurements of Call Detail Records for dialled destination codes and numbers

Objects: Selected dialled digits (i.e. prefixes or entire numbers).

Entities:

a) Service Key value;

b) SCP address;

c) calling number;

d) dialled digits (prefix or number);

e) time of sending the first service request to the SCP;

f) time of receiving the first response from the SCP;

g) routing number for the first onward routing;

h) time of receiving a B-answer signal;

i) time of receiving a call release request;

j) cause code value.

ANNEX A

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 7.2 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.

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