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INTEGRATED SERVICES DIGITAL NETWORK (ISDN) OVERALL NETWORK ASPECTS AND FUNCTIONS

REFERENCE EVENTS FOR DEFINING ISDN PERFORMANCE PARAMETERS

ITU-T Recommendation I.353

(Previously “CCITT Recommendation”)

FOREWORD

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

The World Telecommunication Standardization Conference (WTSC), which meets every four years, established the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

ITU-T Recommendation I.353 was prepared by the ITU-T Study Group XVIII (1988-1993) and was approved by the WTSC (Helsinki, March 1-12, 1993).

NOTES

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 Similarly, in this reform process, the CCIR and the IFRB have been replaced by the Radiocommunication Sector.

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

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

Recommendation I.353

REFERENCE EVENTS FOR DEFINING ISDN PERFORMANCE PARAMETERS

(Helsinki, 1993)

1 Introduction

This Recommendation is one of the Recommendations (I.350, I.351 and I.353) that define general aspects of ISDN performance and provide a basis for the definition of specific performance parameters and values in other I-Series and G-Series Recommendations.

The ISDN performance parameters are defined in terms of reference events which can be observed at physical measurement points within an ISDN connection. This Recommendation defines the relevant measurement points and associated performance-significant ISDN reference events.

2 General definitions

In the context of these ISDN performance Recommendations, the following general definitions apply.

measurement point (MP): A measurement point is located at a physical interface which separates either customer equipment/customer network (collectively abbreviated CEQ) or a switching or signalling node (SSN) from an attached transmission system at which CCITT-recommended protocols can be observed.

measurement point T (MPT): A measurement point T is located at the interface associated with a T reference point. This interface separates CEQ from an attached digital section.

measurement point I (MPI): A measurment point I is located at an interface that terminates a transmission system at an International Switching Centre (ISC). The exact location of the MPI depends on the connection type and is specified, for each connection type, in the associated Network Performance Recommendation. For each MPT within a nation, the set of *associated MPIs* is the set of MPIs within the same nation. MPTs and individual associated MPIs delimit portions of an end-to-end ISDN connection for which performance objectives are specified[1)].

NOTES

1 The MPI for circuit-switched connection types is generally located at the national side of an ISC. For packet-switched connection types, the MPI is generally located at the international side of an international packet switching gateway.

2 As defined, MPs exist at many physical interfaces in a connection. It is not the intention in these Recommendations to specify performance between arbitrary pairs of MPs – particularly pairs within a nation. These Recommendations will only specify the performance of portions delimited by MPTs and MPIs.

3 With regard to the definitions of customer equipment and customer network, see Recommendations I.430 and I.570 respectively.

ISDN reference event: An ISDN reference event is the transfer of a discrete unit of control or user information encoded in accordance with CCITT-recommended protocols across an MP. Specified information units and associated resulting protocol state(s) are identified by an event code used for reference in defining performance parameters. The resulting state(s) in turn establish which reference events can subsequently occur. Two classes of reference events are distinguished: exit events and entry events.

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1) The differences in MPI location among connection types are a result of the need to ensure consistency between the emerging ISDN performance Recommendations and existing Recommendations that specify the performance of service-dedicated networks. As circuit mode, packet mode, and other transfer capabilities are more fully integrated in ISDNs, it may be possible to identify common measurement points.

exit event: An exit event is a reference event that corresponds to an information unit exiting an SSN or CEQ.

entry event: An entry event is a reference event that corresponds to an information unit entering an SSN or CEQ.

time of occurrence of an exit event: The time of occurrence of an exit event is defined to coincide with the time at which the first bit of the unit of control or user information crosses the MP out of the SSN or CEQ.

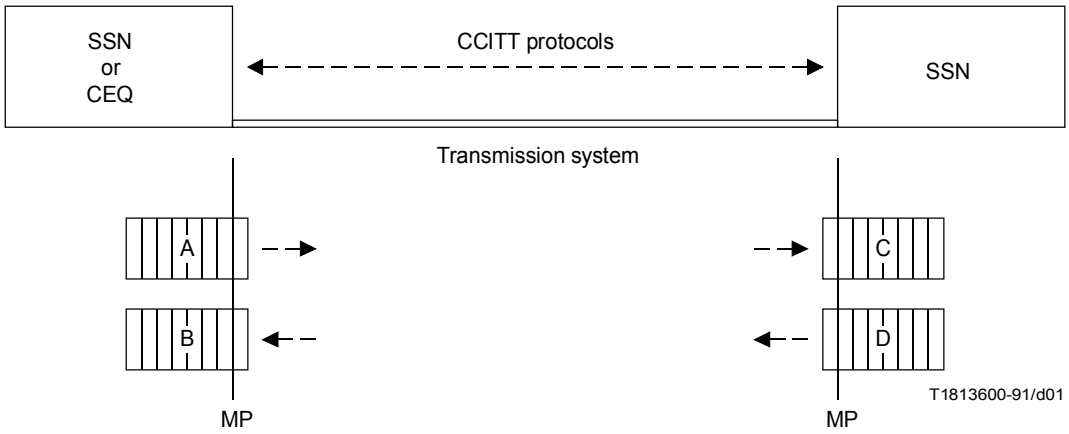
time of occurrence of an entry event: The time of occurrence of an entry event is defined to coincide with the time at which the last bit of the unit of control or user information crosses the MP into the SSN or CEQ. If retransmissions occur, the exit event occurs with the first transmission and the entry event occurs with the last transmission.

Figures 1 and 2 illustrate these concepts:

3 Performance-significant reference events

Performance-significant reference events are reference events useful in defining performance parameters. Table 1 provides references to following subclauses or related Recommendations that define a set of performance-significant reference events for ISDN performance description.
If the state resulting from transfer of the control or user information unit across the MP is not the one listed in the relevant table or remains unchanged, the reference event does not occur. Aspects of the state other than those listed in these tables may change during entry or exit events, but those events are not viewed as performance-significant reference events.

When the tables list more than one aspect of the state that might be changed as a result of a particular exit or entry event, each of those changes represents a distinct reference event that can be used in defining different performance parameters. For example, in Table 1/X.134, event 9a would be used where the correct receipt of the data is relevant, and 9b would be used when the receipt of the acknowledgement is relevant[2]. Event 26b would be used in association with permanent virtual circuits and 26a with other logical channels.



Exit events for A, D
Entry events for B, C

[2] In the case of packet communications, the virtual connection section boundaries defined in Recommendation X.134 are the relevant measurement points.

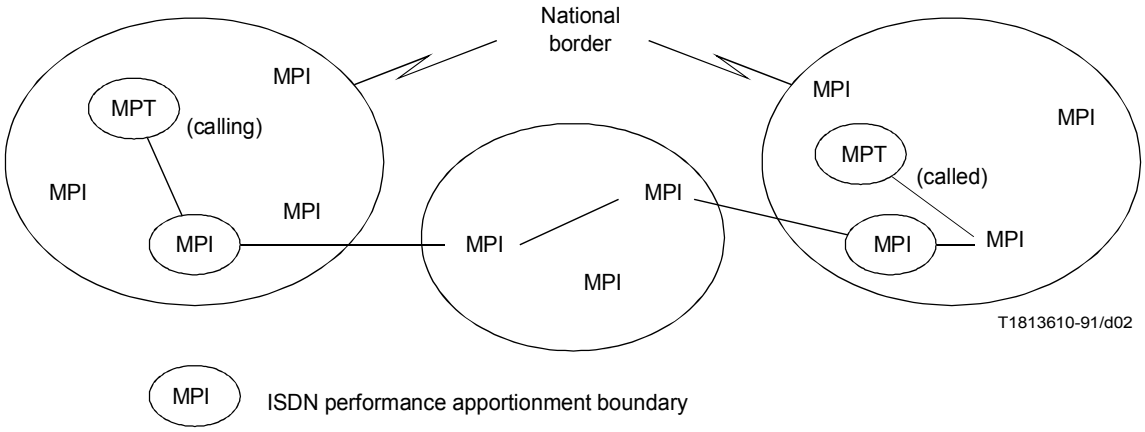


FIGURE 2/I.353

TABLE 1/I.353

References to information specifying performance-significant reference events

Protocol at MP	Reference
Rec. Q.931 (Rec. I.451)	Rec. I.353, subclause 3.1
Rec. Q.921	Rec. I.353, subclause 3.2
X.25 layer 3	Rec. X.134
X.25 layer 2 (LAPB)	Rec. I.353, subclause 3.3
Rec. X.75	Rec. X.134
Rec. Q.764	Rec. I.353, subclause 3.4
Frame switching	Rec. I.353, subclause 3.5
Frame relaying	Rec. I.353, subclause 3.6
B-ISDN ATM layer	Rec. I.353, subclause 3.7
Unrestricted digital bearer services	Rec. I.353, subclause 3.8

3.1 Recommendation Q.931 (Recommendation I.451)

Table 2 lists performance-significant reference events associated with the Q.931 protocol. The table entries are:

- event identification code;
- type of Q.931 layer 3 message transferred; and
- resulting state of the Q.931 layer 3 interface.

The unit of information transferred is the layer 2 frame carrying the Q.931 layer 3 message.

TABLE 2/I.353

Performance-significant reference events based on Q.931 (I.451) layer 3 message transfer

Code	Layer 3 message	Resulting state
P1a	SETUP	N1 (Call Initiated)
b	SETUP	N6 (Call Present)
P2a	SETUP ACKnowledge	N25 (Overlap Receiving)
b	SETUP ACKnowledge	N2 (Overlap Sending)
P3	INFOrmation	N2 (Overlap Sending)
P4a	CALL PROCeeding	N9 (Incoming Call Proc.)
b	CALL PROCeeding)	N3 (Outgoing Call Proc.)
P5a	ALERTing	N7 (Call Receive)
b	ALERTing	N4 (Call Delivered)
P6a	CONNect	N8 (Connect Request)
b	CONNect	N10 (Active)
P7	CONNect ACKnowl	N10 (Active)
P8a	DISConnect	N11 (Disconnect Request)
b	DISConnect	N12 (Disconnect Ind.)
P9	RELease	N19 (Release Request)
P10	RELease COMplete	N0 (Null)

3.2 Recommendation Q.921

Table 3 lists performance-significant reference events associated with the Q.921 protocol. The table entries are:

- event identification code;
- type of Q.921 layer 2 frame transferred; and
- resulting state of the Q.921 layer 2 interface.

The unit of information transferred is the layer 2 frame.

TABLE 3/I.353

Performance-significant reference events based on Q.921 layer 2 frame transfer

Code	Layer 2 frame	Resulting state (Note 1)
Q1a b	I I	V(R) becomes N(S) + 1 V(A) becomes N(R)
Q2	RR	V(A) becomes N(R); PRB cleared
Q3	RNR	V(A) becomes N(R); PRB set
Q4	REJ	V(A) becomes N(R); PRB cleared
Q5	SABME	Awaiting Establishment
Q6	DM	TEI Assigned
Q7	UI	(Note 2)
Q8	DISC	Awaiting Release
Q9a b	UA UA	Multiple Frame Established (Note 3) TEI Assigned (Note 4)
Q10	FRMR	Awaiting Establishment

I	Information
RR	Receiver Ready
RNR	Receiver Not Ready
REJ	Reject
SABME	Set Asynchronous Balanced Mode Extended
DM	Disconnect Mode
UI	Unnumbered Information
DISC	Disconnect
UA	Unnumbered Acknowledgement
FRMR	Frame Reject
V(R)	Receive State Variable
N(S)	Send Sequence Number
V(A)	Acknowledge State Variable
N(R)	Receive Sequence Number
PRB	Peer Receiver Busy
TEI	Terminal Endpoint Identifier

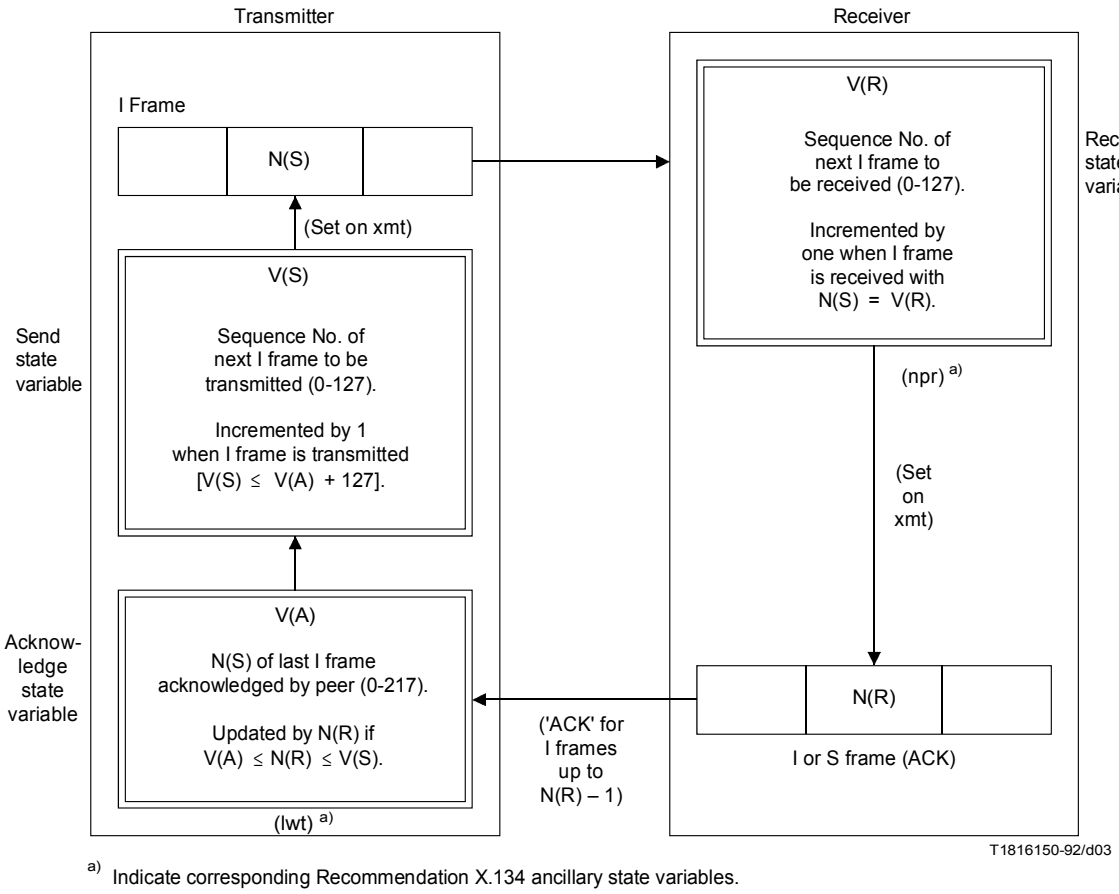
NOTES

1 Figure 3 defines the state variables used in frame flow control.

2 UI frames have no effect on the data link layer state variables defined in Recommendation Q.921. Their transmission and reception could be recorded by incrementing ancillary state variables if required for performance assessment purposes.

3 Q9a occurs in response to an SABME command. Q9b occurs in response to a DISC command.

4 Exchange Identification (XID) frames have no effect on the operational mode or state variables associated with data link layer entities.



a) Indicate corresponding Recommendation X.134 ancillary state variables.

FIGURE 3/I.353

Q.921 state variables used in frame flow control

3.3 X.25 layer 2 (LAPB)

Table 4 lists performance-significant reference events associated with the X.25 layer 2 (LAPB) protocol. The table entires are:

- event identification code;
- type of X.25 layer 2 (LAPB) frame transferred; and
- resulting state of the X.25 layer 2 interface.

The unit of information transferred is the layer 2 frame carrying the X.25 layer 3 message.

3.4 Recommendation Q.764

Table 5 lists performance-significant reference events associated with the Q.764 protocol. The table entries are:

- event identification code;
- type of Q.764 message transferred; and
- resulting state of the Q.764 interface.

The unit of information transferred is the Q.764 message.

TABLE 4/I.353

Performance-significant reference events based on X.25 layer 2 (LAPB) frame transfer

Code	Layer 2 frame	Resulting state
B1a b	I I	V(R) becomes N(S) + 1 V(A) becomes N(R) (Note 1)
B2	RR	V(A) becomes N(R); PRB cleared (Note 1)
B3	RNR	V(A) becomes N(R); PRB set (Note 1)
B4	REJ	V(A) becomes N(R); PRB cleared (Note 1)
B5	SABM	Awaiting Establishment
B6	SABME	Awaiting Establishment
B7	DM	TEI Assigned
B8	DISC	Awaiting Release
B9a b	UA UA	Multiple Frame Established (Note 2) TEI Assigned (Note 2)
B10	FRMR	Awaiting Establishment

SABM Set Asynchronous Balanced Mode

NOTES

1 V(A) and PRB are ancillary state variables not explicitly defined in Recommendation X.25. With the appropriate notational changes, Figure 3 generally applies to the interpretation of Table 4.

2 B9a occurs in response to an SABM or SABME command. B9b occurs in response to a DISC command.

TABLE 5/I.353

Performance-significant reference events based on Q.764 message transfer

Code	Q.764 message	Resulting state
S1a b	Initial Address (IAM) Initial Address (IAM)	Wait for ACM (2) Wait for OGC Select (2)
S2a b	Address Complete (ACM) Address Complete (ACM)	Wait for Answer (3) Wait for Answer (5)
S3a b	Answer (ANS) Answer (ANS)	OGC Ansered (4) ICC Answered (4)
S4a b	Release (REL) Release (REL)	Wait for RLC (7) Wait for RLC (9)
S5	Release Complete (RLC)	Idle (0)

OGC Outgoing trunk circuit

ICC Incoming trunk circuit

NOTE – The connection processing control states have been divided into those used in incoming and outgoing circuit handling.

3.5 Frame switching

For further study.

3.6 Frame relaying

For further study.

3.7 B-ISDN ATM layer

Table 6 lists performance-significant reference events associated with ATM cell transfer (for further study). The table entries are:

- event identification code;
- type of ATM layer cell transferred; and
- resulting state of the ATM layer interface.

Unassigned cells do not create cell reference events. The unit of information transferred is the ATM cell.

TABLE 6/I.353

Performance-significant reference events based on ATM layer cell transfer

Code	Cell type	Resulting state
A1	UI	For further study
A2	UI	For further study
UI User information NOTE – Table 6 for further study.		

3.8 Unrestricted digital bearer services

3.8.1 Performance-significant reference events

A performance-significant reference event for unrestricted digital bearer services is the appearance of a relevant user information bit at a relevant boundary. The relevant boundary is the measurement point where performance is to be quantified. The unit of information transferred is one bit of user information. Additional events may be defined based on the specific structure of the transmitted bit stream, e.g. framing.

To communicate direction, entry events can be distinguished from exit events. Entry events are created when the bit is travelling across the measurement point into a switching node or a CEQ. Exit events are created when the bit is travelling across the measurement point out of a switching node or a CEQ.

In general, there are no protocol state changes associated with the user information transfer phase of unrestricted digital bearer services. Therefore in identifying their reference events state changes need not be discussed.

3.8.2 The relevant bit of user information

The ability to identify the relevant bit of user information is essential to the definition of the user information transfer parameters. Unrestricted digital bearer services accept a sequence of bits $\{a_i\}$ at one measurement point and deliver a sequence of bits $\{b_i\}$ at another measurement point. When measuring information transfer performance between those two boundaries the relevant bits are usually "corresponding" bits in the two sequences. The term "corresponding" has meaning if, and only if, there exists a large number N and other numbers i and d such that:

$$\text{for almost all intergers } i,\ m \leq i \leq m + N \tag{3-1}$$

where

m is the first bit in a sequence of corresponding bits;

d is the displacement.

Then for all i, $m \leq i \leq m + N$, bit b_{i+d} is said to correspond to bit a_i.

When the corresponding bits a_i and b_{i+d} are not equal, the bit b_{i+d} is said to be errored. When the corresponding bits a_i and b_{i+d} are equal, the bit b_{i+d} is said to be unerrored. If there are no large N, m and d for which equation (3-1) holds, the condition is referred to as failure to synchronize, or no synch.

Before counting errored and unerrored bits in user information transfer measurement results it is advisable to adjust m, d and N in a way that maximizes N. However, m, d and N should also be chosen so that:

- equation (3-1) remains satisfied; the
- the large majority of bits at both the beginning and the end of the sequence $\{b_{m+di} \ldots b_{m+N+d}\}$ are unerrored.

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