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SPECIFICATIONS OF SIGNALLING SYSTEM No. 7

SIGNALLING SYSTEM No. 7 MANAGEMENT

MONITORING AND MEASUREMENTS FOR SIGNALLING SYSTEM No. 7 NETWORKS

ITU-T Recommendation Q.752

(Previously "CCITT Recommendation")

FOREWORD

The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the International Telecommunication Union. The 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 Conference (WTSC), which meets every four years, established the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

ITU-T Recommendation Q.752 was prepared by the ITU-T Study Group XI (1988-1993) and was approved by the WTSC (Helsinki, March 1-12, 1993).

NOTES

1 As a consequence of a reform process within the International Telecommunication Union (ITU), the CCITT ceased to exist as of 28 February 1993. In its place, the ITU Telecommunication Standardization Sector (ITU-T) was created as of 1 March 1993. Similarly, in this reform process, the CCIR and the IFRB have been replaced by the Radiocommunication Sector.

In order not to delay publication of this Recommendation, no change has been made in the text to references containing the acronyms "CCITT, CCIR or IFRB" or their associated entities such as Plenary Assembly, Secretariat, etc. Future editions of this Recommendation will contain the proper terminology related to the new ITU structure.

2 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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MONITORING AND MEASUREMENTS FOR SIGNALLING SYSTEM No. 7 NETWORKS

(Helsinki, 1993)

1 Introduction

1.1 General

1.1.1 In order to manage effectively the resources provided by a Signalling System No. 7 network, it is necessary to monitor and measure the present, and estimate the future performance, utilization and availability of these resources. The principles and scope of this Recommendation are:

- measurements made on the signalling network resources are known as "raw" or primitive measurements, and in general only these measurements are identified in this Recommendation;
- the recommended primitive measurements and, at times, other derived measurements, whose computation using the primitive measurements is described, are those required for the effective management of the signalling network resources;
- a basic subset (marked as "obligatory" in the tables) of signalling network measurements is recommended for international networks, but it is intended that this subset also be useful for national networks, which, however may need additional measurements;
- monitoring and measuring are considered to be passive processes, and although the results of monitoring and measuring may be used to invoke test and maintenance actions and procedures, it is left to other Recommendations, e.g. Recommendation Q.753, to provide details of such actions and procedures;
- Q.752 is not intended to provide signalling network testing and maintenance procedures; it is left to other Recommendations to provide such procedures, e.g. Recommendations Q.707, Q.753, etc.

1.1.2 The measurements defined in this Recommendation are intended to be controlled through the use of the operations and maintenance application part defined in Recommendations Q.750 to Q.755. Recommendation Q.751 defines the functions needed to initiate and stop the measurements and the procedures to handle the transfer of data after collection.

1.2 Network view

1.2.1 The signalling network measurements can provide both a local and a global network view of the performance of the signalling network. The primitive measurements which provide the two views are not necessarily different. Rather, the global view is a result of a summary of measurements from more than a single signalling point so that the behaviour of the network is centrally observable. A global view of the performance of the signalling network, in general, becomes more useful as the network becomes larger (i.e. more signalling points or multiple users).

1.3 Guidelines for uses of measurements

1.3.1 The measurements may be used singly, or in conjunction with other measurements. It is not the intent of the Recommendation to specify the computations and algorithms to be applied to the primitive measurements. Guidelines, however, are provided (see clause 6) for some uses of measurements so that, for example, the views at both ends of an international link are consistent.

1.4 Grouping of measurements

1.4.1 Each primitive measurement is classified for the purpose of guidance into one or more categories called fault management (F), configuration management (C), performance management (P), accounting management (A), and network administration and planning (N). Some of these measurements are also for near-real-time use (R).

1.4.2 A tabular listing of the primitive measurements according to the managed object being measured is provided (see clauses 2-5). The tabular listing of the primitive measurements includes for each measurement an indication of the appropriate categories and reference to the pertinent Recommendations.

1.5 Collection of measurements

Recommendation Q.751 contains a description of the operations that may be performed upon measurement managed objects. CCITT Recommendations X.733 (Alarm Reporting Function for CCITT Applications), X.734 (Event Reporting Management Function for CCITT Applications), X.735 (Log Control Function for CCITT Applications) and X.738 (Measurement Summarization Function for CCITT Applications) contain descriptions of the requirements for measurement collection.

1.6 Definition of terms

The classification categories below indicate the general area of use of the measurement, the first four correspond to the respective OSI management categories (see for example 2.2/Q.750), the penultimate one is equivalent to the "administration" category of Q.791.

The distinction between categories is not always sharp, for example, a fault measurement may cause the network administration to decide to change the configuration, and measurements may be taken to see if the change had the results desired. The category of the latter measurement might be F or C.

1.6.1 fault (F): This category utilises on occurrence events and measurements, 5 minute and "1st & interval" measurements (see 1.7.1.7) to report and detect faults, and monitor the signalling network response to abnormal conditions.

Measurements made for this purpose are usually for use in near-real time, but resources performing to "just acceptable" limits might require long measurement intervals.

1.6.2 configuration (C): This category is used for dynamic configuration changes associated with faults or administrative action. The measurements are usually for use in near-real time.

1.6.3 performance (P): This category is used for near-real time, medium term and long term control.

The purpose is to sustain network performance, over both the short and long term.

1.6.4 accounting (A): This category is for further study, in particular with respect to the reliability requirements for collection and storage of data, and in the security requirements for access to it.

However, certain measurements (see Table 6), could be useful for STP accounting purposes.

1.6.5 network planning and administration (N): This category is the same as the "administration" category of *Blue Book* 2.3/Q.791. It involves measurements that are used on a long-term basis and are in general retained external to the signalling network resources.

The activities include planning and dimensioning (engineering) the signalling network resources, including determination of the resource quantities, e.g. number of link sets, and resource configuration, e.g. routing.

1.6.6 near real time measurements (R): This classification is applied in addition to the categories defined above for those measurements which are for use in near real time. Usually it is applied to those measurements which are marked as "on occurrence", or "1st & interval", or "5 minute" duration. These measurements include for TMN all of the alarms pertinent to the SS No. 7 network, and these might require immediate reaction.

1.7 Listing of measurements

1.7.1 General

1.7.1.1 The recommended measurements are presented in the tables. Explanatory notes relating to the contents of these tables are given below.

1.7.1.2 The Obl. (for Obligatory) column is used to indicate those measurements which must be provided. The additional Act./Perm. column indicates whether these measurements are activated on demand, or permanently active, respectively. In non-obligatory cases, if the measurement is provided, the network operator must also decide whether the measurement will be activated on demand or be permanently active. Some non-obligatory measurements are marked "perm." or "act.", this is just for guidance.

1.7.1.3 The Usage column indicates which categories apply to each measurement.

1.7.1.4 The From column indicates, when the measurement is not basic, from which other measurements it might be derived.

1.7.1.5 The count items in the tables, identified in the Units column as "event/SP", "MSUs/SL", etc., imply the total count of items in the specified period, and implicitly indicate the identity of what is being counted, i.e. "event/SP" identifies the Signalling Point, "MSUs/SL" identifies the Signalling Link, etc. The identity of the network element where the measurement is made is also included in the report.

1.7.1.6 The event items in the tables, which are recorded "on occurrence", are intended to be recorded with a time stamp, giving the unique network time when the event indicator was generated. The resolution and accuracy of the time stamp should be as high as possible, to increase the ability to resolve complex and rapid sequences of events.

1.7.1.7 Many of the event items in the tables, which were defined in the *Blue Book* to be recorded "on occurrence", are now to be recorded as "1st & interval" in order to avoid occasional massive outputs. Relevant measurements in the tables for SCCP, TC and ISUP are handled in the same way. These events are expected to occur infrequently, they might indicate failures or loss of quality, but their exact numbers are not of interest.

These events are expected to occur infrequently, they might indicate failures or loss of quality, but their exact numbers are not of interest.

The first event occurring is reported immediately to the external management system (e.g. TMN-OS) with a time stamp. Following events within the interval which are related to the measurement are counted. At the end of the interval the count is output, by the TMN-OS if the counting is done there, or to the external management system if not. The count is then set to zero.

The "1st & interval" measurements can be permanent or activated.

1.7.2 Intervals for measurements

For each type of measurement interval ("5 min.", "15 min.", "30 min." or "1st & interval" – shown as "1st & Δ") in the "duration" column, time is divided into a sequence of equal length consecutive intervals, independent of any events.

The "1st & interval" measurements use an already-running clock/timer, the first event in the interval is associated with that interval, and is reported. The first event plus any successive events are counted, and this count is reported at the end of the interval in which it was made.

For cooperation with a TMN-OS, the future target will be 5 minute intervals for:

- the events measured as "1st & Δ";
- those other measurements for near-real time use indicated with "R" in the Usage column.

For traffic measurements, the future target interval is 15 minutes.

2 MTP monitoring and measurements

2.1 General

Signalling link faults and performance, availability and utilization indicators are detailed in Tables 1, 2 and 3 respectively.

These relate to the MTP managed objects signalling link and signalling link NE part[1)].

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1) "NE part" denotes that this is, for example, one end of a signalling link or linkset.

Signalling linkset and routeset availability indicators are detailed in Table 4. These relate to the MTP managed objects signalling linkset, signalling linkset NE part, signalling routeset and signalling routeset NE part[1)].

Table 5 details the signalling point status (adjacent SP accessibility, routing performance, and MTP User Part availability) indicators.

These relate to the MTP managed objects signalling point and MTP User.

Table 6 defines the Signalling Route utilization indicators.

These relate to the MTP managed objects signalling route and signalling linkset NE part[1)].

2.2 Table 1

The following comments give the most probable failure reasons. In some cases, other reasons might apply. The comparison of several measurements might give additional information.

2.2.1 Item 1.1 could be derived from 1.2 and 1.12.

2.2.2 The measurement of signalling link (SL) failure is recommended (see Item 1.2). However, the specific cause for the failure (see Items 1.3-1.6) is an additional non-obligatory measurement.

- Item 1.3 indicates complex failures in transmission or an intermittent hardware fault or even a design error.
- Item 1.4 may indicate serious disturbance or an interruption of the signalling data link (SdL).
- Item 1.5 indicates a "noisy" link.
- Item 1.6 may indicate serious congestion at the remote end of the signalling link.
- Item 1.7 indicates a signalling data link fault which prevents the SdL moving into service.
- Item 1.8 indicates the incoming message error rate.
- Item 1.9 indicates the outgoing message error rate.
- Items 1.10 and 1.11 can be deduced from measurements 1.2 and 1.12.
- Items 1.2 and 1.12 are used to update the status of a link. They are "event reports" in OSI management.

2.2.3 The measurement of "number of Signal Units received in error" (see Item 1.8) contains the number of items (not necessarily the number of Signal Units sent) between what are perceived as "Flags" plus the number of sets of 16 octets received in the "octet counting" mode.

2.3 Table 2

2.3.1 Item 2.1 could be derived from other measurements.

2.3.2 Items 2.5 and 2.6 could be derived from more basic measurements which are the start and end of inhibition.

Item 2.7 could be derived from measurements 1.2 and 1.12.

Item 2.9 could be derived from measurements 2.10 and 2.11.

2.3.3 Items 2.10 and 2.11 (start and end respectively of remote processor outage) can be used to deduce item 2.9. They indicate a problem and its cessation at the other end of the link, this problem could be one between level 2 and level 3.

2.3.4 Items 2.13 and 2.14 can be derived from measurements 2.16 and 2.17.

2.3.5 Item 2.15 is a "local busy" measurement. "Local busy" is defined as a period in which "busy" link status signal units (LSSU SIB) are transmitted. The *Blue Book* Q.791 duration measurement is replaced by a count of the number of LSSU SIBs sent.

2.3.6 Items 2.16 to 2.19 inclusive are basic measurements from which items 2.5, 2.6, 2.13 and 2.14 can be deduced.

2.4 Table 3

2.4.1 Items 3.1 to 3.5 inclusive enable the link occupancy to be determined. The "wasted" occupancy due to retransmissions can also be assessed. The average message length can be calculated.

2.4.2 The number of SIF and SIO octets transmitted (see Item 3.1) does not include SIF and SIO octets which are retransmitted.

2.4.3 The opening flag and the check bits are included in Item 3.2.

2.4.4 The number of message signal units transmitted (see Item 3.3) does not include message signal units which are retransmitted.

2.4.5 The number of MSUs received (see Item 3.5) consists of all MSUs that are passed to level 3 for processing.

2.4.6 The signalling link congestion (see Item 3.6) refers to link status "congested" at Level 3. A link is marked at Level 3 as congested when a congestion threshold is reached at the transmit side (see 3.6/Q.704 on Signalling Network Congestion and clause 11 on Signalling Traffic Flow Control). Measurements should be kept for thresholds 1, 2, and 3 separately if that national option is selected.

NOTE – The reporting of this item on occurrence should be considered carefully, since there might be many events in a short interval. This might occur for example if the congestion onset and abatement thresholds were close together, or if the transmission/retransmission buffer size were significantly greater than the reception buffer at the other end of the link, and congestion occurred.

2.4.7 Item 3.7, cumulative duration of SL congestion, is kept separately per threshold. The durations are measured on a non-overlapping basis. For example, for the national option of multiple congestion levels with message priorities (see 2.3.5/Q.704 and 3.8.2/Q.704), if a signalling link which has already exceeded congestion onset threshold 1 becomes more congested and exceeds congestion onset threshold 2, the congestion duration measurement for threshold 1 is suspended and the congestion duration measurement for threshold 2 begins (or resumes). If the signalling link becomes less congested and falls below congestion abatement threshold 2, the congestion duration measurement for threshold 2 is suspended, and the congestion duration measurement for threshold 1 is resumed.

2.4.8 Item 3.9 (stop of SL congestion) occurs for a link at level 3 when the buffer occupancy has dropped below the congestion abatement threshold. If a number of thresholds are used, the event is marked separately for each threshold. See also the Note to 2.4.6.

2.4.9 Item 3.10 is the number of MSUs discarded due to signalling link congestion. The significance and method of measuring this item depends upon the method of congestion handling employed in the network. The three congestion handling methods are:

a) single congestion level without priority (see 2.3.5.1/Q.704 international method and 3.8.2/Q.704); or

b) national option of multiple levels without message priorities (see 3.8.2.3/Q.704); or

c) the national option of multiple congestion levels with message priorities (see 2.3.5/Q.704 and 3.8.2/Q.704).

For cases a) and b), messages are discarded by the MTP only under extreme overload. Thus the count indicates, if greater than zero, an extreme congestion. It indicates the effectiveness of the flow control procedures. For case c), messages with priority less than the discard level are discarded in the MTP. For this case, the MSUs discarded due to SL congestion (thresholds 1, 2, and 3 separately) are counted based on the greatest congestion discard threshold in effect on the link. For example, if the congestion of a link has exceeded congestion discard threshold 2, and therefore MSUs with priority 0 and 1 are being discarded, a MSU discarded with priority 0 is counted in the threshold 2 count.

2.4.10 Item 3.11 is kept per congestion level. For the national option of multiple congestion levels with message priorities, a congestion event which may result in the loss of MSUs for threshold *n* begins when congestion discard threshold *n* is exceeded. A new congestion event which may result in the loss of MSUs for threshold *n* cannot begin until the congestion level falls below congestion abatement threshold *n*. Only one congestion event which may result in the loss of MSUs can be in effect at one time, this being the greatest numbered threshold. Therefore, the congestion

event which may result in the loss of MSUs for threshold n is suspended (not stopped) when congestion discard threshold $n + 1$ is exceeded, and resumed (not a new one started) when the congestion level falls below congestion abatement threshold $n + 1$.

2.5 Table 4

2.5.1 Item 4.2 is not a basic measurement. It can be derived from items 4.3 and 4.4.

2.5.2 Item 4.5 – TFPs should be broadcast by an STP each time a destination becomes unavailable for this STP. Item 4.5 is measured when the destination becomes unavailable because of failure of a linkset connected to the STP.

2.5.3 Item 4.6 – TFAs should be broadcast by an STP whenever a destination becomes available for this STP. Item 4.6 is measured when the destination becomes available due to the recovery of a linkset connected to the STP.

2.5.4 Items 4.9 and 4.10 can be derived from 4.11 and 4.12. They are not basic measurements. They are obligatory however in international networks.

2.5.5 Measurements 4.11 and 4.12 are required at Signalling Points in international networks if measurements 5.1 and 5.4 throughout the network are not available to a network operator. In other networks, measurements 5.1 and 5.4 at consecutive Signalling Points on all routes from origin to destination of a routeset might be used to derive measurements 4.11 and 4.12, consequently real time collection of the latter may not be necessary. It should be noted in this that a routeset can become unavailable (depending upon network topology and routing rules) even though all adjacent SPs are accessible.

2.5.6 Measurements 4.5 and 4.6 could only be required at Signalling Transfer Points.

2.5.7 Item 4.13 is a record of failures and recoveries (and all other availabilities and unavailabilities) of a linkset. The identity of the new linkset used (if any), and the old linkset used (if any), are included, as well as the identity of the adjacent SP.

2.6 Table 5

2.6.1 Measurement 5.5, the number of MSUs discarded due to a routing data error, is obligatory, and could indicate a severe problem. It indicates incorrect routing or a data error. It could be a reason to start the MTP Route Verification Test (MRVT), described in 2.2/Q.753.

2.6.2 Item 5.8, TFC received, indicates congestion in the routeset towards the destination (see 3.8.4/Q.704, 11.2.3/Q.704, 11.2.4/Q.704 and 11.2.5/Q.704). For the national option of multiple levels of congestion, the congestion status is included.

2.7 Table 6

2.7.1 These measurements are needed on a per linkset basis.

2.7.2 Activation of the measurements in Table 6 is recommended on a per Point Code (PC) or set of Point Codes and/or Service Information Octet (SIO) basis. The measurements are not obligatory. They may be used to diagnose focussed signalling overloads.

2.7.3 Some of the measurements in Table 6 may be of interest for accounting purposes. The reliability requirements for their collection and retention are for further study.

2.7.4 Items 6.1 through 6.5 could be derived from item 6.6. It should be possible, possibly by activating just a few combinations of OPC, DPC and SIO at a time, to cover any combination that might be applicable for the network in the node in which the measurements are being performed.

Note that these measurements do not specify where they are to be taken, neither do they state what should collect them (e.g. an external monitoring device connected to the signalling links concerned).

Item 6.6 enables the signalling traffic octet dispersion to be measured, 6.7 measures the message dispersion. The effect on the signalling point and network performance should be considered when taking these measurements.

3 SCCP monitoring and measurements

3.1 General

The SCCP error performance indicators are detailed in Table 7.

Table 8 details the SCCP and subsystem availability indicators.

Table 9 describes the SCCP utilization indicators.

Table 9 *bis* describes the SCCP quality of service measurements.

Note that internal messages (i.e. those whose source and sink are in the same node) are also counted.

3.2 Table 7

3.2.1 Routing failure measurements (Items 7.1 through 7.7 and 7.9) refer to all possible failures (both local and remote) detected by SCCP Routing Control, and count all SCCP messages which encounter transport problems, regardless of whether or not a Unitdata Service message or N-NOTICE primitive is returned to the originator. Receipt of a Unitdata Service message is not included in this count.

All of these measurements are marked as "1st & interval". They enable SCCP routing failures to be identified.

3.3 Table 8

3.3.1 Item 8.5, duration of local SCCP unavailable (all reasons), can be deduced from other measurements, and is not basic.

3.3.2 Coordinated State Change Control measurements (Items 8.6 and 8.7) are to be taken at the signalling point of the subsystem requesting to go out of service. These measurements are only applicable at nodes with replicated subsystems.

3.3.3 Unavailability measurements 8.1, 8.2, 8.3 and 8.4 are architecturally dependent and are non-obligatory.

3.4 Table 9

3.4.1 SCCP management messages are included in the totals of items 9.3 to 9.7 (they have SSN = 1 and protocol class = 0).

3.4.2 SCCP utilization measurements, items 9.3 and 9.4 refer to all messages processed by SCCP Routing Control, whether or not the message is processed or delivered successfully. In item 9.3 it is assumed that a message transmitting an SCCP relay point is counted only once. Item 9.4 is for messages received for local subsystems.

3.4.3 Measurement 9.5 measures the utilization of the translation function within SCCP Routing Control and is a count of all messages for which global title translation is attempted. The measurement is only applicable at nodes with translation capabilities.

3.4.4 Measurements 9.6 and 9.7 are taken per protocol class and per SSN. 9.6 is counted at the origin per source SSN, 9.7 is counted at the destination per sink SSN.

3.4.5 Measurement 9.8 refers only to those messages which would normally have been routed to a subsystem but because of a change in the translation process (e.g. due to a routing failure towards that subsystem), are directed to a backup subsystem. The measurement is only applicable at replicated nodes with translation capabilities.

3.4.6 Measurements 9.9, 9.10, 9.11, 9.12, 9.13 and 9.14 are utilization measurements for the data messages sent and received using the SCCP connection oriented service. They are counted per SSN.

All of these Items are to be measured over 5 (P) or 30 (N) minute periods.

3.5 Table 9 *bis*

3.5.1 The SCCP Quality of Service is estimated by comparing the number of unsuccessful UDT transfers (Items 9 *bis*.2 and 9 *bis*.4) to the total number of UDT transfers (9 *bis*.1 and 9 *bis*.3), the number of unsuccessful connection establishments (9 *bis*.6 and 9 *bis*.8) to the total number of establishment attempts (9 *bis*.5 and 9 *bis*.7), the number of resets and syntax errors detected on existing signalling connections (9 *bis*.9 to 9 *bis*.12) to the total number of successful connection establishments, and the number of unsuccessful XUDT transfers (Items 9 *bis*.14 and 9 *bis*.16) to the total number of XUDT transfers (9 *bis*.13 and 9 *bis*.15) (the XUDT transfer counts are for further study). All of these measurements are taken over 5-minute periods (R) or 30-minute periods.

4 ISDN-UP monitoring and measurements

4.1 General

The ISDN User Part availability measurements are detailed in Table 10.

Table 11 details the ISDN-UP utilization measurements.

Table 12 details the ISDN-UP error performance measurements.

4.2 Table 10

ISDN User Part availability, unavailability and congestion measurements are listed in Table 10.

4.2.1 The local ISDN-UP availability measurements 10.1, 10.2, 10.3 and 10.4 are architecturally dependent and are non-obligatory.

4.2.2 Item 10.4, duration of local ISDN-UP unavailable (all reasons) can be deduced from items 10.1, 10.2 and 10.3, and is not basic.

4.2.3 Local ISDN-UP congestion measurements 10.5 and 10.6 are architecturally dependent and are not obligatory. If required, measurement 10.5 is only activated if the congestion exceeds an implementation-dependent threshold, to free the management function from less severe overload conditions.

4.2.4 Item 10.7, duration of local ISDN-UP congestion, can be deduced from items 10.5 and 10.6, and is not basic.

4.2.5 Items 10.8 through 10.13 apply only to gateway exchanges, since items 10.1 to 10.7 measured remotely would furnish the same information to a centralised network management system.

4.3 Table 11

ISDN User Part utilization measurements are listed in Table 11. These are taken at a Signalling Point.

4.3.1 Measurements 11.1 and 11.2 accumulated over all message types are obligatory. However, a count per message type is not obligatory.

4.4 Table 12

ISDN User Part error performance measurements are listed in Table 12. In the event of a catastrophic failure, there are potentially many reports, and these might need to be filtered.

4.4.1 Items 12.8 through 12.15 refer to the abnormal blocking and circuit group blocking procedures in 2.9.2.3/Q.764, of which the management system should be notified.

4.4.2 Items 12.1 and 12.2 refer to failures of the reset circuit and reset circuit group procedures in 2.10.3/Q.764.

4.4.3 Items 12.16 through 12.19 refer to failures in the blocking/unblocking sequences defined in 2.10.4/Q.764.

4.4.4 Items 12.20 through 12.22 relate to protocol errors, namely receipt of unreasonable signalling information messages. See 2.10.5/Q.764.

4.4.5 Item 12.5 reports the failure condition of non-receipt of Release Complete message on expiry of timer T5. See 2.10.6/Q.764.

4.4.6 Items 12.6 and 12.23 refer to the inability to release a circuit and the abnormal release conditions described in 2.10.8/Q.764.

5 TC monitoring and measurements

5.1 General

Table 13 describes the TC utilization measurements.

Table 14 defines the TC error performance and stability measurements.

5.2 Table 13

TC utilization measurements are listed in Table 13.

5.2.1 Measurements 13.1 and 13.2 are taken per message type.

5.3 Table 14

TC error performance and stability measurements are listed in Table 14.

5.3.1 Measurements 14.4 through 14.6 are for error notifications sent, and require the destination address to be logged.

6 Uses of measurements

6.1 Introduction

6.1.1 This clause provides a context for the measurements listed in the tables. It describes briefly the management activities likely to be associated with a Signalling System No. 7 network and how the measurements may be used to support these activities.

6.1.2 A list of supporting measurements sometimes follows each description. Each measurement is identified by its table number followed by a decimal point and the sequence number of the measurement within the table (e.g. Item 1.2 is the second measurement of Table 1).

6.2 Message transfer part (MTP)

6.2.1 Fault and configuration management measurements

6.2.1.1 Detection of link failure events in either direction

By “link failure” is meant an event which causes a particular link to be unavailable for signalling (i.e. a failure at Level 1 or Level 2). Signalling link failures are counted to determine preventive and corrective maintenance actions in order to restore network capabilities. This maintenance action can be required on a single failure event or when the number of failed signalling links in a link set, or across different link sets, exceeds a threshold.

Signalling link failure measurements are summarized not only for specific link sets, but also across many different link sets, where these may involve common transmission systems or signalling points. The distribution of failure and degradation sources may be randomly located, but if specific network elements appear to be common to a large number of the failures, then they are suspect as a significant failure source requiring further maintenance action.

Measurements:

– number of link failures:

all reasons (Item 1.2);

abnormal FIBR/BSNR (Item 1.3);

excessive delay of acknowledgement (Item 1.4);

excessive error rate (Item 1.5);

excessive duration of congestion (Item 1.6);

signalling link restoration (Item 1.12).

6.2.1.2 Surveillance of network status

This activity is concerned with surveillance of the network as a whole, in order to coordinate and assign priorities to maintenance actions. The information to support this activity will come from indicators of the operational and congestion status. These indicators may be found in the tables designated as Usage "F" or "C" and duration of measurements "on occurrence" or "1st & interval".

Measurements to survey network status:

– local automatic changeover (Item 1.10);

– local automatic changeback (Item 1.11);

– start of remote processor outage (Item 2.10);

– stop of remote processor outage (Item 2.11);

– SL congestion indications (Item 3.6);

– stop of SL congestion (Item 3.9);

– number of congestion events resulting in loss of MSUs (Item 3.11);

– start of linkset failure (Item 4.3);

– stop of linkset failure (Item 4.4);

– initiation of Broadcast TFP due to failure of measured linkset (Item 4.5);

– initiation of Broadcast TFA for recovery of measured linkset (Item 4.6);

– start of unavailability in measurement 4.9 (Item 4.11);

– stop of unavailability in measurement 4.9 (Item 4.12);

– adjacent signalling point inaccessible (Item 5.1);

– stop of adjacent signalling point inaccessible (Item 5.4);

– start and end of local inhibition (Items 2.16 and 2.17);

– start and end of remote inhibition (Items 2.18 and 2.19).

Additional measurement may be provided to the user for determining the integrity of the network.

Measurements:

– local management inhibit (Item 2.13);

– local management uninhibit (Item 2.14);

– duration of local busy (Item 2.15);

– number of SIF and SIO octets received (Item 3.4);

– unavailability of route set to a given destination or set of destinations (Item 4.9);

– duration of adjacent signalling point inaccessible (Item 5.2).

6.2.1.3 Detection of routing and distribution table errors

In operation, the Signalling System No. 7 routing data will be updated frequently as the network changes. It is necessary to keep track of signalling point status and routing problems on a routine basis (see Recommendation Q.753).

Measurements:

- duration of unavailability of signalling linkset (Item 4.2);
- start of linkset failure (Item 4.3);
- stop of linkset failure (Item 4.4);
- initiation of Broadcast TFP due to failure of measured linkset (Item 4.5);
- initiation of Broadcast TFA for recovery of measured linkset (Item 4.6);
- unavailability of route set to a given destination or set of destinations (Item 4.9);
- duration of unavailability in measurement 4.9 (Item 4.10);
- start of unavailability in measurement 4.9 (Item 4.11);
- stop of unavailability in measurement 4.9 (Item 4.12);
- adjacent SP inaccessible (Item 5.1);
- duration of adjacent SP inaccessible (Item 5.2);
- stop of adjacent SP inaccessible (Item 5.4);
- number of MSUs discarded due to a routing data error (Item 5.5);
- User Part Unavailable MSUs transmitted and received (Items 5.6 and 5.7).

6.2.1.4 Long term fault detection

The activities described in this subclause relate to the detection of degraded performance and to the maintenance of a particular signalling point and the signalling links associated with that signalling point. They may be used on a near-real time basis, or may be monitored over a period of days or weeks to detect unfavourable trends. They are designed so that one signalling point can monitor its own status without relying on measurements from adjacent signalling points.

6.2.1.4.1 Detection of increases in link SU error rates

This activity ensures that the signalling data link error rate is not rising beyond specification. The SU Error Rate Monitor is the basic instrument for monitoring signalling data link performance. Basic traffic counts are used to normalize performance measurements in order to compare system performance measurements.

Measurements:

- number of SIF and SIO octets transmitted (Item 3.1);
- number of SIF and SIO octets received (Item 3.4).

Operational measurements counting error events provide supplementary information to warn of impending failures or give a running assessment of signalling data link quality.

Measurements:

- number of Signal Units (SUs) in error (monitors incoming performance) (Item 1.8);
- number of Negative Acknowledgements (NACKS) received (monitors outgoing performance) (Item 1.9).

Counting total Signal Unit errors allows the estimation of Signalling Data Link bit error rates (see 3.1/Q.706) assuming that errors are random. The estimate uses measurement 1.1, duration of link in the in-service state, multiplied by the link transmission rate.

Measurements:

- duration of link in the in-service state (Item 1.1);
- duration of link unavailability (any reason) (Item 2.1).

6.2.1.4.2 Detection of marginal link faults

The SU Error Rate Monitor applies to lost alignment as well as corrupted data. Usually both conditions are caused by degraded performance of the transmission facility. Alignment and proving failures often indicate a marginally performing link.

Measurement:

– SL alignment or proving failure (Item 1.7).

This activity is concerned with detecting routing instabilities caused by marginal link faults.

Measurements:

– local automatic changeover (Item 1.10);

– local automatic changeback (Item 1.11);

– SL congestion indications (Item 3.6);

– cumulative duration of SL congestions (Item 3.7);

– number of congestion events resulting in loss of MSUs (Item 3.11).

6.2.2 MTP performance

6.2.2.1 Link, linkset, signalling point and routeset utilization

MTP utilization measurement is concerned with evaluating message flows to ensure that they are not beginning to exceed stated link and signalling point capacities. It also ensures that existing routing is resulting in proportionate utilization of available capacity.

The following measurements are defined:

Measurements by link:

– duration of link in the in-service state (Item 1.1);

– duration of SL unavailable (for any reason) (Item 2.1);

– duration of SL unavailability due to remote processor outage (Item 2.9);

– duration of local busy (Item 2.15);

– number of SIF and SIO octets transmitted (Item 3.1);

– number of octets retransmitted (Item 3.2);

– number of message signal units transmitted (Item 3.3);

– number of SIF and SIO octets received (Item 3.4);

– number of message signal units received (Item 3.5);

– SL congestion indications (Item 3.6);

– cumulative duration of SL congestions (Item 3.7);

– MSUs discarded due to SL congestion (Item 3.10);

– number of congestion events resulting in loss of MSUs (Item 3.11).

Measurements by link set:

– duration of unavailability of signalling link set (Item 4.2).

Measurements by signalling point:

– number of SIF and SIO octets received:

with given origination point code (OPC) (Item 6.1);

with given OPC and SIO (Item 6.4);

– number of SIF and SIO octets transmitted:

with given destination point code (DPC) (Item 6.2);

with given DPC and SIO (Item 6.5);

– number of SIF and SIO octets handled:

  with given SIO (Item 6.3);

  with given OPC, DPC and SIO (Item 6.6).

Measurements by signalling route set:

– unavailability of route set to a given destination or set of destinations (Item 4.9);
– duration of unavailability in measurement 4.9 (Item 4.10);
– duration of adjacent signalling point inaccessible (Item 5.2);
– MSUs discarded due to routing data error (Item 5.5);
– User Part Unavailability MSUs sent and received (Items 5.6 and 5.7);
– Transfer Controlled MSU received (Item 5.8).

6.2.2.2 Component reliability and maintainability studies

These studies are concerned with calculating the mean time between failures (MTBF) and mean time to repair (MTTR) for each type of component in the Signalling System No. 7 network. It may be useful for some purposes to have MTBF and MTTR data by Signalling System No. 7 function with which to correlate associated maintenance action.

Measurements:

– number of link failures:

  all reasons (Item 1.2);

  abnormal FIBR/BSNR (Item 1.3);

  excessive delay of acknowledgement (Item 1.4);

  excessive error rate (Item 1.5);

  excessive duration of congestion (Item 1.6);
– duration of SL inhibition due to local management actions (Item 2.5);
– duration of SL inhibition due to remote management actions (Item 2.6);
– duration of SL unavailability due to link failure (Item 2.7);
– duration of SL unavailability due to remote processor outage (Item 2.9);
– start of remote processor outage (Item 2.10);
– stop of remote processor outage (Item 2.11);
– local management inhibit (Items 2.16 and 2.17);
– local management uninhibit (Items 2.18 and 2.19).

6.3 Signalling connection control part (SCCP)

6.3.1 SCCP fault management

6.3.1.1 Routing failures

The monitoring of routing failures allows the SCCP Routing and Translation function to detect any abnormal number of messages which cannot be routed, independent of the originator being informed through message return.

Measurements:

Routing Failure due to:

– no translation for address of such nature (Item 7.1);
– no translation for this specific address (Item 7.2);
– network failure (point code not available) (Item 7.3);
– network congestion (Item 7.4);

– subsystem failure (unavailable) (Item 7.5);
– subsystem congestion (Item 7.6);
– unequipped user (subsystem) (Item 7.7);
– reason unknown (Item 7.9);
– syntax error detected (Item 7.8).

The last item, 7.8, could occur if there were protocol interworking problems.

In addition, the following measurements can be used as a consistency check or a network protection mechanism:

– UDTS messages sent (Item 9 *bis*.2);
– XUDTS messages sent (Item 9 *bis*.14) (for further study);
– UDTS messages received (Item 9 *bis*.4);
– XUDTS messages received (Item 9 *bis*.16) (for further study).

6.3.1.2 SCCP unavailability

Local SCCP measurements are:

Local SCCP unavailable due to

– failure (Item 8.1);
– maintenance made busy (Item 8.2);
– congestion (Item 8.3);

Stop of local SCCP unavailable

– all reasons (Item 8.4).

6.3.2 SCCP configuration management

The SCCP measurements for this are those for Coordinated State Change Control.

Measurements:

– subsystem out of service request granted (Item 8.6);
– subsystem out of service request denied (Item 8.7).

6.3.3 SCCP performance

6.3.3.1 Utilization

Network administration is interested in monitoring SCCP utilization for use in analyzing the current network and designing future network configurations. One way to monitor SCCP utilization is to measure the amount of SCCP traffic.

Measurements:

SCCP traffic received:

– UDTS messages (Item 9 *bis*.4) ;
– UDT messages (Item 9 *bis*.3);
– XUDT messages (Item 9 *bis*.15) (for further study);
– DT1 messages/SSN (Item 9.9);
– DT2 messages/SSN (Item 9.11);
– ED messages/SSN (Item 9.14);
– XUDTS messages (Item 9 *bis*.16) (for further study);
– total messages (connectionless classes 0 and 1 only) per SSN (Item 9.7);

SCCP traffic sent:

– UDTS messages (Item 9 *bis*.2);
– UDT messages (Item 9 *bis*.1);
– XUDT messages (Item 9 *bis*.13) (for further study);

– DT1 messages/SSN (Item 9.10);
– DT2 messages/SSN (Item 9.12);
– ED messages/SSN (Item 9.13);
– XUDTS messages (Item 9 *bis*.14) (for further study);
– total messages (connectionless classes 0 and 1 only) per SSN (Item 9.6).

General:

– total messages handled (from local or remote subsystems) (Item 9.3);
– total messages intended for local subsystems (Item 9.4);
– total messages requiring global title translation (Item 9.5);
– total messages sent to a backup subsystem (Item 9.8).

6.3.3.2 SCCP Quality of Service

The SCCP Quality of Service can be estimated using the following measurements:

Connectionless outgoing traffic:

– UDT messages sent (Item 9 *bis*.1);
– XUDT messages sent (Item 9 *bis*.13) (for further study);
– UDTS messages received (Item 9 *bis*.4);
– XUDTS messages received (Item 9 *bis*.16) (for further study);

Connectionless incoming traffic:

– UDT messages received (Item 9 *bis*.3);
– XUDT messages received (Item 9 *bis*.15) (for further study);
– UDTS messages sent (Item 9 *bis*.2);
– XUDTS messages sent (Item 9 *bis*.14) (for further study).

Connection oriented establishments:

Outgoing:

– CR messages sent (Item 9 *bis*.5);
– CREF messages received (Item 9 *bis*.8).

Incoming:

– CR messages received (Item 9 *bis*.7);
– CREF messages sent (Item 9 *bis*.6).

Connection oriented syntax/protocol errors:

– RSR messages sent/received (Items 9 *bis*.9 and 9 *bis*.10);
– ERR messages sent/received (Items 9 *bis*.11 and 9 *bis*.12).

6.4 Integrated services digital network user part (ISDN-UP)

6.4.1 Fault and configuration management

6.4.1.1 ISDN-UP availability/unavailability

The monitoring of ISDN-UP availability may prove useful in the activation or deactivation of other network measurements.

Measurements:

– start of ISDN-UP unavailable due to failure (Item 10.1);
– start of ISDN-UP unavailable due to maintenance (Item 10.2);
– start of ISDN-UP unavailable due to congestion (Item 10.5);

– stop of ISDN-UP unavailable (all reasons) (Item 10.3);

– total duration of ISDN-UP unavailable (all reasons) (Item 10.4);

– stop of local ISDN-UP congestion (Item 10.6);

– duration of local ISDN-UP congestion (Item 10.7);

– start of remote ISDN-UP unavailable (Item 10.8);

– stop of remote ISDN-UP unavailable (Item 10.9);

– duration of remote ISDN-UP unavailable (Item 10.10);

– start of remote ISDN-UP congestion (Item 10.11);

– stop of remote ISDN-UP congestion (Item 10.12);

– duration of remote ISDN-UP congestion (Item 10.13).

6.4.1.2 ISDN-UP errors

Problem isolation might be assisted by measurements which indicate the reason for a protocol error being reported.

Measurements:

– missing blocking acknowledgement in CGBA message for blocking request in previous CGB message (Item 12.8);

– missing unblocking acknowledgement in CGUA message for unblocking request in previous CGU message (Item 12.9);

– abnormal blocking acknowledgement in CGBA message with respect to previous CGB message (Item 12.10);

– abnormal unblocking acknowledgement in CGUA message with respect to previous CGU message (Item 12.11);

– unexpected CGBA message received with an abnormal blocking acknowledgement (Item 12.12);

– unexpected CGUA message received with an abnormal unblocking acknowledgement (Item 12.13);

– unexpected BLA message received with an abnormal blocking acknowledgement (Item 12.14);

– unexpected UBA message received with an abnormal unblocking acknowledgement (Item 12.15);

– no RLC message received for a previously sent RSC message within timer T17 (Item 12.1);

– no GRA message received for a previously sent GRS message within timer T23 (Item 12.2);

– no BLA message received for a previously sent BLO message within timer T13 (Item 12.16);

– no UBA message received for a previously sent UBL message within timer T15 (Item 12.17);

– no CGBA message received for a previously sent CGB message within timer T19 (Item 12.18);

– no CGUA message received for a previously sent CGU message within timer T21 (Item 12.19);

– message format error (Item 12.20);

– unexpected message received (Item 12.21);

– release due to unrecognised information (Item 12.22);

– RLC not received for a previously sent REL message within timer T5 (Item 12.5);

– inability to release a circuit (Item 12.23);

– abnormal release condition (Item 12.6);

– circuit blocked because of excessive errors detected by CRC failure (Item 12.7).

6.4.2 ISDN-UP performance

Aspects of ISDN-UP performance which can be monitored are its processing ability in relation to known message volumes.

Measurements:

– total ISDN-UP messages sent (Item 11.1);

– total ISDN-UP messages received (Item 11.2).

6.5 Transaction Capabilities (TC)

6.5.1 TC fault management measurements

Problem isolation may be assisted by measurements which indicate the reason for a protocol error being reported.

Measurements:

– protocol error detected in transaction portion [Items 14.1 a) to e) and 14.4 a) to e)];

– protocol error detected in component portion [Items 14.2 a) to h) and 14.5 a) to h)];

– TC user generated problems [Items 14.3 a) to k) and 14.6 a) to k)].

6.5.2 TC performance

The loading of TC resources may be indicated through the volume of messages and components handled.

Measurements:

– total number of TC messages sent by the node (by message type) (Item 13.1);

– total number of TC messages received by the node (by message type)(Item 13.2);

– total number of components sent by the node (Item 13.3);

– total number of components received by the node (Item 13.4);

– total number of active TC transactions supported by the node – this is to be compared against the range of transaction identities that could be used at the node, to give an idea of the total TC "traffic" at the node (Item 13.5);

– total number of used TC transaction identities (Item 13.6).

6.6 Preparation of traffic forecasts

6.6.1 This activity is concerned with the calculation of values which will be entered into provisioning tables to determine future equipment quantities required. The data to be used are those already collected to support activities categorised as "P" and "N". Depending upon implementation, more detailed measurements may be required to provision such items as internal buffers or number of processors where these may vary.

6.7 Network planning

6.7.1 This activity requires longer-term traffic forecasts, based as much upon marketing intentions as upon extrapolations of existing patterns. Nevertheless, to understand existing patterns, planners need knowledge of traffic origins and destinations.

6.7.2 The measurements in Table 6, Table 9, Table 11 and Table 13 indicate how much traffic is being originated at the measured signalling point, and how much traffic has that signalling point as a destination. These measurements are useful for calculating traffic flows by origin-destination pair.

6.7.3 In reality, however, traffic flows do not spread randomly through a network. For each origin, distance and other factors result in a concentration of flows to favoured destinations. As a result, it will be necessary to measure traffic flows on the network by destination.

6.7.4 Given the large potential number of destinations, measurements may have to be grouped. (See the notes in clauses 2 to 5).

6.8 Evaluation of maintenance force effectiveness

6.8.1 This activity consists of managerial control of the maintenance function, through examination of failure trends, equipment availabilities, and the amount of outage due to manual as opposed to automatic busying of components.

TABLE 1/Q.752

MTP Signalling Link Faults and Performance

Description of Measurements	Units	Usage	Duration	From	Obl.	Act./Perm.	References
1.1 Duration of link in the In-service state	s/SL	F, P, N	30 min	1.2, 1.12	Yes	Perm.	
1.2 SL failure – All reasons	Event/SL	F, R, P	On occur.	–	Yes	Perm.	
1.3 SL failure – Abnormal FIBR/BSNR	Event/SL	F, R, P	On occur.	–	No		5.3/Q.703
1.4 SL failure – Excessive delay of ack.	Event/SL	F, R, P	On occur.	–	No		5.3.1/Q.703
1.5 SL failure – Excessive error rate	Event/SL	F, R, P	On occur.	–	No		10.2.2/Q.703
1.6 SL failure – Excessive duration of congestion	Event/SL	F, R, P	On occur.	–	No		9.3/Q.703
1.7 SL alignment or proving failure	Event/SL	F, R F, P	5 min 30 min	–	No No		10.3/Q.703
1.8 Number of signal units received in error [a)]	Event/SL	F, R, P F, P	5 min 30 min	–	No Yes	Perm. Perm.	4/Q.703
1.9 Number of negative ack. received	Event/SL	F, R, P F, P	5 min 30 min	–	No No		
1.10 Local automatic changeover	Event/SL Event/SL	F, R, C P	On occur. 30 min	1.2	No No		5/Q.703
1.11 Local automatic changeback	Event/SL	F, R, P, C	On occur.	1.12	No		6/Q.704
1.12 SL restoration	Event/SL	F, R, P	On occur.	–	No		3.2.3/Q.704

SL Signalling link

a) The interpretation of this count is implementation dependent.

NOTES

1 Managed objects are signalling link and signalling link NE part.

2 For the meaning of the headings, see 1.7 (applies to all tables).

TABLE 2/Q.752

MTP Signalling Link Availability

	Description of Measurements	Units	Usage	Duration	From	Obl.	Act./Perm.	References
2.1	Duration of SL unavailability (for any reason)	s/SL	F P, N	30 min	1.2, 1.12 2.5, 2.6	Yes	Perm.	
2.2 – 2.4	Deleted							
2.5	Duration of SL inhibition due to local management actions	s/SL	P	30 min	2.16, 2.17	No		3.2.8/Q.704
2.6	Duration of SL inhibition due to remote management actions	s/SL	P	30 min	2.18, 2.19	No		3.2.8/Q.704
2.7	Duration of SL unavailability due to link failure	s/SL	P	30 min	1.2, 1.12	No		3.2.2/Q.704
2.8	Deleted							
2.9	Duration of SL unavailability due to remote processor outage	s/SL	P	30 min	2.10, 2.11	No		3.2.6/Q.704
2.10	Start of remote processor outage	Event/SL	F, R, P, C	On occur.	–	No		3.2.6/Q.704
2.11	Stop of remote processor outage	Event/SL	F, R, P, C	On occur.	–	No		3.2.7/Q.704
2.12	Deleted							
2.13	Local management inhibit	Event/SL Event/SL	– –	30 min 5 min	2.16 2.16	No No		10.2/Q.704
2.14	Local management uninhibit	Event/SL Event/SL	– –	30 min 5 min	2.17, 2.19 2.17, 2.19	No No		10.3/Q.704
2.15	Duration of local busy	SIBs/SL	F, R, P F, P	5 min 30 min	–	No No		9.3/Q.703
2.16	Start of local inhibition	Event/SL	F, R, C	On occur.	–	No		10/Q.704
2.17	End of local inhibition	Event/SL	F, R, C	On occur.	–	No		
2.18	Start of remote inhibition	Event/SL	F, R, C	On occur.	–	No		
2.19	End of remote inhibition	Event/SL	F, R, C	On occur.	–	No		

NOTE – Managed objects are signalling link and signalling link NE part.

TABLE 3/Q.752

MTP Signalling Link Utilization

Description of Measurements	Units	Usage	Duration	From	Obl.	Act./Perm.	References
3.1 Number of SIF and SIO octets transmitted	Octets/SL Octets/SL	P, R, N P, N	5 min 30 min	– –	No Yes	Perm. Perm.	2.3.8/Q.703
3.2 Octets retransmitted	Octets/SL Octets/SL	P, R, N P, N	5 min 30 min	– –	No No		5/Q.703
3.3 Number of message signal units transmitted	MSUs/SL MSUs/SL	P, R, N N, P	5 min 30 min	–	No No		
3.4 Number of SIF and SIO octets received	Octets/SL Octets/SL	P, R, N N, P	5 min 30 min	– –	No Yes	 Act.	
3.5 Number of message signal units received	MSUs/SL MSUs/SL	P, R, N N, P	5 min 30 min	–	No No		
3.6 SL congestion indications	Event/SL Event/SL Event/SL	F P, R, F, N N, P, F	1st & Δ 5 min 30 min	–	No No No	Act. Perm. Perm.	3.8/Q.704
3.7 Cumulative duration of SL congestion	s/SL	F, P, N	30 min	3.6, 3.9	No		
3.8 Deleted							
3.9 Stop of SL congestion	Event/SL	F, P	1st & Δ	–	No	Act.	3.8/Q.704
3.10 MSUs discarded due to SL congestion	MSUs/SL MSUs/SL	F, P, R, N N, F, P	5 min 30 min	– –	No Yes	Perm. Perm.	
3.11 Number of congestion events resulting in loss of MSUs	Event/SL Event/SL Event/SL	F, R P, R, N N, P	1st & Δ 5 min 30 min	–	No No No		
NOTE – Managed objects are signalling link and signalling link NE part.							

TABLE 4/Q.752

MTP Signalling Link Set and Route Set Availability

Description of Measurements		Units	Usage	Duration	From	Obl.	Act./Perm.	References
4.1	Deleted							
4.2	Duration of unavailability of signalling linkset	s/linkset	F, P	30 min	4.3, 4.4	No		
4.3	Start of linkset failure	Event/linkset	F, R, C	On occur.	–	No		
4.4	Stop of linkset failure	Event/linkset	F, R, C	On occur.	–	No		
4.5	Init. of broadcast TFP due to failure of measured linkset[a)]	Event/linkset	F, R, C	On occur.	–	No		13/Q.704
4.6	Init. of broadcast TFA for recovery of measured linkset[a)]	Event/linkset	F, R, C	On occur.	–	No		13/Q.704
4.7 – 4.8	Deleted							
4.9	Unavailability of route set to a given destination or set of destinations	Event/destination(s)	P, C, N	30 min	4.11	[b)]	Perm.	11.2.1/Q.704
4.10	Duration of unavailability in 4.9	s/destination(s)	C, P, N	30 min	4.11, 4.12	[b)]	Perm.	11.2.2/Q.704
4.11	Start of unavailability in 4.9	Event/destination(s)	F, R, C	On occur.	–	No		11.2.1/Q.704
4.12	Stop of unavailability in 4.9	Event/destination(s)	F, R, C	On occur.	–	No		11.2.2/Q.704
4.13	Change in linkset used to adjacent SP	Dest. & linkset	F, R, C	On occur.	–	No	Perm.	

a) These measurements only apply to Signal Transfer Points.

b) These measurements are obligatory only in the international network.

NOTE – Managed objects are linkset, linkset NE part, routeset.

TABLE 5/Q.752

MTP Signalling Point Status

Description of Measurements	Units	Usage	Duration	From	Obl.	Act./perm.	References
5.1 Adjacent SP inaccessible	Event/SP Event/SP Event/SP	F, R P, R P	On occur. 5 min 30 min	–	Yes No No	Perm.	
5.2 Duration of adjacent SP inaccessible	s/SP s/SP	P, R P	5 min 30 min	5.1, 5.4	Yes	Perm.	
5-3 Deleted							
5.4 Stop of adjacent SP inaccessible	Event/SP	F, R, C	On occur.	–	No		
5.5 MSU discarded due to a routing data error[a)]	MSUs/SP	F, R, P, N N, F, P	1st & Δ 30 min	–	No Yes	Perm. Perm.	2.3.3/Q.704
5.6 User Part Unavailable MSU transmitted[b)]	Event/UP/SP	F, R, C, P	1st & Δ	–	No	Perm.	11.7.2/Q.704
5.7 User Part Unavailable MSU received[b), c)]	Event/UP/SP	F, R, C, P	1st & Δ	–	No	Perm.	11.7.2/Q.704
5.8 TFC received	Event/SP/ cong.level	F, R, P	1st & Δ	–	No	Perm.	

a) The number of MSUs discarded can be used to trigger the MTP Route Verification Test (MRVT) described in 2.2/Q.753.

b) If either of these measurements exceeds an implementation-dependent threshold, the management process is informed.

c) Includes UPU received for a not-equipped MTP User. The management process is informed immediately for this occurrence.

NOTE – Managed objects are signalling point, MTP User.

TABLE 6/Q.752

MTP Signalling Traffic Distribution (Signalling Route Utilization)

Description of Measurements	Units	Usage	Duration	From	Obl.	Act./Perm.	References
6.1 Number of SIF and SIO octets received with given OPC[a)]	Octets/OPC	A, N, P P, A, N	15 min 30 min	6.6	No No		
6.2 Number of SIF and SIO octets transmitted with given DPC[a)]	Octets/DPC	P, A, N P, A, N	15 min 30 min	6.6	No No		
6.3 Number of SIF and SIO octets handled with given SIO	Octets/SIO	P, A, N P, A, N	15 min 30 min	6.6	No No		
6.4 Number of SIF and SIO octets received with given OPC and SIO[a)]	Octets/SIO/OPC	P, A, N P, A, N	15 min 30 min	6.6	No No		
6.5 Number of SIF and SIO octets transmitted with given DPC and SIO[a)]	Octets/SIO/DPC	P, A, N P, A, N	15 min 30 min	6.6	No No		
6.6 Number of SIF and SIO octets handled with given OPC, DPC and SIO[b)]	Octets/SIO/ OPC/DPC	P, A, N P, A, N	5 min 30 min	–	No No		
6.7 Number of MSUs handled with given OPC, DPC and SIO[b)]	MSUs/SIO/ OPC/DPC	A, P, R, N P, A, N	5 min 30 min	–	No No		

a) Activation of these measurements should be limited to a small number of signalling point codes at a given time.

b) Activation of these measurements should be limited to a small number of OPC/DPC combinations at a given time.

NOTE – Managed objects are signalling route and signalling linkset NE part.

TABLE 7/Q.752

SCCP Error Performance

Description of Measurements	Units	Usage	Duration	From	Obl.	Act./Perm.	References
7.1 Routing Failure – No translation for address of such nature[a)]	Events	F, R, P N	1st & Δ 30 min	–	Yes[c)]	Act. Perm.	2.4/Q.714
7.2 Routing Failure – No translation for this specific address[a)]	Events	F, R, P N	1st & Δ 30 min	–	Yes[c)]	Act. Perm.	2.4/Q.714
7.3 Routing Failure – Network Failure (Point Code not available)	Events	F, R, P N	1st & Δ 30 min	–	Yes[c)]	Act Perm.	2.4/Q.714
7.4 Routing Failure – Network Congestion	Events	F, R, P N	1st & Δ 30 min	–	Yes[c)]	Act. Perm.	2.4/Q.714
7.5 Routing Failure – Subsystem Failure (unavailable)	Events	F, R, P, C N	1st & Δ 30 min	–	Yes[c)]	Act. Perm.	2.4/Q.714
7.6 Routing Failure – Subsystem Congestion[b)]	Events	F, R, P N	1st & Δ 30 min	–	Yes[c)]	Act. Perm.	2.4/Q.714
7.7 Routing Failure – Unequipped user (Subsystem)	Events	F, R, C N	1st & Δ 30 min	–	Yes[c)]	Act. Perm.	2.4/Q.714
7.8 Syntax Error Detected	Events	F, R, P –	1st & Δ 30 min	–	Yes[c)]	Act. Perm.	4.3/Q.714
7.9 Routing Failure – Reason unknown	Events	F, R, P, C N	1st & Δ 30 min	–	Yes[c)]	Act. Perm.	2.4/Q.714

a) These measurements are only required at SCCP nodes with global title translation capabilities.

b) For further study.

c) Recommendation Q.791 (*Blue Book*) had duration "on occurrence" marked as obligatory. See 6.2/Q.750 for compatibility between implementations to Recommendation Q.791 and this Recommendation.

NOTE – Managed objects to be specified (but includes SCCP routing tables).

TABLE 8/Q.752

SCCP Subsystem Availability

Description of Measurements	Units	Usage	Duration	From	Obl.	Act./Perm.	References
8.1 Start of local SCCP unavailable – Failure[a)]	Event	F, R, P, C	On occur.	–	No	Perm.	
8.2 Start of local SCCP unavailable – Maintenance made busy[a)]	Event	R, P, C	On occur.	–	No	Perm.	
8.3 Start of local SCCP unavailable – Congestion[a)]	Event	F, R, P, C	On occur.	–	No	Perm.	
8.4 Stop of local SCCP unavailable – All reasons[a)]	Event	F, R, P, C	On occur.	–	No	Perm.	
8.5 Duration of local SCCP unavailable – All reasons[a)]	s	P, N	30 min	8.1, 8,2, 8.3, 8.4	No	Perm.	
8.6 Subsystem out-of-service request granted	Event	C, R	On occur.	–	[b)]	Perm.	5.3.5.3/Q.714
8.7 Subsystem out-of-service request denied	Event	C, R	On occur.	–	[b)]	Perm.	5.3.5.3/Q.714

a) These measurements are system architecture dependent.

b) These measurements are obligatory for replicated subsystems.

NOTE – Managed objects to be specified (include subsystem availability status).

TABLE 9/Q.752

SCCP – Utilization

Description of Measurements	Units	Usage	Duration	From	Obl.	Act./perm.	References
9.1 UDTS messages sent moved to 9 *bis*.2							
9.2 UDTS messages received moved to 9 *bis*.4							
9.3 Total messages handled (from local or remote subsystems)	Msgs	P, R, N N, P	5 min 30 min	–	No No	Perm.	2.3/Q.714
9.4 Total messages intended for local subsystems	Msgs	P, R, N N, P	5 min 30 min	–	No No	Perm.	2.3/Q.714
9.5 Total messages requiring global title translation[a)]	Msgs	P, R, N N, P	5 min 30 min	–	No No	Perm.	2.2/Q.714
9.6 Total messages originating (for connectionless classes 0,1 only) per source SSN	Msgs/ class/SSN	P, R, N N, P	5 min 30 min	–	No Yes	Perm.	1.1.2/Q.714
9.7 Total messages received (for connectionless classes 0,1 only) per sink SSN	Msgs class/SSN	P, R, N N, P	5 min 30 min	–	No Yes	Perm.	1.1.2/Q.714
9.8 Messages sent to a backup subsystem	Msgs/SS	P, R, N N, P	5 min 30 min	–	No [b)]	Perm.	5.3.2/Q.714
9.9 DT1 messages received from MTP per sink SSN	Msgs/SSN	P, R, N N, P	5 min 30 min	–	No	Perm.	3.5/Q.714
9.10 DT1 messages sent to MTP per source SSN	Msgs/SSN	P, R, N N, P	5 min 30 min	–	No	Perm.	3.5/Q.714
9.11 DT2 messages received from MTP per sink SSN	Msgs/SSN	P, R, N N, P	5 min 30 min	–	No	Perm.	3.5/Q.714
9.12 DT2 messages sent to MTP per source SSN	Msgs/SSN	P, R, N N, P	5 min 30 min	–	No	Perm.	3.5/Q.714
9.13 ED messages sent to MTP per source SSN	Msgs/SSN	P, R, N N, P	5 min 30 min	–	No	Perm.	3.6/Q.714
9.14 ED messages received from MTP per sink SSN	Msgs/SSN	P, R, N N, P	5 min 30 min	–	No	Perm.	3.6/Q.714

a) This measurement is required only at SCCP nodes with global title translation capabilities.

b) 30 minute measurement is obligatory for replicated subsystems.

NOTE – Managed objects for further study.

TABLE 9 *bis*/Q.752

SCCP – Quality of Service

Description of Measurements		Units	Usage	Duration	From	Obl.	Act./Perm.	References
9 *bis*.1	UDT messages sent	Msgs	P, R P	5 min 30 min	9.6 & 9 *bis*.2	No	Perm.	4.1/Q.714
9 *bis*.2	UDTS messages sent	Msgs	P, R, F P, F	5 min 30 min	–	No	Perm.	4.2/Q.714
9 *bis*.3	UDT messages received	Msgs	P, R P	5 min 30 min	9.7 & 9 *bis*.4	No	Perm.	4.1/Q.714
9 *bis*.4	UDTS messages received	Msgs	P, R, F P, F	5 min 30 min	–	No	Perm.	4.2/Q.714
9 *bis*.5	CR messages sent to MTP plus ISDN-UP embedded CRs (ffs)	Msgs	P, R P	5 min 30 min	–	No	Perm.	3.1/Q.714
9 *bis*.6	CREF messages sent to MTP	Msgs	P, R P	5 min 30 min	–	No	Perm.	3.2/Q.714
9 *bis*.7	CR messages received from MTP plus ISDN-UP embedded CRs (ffs)	Msgs	P, R P	5 min 30 min	–	No	Perm.	3.1/Q.714
9 *bis*.8	CREF messages received from MTP	Msgs	P, R P	5 min 30 min	–	No	Perm.	3.2/Q.714
9 *bis*.9	RSR messages sent to MTP	Msgs	P, R P	5 min 30 min	–	No	Perm.	3.7/Q.714
9 *bis*.10	RSR messages received from MTP	Msgs	P, R P	5 min 30 min	–	No	Perm.	3.7/Q.714
9 *bis*.11	ERR messages sent to MTP	Msgs	P, R P	5 min 30 min	–	No	Perm.	3.10/Q.714
9 *bis*.12	ERR messages received from MTP	Msgs	P, R P	5 min 30 min	–	No	Perm.	3.10/Q.714
9 *bis*.13	XUDT messages sent (ffs)	Msgs	P, R P	5 min 30 min	–	No	Perm.	4.1/Q.714
9 *bis*.14	XUDTS messages sent (ffs)	Msgs	P, R, F P, F	5 min 30 min	–	No	Perm.	4.2/Q.714
9 *bis*.15	XUDT messages received (ffs)	Msgs	P, R P	5 min 30 min	–	No	Perm.	4.1/Q.714
9 *bis*.16	XUDTS messages received (ffs)	Msgs	P, R, F P, F	5 min 30 min	–	No	Perm.	4.2/Q.714

TABLE 10/Q.752

ISDN User Part Availability

	Description of Measurements	Units	Usage	Duration	From	Obl.	Act./Perm.	References
10.1	Start of local ISDN-UP unavailable-failure[b)]	Event	F, P, R	On occur.	–	No	Act.	11.2.7/Q.704
10.2	Start of local ISDN-UP unavailable – maint. made busy[b)]	Event	P, R, C	On occur.	–	No	Act.	
10.3	ISDN-UP available[b)]	Event	F, P, R, C	On occur.	–	No	Act.	11.2.7/Q.704
10.4	Total duration ISDN-UP unavailable[b)]	s	P, N	30 min	10.1, 10.2, 10.3	No	Act.	
10.5	Start of local ISDN-UP congestion[a)]	Event	P, R	On occur.	–	No	Act.	2.12/Q.764
10.6	Stop of local ISDN-UP congestion	Event	P, R	On occur.	–	No	Act.	2.12/Q.764
10.7	Duration of local ISDN-UP congestion[a)]	s	P	30 min	10.5, 10.6	No	Act.	2.12/Q.764
10.8	Start of remote ISDN-UP unavailable[b), c)]	Event/dest.	F, P, C, R	On occur.	–	No	Act.	2.14/Q.764 2.15/Q.764
10.9	Stop of remote ISDN-UP unavailable[b), c)]	Event/dest.	F, P, C, R	On occur.	–	No	Act.	2.14/Q.764 2.15/Q.764
10.10	Duration of remote ISDN-UP unavailable[b), c)]	s/dest.	P	30 min	10.8, 10.9	No	Act.	2.14/Q.764 2.15/Q.764
10.11	Start of remote ISDN-UP congestion[c)]	Event/dest.	P, R	On occur.	–	No	Act.	2.12/Q.764
10.12	Stop of remote ISDN-UP congestion[c)]	Event/dest.	P, R	On occur.	–	No	Act.	2.12/Q.764
10.13	Duration of remote ISDN-UP congestion[c)]	s/dest.	P	30 min	10.11, 10.12	No	Act.	2.12/Q.764

a) If required, this measurement is only activated if the congestion exceeds an implementation-dependent threshold.

b) These measurements are system architecture dependent.

c) Remote measurements are only necessary at gateway signalling points.

NOTE – Managed objects for further study.

TABLE 11/Q.752

ISDN User Part Utilization

Description of Measurements	Units	Usage	Duration	From	Obl.	Act./Perm.	References
11.1 Total ISDN-UP messages sent	Msgs/type	N, P, R P, N	5 min 30 min	–	a)	Act.	
11.2 Total ISDN-UP messages received	Msgs/type	N, P, R P, N	5 min 30 min	–	a)	Act.	

a) Only the sum over all message types is obligatory. The count per type is non-obligatory.

NOTE – Managed objects for further study.

TABLE 12/Q.752

ISDN User Part errors

Description of Measurements		Units	Usage	Duration	From	Obl.	Act./Perm.	References
12.1	No ack. for ckt. reset within T17	Event/CIC/dest.	F, R	1st & Δ	–	No	Act.	2.10.3.1/Q.764
12.2	No GRA received for GRS within T23	Event/CIC/dest.	F, R	1st & Δ	–	No	Act.	2.10.3.2/Q.764
12.3	Measurement replaced							
12.4	Measurement replaced							
12.5	RLC not received within T5	Event/CIC/dest.	F, R	On occur.	–	Yes	Act.	2.10.6.2/Q.764
12.6	Release initiated due to abnormal conditions	Event/CIC/dest.	F, R	1st & Δ	–	Yes	Act.	2.10.8.3/Q.764
12.7	Circuit BLO (excessive errors detected by CRC)	Event/CIC/dest.	F, R	On occur.	–	No	Act.	G.704
12.8	Missing blocking ack. in CGBA for previous CGB	Event/CIC/dest.	F, R	1st & Δ	–	Yes	Act.	2.9.2.3 iv)/Q.764
12.9	Missing unblocking ack. in CGUA for previous CGU	Event/CIC/dest.	F, R	1st & Δ	–	Yes	Act.	2.9.2.3 iv)/Q.764
12.10	Abnormal blocking ack. in CGBA for previous CGB	Event/CIC/dest.	F, R	1st & Δ	–	Yes	Act.	2.9.2.3 v)/Q.764
12.11	Abnormal unblocking ack. in CGUA for previous CGU	Event/CIC/dest.	F, R	1st & Δ	–	Yes	Act.	2.9.2.3 vi)/Q.764
12.12	Unexpected CGBA with abnormal blocking ack.	Event/CIC/dest.	F, R	1st & Δ	–	Yes	Act.	2.9.2.3 vii)/Q.764
12.13	Unexpected CGUA with abnormal unblocking ack.	Event/CIC/dest.	F, R	1st & Δ	–	Yes	Act.	2.9.2.3 viii)/Q.764

TABLE 12/Q.752

ISDN User Part errors *(concluded)*

Description of Measurements	Units	Usage	Duration	From	Obl.	Act./Perm.	References
12.14 Unexcepted BLA with abnormal blocking ack.	Event/CIC/dest.	F, R	1st & Δ	–	Yes	Act.	2.9.2.3 xii)/Q.764
12.15 Unexcepted UBA with abnormal unblocking ack.	Event/CIC/dest.	F, R	1st & Δ	–	Yes	Act.	2.9.2.3 xiii)/Q.764
12.16 No BLA received for BLO within T13 (old 12.3+)	Event/CIC/dest.	F, R	1st & Δ	–	Yes	Act.	2.10.4/Q.764
12.17 No UBA received for UBL within T15 (old 12.3+)	Event/CIC/dest.	F, R	1st & Δ	–	Yes	Act.	2.10.4/Q.764
12.18 No CGBA received for CGB within T19 (old 12.3+)	Event/CIC/dest.	F, R	1st & Δ	–	Yes	Act.	2.10.4/Q.764
12.19 No CGUA received for CGU within T21 (old 12.3+)	Event/CIC/dest.	F, R	1st & Δ	–	Yes	Act.	2.10.4/Q.764
12.20 Message format error (old 12.4+)	Event/CIC/dest.	F, R	1st & Δ	–	No	Act.	2.10.5/Q.764
12.21 Unexpected message received (old 12.4+)	Event/CIC/dest.	F, R	1st & Δ	–	No	Act.	2.10.5.1/Q.764
12.22 Release due to unrecognized info. (old 12.4+)	Event/CIC/dest.	F, R	1st & Δ	–	No	Act.	2.10.5.3/Q.764
12.23 Inability to release a circuit[a)]	Event/CIC	F, R	1st & Δ	–	Yes	Act.	2.10.8.1/Q.764

a) This measurement is implementation dependent.

NOTE – Managed objects for futher study.

TABLE 13/Q.752

Local TC Utilization

Description of Measurements	Units	Usage	Duration	From	Obl.	Act./Perm.	References
13.1 Total number of TC messages sent by the node (by message type)	Messages	P, R N	5 min 30 min	–	a)	Perm.	
13.2 Total number of TC messages received by the node (by message type)	Messages	P, R N	5 min 30 min	–	a)	Perm.	
13.3 Total number of components sent by the node	Comps	P, R N	5 min 30 min	–	No	Act.	3.1/Q.772
13.4 Total number of components received by the node	Comps	P, R N	5 min 30 min	–	No	Act.	3.1/Q.772
13.5 Total number of active TC transactions[b)]	Trans.	P, R N	5 min 30 min	–	No	Act.	Q.774, clause?
13.6 Total number of used TC trans. ids.[c)]	Trans.	P, R N	5 min 30 min	–	No	Act.	Q.774, clause?

a) Only the sum over all message types is obligatory. Each total per type is non-obligatory.

b) This is to be compared against the range of transaction identities. "Active" means that the transaction is open, although there might be no activity within TC in this transaction at the time the measurement is made.

c) "Used" means that the transaction identity can not be selected, although not necessarily allocated to an active transaction.

NOTE – Managed objects for further study.

TABLE 14/Q.752

TC Fault Measurements

Description of Measurements	Units	Usage	Duration	From	Obl.	Act./Perm.	References
14.1 Protocol error detected in transaction portion (abort received) – with P-abort cause:							2.3/Q.774
a) unrecognized message type	Event	F, R	1st & Δ	–	Yes	Act.	
b) incorrect TP	Event	F, R	1st & Δ	–	Yes	Act.	
c) badly formatted TP	Event	F, R	1st & Δ	–	Yes	Act.	
d) unrecognized TID	Event	F, R	1st & Δ	–	Yes	Act.	
e) resource limitation	Event	F, R	1st & Δ	–	No	Act.	
14.2 Protocol error detected in component portion (reject received) – with problem code:							3.8/Q.772
a) unrecognized component (general problem)	Event	F, R	1st & Δ	–	Yes	Act.	
b) mistyped component (general problem)	Event	F, R	1st & Δ	–	Yes	Act.	
c) badly structured component (general problem)	Event	F, R	1st & Δ	–	Yes	Act.	
d) unrecognized linked id. (invoke) (invoke problem)	Event	F, R	1st & Δ	–	No	Act.	
e) unrecognized invoke id. (return result problem)	Event	F, R	1st & Δ	–	No	Act.	
f) return result (RR) unexpected (return result problem)	Event	F, R	1st & Δ	–	No	Act.	
g) unrecognized invoke id. (RE) (return error problem)	Event	F, R	1st & Δ	–	No	Act.	
h) return error (RE) unexpected (return error problem)	Event	F, R	1st & Δ	–	No	Act.	
NOTE – Managed objects for further study.							

TABLE 14/Q.752 *(continued)*

TC Fault Measurements

Description of Measurements	Units	Usage	Duration	From	Obl.	Act./Perm.	References
14.3 TC user generated problems (TC-user Reject received):							3.8/Q.772
a) duplicate invoke id. (invoke problem)	Event	F, R	1st & Δ	–	No	Act.	
b) unrecognized operation (invoke problem)	Event	F, R	1st & Δ	–	No	Act.	
c) mistyped parameter (invoke problem)	Event	F, R	1st & Δ	–	No	Act.	
d) resource limitation (invoke problem)	Event	F, R	1st & Δ	–	No	Act.	
e) initiating release (invoke problem)	Event	F, R	1st & Δ	–	No	Act.	
f) linked response unexpected (invoke problem)	Event	F, R	1st & Δ	–	No	Act.	
g) unexpected linked operation (invoke problem)	Event	F, R	1st & Δ	–	No	Act.	
h) unrecognized error (return error problem)	Event	F, R	1st & Δ	–	No	Act.	
i) unexpected error (return error problem)	Event	F, R	1st & Δ	–	No	Act.	
j) mistyped parameter (return result problem)	Event	F, R	1st & Δ	–	No	Act.	
k) mistyped parameter (return error problem)	Event	F, R	1st & Δ	–	No	Act.	
NOTE – Managed objects for further study.							

TABLE 14/Q.752 *(continued)*

TC Fault Measurements

Description of Measurements	Units	Usage	Duration	From	Obl.	Act./Perm.	References
14.4 Protocol error detected in component portion (reject sent) – with problem code:							2.3/Q.772
a) unrecognized message type	Event/dest. User	F, R	1st & Δ	–	No	Act.	
b) incorrect TP	Event/dest. User	F, R	1st & Δ	–	No	Act.	
c) badly formatted TP	Event/dest. User	F, R	1st & Δ	–	No	Act.	
d) unrecognized TID	Event/dest. User	F, R	1st & Δ	–	No	Act.	
e) resource limitation	Event/dest. User	F, R	1st & Δ	–	No	Act.	
14.5 Protocol error detected in component portion (reject sent) – with problem code:							8/Q.772
a) unrecognized component (general problem)	Event	F, R	1st & Δ	–	No	Act.	
b) mistyped component (general problem)	Event	F, R	1st & Δ	–	No	Act.	
c) badly structured component (general problem)	Event	F, R	1st & Δ	–	No	Act.	
d) unrecognized linked id. (invoke problem)	Event	F, R	1st & Δ	–	No	Act.	
e) unrecognized invoke id.(return result problem)	Event	F, R	1st & Δ	–	No	Act.	
f) return result unexpected (RR problem)	Event	F, R	1st & Δ	–	No	Act.	
g) unrecognized invoke id. (return error problem)	Event	F, R	1st & Δ	–	No	Act.	
h) return error unexpected (return error problem)	Event	F, R	1st & Δ	–	No	Act.	
NOTE – Managed objects for further study.							

TABLE 14/Q.752 *(concluded)*

TC Fault Measurements

Description of Measurements	Units	Usage	Duration	From	Obl.	Act./Perm.	References
14.6 TC-user generated problems TC-user reject sent:							8/Q.772
a) duplicate invoke id. (invoke problem)	Event/dest. User	F, R	1st & Δ	–	No	Act.	
b) unrecognized operation (invoke problem)	Event/dest. User	F, R	1st & Δ	–	No	Act.	
c) mistyped parameter (invoke problem)	Event/dest. User	F, R	1st & Δ	–	No	Act.	
d) resource limitation (invoke problem)	Event/dest. User	F, R	1st & Δ	–	No	Act.	
e) initiating release (invoke problem)	Event/dest. User	F, R	1st & Δ	–	No	Act.	
f) linked response unexpected (invoke problem)	Event/dest. User	F, R	1st & Δ	–	No	Act.	
g) unexpected linked operation (invoke problem)	Event/dest. User	F, R	1st & Δ	–	No	Act.	
h) unrecognized error (return error problem)	Event/dest. User	F, R	1st & Δ	–	No	Act.	
i) unexpected error (return error problem)	Event/dest. User	F, R	1st & Δ	–	No	Act.	
j) mistyped parameter (return result problem)	Event/dest. User	F, R	1st & Δ	–	No	Act.	
k) mistyped parameter (return error problem)	Event/dest. User	F, R	1st & Δ	–	No	Act.	
NOTE – Managed objects for further study.							