INTERNATIONAL TELECOMMUNICATION UNION

CCITT

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

I.352

(11/1988)

SERIES I: INTEGRATED SERVICES DIGITAL NETWORK (ISDN)

Overall network aspects and functions, ISDN user-network interfaces

---

NETWORK PERFORMANCE OBJECTIVES FOR CONNECTION PROCESSING DELAYS IN AN ISDN

Reedition of CCITT Recommendation I.352 published in the Blue Book, Fascicle III.8 (1988)

NOTES

1 CCITT Recommendation I.352 was published in Fascicle III.8 of the *Blue Book*. This file is an extract from the *Blue Book*. While the presentation and layout of the text might be slightly different from the *Blue Book* version, the contents of the file are identical to the *Blue Book* version and copyright conditions remain unchanged (see below).

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

Recommendation I.352

NETWORK PERFORMANCE OBJECTIVES FOR CONNECTION PROCESSING DELAYS IN AN ISDN

(Melbourne, 1988)

1 General

1.1 *Reference model*

This Recommendation provides network performance objectives for connection processing delays. The reference model provided in Recommendation I.340 was used to provide a baseline reference configuration. In addition, Recommendation Q.709 was taken into account in the determination of values.

Note – This Recommendation does not take into account the performance of private networks. In case of private networks connected to the ISDN, the recommended values refer to reference point T. Reference point S applies in cases where S and T are coincident.

1.2 *Measurement*

All parameter values are specified at network boundaries. These values are measured at the ISDN S/T reference points using all processing message transfer events (MTEs) (Recommendation Q.931 messages or the corresponding Signalling System No. 7 messages), where appropriate.

1.3 *Network conditions*

The values for delay given in this Recommendation include an allowance for the effects on delay that might be introduced during a nominal busy hour. Consideration was given to the possibility that individual busy hours might not be coincident. The values also include the effects of network component failures. The specified values do not apply under conditions of network unavailability. These delays are expressed in terms of mean and 95% probability values.

1.4 *User delay*

Values are provided for measurements made at a single connection element boundary as well as measurements made between two connection element boundaries. This allows for calculations that would avoid inclusion of any delay that might be introduced by users or user equipment.

1.5 *Allocation*

Overall connection processing delays between S/T reference points can be divided into sub-values for each connection element including the national and international portions.

1.6 *Basic connection*

Connection processing delays are only defined for a basic connection and therefore do not provide for any effects that might be introduced by supplementary services (see Figure 1/I.352).

1.7 *Phases*

Connection processing delay values are specified for the connection set-up and disconnection phase.

2 Purpose

The purpose of this Recommendation is to provide values for connection processing delays that can be used as design objectives in network planning and system design. Quality of Service information should be provided to the user after mapping Network Performance into user-oriented expressions.

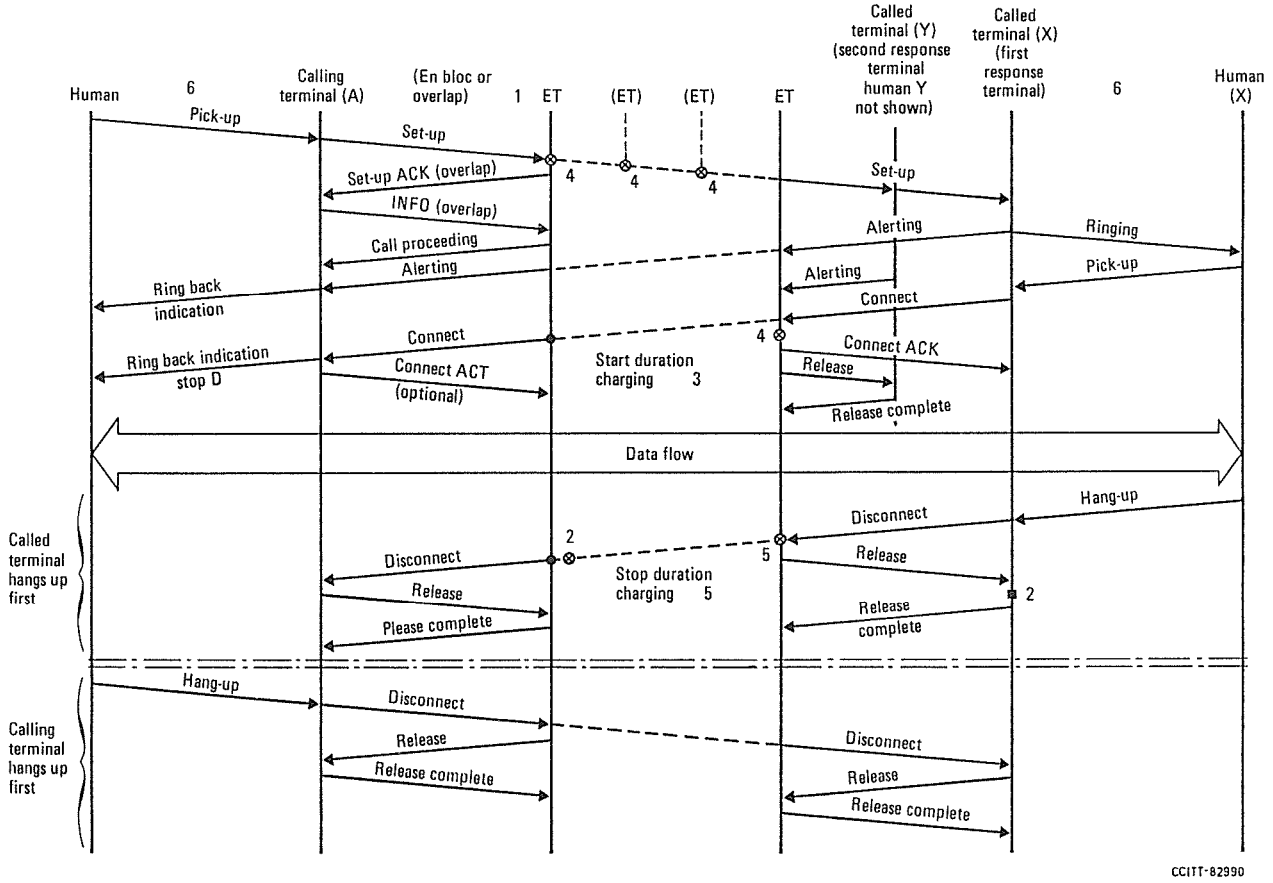

FIGURE 1/I.352

Procedure for a simple circuit switched call (example)

3 Connection processing delays in ISDN circuit switched connections

The values for the connection processing delay parameters have been determined taking into account that:

- the calling access link;
- the connection processing at the originating local exchange,
- the connection processing at transit exchanges,
- the usage of signalling transfer points (STP),
- the internodal links,
- the connection processing at the terminating local exchange, and
- the connected access link

cause delay.

These values are representative for all terrestrial connections and also for connections involving a satellite in an internodal link allowing a smaller number of transit exchanges in that connection.

3.1 *Connect phase parameters*

3.1.1 *Connection set-up delay*

Connection set-up delay is defined initially, based on observations at a single connection element boundary, B_i as shown in Figure 2/I.352, and then between two connection element boundaries (B_i, B_j). In the former case, the connection set-up delay includes the delay for all connection elements on the called user side of B_i and the terminal device. In the latter case, the connection set-up delay includes only the delay between B_i and B_j.

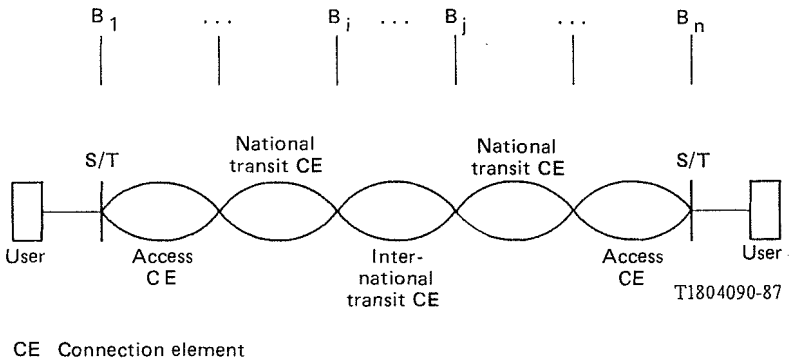

FIGURE 2/I.352

General reference configuration

(based on reference configuration in Recommendation I.352)

3.1.1.1 *Definition of connection set-up delay observed at a single connection element boundary*

connection set-up delay at a single connection element boundary, B_i, is defined using two call processing message transfer events (MTEs). Table 1/I.352 identifies the message transfer events and the resulting call states for 1.451(Q.931) connection processing messages. Table 2/I.352 identifies the message transfer events and the resulting call states for the relating Signalling System No. 7 user-part messages defined in Recommendation Q.762. Connection set-up delay is the length of time that starts when a SETUP or the last address information message creates a message transfer event at B_i; and ends when the corresponding CONNECT message returns and creates its message transfer event at B_i.

Connection set-up delay observed at a single connection element boundary = $(t_2 - t_1)$

where

t_1 is the time of occurrence of the starting message transfer event

t_2 is the time of occurrence of the ending message transfer event.

The transfer of the I.451(I.931) messages and their corresponding user-part messages of Signalling System No. 7 is shown in Figure 3/I.352 along with connection element boundaries. The specific message transfer events used in measuring connection set-up delay are shown in Table 3/I.352.

Note – "Set-up" does not imply a through connection or that capability for information transfer has been established.

3.1.1.2 *Definition of connection set-up delay between two connection element boundaries*

The **connection set-up delay between two connection element boundaries** can be measured at one connection element boundary, B_1, and then measured at another boundary, B_2, from the distant calling S/T interface. The difference in the values obtained is the connection set-up delay contributed by the connection elements between two boundaries.

Connection set-up delay between two boundaries = $(d_i - d_2)$

where

d_i is the connection set-up delay at $\mathbf{B}_1$,

d_2 is the connection set-up delay at $\mathbf{B}_2$.

The overall connection set-up delay is the connection set-up delay between the two S/T interfaces, e.g. B_i and B_n in Figure 2/I.352. This overall connection delay excludes the called user response time. The connection set-up delay for a connection element is the connection set-up delay between the boundaries delimiting that connection element.

3.1.1.3 *Connection set-up delay specification*

The overall connection set-up delay should not exceed the values given in Table 4/I.352.

The allocation of the connection set-up delay among the elements of the connections are for further study.

3.1.2 *Alerting delay (applicable in case of manual answering terminals and some automatic answering terminals)*

Alerting delay is defined using an approach similar to that described in § 3.1.1 for connection set-up delay.

3.1.2.1 *Definition of alerting delay observed at a single connection element boundary*

alerting delay at a single element boundary, B_i, is defined as the length of time that starts when a SETUP or the last address information message creates a message transfer event at B_i, and ends when the corresponding ALERTing message returns and creates its message transfer event at B_i.

Alerting delay observed at a single connection element boundary = $(t_2 - t_1)$

where

t_1 is the time of occurrence for the starting message transfer event,

t_2 is the time of occurrence for the ending message transfer event.

The specific message transfer events used in measuring alerting delay are shown in Table 5/I.352.

TABLE 1/I.352

Message transfer events based on Rec. 1.451 layer 3 messages

No.	Layer 3 message	Message flow	Event	Resulting state
1	SET-UP	u – n	Entry	Ni (Call initiated)
2	SET-UP	n – u	Exit	N6 (Call present)
3	SET-UP ACKnowledge	u – n	Entry	N25 (Overlap receiving)
4	SET-UP ACKnowledge	n – u	Exit	N2 (Overlap sending)
5	INFOrmation	u – n	Entry	N2 (Overlap sending)
6	CALL PROCeeding	u – n	Entry	N9 (Incoming call proceeding)
7	CALL PROCeeding	n – u	Exit	N3 (Outgoing call proceeding)
8	ALERTing	u – n	Entry	N7 (Call receive)
9	ALERTing	n – u	Exit	N4 (Call delivered)
10	CONNect	u – n	Entry	N8 (Connect request)
11	CONNect	n – u	Exit	N10 (Active)
12	CONNect ACKnowledge	u – n	Entry	N10 (Active)
13	CONNect ACKnowledge	n – u	Exit	N10 (Active)
14	DISConnect	u – n	Entry	N11 (Disconnect request)
15	DISConnect	n – u	Exit	N12 (Disconnect indication)
16	RELease	n – u	Exit	N19 (Release request)
17	RELease COMplete	u – n	Entry	N0 (Null)
18	RELease COMplete	n – u	Exit	N0 (Null)

u – n user to network

n – u network to user

Note – The terminology for message flow is given in Rec. I.451.

TABLE 2/I.352

Message transfer events based on Rec. Q.764

No.	Signalling System No. 7 message	Direction [a)]	Event	Resulting state
S1	Initial address (IAM)	Outgoing	Entry	Wait for ACM (2)
S2	Initial address (IAM)	Incoming	Exit	Wait for OGC select (2)
S3	Address complete (ACM)	Outgoing	Exit	Wait for answer (3)
S4	Address complete (ACM)	Incoming	Entry	Wait for answer (5)
S5	Answer (ANS)	Outgoing	Exit	OGC answered (4)
S6	Answer (ANS)	Incoming	Entry	ICC answered (4)
S7	Release (REL)	Outgoing	Entry	Wait for RLC (7)
S8	Release (REL)	Incoming	Exit	Wait for RLC (9)
S9	Release complete (RLC)	Outgoing	Exit	Idle (0)
S10	Release complete (RLC)	Incoming	Entry	Idle (0)

OGC Outgoing trunk circuit

ICC Incoming trunk circuit

a) The connection processing control states have been divided into those used in incoming and outgoing circuit handling. The usage of the term direction in this context refers to the direction of the connection.

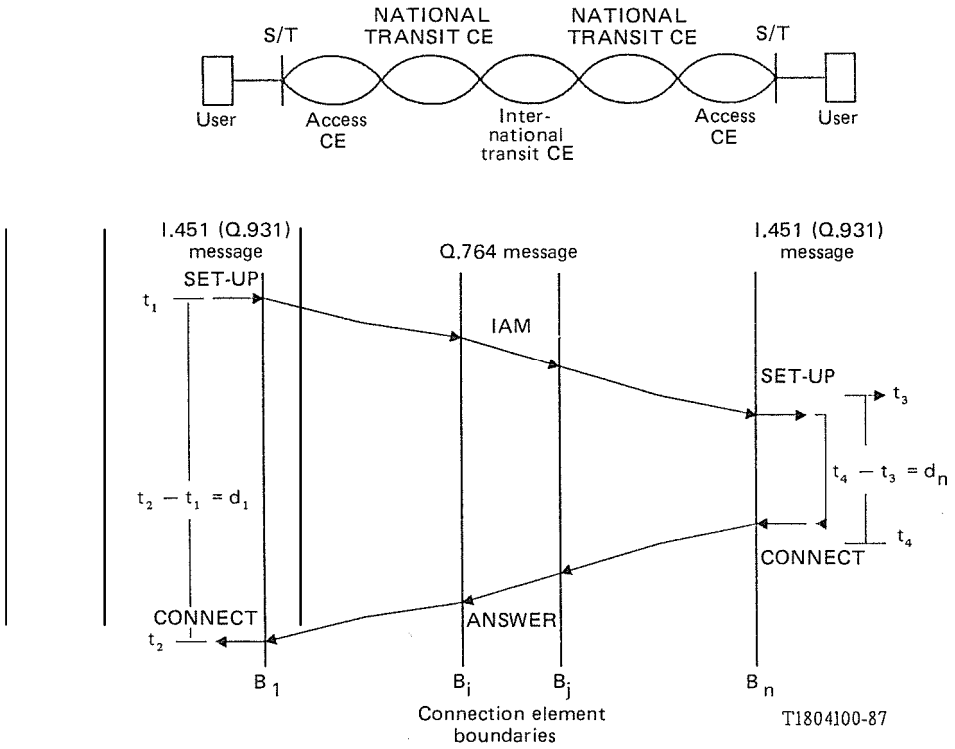

FIGURE 3/I.352

Connection set-up delay events (example)

TABLE 3/I.352

Message transfer events for measuring connection set-up delay

Connection element boundary	Message transfer event	
	Starting event number	Ending event number
Calling S/T interface	1 (en bloc) or 5 (overlap sending)	11
Called S/T interface	2	10
Access/national transit (originating)	S1	S5
Access/national transit (terminating)	S2	S6
National/international transit (originating)	S2	S6
National/international transit (terminating)	S1	S5

Note – En bloc and overlap sending options at the calling S/T interface.

TABLE 4/I.352

Overall connection set-up delay

ISDN connection type	Statistic	Connection set-up delay
No. 1: 64 kbit/s unrestricted switched	Mean	4 500 ms [a)]
	95%	8 350 ms [a)]

[a)] Provisional values; the actual target values are for further study.

Note 1 – The values take into account worst case situations such as the longest length reference connection (27 500 km) as specified in Recommendation G.104.

The values observed will be dominated by the number of exchanges in a connection. For the moderate length reference connection (11 000 km), the observed values will be lower.

Note 2 – Delays are specified for a nominal busy hour.

Note 3 – Connection set-up attempts which exceed a specified timeout value are excluded in computing these statistics and are counted separately as connection set-up denials.

Note 4 – In this table, the relevant ISDN connection types given in Table 2/I.340 are specified.

Note 5 – Those message processing delays that are dependent on a user equipment network are not included. In addition, when transmitting a signal message defined in Recommendation Q.931 from the network to a user, before the message actually passes across the S/T reference point, it may have to wait in the exchange or signalling system while another message (signal or user packet) is being transmitted to the user. Since this waiting time depends on the volume of user packet (message) traffic over the D-channel, the resulting delay is beyond the responsibility of the network provider.

Note 6 – The values take into account the additional signalling points for the 95% case of the hypothetical signalling reference connection in Recommendation Q.709.

Note 7 – The delay objectives in the table are primarily applicable to connections provided exclusively over ISDNs, i.e. no interworking.

Note 8 – The connection set-up and disconnected procedures in ISDNs for circuit-mode voice and data are essentially the same; therefore, the delay definitions are applicable for circuit-mode voice and circuit-mode data. The provisional values in the tables are applicable for both circuit-mode voice and circuit-mode data with no interworking. However, the observed delay performance may not be identical due to network architectural differences and interworking.

TABLE 5/I.352

Message transfer events for measuring alerting delay

Connection element boundary	Message transfer event	
	Starting event number	Ending event number
Calling S/T interface	1 (en bloc) or 5 (overlap sending)	9
Called S/T interface	2	6
Access/national transit (originating)	S1	S3
Access/national transit (terminating)	S2	S4
National/international transit (originating)	S2	S4
National/international transit (terminating)	S1	S3

Note – En bloc and overlap sending options at the calling S/T interface.

3.1.2.2 *Definition of alerting delay between two connection element boundaries*

The alerting delay between two connection element boundaries can be measured at one connection element boundary, B_i, and then measured at another boundary, $\mathbf{B_i}$, further from the calling S/T interface. The difference in the values obtained is the alerting delay contributed by the connection elements between the two boundaries.

Alerting delay between two connection element boundaries = $(d_i - d_j)$

where

d_i is the alerting delay measured at B_i,

d_j is the alerting delay measured at B_j.

The overall alerting delay is the alerting delay between the two S/T interfaces, B_i and B_n in Figure 1/I.352 for the reference configuration types in Recommendation I.340. This overall alerting delay excludes the called user response time. The alerting delay for a connection element is the alerting delay between the boundaries delimiting that connection element.

3.1.2.3 *Alerting delay specification*

The overall alerting delay should not exceed the values given in Table 6/I.352.

The allocation of the alerting delay among the elements of the connections are for further study.

TABLE 6/I.352

Overall alerting delay

ISDN connection type	Statistic	Alerting delay
No. 1: 64 kbit/s unrestricted switched	Mean	4 500 ms [a)]
	95%	8 350 ms [a)]

[a)] Provisional values; the actual target values are for further study.

Note 1 – The **values** take into account worst case situations such as the longest length reference connection (27 500 km) as specified in Recommendation G.104.

The values observed will be dominated by the number of exchanges in a connection. For the moderate length reference connection (11 000 km) the observed values will be lower.

Note 2 – Delays are specified for a nominal busy hour.

Note 3 – Connection set-up attempts which exceed a specified timeout value are excluded in computing these statistics and are counted separately as connection set-up denials.

Note 4 – In this table the relevant ISDN connection types given in Table 2/1.340 are specified.

Note 5 – Those message processing delays that are dependent on a user equipment/network are not included. In addition, when transmitting a signal message defined in Recommendation Q.931 from the network to a user, before the message actually passes across the S/T reference-point, it may have to wait in the exchange or signalling system while another message (signal or user packet) is being transmitted to the user. Since this waiting time depends on the volume of user packet (message) traffic over the D-channel, the resulting delay is beyond the responsibility of the network provider.

Note 6 – The values take into account the additional signalling points for the 95% case of the hypothetical signalling reference connection in Recommendation Q.709.

Note 7 – The delay objectives in the table are primarily applicable to connections provided exclusively over ISDNs, i.e. no interworking.

Note 8 – The connection set-up and disconnect procedures in ISDNs for circuit-mode voice and data are essentially the same. Therefore, the delay definitions are applicable for circuit-mode voice and circuit-mode data. The provisional values in the tables are applicable for both circuit-mode voice and circuit-mode data with no interworking. However, the observed delay performance may not be identical due to network architectural differences and interworking.

3.2 *Disconnect phase parameters*

3.2.1 *Disconnect delay*

Disconnect definition is based only on a one-way message transport from the clearing party to be cleared party. Therefore, this parameter requires observations at two connection element boundaries.

3.2.1.1 *Definition of disconnect delay between two connection element boundaries*

Disconnect delay between two connection element boundaries, B_i and B_j, is defined as the length of time that starts when a DISConnect message creates a message transfer event at B_i and ends when that DISConnect message creates a message transfer event at B_j, further from the clearing party S/T interface.

Disconnect delay between two connection element boundaries = $(t_2 - t_1)$

where

t_1 is the time of occurrence for the message transfer event at B_i,

t_2 is the time of occurrence for the message transfer event at B_j.

The overall disconnect delay is the disconnect delay between two S/T interfaces, B_1 and B_n, in Figure 1/I.352 for the reference configuration types in Recommendation I.340. The disconnect delay for a connection element is the disconnect delay between the boundaries delimiting that connection element. The specific message transfer events used in measuring disconnect delay are shown in Table 7/I.352.

TABLE 7/I.352

Message transfer events for measuring disconnect delay

Connection element(s)	Message transfer event (at connection element boundary)	
	Starting event number	Ending event number
S/T to S/T interface	14 (Clearing end)	15 (Cleared end)
National transit	S7 (Access/national transit)	S8 (National/international transit)
International transit	S8 (National/international transit)	S7 (International/national transit)

3.2.1.2 *Disconnect delay specification*

The overall disconnect delay should not exceed the values given in Table 8/I.352.

The disconnect delay values for connection elements are for further study.

3.2.2 *Release delay*

Release delay is defined only at the clearing party S/T interface.

3.2.2.1 *Definition of release delay*

release delay is defined as the length of time that starts when a DISConnect message from the clearing party creates a message transfer event at the clearing party S/T interface and ends when the RELease message creates a message transfer event at the same interface.

Release delay at the clearing part S/T interface = $(t_2 - t_1)$

where

t_1 is the time of occurrence for the starting message transfer event,

t_2 is the time of occurrence for the ending message transfer event.

Since the release message sent by the exchange at the clearing end is only transported over the access connection element at that end, the distinction between overall delay and connection element delay is not relevant. The specific message transfer events used in measuring release delay are shown in Table 9/I.352.

TABLE 8/I.352

Disconnect delay

ISDN connection type	Statistic	Disconnect delay
No. 1: 64 kbit/s unrestricted switched	Mean	2 700 ms [a)]
	95%	4 700 ms [a)]

[a)] Provisional values; the actual target values are for further study.

Note 1 – The values take into account worst case situation such as the longest length reference connection (27 500 km) as specified in Recommendation G.104.

The values observed will be dominated by the number of exchanges in a connection. For the moderate length reference connection (11 000 km) the observed values will be lower.

Note 2 – Delays are specified for a nominal busy hour.

Note 3 – In this table the relevant ISDN connection types given in Table 2/I.340 are specified.

Note 4 – The values take into account the additional signalling points for the 95% case of the hypothetical signalling reference connection in Recommendation Q.709.

Note 5 – The delay objectives in the table are primarily applicable to connections provided exclusively over ISDNs, i.e. no interworking.

Note 6 – The connection set-up and disconnect procedures in ISDNs for circuit-mode voice and data are essentially the same. Therefore, the delay definitions are applicable for circuit-mode voice and circuit-mode data. The provisional values in the tables are applicable for both circuit-mode voice and circuit-mode data with no interworking. However, the observed delay performance may not be identical due to network architectural differences and interworking.

TABLE 9/I.352

Message transfer events for measuring release delay

Connection element boundary	Message transfer event	
	Starting event number	Ending event number
Clearing party S/T	14	16
Cleared party S/T	Not applicable	Not applicable
Access/National transit	Not applicable	Not applicable
National/international transit	Not applicable	Not applicable

3.2.2.2 *Release delay specification*

The release delay should not exceed the values given in Table 10/I.352.

TABLE 10/I.352

Release delay

ISDN connection type	Statistic	Release delay
No. 1: 64 kbit/s unrestricted switched	Mean	300 ms [a)]
	95%	850 ms [a)]

[a)] Provisional values; the actual target values are for further study.

Note 1 – The delay objectives in the table are primarily applicable to connections provided exclusively over ISDNs, i.e. no interworking.

Note 2 – The connection set-up and disconnect procedures in ISDNs for circuit-mode voice and data are essentially the same. Therefore, the delay definitions are applicable for circuit-mode voice and circuit-mode data. The provisional values in the tables are applicable for both circuit-mode voice and circuit-mode data with no interworking. However, the observed delay performance may not be identical due to network architectural differences and interworking.

ITU-T RECOMMENDATIONS SERIES

Series A	Organization of the work of the ITU-T
Series B	Means of expression: definitions, symbols, classification
Series C	General telecommunication statistics
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	**Integrated services digital network**
Series J	Transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	TMN and network maintenance: international transmission systems, telephone circuits, telegraphy, facsimile and leased circuits
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks and open system communications
Series Y	Global information infrastructure and Internet protocol aspects
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland

Geneva, 2009