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SERIES Q: SWITCHING AND SIGNALLING

Specifications of Signalling System No. 7 – Signalling System No. 7 management

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Monitoring and measurements for Signalling System No. 7 networks

ITU-T Recommendation Q.752

(Previously CCITT Recommendation)

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ITU-T RECOMMENDATION Q.752

MONITORING AND MEASUREMENTS FOR SIGNALLING SYSTEM No. 7 NETWORKS

Summary

This Recommendation defines measurements appropriate to the management of the resources in the SS No. 7 network. These measurements are classified as pertinent to fault management, configuration management, performance management, message traffic accounting, and network planning and administration

This Recommendation defines just the primitive data for collection; the filtering and manipulation of them to provide statistics is left to other Recommendations, as is the control (i.e. starting and stopping, collection of results) of these measurements.

Some of the measurements are marked as obligatory, these form the minimum set recommended for use in the international network.

Sets of measurements are defined for each SS No. 7 level. Each manageable resource of each SS No. 7 level has a number of measurements, partitioned according to one or more of the classifications of fault management, configuration management, etc.

Guidelines for the uses of measurements are given.

The main revisions to the 1993 version of this Recommendation are the addition of measurements for message traffic accounting, the enhancement of measurements for the SCCP – including hop counter violations, segmenting and reassembly errors, and a reduction in the number of the Transaction Capabilities (TCs) operational measurements.

Source

ITU-T Recommendation Q.752 was revised by ITU-T Study Group 11 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on the 5th of June 1997.

FOREWORD

ITU (International Telecommunication Union) is the United Nations Specialized Agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the ITU. 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, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 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, the ITU had/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.

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Recommendation Q.752

MONITORING AND MEASUREMENTS FOR SIGNALLING SYSTEM No. 7 NETWORKS

(revised in 1997)

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;

– this Recommendation 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.;

– this Recommendation does not describe any filtering techniques to be applied after measurements are taken (apart from the "first and interval" method to reduce the number of output reports). The Q.820-Series of Recommendations define filtering techniques useful for control of the SS No. 7 network. In particular, Recommendation Q.822 defines packages of counters, grouped into one data object. So, for instance, if the operator wishes to monitor error performance, all counters in a group could be activated at the same time. The distinction made in the 1993 version of Recommendation Q.752 between "permanent" and "activated" measurements also disappears – all measurements are inherently "activated", permanency can be achieved by keeping a measurement activated all the time.

1.1.2 The measurements defined in this Recommendation are intended to be controlled through the use of the operations, maintenance and administration part defined in Recommendations Q.750 to Q.755. The Q.751-Series of Recommendations define 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 this 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 is provided (see clauses 2 to 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

The Q.751-Series of Recommendations contain a description of the operations that may be performed upon measurement managed objects. 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 Recommendation X.701), the penultimate one is equivalent to the "administration" category of Recommendation 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 utilizes 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.

1.6.5 network administration and planning (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.

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.

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.

Where the first report of the "1st & interval" measurements contains more required information than that to be given out associated with the interval, there is a "Report" column indicating what is to be output in the first report, and also a "Units" column containing the registration items applied in the

interval. Essentially, what is required in the first report is a "dump" of the message being reported, whereas the interval measurement is usually an accumulation over all events of this type in the interval.

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.

1.8 Techniques for filtering measurements

1.8.1 Single faults giving rise to multiple error reports

Where a single fault could cause recurring event reports (e.g. a single MTP routing data corruption could result in many MSUs being discarded), the first and interval measurement technique can be used. The initial report should contain enough information to establish the location of the fault, the interval count will then indicate its severity. The interval should be short enough to allow real time control. This technique presents information essential to the maintenance staff, and filters out that which is redundant.

2 MTP monitoring and measurements

2.1 General

The measurements for MTPs according to Recommendation Q.2210 have yet to be defined in detail; however, the ones included here for Level 3 are likely to be appropriate also in the broadband environment.

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].

Signalling link set and route set availability indicators are detailed in Table 4. These relate to the MTP managed objects signalling link set, signalling link set NE part, signalling route set and signalling route set 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.

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

These relate to the MTP managed objects signalling route and signalling link set 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 to 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 measurements 1.2, 1.12, 2.5 and 2.6.

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/Q.704 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 is deleted.

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 link set 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 link set 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 route set 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 route set 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. It should be noted that the modelling of Item 4.6 in the 1996 version of Recommendation Q.751.1 might cause a problem – the reporting of one link set becoming available should not cause the alarm status of link sets which are still failed to be reset. For example, if a Transfer Prohibited message referring to SP A, and another TFP referring to SP B were received in an SP X, currently Q.751.1 modelling would reset alarms at X for both SP A and SP B if a Transfer Allowed message referring to, for example SP B were subsequently received in X, without a TFA referring to A having been received.

2.5.7 Item 4.13 is a record of failures and recoveries (and all other availabilities and unavailabilities) of a link set. The identity of the new link set used (if any), and the old link set 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 route set 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 link set or per route 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 Indicator (SI) or set of SI basis. For an example of a set of point codes that might be used as a basis, Recommendation Q.708 defines the format of International Point Codes. Resolution down to the area or network is done in the 11 most significant bits, and the set could be all those SPs in an area. Another possibility for the set could be all Point Codes.

The measurements are not obligatory. They may be used to diagnose focused signalling overloads.

2.7.3 It should be possible, possibly by activating just a few combinations of OPC (or OPC sets), DPC (or DPC sets) and SI (or SI sets) 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, Item 6.7 measures the message dispersion. The effect on the signalling point and network performance should be considered when taking these measurements.

Measurements using SI or SI set for registration could additionally use, say, one particular SI value to identify an MTP User under study, and a set of SIs containing all other SIs pertinent in the network.

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 and congestion 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 (L)(X)Unitdata Service message or N-NOTICE primitive is returned to the originator. Receipt of a (L)(X)Unitdata Service message is not included in this count. The measurements refer to both primary and secondary entities, or just the primary if no secondary entity is prescribed.

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

The measurements are also marked as "30 minutes" for network dimensioning and reliability studies.

The reassembly error measurements (Items 7.10 through 7.12) are prescribed for the SCCP connectionless reassembly service. Item 7.12 (no reassembly space) indicates a resource limitation when the first segment of a sequence is received.

Item 7.13 (Hop counter violation) indicates a routing failure, possibly an SCCP circular route. All hop counter violations are reported with this Item, including those from Connection Request messages.

The report associated with the first event of Items 7.10 and 7.11 should contain at least the calling party address and the segmentation local reference as diagnostic information.

The report associated with the first event of Item 7.13 should contain as diagnostic information at least the called party address, and the OPC of the MTP routing label. If present, the calling party address should also be included.

The report associated with the first event of Item 7.14 should contain as diagnostic information the subsystem number and called party address.

The reports associated with the first event of Items 7.15, 7.16, 7.17 and 7.18 should contain as diagnostic information at least the MTP Service Access Point (SAP) identity (implementation dependent), the connection references (local and remote) and the DPC.

Items 7.17 and 7.18 should also contain the cause.

3.3 Table 8

3.3.1 Item 8.5 is deleted.

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.

3.3.4 Care should be taken in the information modelling of Items 8.9 and 8.10, and 8.11 and 8.12. The ending of prohibition for one subsystem should not lift the alarms for other still-prohibited subsystems.

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 transiting an SCCP relay point is counted only once.

Item 9.4 is for messages received for local subsystems. This includes, for example, RLC messages received in a relay node for a connection section, CR or (L)(X)UDT messages received for an unequipped subsystem, etc.

Both Items include any internal messages between users in the same SCCP node.

3.4.3 Measurement 9.5 measures the utilization of the translation function within SCCP Routing Control and is a count of all messages [including locally generated (L)(X)UDTS 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 [as present in the protocol class parameter of (L)(X)UDT messages] and per SSN. Item 9.6 is counted at the origin per source SSN and refers to messages delivered to an MTP Service Access Point, Item 9.7 is counted at the destination per sink SSN and refers to messages received from an MTP Service Access Point.

3.4.5 Measurement 9.8 refers only to those messages which would normally have been routed to a local 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 that are originated by or delivered to a local subsystem through SCCP connection oriented services. They are counted per SSN.

3.5 Table 9 *bis*

3.5.1 The SCCP Quality of Service (QOS) 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 protocol errors detected on existing signalling connections (9 *bis*.9 to 9 *bis*.12) to the total number of successful connection establishments, 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), and the number of unsuccessful LUDT transfers (Items 9 *bis*.18 and 9 *bis*.20) to the total number of LUDT transfers (9 *bis*.17 and 9 *bis*.19). All of these measurements are taken over 5-minute periods (R) or 30-minute periods.

It should be noted that the number of (L)(X)UDTS messages measured against the number of successful (L)(X)UDT messages does not directly give the SCCP QOS, since the return on error option is not always set in (L)(X)UDT messages. Errors in transmission of segments of long messages might also affect the ratio, since it is an implementation decision at a segmenting node to request the return option in the first segment or in all.

The quantity of CREF messages can give only an indication of SCCP QOS, since the SCCP user is the most likely generator of the CREF, rather than the SCCP. Timeout of establishment timers, reception of ERR or RLSD messages also have a bearing on the SCCP QOS.

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 Item 13.7 is a count of all new transactions in the interval, including those closed immediately by an ABORT after the opening BEGIN.

Item 13.8 is a measurement of the mean number of open transactions in the interval. An open transaction is one to which a transaction identity has been allocated, and this identity is not yet frozen.

Measurement 13.10 (the cumulative mean duration of transactions) is the mean duration for all transactions that began between the start of measurements and the end of the measurement interval.

It includes the time from opening the transaction to the end of the interval, for those transactions that did not close during the interval. Here, the transaction duration is defined as the time from allocation of the transaction identity to freezing it.

See clause 5.2.2 for more information.

5.2.2 An example of collection of measurements

A model to describe the collection of Items 13.8 and 13.10, used to explain possible measurement techniques but which is not intended to specify implementation, is as follows:

Suppose a system collects measurements in a number *s* of "measurement centres". A measurement centre can be defined as a point in the system that launches, or observes directly the launching of, a TC transaction, and it also either finishes the transaction, or observes directly its passing. This point is assumed also to be able to count the number of free, frozen and thawing transaction identities with which it is concerned. Thus in a multiprocessor system, there might be one (or more) measurement centre(s) per processor per Application Entity definition, which is responsible for launching all the transactions (instances) of that Application Entity. In order for measurements collected by all the centres to refer to the same interval, it is assumed that each centre has a clock which "ticks" at a rate sufficiently high to be able to measure with the required precision. The clocks are also assumed to be synchronized to within one clock tick (if they were not, further calculations would be needed to determine the overall precision). If necessary, each centre would have an "active" set of measurements, and another set taken in the previous measurement interval, which might be awaiting collection.

Measurement 13.8 is the mean number of open transactions, estimated over a measurement interval, observations are taken at each new transaction during the interval.

The measurements can be over the whole Application Entity, or at each centre, and then accumulated for the whole Application Entity.

Define a cumulative total A_c of open transactions (this is set to 0 at the start of each measurement interval), and define a as the number of open transactions at any time. a is set to 0 at system initialisation, it is incremented at each transaction arrival, and decremented when each transaction leaves. Define n as the number of new transactions arriving during the measurement interval (which is set to 0 at the start of each interval).

When a transaction arrives, set:

$$A_c = A_c + a; \quad a = a + 1; \quad n = n + 1$$

When a transaction finishes, set:

$$a = a - 1$$

When the reporting event occurs at the end of the measurement interval, report A_c, n and a. Then initialize A_c and n to 0.

The mean number of open transactions during the interval for this measurement centre is $\frac{A_c}{n}$, for several centres use the expression $\frac{\sum A_c}{\sum n}$

Item 13.10, the cumulative mean duration of transactions, requires that those transactions that were open at the start of measurements (but **not** those open at the start of the interval), be excluded from the measurements. (It would be possible to include those open at the start of measurements, if some

estimate of their age could be made, but for simplicity this is not considered here.) In order to do this, the transaction record itself needs an indicator equal to an overall (measurement centre) value set when measurements start, and unset when measurements finish, in order to exclude transactions which started before measurements did.

For this measurement, the following variables are kept at each measurement centre:

– A running cumulative transaction length time T_C. This is set to 0 at the start of measurements, but is kept running during the successive measurement intervals.

– A cumulative transaction arrival counter R_C. This is initialized to 0 at the start of measurements, and is kept running during the successive measurement intervals.

– A counter *time* which is set to 0 at the start of measurements, and is incremented by 1 for each clock tick.

The measurement is performed as follows:

1) when a transaction arrives, set $T_c = T_c - time$; $R_c = R_c + 1$;

2) when a transaction finishes, if it started at or after the start of measurements, set $T_c = T_c + time$;

3) at the end of the measurement interval, report T_c, R_c and use a from Item 13.8 (but with a initialized at the start of measurements). The mean duration of transactions measured in this interval is $\frac{T_c + a.time}{R_c}$ for the centre, with appropriate extensions for the overall mean.

A possible alternative measurement could be the mean duration of new transactions occurring in the interval (providing those transactions open at the start of the interval, and long transactions, were catered-for separately). If this were required, then some form of "phase" indication would be required to be kept in each transaction record, so that the finish of a "new" transaction could be distinguished from the finish of a transaction that was open at the start of the interval. Then T_c, R_c, *time* and a would be kept relative to the interval, with them all set to 0 at its start.

5.3 Table 14

TC error performance and stability measurements are listed in Table 14. Measurements with detailed reasons can be found in Annex A, these are more appropriate during development of a service, rather than for operational use.

5.3.1 Measurement 14.4 e) (resource limitation) can indicate a local TC resource problem, and requires the maintenance staff to be notified.

Measurement 14.4 d) (unrecognized transaction identity) might indicate problems of an operational nature. Possible examples are:

- because of SCCP routing problems, the local TC has received a message for a transaction that never existed;
- messages arriving for transactions that have timed-out and been closed by the application.

To allow the source of the error to be traced, the originating address of the received message should be logged for later retrieval.

At the first report, sufficient additional information should be provided to establish the fault's location.

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);

– number of congestion events resulting in loss of MSUs (Item 3.11);
– start of link set failure (Item 4.3);
– stop of link set failure (Item 4.4);
– initiation of Broadcast TFP due to failure of measured link set (Item 4.5);
– initiation of Broadcast TFA for recovery of measured link set (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 link set (Item 4.2);
– start of link set failure (Item 4.3);
– stop of link set failure (Item 4.4);
– initiation of Broadcast TFP due to failure of measured link set (Item 4.5);
– initiation of Broadcast TFA for recovery of measured link set (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, link set, signalling point and route set 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 (see 2.7)

– number of SIF and SIO octets received:
  with given Origination Point Code (OPC) or set of OPCs (Item 6.1);
  with given OPC or set of OPCs and SI or set of SIs (Item 6.4);
– number of SIF and SIO octets transmitted:
  with given Destination Point Code (DPC) or set of DPCs (Item 6.2);
  with given DPC or set of DPCs and SI or set of SIs (Item 6.5);
– number of SIF and SIO octets handled:
  with given SI or set of SIs (Item 6.3);
  with given OPC or set of OPCs, DPC or set of DPCs and SI or set of SIs (Item 6.6);
– number of MSUs handled with given OPC set, DPC set and SI set (Item 6.7).

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:

– Hop counter violation (Item 7.13) (indicates a possible SCCP circular route);
– UDTS messages sent (Item 9 *bis*.2);
– XUDTS messages sent (Item 9 *bis*.14);
– LUDTS messages sent (Item 9 *bis*.18);
– UDTS messages received (Item 9 *bis*.4);
– XUDTS messages received (Item 9 *bis*.16);
– LUDTS messages received (Item 9 *bis*.20).

6.3.1.2 SCCP unavailability and congestion

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).

A remote SCCP measurement is:

– SCCP/subsystem congestion message received (Item 8.8).

6.3.1.3 Connectionless SCCP segmentation and reassembly faults

Items 7.10 and 7.11 count failures of the reassembly or segmentation processes, possibly due to MTP transport difficulties with the segments.

Item 7.12 is a "1st & interval" report of lack of reassembly space for new reassembly sequences.

Items 7.19 through 7.21, segmentation (e.g. to XUDT) and reassembly faults of LUDT messages are included.

6.3.2 SCCP configuration management

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

Measurements

– subsystem out of service grant message received (Item 8.6);
– subsystem out of service request denied (timeout of T_{coord}) (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);
  - XUDTS messages (Item 9 *bis*.16);
  - LUDT messages (Item 9 *bis*.19);
  - LUDTS messages (Item 9 *bis*.20);
  - DT1 messages/SSN (Item 9.9);
  - DT2 messages/SSN (Item 9.11);
  - ED messages/SSN (Item 9.14);
  - 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);
  - LUDT messages (Item 9 *bis*.17);
  - XUDTS messages (Item 9 *bis*.14);
  - LUDTS messages (Item 9 *bis*.18);
  - DT1 messages/SSN (Item 9.10);
  - DT2 messages/SSN (Item 9.12);
  - ED messages/SSN (Item 9.13);
  - 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);
- LUDT messages sent (Item 9 *bis*.17);
- UDTS messages received (Item 9 *bis*.4);
- XUDTS messages received (Item 9 *bis*.16);
- LUDTS messages received (Item 9 *bis*.20).

Connectionless incoming traffic

- UDT messages received (Item 9 *bis*.3);
- XUDT messages received (Item 9 *bis*.15);
- LUDT messages received (Item 9 *bis*.19);
- UDTS messages sent (Item 9 *bis*.2);

– XUDTS messages sent (Item 9 *bis*.14);
– LUDTS messages sent (Item 9 *bis*.18).

Connection-oriented establishments

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

b) 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).

Congestion

– SCCP/subsystem congestion (Item 8.3);
– SSC messages received (Item 8.8).

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 unrecognized 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 (TCs)

6.5.1 TC fault management measurements

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

Measurements (those of which are not of resource limitation are in Annex A)

– 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)].

During operation, resource limitation measurements 14.1 e), 14.3 d), 14.4 e) and 14.6 d) are pertinent. In addition, Items 14.7 through 14.11 are counts for protocol errors, and provide a summary for the Items in Annex A.

The purpose of these measurements is to monitor abnormal events of an operational nature, or peaks in errors that affect the quality of service offered to the TC users. They also provide the means to collect additional information that allows the source of the errors to be traced. To this end, a log of notifications which is retrievable on command (e.g. from an Operations System) could be kept.

Measurements 14.3 d) and 14.6 d) (resource limitations) indicate TC user resource problems when processing an invoked operation. They are included in the TC measurements as they might be applicable to a number of different TC users.

6.5.2 TC performance

The loading of TC resources may be indicated through the volume of messages and components handled. The dynamic loading of TC resources can be observed by counting the number of new transactions during an interval, the mean number of open transactions during an interval indicates the static loading of TC. The cumulative mean duration of transactions can be used for dimensioning TC and TC user resources, and to indicate operational problems.

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);

– number of new transactions during an interval (Item 13.6);

– mean number of open transactions during an interval (Item 13.7);

– cumulative mean duration of transactions (Item 13.9);

– maximum number of open transactions during an interval (Item 13.10).

In addition, an Operations System can use a measurement to activate this set of measurements:

– a report when the number of open transactions is greater than a pre-defined threshold (Item 13.11).

Items 13.10 and 13.11 are equivalent to the X.738 minMaxScanner and Q.822 gaugeThreshold respectively, but they utilize an internal counter per Application Entity which is not itself reported, and hence is not given as a measurement (this is the current number of open transaction identities for which a "snapshot" of open transactions at the measurement time is not necessarily representative of the performance of the Application Entity's transactions throughout the measurement interval). For an example of a possible method of implementing these measurements, see 5.2.1.

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.

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.

6.9 Near real time network control

This activity consists of managing the network configuration and routing tables to maintain service. For this, use is made of near real time measurements.

7 Accounting of MTP and SCCP message traffic

7.1 General

7.1.1 This clause covers all registration items appropriate to support cascade remuneration. This accounting method is based on the principle that the originator pays the operator (if different) of the next node in the message's path for delivering the message; the next node's operator pays the operator of its next node, and so on. The measurements here, because they differentiate on the basis of the destination of the messages, would allow all the network operators involved to be remunerated.

7.1.2 Two functions are defined for SS No. 7 message accounting:

1) verification of the number of messages sent for which the receiving operator should be paid (this function is optional);
2) registration by the receiving operator of the number of messages for which payment is to be received.

7.1.3 Two types of traffic registration are distinguished. The registration of the MTP signalling traffic refers to the usage of the "transfer" resources. The registration of the SCCP signalling traffic refers to the usage of the "relay" resources. Traffic registration will not only be needed for

remuneration but also for remuneration verification. Correlation between both kinds of traffic registration within one node is not required. The role of Signalling End Points (SEPs) and SCCP end points in accounting and accounting verification is for further study.

NOTE – The use of SI, SSN and SCCP class as registration items for accounting purposes should be considered in the light of the need for data protection, information security and fair competition (see Recommendation Q.756).

7.2 MTP traffic registration

MTP traffic registration is applicable within one Operator's MTP network or a group of Operators of one MTP network (e.g. different countries owning parts of the overall international signalling network). If required, these networks can also be subdivided into different parts (in order to apply different tariffs).

7.2.1 Basic registration principles

7.2.1.1 For remuneration purposes, the incoming MTP signalling traffic should be registered against the following items:

- The identity of the adjacent network operator sending the MTP message. If discrimination between several operators is not required, the identity of a group of these operators should be used.
- Destination information, as far as relevant for the accounting agreements. This information may identify one or more networks. If also required, network parts could be identified.
- Optionally, the identity of the requested service or group of services.

For each relevant combination, the number of messages transferred as well as the number of octets should be registered per specific time interval (e.g. every 30 minutes).

7.2.1.2 For remuneration verification, the outgoing MTP signalling traffic should be registered against the following items:

- The identity of the adjacent network operator receiving the MTP message. If discrimination between several operators is not required, the identity of a group of these operators should be used.
- Destination information, as far as relevant for the accounting agreements. This information may identify one or more networks. If also required, network parts could be identified.
- Optionally, the identity of the requested service or group of services.

For each relevant combination, the number of messages sent out as well as the number of octets should be registered per specific time interval (e.g. every 30 minutes).

7.2.1.3 The results of both periodic measurements should be provided with the date (year, month, day) and time (hours, minutes) of the start of each time interval.

7.2.1.4 The following MTP related information is used to identify the items involved in remuneration and remuneration verification:

- The ILS (Incoming Link Set) or set of ILSs should be used to identify the adjacent network operator or group of operators from which the MTP message was received.
- The OLS (Outgoing Link Set) or set of OLSs should be used to identify the adjacent network operator or group of operators to which the message is sent.
- The DPC or set of DPCs should be used to identify the relevant destination information.
- If the option is selected, the SI value or set of values should be used to identify the requested service or group of services.

7.2.2 Limitations

7.2.2.1 Although each network operator is responsible for defining the relevant combinations, limits should be placed on the number of registration items mentioned in 7.2.1.1 and 7.2.1.2. A limit should also be placed on the number of combinations.

7.2.2.2 The effect of retransmissions due to, for example, changeover can be ignored. Tariffs could always be adjusted to compensate for the predicted traffic volume from this effect.

7.2.2.3 No particular attempt will be made to account separately for, or exclude from accounting, MTP-own messages with SI = 0000 or 0001 (the number of messages should anyway be small).

7.3 SCCP traffic registration

SCCP traffic registration is applicable in all cases where a GTT (Global Title Translation) is done, for example, at relay nodes or at gateways between MTP networks.

7.3.1 Basic registration principles

7.3.1.1 For remuneration purposes, the incoming SCCP signalling traffic should be registered against the following items:

- The identity of the operator of the previous network adjacent to the gateway (where accounting is done) sending the SCCP message (identity of the previous SCCP node). If discrimination between several operators is not required, the identity of a group of these operators should be used.
- Destination information, as far as relevant for the accounting agreements. This information may identify one or more destination or intermediate networks. If also required, network parts could be identified.
- Optionally, the identity of the requested service application type (HLR, VLR, ISDN, SS, etc.) or group of service application types. The required number of such groups and their constituents is for further study.
- Optionally, the identity of the SCCP class requested (0, 1, 2 or 3).

For each relevant combination, the number of transferred messages as well as the number of SIF + SIO octets should be registered per specific time interval (e.g. every 30 minutes).

It is for further study for which network arrangements the last two registration items might be required.

7.3.1.2 For remuneration verification, the outgoing SCCP signalling traffic should be registered against the following items:

- The identity of the operator of the following network adjacent to the gateway (where accounting is done) which received the SCCP message (identity of the next SCCP node). If discrimination between several operators is not required, the identity of a group of these operators should be used.
- Destination information, as far as relevant for the accounting agreements. This information may identify one or more destination or intermediate networks. If also required, network parts could be identified.
- Optionally, the identity of the requested service application type (HLR, VLR, ISDN, SS, etc.) or group of service application types. The required number of such groups and their constituents is for further study.
- Optionally, the identity of the SCCP class used (0, 1, 2 or 3).

For each relevant combination, the number of messages sent out as well as the number of SIF + SIO octets should be registered per specific time interval (e.g. every 30 minutes).

It is for further study for which network arrangements the last two registration items might be required.

7.3.1.3 The results of both periodic measurements should be provided with the date (year, month, day) and time (hours, minutes) of the start of each time interval.

7.3.1.4 The following SCCP related information should be used to identify the items involved in remuneration and remuneration verification. For remuneration, the information of the received message should be used. For remuneration verification, the information resulting from the global title translation in the sending node should be used.

- The OPC [+ MTP service access point instance (which is implementation-dependent and indicates the MTP network)], as provided by the MTP to the SCCP, should be used to identify the operator of the previous node/network from which the SCCP message was received.
- The DPC [+ MTP service access point instance (which is implementation-dependent and indicates the MTP network)], resulting from a global title translation, should be used to identify the operator of the following node/network to which the SCCP message is sent.
- The following called party address global title items should be used to deduce the relevant destination information:
  - Global title indicator.
  - The relevant parts of the address information.
  - Nature of address indicator (optional).
  - Numbering plan (optional).
  - Translation type (optional).

  Whether or not the GTI, NAI, NP and TT are used, their values, and which parts of the address information are used, depend upon the particular network arrangements, and are for further study.

  NOTE 1 – Although a DPC may be used instead of a global title, it is assumed that accounting will only be needed between MTP network boundaries [in which case the GTAI (Global Title Address Information) is mandatory] and therefore the DPC is not included here.
- If the option is selected, the SSN or set of SSNs should be used to identify the requested service application type (HLR, VLR, ISDN, SS, etc.).

  NOTE 2 – The network operator will decide how to handle (to group) a called party address with a SSN value 0 or SSN that is not recognized and/or standardized.
- If the option is selected, the "protocol class" parameter field should be used to identify the requested SCCP class (0, 1, 2 or 3).

7.3.2 Limitations

7.3.2.1 Although the network operator is responsible for defining the relevant combinations, limits should be placed on the number of registration items mentioned in 7.3.1.1 and 7.3.1.2. A limit should also be placed on the number of combinations.

7.3.2.2 No particular attempt will be made to account separately for, or exclude from accounting, SCCP-own messages with SSN = H01 (the number of messages should anyway be small).

Table 1/Q.752 – MTP signalling link faults and performance

	Description of measurements	Units	Usage	Duration	From	Obl.	References
1.1	Duration of link in the In-service state	s/SL	F, P, N	30 min	1.2, 1.12	Yes	
1.2	SL failure – All reasons	Event/SL	F, R, P	On occur.	–	Yes	
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	Events/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)]	Events/SL	F, R, P F, P	5 min 30 min	–	No Yes	Clause 4/Q.703
1.9	Number of negative ack. Received	Events/SL	F, R, P F, P	5 min 30 min	–	No No	
1.10	Local automatic changeover	Event/SL Events/SL	F, R, C P	On occur. 30 min	1.2	No No	Clause 5/Q.703
1.11	Local automatic changeback	Event/SL	F, R, P, C	On occur.	1.12	No	Clause 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.

NOTE – 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.	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	
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	Events/SL Events/SL	– –	30 min 5 min	2.16 2.16	No No	10.2/Q.704
2.14	Local management uninhibit	Events/SL Events/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	Clause 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	

Table 3/Q.752 – MTP signalling link utilization

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

Table 4/Q.752 – MTP signalling link set and route set availability

Description of measurements		Units	Usage	Duration	From	Obl.	References
4.1	Deleted						
4.2	Duration of unavailability of signalling link set	s/link set	F, P	30 min	4.3, 4.4	No	
4.3	Start of link set failure	Event/link set	F, R, C	On occur.	–	No	
4.4	Stop of link set failure	Event/link set	F, R, C	On occur.	–	No	
4.5	Init. Of Broadcast TFP due to failure of measured link set[a)]	Event/link set	F, R, C	On occur.	–	No	Clause 13/Q.704
4.6	Init. of Broadcast TFA for recovery of measured link set[a)]	Event/link set	F, R, C	On occur.	–	No	Clause 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)]	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)]	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 link set used to adjacent SP	Dest. & link set	F, R, C	On occur.	–	No	

a) These measurements only apply to Signalling Transfer Points.

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

Table 5/Q.752 – MTP signalling point status

	Description of measurements	Units	Usage	Duration	From	Obl.	References
5.1	Adjacent SP inaccessible	Event/SP Events/SP Events/SP	F, R P, R P	On occur. 5 min 30 min	–	Yes No No	
5.2	Duration of adjacent SP inaccessible	s/SP s/SP	P, R P	5 min 30 min	5.1, 5.4	Yes	
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	2.3.3/Q.704
5.6	User Part Unavailable MSU transmitted[b)]	Event/UP/SP	F, R, C, P	1st & Δ	–	No	11.7.2/Q.704
5.7	User Part Unavailable MSU received[b), c)]	Event/UP/SP	F, R, C, P	1st & Δ	–	No	11.7.2/Q.704
5.8	TFC received	Event/SP/ cong.level	F, R, P	1st & Δ	–	No	

a) The number of MSUs discarded might be used to indicate that the MTP Route Verification Test (MRVT) described in 2.2/Q.753 should be run.

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.

Table 6/Q.752 – MTP signalling traffic distribution (signalling route utilization)

	Description of measurements	Units	Usage	Duration	From	Obl.	References
6.1	Number of SIF and SIO octets received with given OPC (or set of OPCs) at an SEP[a)]	Octets/OPC set	A, N, P P, A, N	15 min 30 min	–	No No	
6.2	Number of SIF and SIO octets transmitted with given DPC or DPC set at an SEP[a)]	Octets/DPC set	P, A, N P, A, N	15 min 30 min	–	No No	
6.3	Number of SIF and SIO octets handled with given SI or SI set, at an STP	Octets/SI set	P, A, N P, A, N	15 min 30 min	–	No No	
6.4	Number of SIF and SIO octets received with given OPC or OPC set and SI or SI set, at an SEP[a)]	Octets/SI set/OPC set	P, A, N P, A, N	15 min 30 min	–	No No	
6.5	Number of SIF and SIO octets transmitted with given DPC or DPC set and SI or SI set, from an SEP[a)]	Octets/SI set/DPC set	P, A, N P, A, N	15 min 30 min	–	No No	
6.6	Number of SIF and SIO octets handled with given OPC set, DPC set and SI set, at an STP[b)]	Octets/SI set/ OPC set/DPC set	P, A, N P, A, N	5 min 30 min	–	No No	
6.7	Number of MSUs handled with given OPC set, DPC set and SI set, at an STP[b)]	MSUs/SI set/ OPC set/DPC set	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 at a given time.

b) Activation of these measurements should be limited to a small number at a given time, and they exclude the STP's own PC.

NOTE – In the above "at an SEP" means at an SP using the SEP function, and "at an STP" means at an SP using the MTP transfer function.

Table 7/Q.752 – SCCP error performance

	Description of measurements	Report	Units	Usage	Duration	From	Obl.	References
7.1	Routing Failure – No translation for address of such nature[a)]	CDPA [/CGPA]	Events	F, R, P N	1st & Δ 30 min	–	Yes[b)]	2.4 and 2.8/Q.714
7.2	Routing Failure – No translation for this specific address[a)]	CDPA [/CGPA]	Events	F, R, P N	1st & Δ 30 min	–	Yes[b)]	2.4 and 2.8/Q.714
7.3	Routing Failure – Network Failure (Point Code not available)	DPC [/CDPA][/CGPA]	Events	F, R, P N	1st & Δ 30 min	–	Yes[b)]	2.4 and 2.8/Q.714
7.4	Routing Failure – Network Congestion	DPC [/CDPA][/CGPA]	Events	F, R, P N	1st & Δ 30 min	–	Yes[b)]	2.4, 2.8, 5.2.4 and 5.3.6.6/Q.714
7.5	Routing Failure – Subsystem Failure (unavailable)	DPC/SSN [/CDPA][/CGPA]	Events	F, R, P, C N	1st & Δ 30 min	–	Yes[b)]	2.4 and 2.8/Q.714
7.6	Routing Failure – Subsystem Congestion	DPC [/CDPA][/CGPA]	Events	F, R, P N	1st & Δ 30 min	–	Yes[b)]	2.4 and 2.8/Q.714
7.7	Routing Failure – Unequipped user (Subsystem)	DPC/SSN [/CDPA][/CGPA]	Events	F, R, C N	1st & Δ 30 min	–	Yes[b)]	2.4 and 2.8/Q.714
7.8	Syntax Error Detected	Message Dump	Events	F, R, P –	1st & Δ 30 min	–	Yes[b)]	4.3/Q.714
7.9	Routing Failure – Unqualified	Message Dump	Events	F, R, P, C N	1st & Δ 30 min	–	Yes[b)]	2.4/Q.714
7.10	Reassembly error – Timer T_{reass} expiry	CGPA /seg.LR	Events	F, R, P	1st & Δ 30 min	–	Yes[c)]	4.1.1.2.3.2/ Q.714
7.11	Reassembly error – Segment received out of sequence (inc. duplicates, recpt. of non-first segment for which no reassembly process)	CGPA /seg.LR	Events	F, R, P	1st & Δ 30 min	–	Yes[c)]	4.1.1.3.2/Q.714
7.12	Reassembly error – No reassembly space		Events	R, P, N	1st & Δ 30 min	–	Yes[c)]	4.1.1.2.3.4/ Q.714

Table 7/Q.752 – SCCP error performance

Description of measurements	Report	Units	Usage	Duration	From	Obl.	References
7.13 Hop counter violation (XUDT, XUDTS, LUDT, LUDTS and CR)	[CGPA] /CDPA	Events	F, R, P	1st & Δ 30 min	–	Yes[d)]	2.3.1 3)/Q.714

Table 7/Q.752 – SCCP error performance (*concluded*)

	Description of measurements	Report	Units	Usage	Duration	From	Obl.	References
7.14	Message too large for segmentation	SSN	Events	F, R, P	1st & Δ 30 min	–	Yes[c)]	4.1.1.1.1/Q.714
7.15	Failure of release complete supervision	DPC/ Protocol class	Events	F, R, P	1st & Δ 30 min	–	Yes[e)]	3.3.4.2/Q.714
7.16	Timer $T_{(iar)}$ expiry	DPC/ Protocol class	Events	F, R, P	1st & Δ 30 min	–	Yes[e)]	3.4/Q.714
7.17	Provider initiated reset of a connection	DPC	Events	F, R, P	1st & Δ 30 min	–	Yes[f)]	3.7/Q.714, Table A.3/Q.713
7.18	Provider initiated release of a connection	DPC/ Protocol class	Events	F, R, P	1st & Δ 30 min	–	Yes[e)]	3.3/Q.714, Table A.2/Q.713
7.19	Segmentation error – Segmenting not supported	Message Dump	Event	F, R, P	1st & Δ 30 min	–	No	4.1.1.1/Q.714
7.20	Segmentation error – Segmentation failed	Message Dump	Event	F, R, P	1st & Δ 30 min	–	Yes	4.1.1.1/Q.714
7.21	Reassembly error – Reassembly failed	Message Dump	Event	F, R, P	1st & Δ 30 min	–	No	4.1.1.1/Q.714

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

b) 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.

c) This measurement is obligatory if SCCP connectionless segmentation and reassembly is supported.

d) This measurement is obligatory if the node supports 1993 SCCP Global Title Translation or later, and the network supports (L)XUDT or (L)XUDTS or other messages (e.g. CR) routed on GT and containing a hop counter. Note that the calling party address (CGPA) might not be present in CR messages. It is used, if present in messages, to register violations.

e) This measurement is obligatory only if the node supports connection-oriented SCCP.

f) This measurement is obligatory only if the node supports Class 3 SCCP.

Table 8/Q.752 – SCCP subsystem availability

	Description of measurements	Report	Units	Usage	Duration	From	Obl.	References
8.1	Start of local SCCP unavailable – Failure[a)]		Event	F, R, P, C	On occur.	–	No	
8.2	Start of local SCCP unavailable – Maintenance made busy[a)]		Event	R, P, C	On occur.	–	No	
8.3	Start of local SCCP unavailable – Congestion[a)]		Event	F, R, P, C	On occur.	–	No	
8.4	Stop of local SCCP unavailable – All reasons[a)]		Event	F, R, P, C	On occur.	–	No	
8.5	Deleted							
8.6	Subsystem out-of-service grant message received		Event/SSN /DPC	C, R	On occur.	–	b)	5.3.5.3/Q.714
8.7	Subsystem out-of-service request denied (T_{coord} expiry)		Event/SSN /DPC	C, R	On occur.	–	b)	5.3.5.3/Q.714
8.8	SCCP/subsystem congested message received	affected SP /cong.level	Events	F, R, P	1st & Δ	–	No	5.2.7/Q.714
8.9	Start of local subsystem prohibited		Event/SSN, Events	F, R, P, C	On occur.	–	No	5.3.2/Q.714
8.10	Stop of local subsystem prohibited		Event/SSN, Events	F, R, P, C	On occur.	–	No	5.3.3/Q.714
8.11	Subsystem prohibited message received	SSN/ affected SP	Events	F, R, P, C	1st & Δ	–	No	5.3.2/Q.714
8.12	Subsystem allowed message received		Event/SSN/ affected SP, Events	F, R, P, C	On occur.	–	No	5.3.3/Q.714

a) These measurements are system architecture dependent.

b) These measurements are obligatory for replicated subsystems

Table 9/Q.752 – SCCP – Utilization

	Description of measurements	Units	Usage	Duration	From	Obl.	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	2.3/Q.714
9.4	Total messages intended for local subsystems	Msgs	P, R, N N, P	5 min 30 min	–	No No	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	2.2/Q.714
9.6	Total (L)(X)UDT messages originated per class and source SSN	Msgs/ class/SSN	P, R, N N, P	5 min 30 min	–	No Yes	1.1.2/Q.714
9.7	Total (L)(X)UDT messages terminated per class and sink SSN	Msgs/ class/SSN	P, R, N N, P	5 min 30 min	–	No Yes	1.1.2/Q.714
9.8	Messages sent to a backup subsystem	Msgs/SSN	P, R, N N, P	5 min 30 min	–	No [b)]	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	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	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	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	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	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	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.

Table 9 *bis*/Q.752 – SCCP – Quality of Service

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

Table 9 *bis*/Q.752 – SCCP – Quality of Service (*concluded*)

Description of measurements	Units	Usage	Duration	From	Obl.	References
9 *bis*.15 XUDT messages received	Msgs	P, R P	5 min 30 min	–	No	4.1/Q.714
9 *bis*.16 XUDTS messages received	Msgs	P, R, F P, F	5 min 30 min	–	No	4.2/Q.714
9 *bis*.17 LUDT messages sent	Msgs	P, R P	5 min 30 min	–	No	4.1/Q.714
9 *bis*.18 LUDTS messages sent	Msgs	P, R, F P, F	5 min 30 min	–	No	4.2/Q.714
9 *bis*.19 LUDT messages received	Msgs	P, R P	5 min 30 min	–	No	4.1/Q.714
9 *bis*.20 LUDTS messages received	Msgs	P, R, F P, F	5 min 30 min	–	No	4.2/Q.714

Table 10/Q.752 – ISDN User Part availability

Description of measurements	Units	Usage	Duration	From	Obl.	References
10.1 Start of local ISDN-UP unavailable – failure[b]	Event	F, P, R	On occur.	–	No	11.2.7/Q.704
10.2 Start of local ISDN-UP unavailable – maint. made busy[b]	Event	P, R, C	On occur.	–	No	
10.3 ISDN-UP available[b]	Event	F, P, R, C	On occur.	–	No	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	
10.5 Start of local ISDN-UP congestion[a]	Event	P, R	On occur.	–	No	2.10/Q.764
10.6 Stop of local ISDN-UP congestion	Event	P, R	On occur.	–	No	2.10/Q.764
10.7 Duration of local ISDN-UP congestion[a]	s	P	30 min	10.5, 10.6	No	2.10/Q.764
10.8 Start of remote ISDN-UP unavailable[b], [c]	Event/dest.	F, P, C, R	On occur.	–	No	2.13/Q.764 2.14/Q.764
10.9 Stop of remote ISDN-UP unavailable[b], [c]	Event/dest.	F, P, C, R	On occur.	–	No	2.13/Q.764 2.14/Q.764
10.10 Duration of remote ISDN-UP unavailable[b], [c]	s/dest.	P	30 min	10.8, 10.9	No	2.13/Q.764 2.14/Q.764
10.11 Start of remote ISDN-UP congestion[c]	Event/dest.	P, R	On occur.	–	No	2.10/Q.764
10.12 Stop of remote ISDN-UP congestion[c]	Event/dest.	P, R	On occur.	–	No	2.10/Q.764
10.13 Duration of remote ISDN-UP congestion[c]	s/dest.	P	30 min	10.11, 10.12	No	2.10/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.

Table 11/Q.752 – ISDN User Part utilization

Description of measurements	Units	Usage	Duration	From	Obl.	References
11.1 Total ISDN-UP messages sent	Msgs/type	N, P, R P, N	5 min 30 min	–	a)	
11.2 Total ISDN-UP messages received	Msgs/type	N, P, R P, N	5 min 30 min	–	a)	
a) Only the sum over all message types is obligatory. The count per type is non-obligatory.						

Table 12/Q.752 – ISDN User Part errors

Description of measurements	Units	Usage	Duration	From	Obl.	References
12.1 No ack. for ckt. reset within T17	Event/CIC/dest.	F, R	1st & Δ	–	No	2.9.3.1/Q.764
12.2 No GRA received for GRS within T23	Event/CIC/dest.	F, R	1st & Δ	–	No	2.9.3.2/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	2.9.6/Q.764
12.6 Release initiated due to abnormal conditions	Event/CIC/dest.	F, R	1st & Δ	–	Yes	2.9.8.3/Q.764
12.7 Circuit BLO (excessive errors detected by CRC)	Event/CIC/dest.	F, R	On occur.	–	No	Rec. G.704
12.8 Missing blocking ack. in CGBA for previous CGB	Event/CIC/dest.	F, R	1st & Δ	–	Yes	2.8.2.3 iv)/Q.764
12.9 Missing unblocking ack. in CGUA for previous CGU	Event/CIC/dest.	F, R	1st & Δ	–	Yes	2.8.2.3 iv)/Q.764
12.10 Abnormal blocking ack. in CGBA for previous CGB	Event/CIC/dest.	F, R	1st & Δ	–	Yes	2.8.2.3 v)/Q.764
12.11 Abnormal unblocking ack. in CGUA for previous CGU	Event/CIC/dest.	F, R	1st & Δ	–	Yes	2.8.2.3 vi)/Q.764

Table 12/Q.752 – ISDN User Part errors (*concluded*)

Description of measurements	Units	Usage	Duration	From	Obl.	References
12.12 Unexpected CGBA with abnormal blocking ack.	Event/CIC/dest.	F, R	1st & Δ	–	Yes	2.8.2.3 vii)/Q.764
12.13 Unexpected CGUA with abnormal unblocking ack.	Event/CIC/dest.	F, R	1st & Δ	–	Yes	2.8.2.3 viii)/Q.764
12.14 Unexpected BLA with abnormal blocking ack.	Event/CIC/dest.	F, R	1st & Δ	–	Yes	2.8.2.3 xii)/Q.764
12.15 Unexpected UBA with abnormal unblocking ack.	Event/CIC/dest.	F, R	1st & Δ	–	Yes	2.8.2.3 xiii)/Q.764
12.16 No BLA received for BLO within T13 (old 12.3+)	Event/CIC/dest.	F, R	1st & Δ	–	Yes	2.9.4/Q.764
12.17 No UBA received for UBL within T15 (old 12.3+)	Event/CIC/dest.	F, R	1st & Δ	–	Yes	2.9.4/Q.764
12.18 No CGBA received for CGB within T19 (old 12.3+)	Event/CIC/dest.	F, R	1st & Δ	–	Yes	2.9.4/Q.764
12.19 No CGUA received for CGU within T21 (old 12.3+)	Event/CIC/dest.	F, R	1st & Δ	–	Yes	2.9.4/Q.764
12.20 Message format error (old 12.4+)	Event/CIC/dest.	F, R	1st & Δ	–	No	2.9.5/Q.764
12.21 Unexpected message received (old 12.4+)	Event/CIC/dest.	F, R	1st & Δ	–	No	2.9.5.1/Q.764
12.22 Release due to unrecognized info. (old 12.4+)	Event/CIC/dest.	F, R	1st & Δ	–	No	2.9.5.3/Q.764
12.23 Inability to release a circuit[a)]	Event/CIC	F, R	1st & Δ	–	Yes	2.9.8.1/Q.764

[a)] This measurement is implementation dependent.

Table 13/Q.752 – Local TC utilization

Description of measurements	Units	Usage	Duration	From	Obl.	References
13.1 Total number of TC messages sent by the node (by message type)	Messages /Type	P, R N	5 min 30 min	–	No	
13.2 Total number of TC messages received by the node (by message type)	Messages /Type	P, R N	5 min 30 min	–	No	
13.1 *bis* Total number of TC messages sent by the node	Messages	P, R N	5 min 30 min	–	Yes	
13.2 *bis* Total number of TC messages received by the node	Messages	P, R N	15 min 30 min	–	Yes	
13.3 Total number of components sent by the node	Comps	P, R N	5 min 30 min	–	No	3.1/Q.772
13.4 Total number of components received by the node	Comps	P, R N	5 min 30 min	–	No	3.1/Q.772
13.5 (Measurement deleted)				–		
13.6 Number of new transactions in the interval	Trans./AE	P, R, N	5 min (prov)	–	No	
13.7 Mean number of open transaction ids in interval (measured at the start of transactions)	Trans./AE	P, R, N	5 min (prov)	–	No	
13.8 *Not used*						
13.9 Cumulative mean duration of transactions	Trans./AE	P, R, N	5 min (prov)	–	No	
13.10 Maximum number of open transaction ids during interval	Trans./AE	P, R, N	5 min (prov)	–	No	
13.11 Number of open transaction ids > threshold[a)]	Event	P, R, N	On occur.	–	No	

a) The threshold is pre-defined per Application Entity.

Table 14/Q.752 – TC fault measurements

Description of measurements	Units	Usage	Duration	From	Obl.	References
14.1 Protocol error detected in transaction portion (abort received) – with P-abort cause:						2.3/Q.774
a) (moved to Annex A)						
b) (moved to Annex A)						
c) (moved to Annex A)						
d) unrecognized TID[a)]	Event	F, R	1st & D	–	Yes	
e) resource limitation	Event	F, R	1st & D	–	Yes	
14.2 Protocol error detected in component portion (reject received) – with problem code: (all moved to Annex A)						3.8/Q.772
14.3 TC user generated problems (TC-user Reject received):						3.8/Q.772
a) (moved to Annex A)						
b) (moved to Annex A)						
c) (moved to Annex A)						
d) resource limitation (invoke problem)	Event	F, R	1st & D	–	No	
e) (moved to Annex A)						
f) (moved to Annex A)						
g) (moved to Annex A)						
h) (moved to Annex A)						
i) (moved to Annex A)						
j) (moved to Annex A)						
k) (moved to Annex A)						
14.4 Protocol error detected in transaction portion (abort sent) – with P-abort cause:						2.3/Q.772
a) (moved to Annex A)						
b) (moved to Annex A)						

Table 14/Q.752 – TC fault measurements (*continued*)

Description of measurements	Units	Usage	Duration	From	Obl.	References
c) (moved to Annex A)						
d) unrecognized TID	Event[a)]	F, R	1st & Δ	–	No	
e) resource limitation	Event	F, R	1st & Δ	–	No	
14.5 Protocol error detected in component portion (reject sent) – with problem code: (all moved to Annex A)						Clause 8/Q.772
14.6 TC-user generated problems. TC-user reject sent:						Clause 8/Q.772
a) (moved to Annex A)						
b) (moved to Annex A)						
c) (moved to Annex A)						
d) resource limitation (invoke problem)	Event/dest. User	F, R	1st & Δ	–	No	
e) (moved to Annex A)						
f) (moved to Annex A)						
g) (moved to Annex A)						
h) (moved to Annex A)						
i) (moved to Annex A)						
j) (moved to Annex A)						
k) (moved to Annex A)						
14.7 Number of TC_L_CANCEL indications for Class 1 operations	Inds.	F, R	5 min (prov)	–	No	Clause 8/Q.772
14.8 Number of messages discarded (all reasons)[a)]	Messages	F, R	5 min (prov)	–	No	Clause 8/Q.772
14.9 *Not used*						

Table 14/Q.752 – TC fault measurements (*concluded*)

Description of measurements	Units	Usage	Duration	From	Obl.	References
14.10 Number of provider aborts received	Messages	F, R	5 min (prov)	–	No	Clause 8/Q.772
14.11 Number of rejects received	Comps	F, R	5 min (prov)	–	No	Clause 8/Q.772
14.12 Number of errors detected in transaction portion	Messages	F, R	5 min (prov)	–	No	Clause 8/Q.772
a) Includes END messages with unrecognized TIDs.						

Table 15/Q.752 – SS No. 7 MTP message accounting

(See 7.2/Q.752)

Description of measurements	Units (Notes 1, 2 and 3)	Usage	Duration	From	Obl.	References
15.1 Messages received	Msgs./sending op./dest.info./ service set	A	30 min (prov)	–	No	
15.2 Octets received	Octets./sending op./dest.info./ service set	A	30 min (prov)	–	No	
15.3 Messages sent	Msgs./rcvng. op./ dest.info./ service set	A	30 min (prov)	–	No	
15.4 Octets sent	Octets/rcvng. op./ dest.info./ service set	A	30 min (prov)	–	No	

NOTE 1 – Sending op. means the identity of the operator(s) of the sending part of the network, rcvng.op. means the identity of the operator(s) of the receiving part of the network, derived from the appropriate link set.

NOTE 2 – Dest.info. means destination information, derived from the MTP label's DPC, which identifies the accounting agreement.

NOTE 3 – The service set is derived from the messages' service indicator (SI) in the SIO, several SIs may be grouped together. This registration unit is optional, and might not be used to discriminate the measurement.

Table 16/Q.752 – SS No. 7 SCCP message accounting

(See 7.3/Q.752)

Description of measurements	Units (Notes 1, 2 and 3)	Usage	Duration	From	Obl.	References
16.1 Messages received	Msgs./prev. op./dest.info./ service set	A	30 min (prov)	–	No	
16.2 Octets received	Octets./prev. op./dest.info./ service set	A	30 min (prov)	–	No	
16.3 Messages sent	Msgs./next op./ dest.info./ service set	A	30 min (prov)	–	No	
16.4 Octets sent	Octets/next op./ dest.info./ service set	A	30 min (prov)	–	No	

NOTE 1 – Prev.op. refers to the identity of the operator of the previous network from where the message was sent, SCCP-adjacent to this accounting gateway. It might be derived from the OPC in the MTP label (+ the MTP SAP instance of this accounting gateway).

NOTE 2 – Next op. refers to the identity of the operator of the following network, which received the SCCP message, SCCP-adjacent to this gateway. It might be derived from the DPC resulting from a Global Title Translation of the called party address, plus the MTP SAP instance.

NOTE 3 – Dest.info. is used to derive the identity of the accounting arrangement. It might be obtained from (parts of some of) the address information, NAI, NP, TT in the called party address.

NOTE 4 – The service set is an optional registration unit, and might be identified by an SSN or set of SSNs. In addition, the requested SCCP class might optionally be included.

ANNEX A

TC: Fault Measurements pertinent to development of TC and its users

Table A.1/Q.752 – TC fault measurements

	Description of measurements	Units	Usage	Duration	From	Obl.	Act./Perm.	References
A.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.	
A.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.	

Table A.1/Q.752 – TC fault measurements (*continued*)

Description of measurements		Units	Usage	Duration	From	Obl.	Act./Perm.	References
A.3	TC user generated problems (TC-user Reject received):							
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)	initiating release (invoke problem)	Event	F, R	1st & Δ	–	No	Act.	
e)	linked response unexpected (invoke problem)	Event	F, R	1st & Δ	–	No	Act.	
f)	unexpected linked operation (invoke problem)	Event	F, R	1st & Δ	–	No	Act.	
g)	unrecognized error (return error problem)	Event	F, R	1st & Δ	–	No	Act.	
h)	unexpected error (return error problem)	Event	F, R	1st & Δ	–	No	Act.	
i)	mistyped parameter (return result problem)	Event	F, R	1st & Δ	–	No	Act.	
j)	mistyped parameter (return error problem)	Event	F, R	1st & Δ	–	No	Act.	
A.4	Protocol error detected in transaction portion (abort sent) – with P-abort cause:							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.	

Table A.1/Q.752 – TC fault measurements (*continued*)

Description of measurements		Units	Usage	Duration	From	Obl.	Act./Perm.	References
A.5	Protocol error detected in component portion (reject sent) – with problem code:							Clause 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.	
A.6	TC-user generated problems. TC-user reject sent:							Clause 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)	initiating release (invoke problem)	Event/dest.User	F, R	1st & Δ	–	No	act.	
e)	linked response unexpected (invoke problem)	Event/dest.User	F, R	1st & Δ	–	No	act.	

Table A.1/Q.752 – TC fault measurements (*concluded*)

Description of measurements		Units	Usage	Duration	From	Obl.	Act./Perm.	References
f)	unexpected linked operation (invoke problem)	Event/dest.User	F, R	1st & Δ	–	No	act.	
g)	unrecognized error (return error problem)	Event/dest.User	F, R	1st & Δ	–	No	act.	
h)	unexpected error (return error problem)	Event/dest.User	F, R	1st & Δ	–	No	act.	
i)	mistyped parameter (return result problem)	Event/dest.User	F, R	1st & Δ	–	No	act.	
j)	mistyped parameter (return error problem)	Event/dest.User	F, R	1st & Δ	–	No	act.	

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