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STANDARDIZATION SECTOR
OF ITU

SERIES I: INTEGRATED SERVICES DIGITAL NETWORK

Internetwork interfaces

Connection of VSAT based private networks to the public ISDN

ITU-T Recommendation I.571

(Previously CCITT Recommendation)

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ITU-T RECOMMENDATION I.571

CONNECTION OF VSAT BASED PRIVATE NETWORKS TO THE PUBLIC ISDN

Source

ITU-T Recommendation I.571 was prepared by ITU-T Study Group 13 (1993-1996) and was approved under the WTSC Resolution No. 1 procedure on the 27th of August 1996.

FOREWORD

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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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Introduction

When VSAT based private networks are connected to public ISDN networks, it is desired to support the following: common and compatible functionality between the VSAT based private network and the public ISDN, end-to-end terminal compatibility over the composite network, terminal interchangeability whereby ISDN terminals for the different teleservices can indistinctly be attached to the VSAT based private network or the public ISDN, and a controlled quality of service by harmonizing the requirements of quality pertaining to the various portions of the connection.

This Recommendation describes different interconnection scenarios between VSAT based private networks and public ISDNs, specifies the requirements that VSAT based private networks should satisfy when connecting to the public ISDN, and provides guidelines for VSAT based private network configuration and operation that contribute to maintaining a controlled quality of service and interoperability between VSAT based private networks and the public ISDN.

Recommendation I.571

CONNECTION OF VSAT BASED PRIVATE NETWORKS TO THE PUBLIC ISDN

(Geneva, 1996)

1 Scope

This Recommendation describes the requirements for interconnection of VSAT based private networks to the public ISDN. In addition, guidelines are provided for VSAT based private network configuration and performance that contribute to maintaining a desirable quality of service and interoperability between VSAT based private networks and the public ISDN.

2 References

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

– CCITT Recommendation E.164 (1991), *Numbering plan for the ISDN era*.

– CCITT Recommendation I.231.1 (1988), *Circuit-mode bearer service categories – Circuit-mode 64 kbit/s unrestricted, 8 kHz structured bearer service.*

– CCITT Recommendation I.231.2 (1988), *Circuit-mode bearer service categories – Circuit-mode 64 kbit/s, 8 kHz structured bearer service usable for speech information transfer.*

– CCITT Recommendation I.231.3 (1988), *Circuit-mode bearer service categories – Circuit-mode 64 kbit/s, 8 kHz structured bearer service usable for 3.1 kHz audio information transfer*.

– CCITT Recommendation I.251.1 (1992), *Number identification supplementary services – Direct-dialling-in*.

– CCITT Recommendation I.251.2 (1992), *Number identification supplementary services – Multiple Subscriber Number.*

– CCITT Recommendation I.251.3 (1992), *Number identification supplementary services – Calling Line Identification Presentation*.

– CCITT Recommendation I.251.4 (1992), *Number identification supplementary services – Calling Line Identification Restriction*.

– CCITT Recommendation I.251.8 (1992), *Number identification supplementary services – Sub-addressing supplementary service.*

– ITU-T Recommendation I.258.1 (1995), *Mobility and modification supplementary services – Terminal Portability*.

– ITU-T Recommendation I.325 (1993), *Reference configurations for ISDN connection types.*

– ITU-T Recommendation I.430 (1995), *Basic user-network interface – Layer 1 specification*.

– ITU-T Recommendation I.431 (1993), *Primary rate user-network interface – Layer 1 specification*.

- ITU-T Recommendation I.570 (1993), *Public/private ISDN interworking*.
- ITU-T Recommendation Q.920 (1993), *ISDN user-network interface data link layer – General aspects*.
- ITU-T Recommendation Q.921 (1993), *ISDN user-network interface – Data link layer specification*.
- ITU-T Recommendation Q.930 (1993), *ISDN user-network interface layer 3 – General aspects.*
- ITU-T Recommendation Q.931 (1993), *ISDN user-network interface layer 3 specification for basic call control*.
- ITU-T Recommendation Q.932 (1993), *Generic procedures for the control of ISDN supplementary services.*
- Recommendation Q.950-Series, *Stage 3 description for supplementary services using DSS 1*.
- CCITT Recommendation X.135 (1992), *Speed of service (delay and throughput) performance values for public data networks when providing international packet-switched services.*
- ITU-T Recommendation X.361 (1996), *Connection of VSAT systems with packet-switched public data networks based on X.25 procedures*.

3 Definitions

This Recommendation defines the following terms.

3.1 hub: The centralized node in VSAT star networks.

3.2 measurement point (MP): An MP is located at a physical interface which separates either a (set of) Customer Premises Equipment (CPE), or a Switching or Signalling Node (SSN) from an attached transmission system at which the protocols can be observed.

3.3 measurement point T (MPT): MPT is an MP located at the interface associated with a T reference point.

3.4 measurement point I (MPI): MPI is an MP located at an interface that terminates a transmission system at an International Switching Centre (ISC).

3.5 network control station (NCS): The centralized controller in mesh VSAT networks.

3.6 terminal equipment (TE): This functional group includes functions belonging to the functional group TE, and which are connected to a Private Telecommunication Network (PTN) via an S reference point as defined in Recommendation I.570.

NOTE – Terminals connected to Private Telecommunication Networks (PTNs) via an S interface are called TEs in Recommendation I.570 and not TE1s.

3.7 terminal equipment 1 (TE1): This functional group includes functions belonging to the functional group TE, and with an interface that complies with the ISDN user-network interface standard.

3.8 VSAT based private ISDN: A VSAT network or part of a VSAT network which offers ISDN services to non-public users.

NOTE – A VSAT based private ISDN is a special case of a VSAT based private network.

3.9 VSAT based private network: A VSAT network which offers services to users via a satellite which includes intra-network communications terminals which may be connected to the VSAT network using standardised or non-standardised interfaces.

3.10 VSAT network: A type of satellite network in which Very Small Aperture Terminals (VSATs) are interconnected.

NOTE – VSATs are defined in ITU-R Recommendation S.725.

4 Abbreviations

This Recommendation uses the following abbreviations.

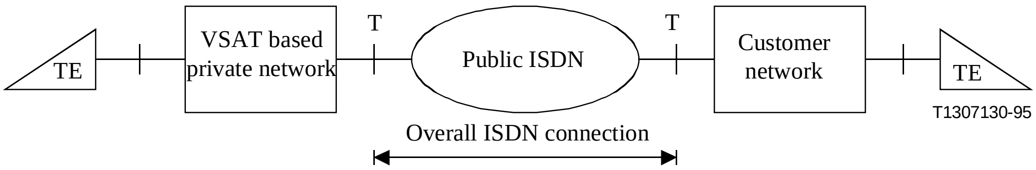
BER	Bit Error Ratio
CE	Connection Element
CONP	Connected Name Identification Presentation
CPE	Customer Premises Equipment
CTR	Common Technical Regulation
DDI	Direct-Dialling-In
DSS 1	Digital Subscriber Signalling System No. 1
ISC	International Switching Centre
ISDN	Integrated Services Digital Network
ISPBX	ISDN Private Branch Exchange
ITU	International Telecommunication Union
ITU-R	International Telecommunication Union – Radiocommunication Sector
ITU-T	International Telecommunication Union – Telecommunication Standardization Sector
LAPD	Link Access Procedure on the D-channel
MP	Measurement Point
MPI	Measurement Point at an ISC
MPT	Measurement Point at reference point T
MSN	Multiple Subscriber Number
NCS	Network Control Station
NT2	Network Termination 2
ONP	Open Network Provision
PTN	Private Telecommunication Network
PTNX	Private Telecommunication Network Exchange
R-ISPBX	Remote ISDN Private Branch Exchange
R-VSAT	Remote Very Small Aperture Terminal
S	Interface reference point S
SSN	Switching or Signalling Node
SUB	Subaddressing
T	Interface reference point T
T-ISPBX	Transit ISDN Private Branch Exchange
T-VSAT	Transit Very Small Aperture Terminal
TE	Terminal Equipment
TE1	Terminal Equipment type 1
TP	Terminal Portability

VSAT Very Small Aperture Terminal

5 Reference configurations

5.1 Overall scenario for interconnection of VSAT networks to public ISDNs

VSAT networks represent a particular form of a private network. VSAT networks should be connected to the public ISDNs using the general principles and guidelines for the interworking of public and private ISDNs described in Recommendation I.570, and as shown in Figure 1.

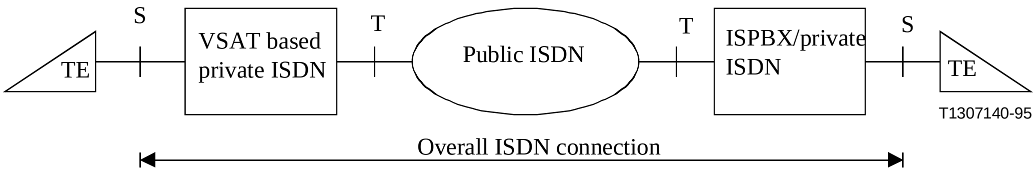


NOTE 1 – The functional group customer network is described in Recommendation I.411.
NOTE 2 – If the VSAT network is null (i.e, null NT2), the ISDN connection can be considered to end at coincident S and T reference points.
NOTE 3 – If the customer network is an ISPBX-based network, providing the same ISDN connection types according to Recommendation I.430 as the public ISDN does, the ISDN connection ends at the S reference point as shown in Figure 2.

Figure 1/I.571 – Overall scenario for interconnection of a VSAT based private ISDN to the public ISDN

The VSAT network is connected to the public network at a T reference point of the public ISDN. A Terminal Equipment (TE) can be connected to the VSAT network at either an S reference point, a coincident S/T reference point, or using a non-ISDN interface via a terminal adapter.

In the case that TEs are connected to the VSAT network using non-ISDN interfaces, the VSAT network is referred to as a *VSAT based private network*. In the case that TEs are connected to the VSAT network using ISDN interfaces, the VSAT network is referred to as a *VSAT based private ISDN*. The case of interconnection of TEs to the VSAT network using a non-standardised ISDN interface is considered to be outside the scope of this Recommendation. Therefore, this Recommendation will only consider the case where ISDN terminals are connected to the VSAT network via an interface at an S or a coincident S/T reference point.



NOTE 1 – This reference configuration applies to the case where the customer network consists only of ISPBXs.
NOTE 2 – The terms "customer equipment" and "public ISDN" do not presuppose a particular regulatory situation in any country and are used purely for technical reasons. The connection type concept is defined in Recommendation I.340.

Figure 2/I.571 – Overall scenario for interconnection of a VSAT based private ISDN to the public ISDN

Figure 2 shows how a VSAT based private ISDN shall be connected to the public ISDN. This interconnection scenario is based on Figure 1/I.570. The figure also shows that TEs should be connected to the VSAT based private ISDN via an S or a coincident S/T reference point. The coincident S/T reference point occurs when no layer 2 and layer 3 functionality are included in the VSAT network, that is, layer 2 and layer 3 messages are transferred transparently through the VSAT network.

NOTE – The ISDN terminals connected to a private ISDN (or VSAT based private ISDN) are called TEs not TE1s.

Two cases of the overall interconnection scenario are identified:

– Case 1: Interconnection of a VSAT based private ISDN to public ISDNs where the VSAT network provides the ISPBX functionality;

– Case 2: Remote access to the public ISDN via a VSAT network.

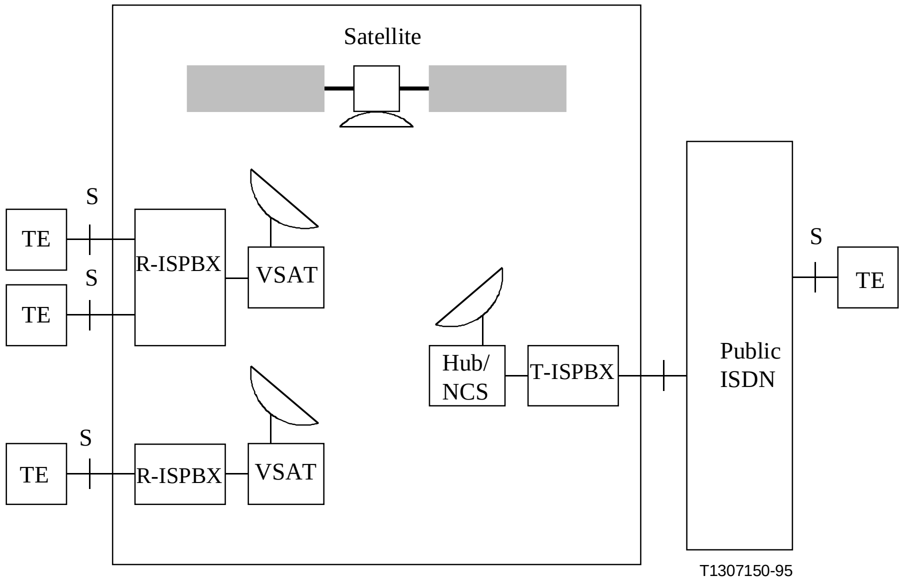
The following two subclauses specify Case 1 and Case 2 of the overall interconnection scenario.

5.2 Case 1: Interconnection of a VSAT based private ISDN with ISPBX functionality to the public ISDN

Figure 3 shows the architecture of Case 1, "Interconnection of a VSAT based private ISDN with ISPBX functionality to the public ISDN." The VSAT network has a star-type architecture.

NOTE – It is possible for the VSAT network to be interconnected with more than one ISDN or at stations other than the hub/NCS; these cases are for further study.

The star-type VSAT network consists of Very Small Aperture Terminals (VSATs), Remote ISDN Private Branch Exchanges (R-ISPBXs), one Transit ISDN Private Branch Exchanges (T-ISPBXs), a satellite, and a hub. An R-ISPBX is an ISPBX connected to a VSAT located at a remote site and a T-ISPBX is an ISPBX directly connected to the public ISDN. The T-ISPBX is located at the hub.



R-ISPBX Remote ISDN Private Branch Exchange
T-ISPBX Transit ISDN Private Branch Exchange

NOTE 1 – No additional routing functions are envisaged within the public ISDN that interconnects with a VSAT based private network. For instance, in the event of a VSAT based private network element failure which affects calls between one of the T reference points between the public ISDN and the VSAT based private network and a specific customer (or group of customers) connected to the VSAT based private network, alternative routing within the public ISDN is not expected.
NOTE 2 – The inclusion of ISPBX functionality at the remote sites does not necessarily imply that all ISPBX functionality are physically located at the remote sites.
NOTE 3 – If the VSAT network has a mesh-type architecture, instead of a star-type architecture, the network normally includes a Network Control Station (NCS) instead of a hub.

Figure 3/I.571 – Network architecture of a VSAT based private ISDN connected to the public ISDN

In this scenario, the VSAT network includes ISDN Private Branch Exchange (ISPBX) functionality at all remote sites and at all sites which have access to the public ISDN. Because of this ISPBX functionality, it will be possible for TEs connected to the VSAT network to communicate with either:

– TEs connected to the same R-ISPBX;
– TEs connected to another ISPBX in the same VSAT network;
– TE1s connected to the public ISDN.

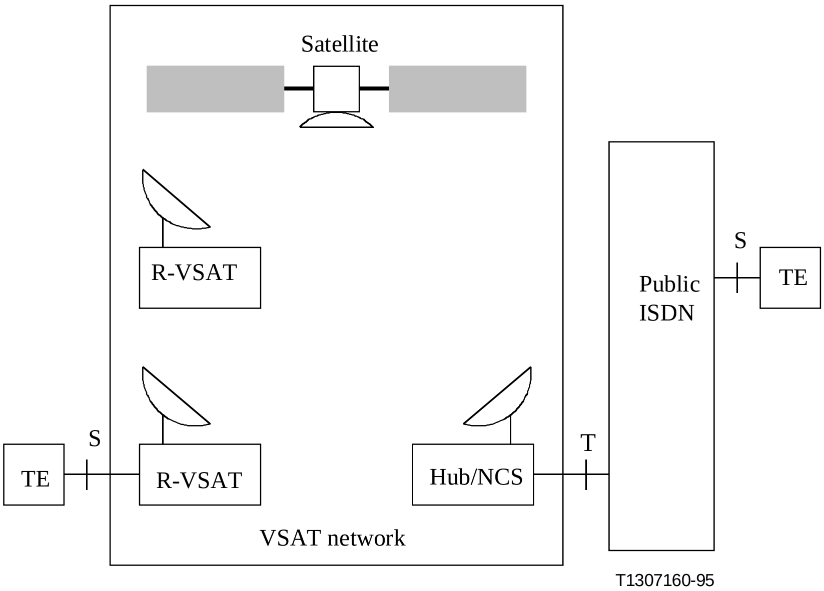
5.3 Case 2: Remote access to the public ISDN via a VSAT network

Case 2 only provides access to an ISDN from a remote site via satellite. In Case 2, the VSAT network consists of Remote Very Small Aperture Terminals (R-VSATs), a satellite, and a hub/NCS. Figure 4 illustrates the architecture of Case 2.

Case 2 provides remote access to a public ISDN and does not provide ISPBX functionality at the remote sites or within VSATs. The result is that a TE connected to the VSAT network can only communicate with TE1s connected to a public ISDN or through the public ISDN to other TEs connected to a VSAT network.

There are two variants of Case 2, (Cases 2a and 2b). In Case 2a, layer 2 and layer 3 messages are transferred transparently through the VSAT network and the interfaces between the TEs and the VSAT network are coincident S/T interfaces.

In Case 2b, layer 2 regeneration is included in the VSAT network, and only layer 3 messages are transferred transparently through the VSAT network. In some VSAT based private network designs, the layer 2 within the VSAT based private network may be different from the layer 2 at its external S and T reference points in order to adapt to the satellite link transmission characteristics (delay, BER, etc.). In these designs, the appropriate actions in the event of a failure of the intermediate layer 2 need to be defined.



R-VSAT Remote Very Small Aperture Terminal

Figure 4/I.571 – Network architecture for remote interconnection of a terminal to a public ISDN via a VSAT network

NOTE – It is possible for the VSAT network to be interconnected with more than one ISDN or at a site different than the Hub/NCS; these cases are for further study.

6 Interface requirements

A VSAT network shall be connected to the public ISDN using either ISDN basic access or ISDN primary rate access. The interface used shall comply to the requirements given below.

6.1 ISDN basic access

When a VSAT network is connected to a public ISDN using a basic rate interface, the procedures and protocols applicable at the reference point T are as defined in Recommendations I.430 for layer 1, Q.920/Q.921 for layer 2 and Q.930/Q.931 for layer 3. The procedures for the support of ISDN supplementary services are described in the Q.950-Series of Recommendations.

6.2 ISDN primary rate access

When a VSAT network is connected to a public ISDN using a primary rate access, it shall comply with the requirements given in Recommendations I.431 for layer 1, Q.920/Q.921 for layer 2 and Q.930/Q.931 for layer 3. The procedures for the support of ISDN supplementary services are described in the Q.950-Series of Recommendations.

7 Service interworking

Service interworking is in accordance with principles described in Recommendation I.570. This clause lists some services which should be offered by the VSAT based private network.

7.1 Bearer services

7.1.1 Bearer services for Case 1

The following bearer services should be offered by the VSAT network of Case 1:

- Circuit-mode 64 kbit/s unrestricted bearer service according to the specification in Recommendation I.231.1.
- Circuit-mode speech bearer service according to the specification in Recommendation I.231.2.
- Circuit-mode 3.1 kHz audio bearer service according to the specification in Recommendation I.231.3.

The offering of other bearer services by a VSAT network is not precluded.

NOTE – No verification specification exists for the PTN bearer service specifications.

7.1.2 Bearer services for Case 2

The following bearer services should be offered by the VSAT network of Case 2:

- Circuit-mode 64 kbit/s unrestricted bearer service according to the specification in Recommendation I.231.1.
- Circuit-mode speech bearer service according to the specification in Recommendation I.231.2.
- Circuit-mode 3.1 kHz audio bearer service according to the specification in Recommendation I.231.3.

7.2 Supplementary services

7.2.1 Supplementary services for Case 1

The following supplementary services are examples of those which may offered by the VSAT network of Case 1:

- Calling Line Identification Presentation (CLIP) according to Recommendation I.251.3.
- Calling Line Identification Restriction (CLIR) according to Recommendation I.251.4.
- Direct-Dialling-In (DDI) according to Recommendation I.251.1
- Multiple Subscriber Number (MSN) according to Recommendation I.251.2.
- Terminal Portability (TP) according to Recommendation I.258.1.
- Subaddressing (SUB) according to Recommendation I.251.8.

7.2.2 Supplementary services for Case 2

For Case 2, the supplementary services of the public ISDN to which the VSAT is attached will be offered transparently via the VSAT network.

8 Interworking requirements

8.1 Addressing

The numbering plan and addressing visible at the T reference point shall follow the requirements given in Recommendation E.164.

8.2 Access between public ISDN and VSAT based private network

Access aspects relating to interworking between public and private ISDNs are described in 5.4.2/I.570.

9 Performance considerations at the ISDN interface

9.1 Parameter values for ISDN access signalling protocols

In a VSAT network based on the Case 1 architecture for which layer 1 and layer 2 are terminated at the hub/NCS, there is no need to change parameter values for protocols operating across the T reference point.

For a VSAT network based on the Case 2 architecture, the default values for Q.921 (LAPD) system parameters (e.g. timers, window) are not appropriate for satellite links. It is recommended that user and network equipment allow selection of alternate values or implement the automatic negotiation of data link parameters procedures of Appendix IV/Q.921. The recommended default value for T200 is 2.5 s. The recommended default value for the maximum number of outstanding I frames (k) is 35.

NOTE – If parameter values cannot be changed, protocol conversion may be necessary.

9.2 Parameter values for end-to-end protocols

Protocol profiles for user communications (e.g. X.25) may have recommended parameter values or procedures which are specifically intended for satellite connections. These recommendations should be followed where possible.

9.3 Impacts on connection processing delays

Annex A contains recommended delay objectives for connection processing.

ANNEX A

Guidelines for VSAT networks interconnecting with a public ISDN

A.1 Introduction

This annex provides guidelines for the design and dimensioning of VSAT based private network concerning: VSAT network performance, terminal interfaces, and protocol performance.

A.2 Interface Recommendations

A.2.1 Interface for Case 1

In the case that the VSAT network is connected to the ISDN according to Case 1, terminals should connect to the VSAT network via the S reference point.

A.2.2 Interface for Case 2

In the case that the VSAT network is connected to the ISDN according to Case 2, terminals should connect to the VSAT network via the S or coincident S/T reference point.

A.3 Circuit-mode performance Recommendations

Network performance parameters are used to specify the performance of a Connection Element (CE) or a concatenation of CEs employed to provide a service (Recommendation I.350).

The VSAT based private ISDN is a Connection Element (VSAT-CE) with the performance boundaries at the S and T interfaces.

The VSAT based ISDN should not add more to the degradation of the network performance parameters than stated in the following subclauses.

This subclause specifies the performance parameters applicable to circuit mode.

A.3.1 Error performance

The bit error ratio at the output (i.e. at either end of a two-way connection) forming part of a 64-kbit/s connection through a VSAT-CE should not exceed, during the available time, the Recommendations given in ITU-R Recommendation S.614.

Verification

Verification should be done according to the measurement procedure given in ITU-R Recommendation S.614, Annex 1.

A.3.2 Availability performance

The unavailability of a 64-kbit/s connection through a VSAT-CE should not exceed the Recommendations given for a digital path in ITU-R Recommendation S.579.

Verification

The unavailability time should be calculated according to the definition of unavailable time in ITU-R Recommendation S.614 and the recommended values in ITU-R Recommendation S.579.

A.3.3 Slip rate performance

The slip rate for a 64-kbit/s connection through a VSAT-CE should not exceed the slip rate objectives in Table A.1 for performance categories (b) and (c) (based on Recommendation G.822):

Table A.1/I.571 – Controlled slip performance on a 64-kbit/s connection through a VSAT-CE

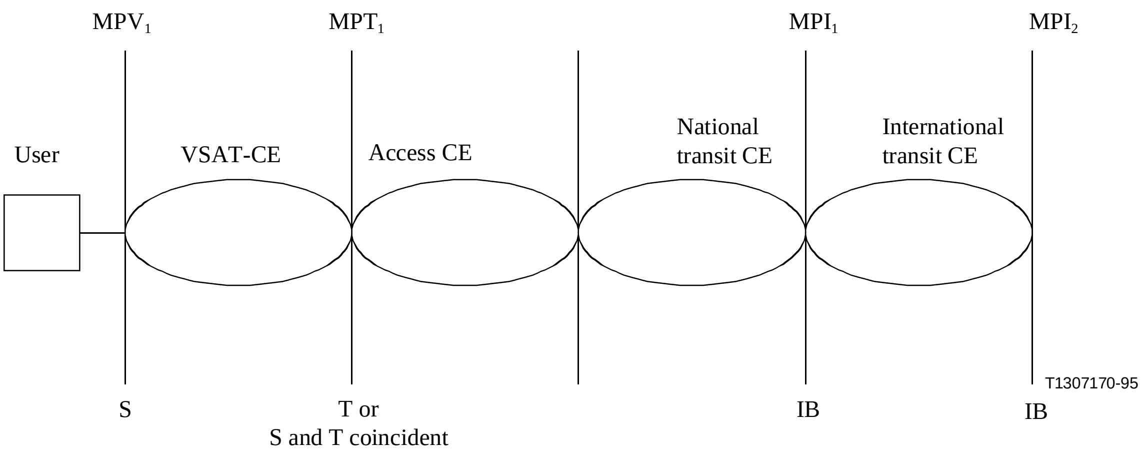
Performance category	Mean slip rate	Proportion of time
(a)	≤ 5 slips in 24 hours	> 99.56%
(b)	> 5 slips in 24 hours and ≤ 30 slips in 1 hour	< 0.4%
(c)	> 30 slips in 1 hour	< 0.04%
NOTE – Total time ≥ 1 year		

A.3.4 Jitter performance

A 64-kbit/s connection through the VSAT-CE should function with jitter at the input port as specified in Recommendation G.823 and the maximum jitter at the output port should not exceed the values specified in Recommendation G.823.

A.4 Network performance Recommendations

Figure A.1 shows the general reference configuration for defining network performance parameters for a VSAT-CE. Compared to the general reference configuration in Recommendation I.325, a VSAT Connection Element (CE) has been added.



CE Connection Element
MPI1 Measurement Point I1
MPI2 Measurement Point I2
MPT1 Measurement Point T1
MPV1 Measurement Point V1
IB Internationl Switching Centre (ISC) Boundary

Figure A.1/I.571 – General reference configurations

Measurement Point I_1 (MPI_1) and Measurement Point I_2 (MPI_2) are the measurement points on the boundaries of the international transit CE. Measurement Point T_1 (MPT_1) is the measurement point between the VSAT network and the Access CE to the national transit CE. Measurement Point V_1 (MPV_1) is the measurement point between the VSAT-CE and the user.

NOTE – The delay performances in A.4.3 and A.4.4 have been determined for VSAT networks using the slotted ALOHA technique with a typical load of 15% and with mean repetition delays of 2 s for the first repetition, and 8 s for the following repetitions. For VSAT networks using other techniques, these delay performances are under study.

A.4.1 Performance-significant reference events

Performance-significant reference events are defined in Recommendations I.353 and X.134. This subclause presents the performance-significant reference events relevant for this Recommendation.

An ISDN reference event is the transfer of a discrete unit of control, or user information, encoded in accordance with ITU-T recommended protocols across a Measurement Point (MP). Specified information units and associated resulting protocol state(s) are identified by an event code used for reference in defining network 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.

An entry event is a reference event that corresponds to an information unit entering a Switching or Signalling Node (SSN), or Customer Premises Equipment (CPE).

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

Figure A.2 conceptually illustrates the two classes of reference events and indicates the measurement points at which entry and exit events are intended to be observed.

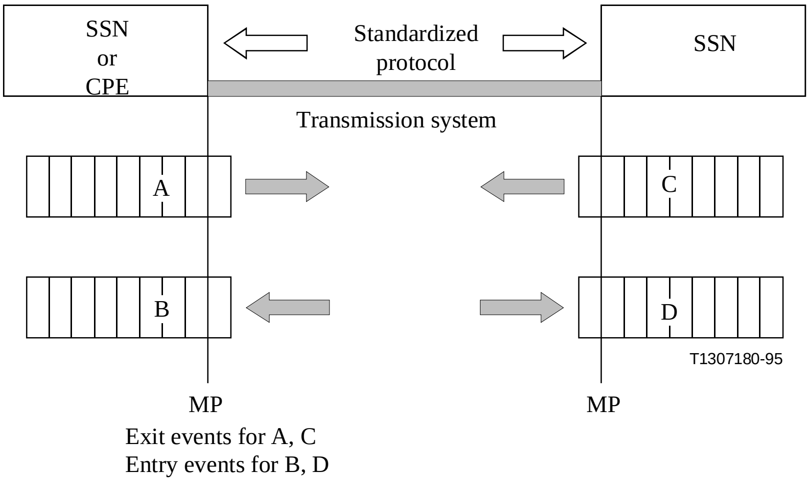


Figure A.2/I.571 – Example entry and exit reference events

Table A.2 lists performance significant DSS 1 layer 3 message transfer reference events associated with the interface at the S and T reference point. The table entries are event identification code, type of DSS 1 layer 3 message transferred, and the resulting state of the DSS 1 layer 3 interface.

Table A.3 lists performance significant X. 25 layer 3 message transfer reference events associated with the interface at the S and T reference point. The table entries are event identification code, type of X.25 layer 3 message transferred, and the resulting state of the X.25 layer 3 interface.

When Table A.2 or A.3 lists 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 network performance parameters.

The time of occurrence of a DSS 1 layer 3 or X.25 layer 3 message 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 CPE. The time of occurrence of a DSS 1 layer 3 or X.25 layer 3 message 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 into the SSN, or CPE. If re-transmission occurs, the exit event occurs with the first transmission, and the entry event occurs with the last transmission.

Table A.2/I.571 – Performance-significant reference events based on DSS 1 layer 3 message transfer at the S and T reference point

Code	Layer 3 Message	Resulting State
P1a	SETUP	N1 (Call Initiated)
P1b	SETUP	N6 (Call Present)
P2a	SETUP ACKnowledge	N25 (Overlap Receiving)
P2b	SETUP ACKnowledge	N2 (Overlap Sending)
P3	INFOrmation	N2 (Overlap Sending)
P4a	CALL PROCeeding	N9 (Incoming Call Proceeding)
P4b	CALL PROCeeding	N3 (Outgoing Call Proceeding)
P5a	ALERTing	N7 (Call Received)
P5b	ALERTing	N4 (Call Delivered)
P6a	CONNect	N8 (Connect Request)
P6b	CONNect	N10 (Active)
P7	CONNect ACKnowledge	N10 (Active)
P8a	DISConnect	N11 (Disconnect Request)
P8b	DISConnect	N12 (Disconnect Indication)
P9	RELease	N19 (Release Request)
P10	RELease COMplete	N0 (Null)

NOTE 1 – In Case 2, DSS 1 layer 3 messages will be transferred transparently through the VSAT network; that is, only the layer 3 messages and not the resulting states of Table A.2 are applicable.

Table A.3/I.571 – Relevant performance-significant reference events based on packet layer message transfer at the S and T reference point

Number	X.25 layer 3	Resulting State
2	Call Request	p2 (DTE Waiting)
3	Call Connected	p4 (Data transfer)
5	Clear Indication	p7 (DCE Clear Indication)
6	Clear Request	p6 (DTE Clear Request)
9a	DCE Data	npr becomes P(S) + 1
10a	DTE Data	npr becomes P(S) + 1

NOTE 2 – If X.25 layer 3 messages are transferred transparently through the VSAT network, only the X.25 layer 3 messages and not the resulting states of Table A.3 are applicable.

A.4.2 Network conditions

The processing delay performance recommendations are defined for VSAT networks submitted to their nominal traffic load in the busy hour. This load should be stated by the manufacturers and should be quoted when claiming compliance with this Recommendation.

The statement should provide at least an indication of:

a) the amount of established traffic on the VSAT network;

b) call processing load.

This is expressed as the number of call attempts and clear attempts handled by the VSAT network per unit of time (second, hour).

A.4.3 Connection processing delay recommendations

A.4.3.1 Connection set-up delay

Specification

The connection set-up delay for the VSAT Connection Element (CE) is defined between measurement points MPV_1 and MPT_1 using performance-significant reference events. Table A.4 identifies the DSS 1 layer 3 start and ending reference events. For each boundary, starting event and ending event are defined. Note that P1a is the starting event code if en bloc sending of set-up information is used, while P3 is the starting event code if overlap sending of set-up information is used.

NOTE – En bloc sending of addressing information means that all addressing information is conveyed in the SETUP message, while overlap sending means that addressing information is conveyed not only in the SETUP message, but also in the consequential INFOrmation messages.

Table A.4/I.571 – Performance-significant reference events for measuring connection set-up delay

Measurement point	Performance-significant reference events	
	Starting event code	Ending event code
MPV_1	P1a (en bloc sending)	P6b
MPV_1	P3 (overlap sending)	P6b
MPT_1	P1a (en bloc sending)	P6b
MPT_1	P3 (overlap sending)	P6b
MPT_1	P1b	P6a
MPV_1	P1b	P6a

The additional connection set-up delay caused by the VSAT-CE can be determined by measurements at measurement points MPV_1 and MPT_1.

The difference in the values is the connection set-up delay contributed by the VSAT-CE = $(d_1 - d_2)$, where d_1 = connection set-up delay at measurement point MPV_1 and d_2 = connection set-up delay at measurement point MPT_1.

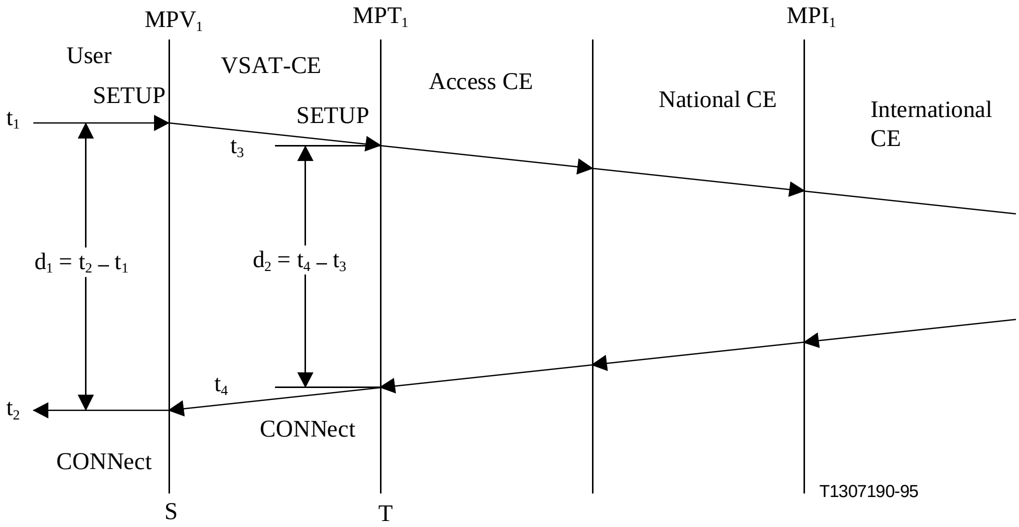


Figure A.3/I.571 – Reference arrow diagram for measuring connection set-up delay

Figure A.3 shows an arrow diagram which illustrates how the connection set-up delay is measured for a VSAT-CE. With reference to the figure, d_1 is defined as the time difference ($t_2 - t_1$), and d_2 is defined as the time difference ($t_4 - t_3$).

The connection set-up delay should be measured in both directions:

- Case i) From MPV_1 to MPT_1.
- Case ii) From MPT_1 to MPV_1.

In Figure A.3, only Case i) is shown.

The connection set-up delay of the VSAT-CE should not exceed the values given in Table A.5.

The values that are defined are average and 95% value. The average value is the expected average of the distribution of the call set-up delays. The 95% value is the delay value which should be satisfied for at least 95% of all call set-ups.

Table A.5/I.571 – Connection set-up delay for the VSAT-CE

Statistics	Connection set-up delay
Mean	3700 ms
95%	4700 ms

Verification

Test configuration:

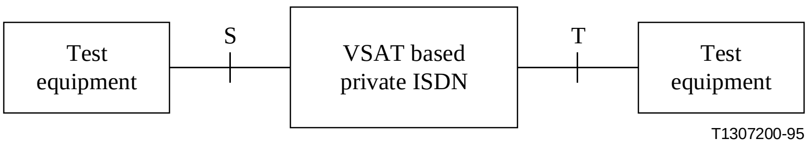


Figure A.4/I.571 – Test configuration

Test equipment should be connected to both ends of the VSAT based private ISDN. The test equipment may be protocol analysers.

i) Verification of call set-up delay from MPV_1 to MPT_1

The VSAT-CE connection set-up delay, given by $D_{SET\text{-}UP} = d_1 – d_2 = (t_2 – t_1) – (t_4 – t_3)$, should be measured a sufficient number of times to guarantee with a high degree of confidence that the delay objectives are met.

NOTE – It has been calculated that in order to provide an estimator which is 1% accurate, the measurement must be performed in excess of 1000 times.

ii) Verification of call set-up delay from MPT_1 to MPV_1

The same procedure as for the call set-up delay from MPV_1 to MPT_1 should be used.

A.4.3.2 Alerting delay

Specification

The alerting delay is defined using an approach similar to that of the connection set-up delay.

The alerting delay for the VSAT Connection Element (CE) is defined between measurement points MPV_1 and MPT_1 using performance-significant reference events. Table A.6 identifies the DSS 1 layer 3 start and ending reference events. For each boundary, starting event and ending event are defined. Note that P1a is the starting event code if en bloc sending is used, while P2b is the starting event code if overlap sending is used.

Table A.6/I.571 – Performance-significant reference events for measuring alerting delay

Measurement point	Performance-significant reference events	
	Starting event code	Ending event code
MPV_1	P1a (en bloc)	P5
MPV_1	P2b (overlap sending)	P5b
MPT_1	P1a (en bloc)	P5b
MPT_1	P2b (overlap sending)	P5b
MPT_1	P1b	P5a
MPV_1	P1b	P5a

The additional alerting delay caused by the VSAT-CE can be determined by measurements at measurement points MPV_1 and MPT_1.

The difference in the values is the alerting delay contributed by the VSAT-CE = $(d_1 – d_2)$, where:

d_1 = alerting delay at measurement point MPV_1

d_2 = alerting delay at measurement point MPT_1.

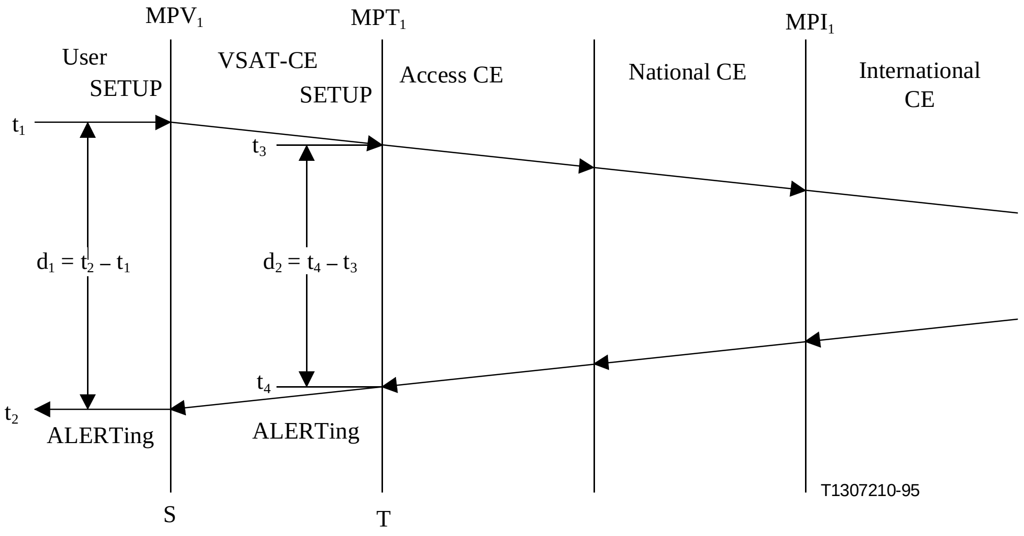


Figure A.5/I.571 – Reference arrow diagram for measuring alerting delay

Figure A.5 shows an arrow diagram which illustrates how the alerting delay is measured for a VSAT-CE. With reference to the figure, d_1 is defined as the time-difference ($t_2 – t_1$) and d_2 is defined as the time difference ($t_4 – t_3$).

The alerting delay should be measured in both directions:

– Case i) From MPV_1 to MPT_1.

– Case ii) From MPT_1 to MPV_1.

In Figure A.5, only Case i) is shown.

The alerting delay of the VSAT-CE should not exceed the values given in Table A.7.

The values that are defined are average and 95% value. The average value is the expected average of the distribution of the alerting delays. The 95% value is the delay value which should be satisfied for at least 95% of all alerting.

Table A.7/I.571 – Alerting delay for the VSAT-CE

Statistics	**Alerting delay**
Mean	3700 ms
95%	4700 ms

Verification

Test configuration:

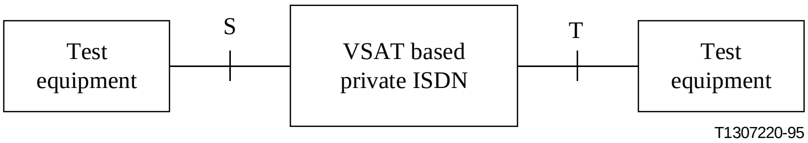


Figure A.6/I.571 – Test configuration

Test equipment should be connected to both ends of the VSAT based private ISDN. The test equipment may be protocol analysers.

i) Verification of alerting delay from MPV_1 to MPT_1

The VSAT-CE alerting delay, given by $D_{ALERT} = d_1 - d_2 = (t_2 - t_1) - (t_4 - t_3)$, should be measured a sufficient number of times to guarantee with a high degree of confidence that the delay objectives are met.

ii) Verification of call alerting delay from MPT_1 to MPV_1

The same procedure as for the alerting delay from MPV_1 to MPT_1 should be used.

A.4.3.3 Disconnect delay

Specification

Disconnect definition is based on only one-way message transport from the clearing party to the cleared party. Therefore, this parameter requires measurement at two measurement points. Disconnect delay for the VSAT Connection Element (CE) is defined between measurement points MPV_1 and MPT_1 using performance-significant reference events. Table A.8 identifies the DSS 1 layer 3 start and ending reference events.

Table A.8/I.571 – Performance-significant reference events for measuring disconnect delay

Measurement point	Performance-significant reference events	
	Starting event code	Ending event code
MPV_1 to MPT_1	P8a (clearing end)	P8b
MPT_1 to MPV_1	P8a	P8b (cleared end)

If the VSAT user is the clearing end, the disconnect delay between measurement points MPV_1 and MPT_1 is defined as the length of time that starts at time when a DISConnect message creates a performance-significant reference event at MPV_1 and ends when that DISConnect message creates a performance-significant reference event at MPT_1.

The disconnect delay of this case is therefore equal to $(t_2 - t_1)$, where:

t_1 = time of occurrence for the performance-significant reference event at measurement point MPV_1;

t_2 = time of occurrence for the performance-significant reference event at measurement point MPT_1.

If the VSAT user is the cleared end, the disconnect delay between measurement points MPV_1 and MPT_1 is defined as the length of time that starts when a DISConnect message creates a performance-significant reference event at MPT_1 and ends when that DISConnect message creates a performance-significant reference event at MPV_1.

The disconnect delay of this case is therefore equal to $(t_2 - t_1)$ where:

t_1 = time of occurrence for the performance-significant reference event at measurement point MPT_1;

t_2 = time of occurrence for the performance-significant reference event at measurement point MPV_1.

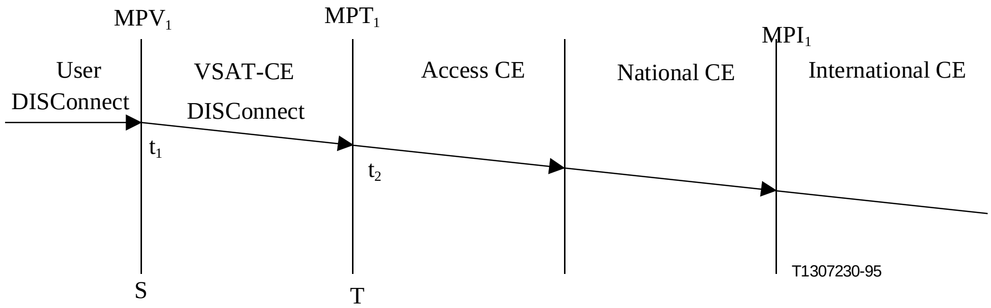


Figure A.7/I.571 – Reference arrow diagram for measuring disconnect delay

Figure A.7 shows an arrow diagram which illustrates how the disconnect delay is measured for a VSAT-CE. The disconnect delay should be measured in both directions:

– Case i) From MPV_1 to MPT_1.

– Case ii) From MPT_1 to MPV_1.

In Figure A.7, only Case i) is shown.

The disconnect delay of the VSAT-CE should not exceed the values given in Table A.9.

The values that are defined are average and 95% value. The average value is the expected average of the distribution of the disconnect delays. The 95% value is the delay value which should be satisfied for at least 95% of all disconnects.

Table A.9/I.571 – Disconnect delay of the VSAT-CE

Statistics	**Disconnect delay**
Mean	1250 ms
95%	1750 ms

Verification

Test configuration:

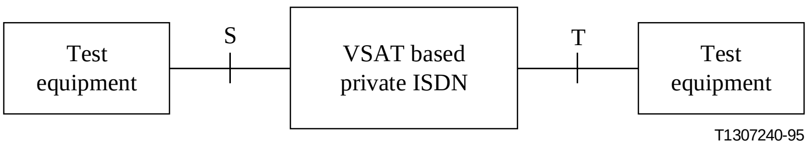


Figure A.8/I.571 – Test configuration

Test equipment should be connected to both ends of the VSAT based private ISDN. The test equipment may be protocol analysers.

i) Verification of disconnect delay from MPV_1 to MPT_1

The VSAT-CE disconnect delay, given by $D_{DISC} = (t_2 – t_1)$, should be measured a sufficient number of times to guarantee with a high degree of confidence that the delay objectives are met.

ii) Verification of disconnect delay from MPT_1 to MPV_1

The same procedure as for the disconnect delay from MPV_1 to MPT_1 should be used.

A.4.3.4 Release delay

Specification

Release delay is defined only at the clearing party interface at the S or T reference point. Release delay is defined using performance-significant reference events. Table A.10 identifies the DSS 1 layer 3 start and ending reference events.

Table A.10/I.571 – Performance-significant reference events for measuring release delay

Measurement point	Performance-significant reference events	
	Starting event code	Ending event code
MPV_1 or MPT_1 (clearing party)	P8a	P9

Release delay is defined as the length of time that starts when a DISConnect message from the clearing party creates a performance-significant reference event at the clearing party interface at the S or T reference point and ends when the RELease message creates a performance-significant reference event at the same interface.

Release delay at the S or S/T reference point is $d_1 = (t_2 – t_1)$, where:

t_1 = time of occurrence for the starting performance-significant reference event

t_2 = time of occurrence for the ending performance-significant reference event.

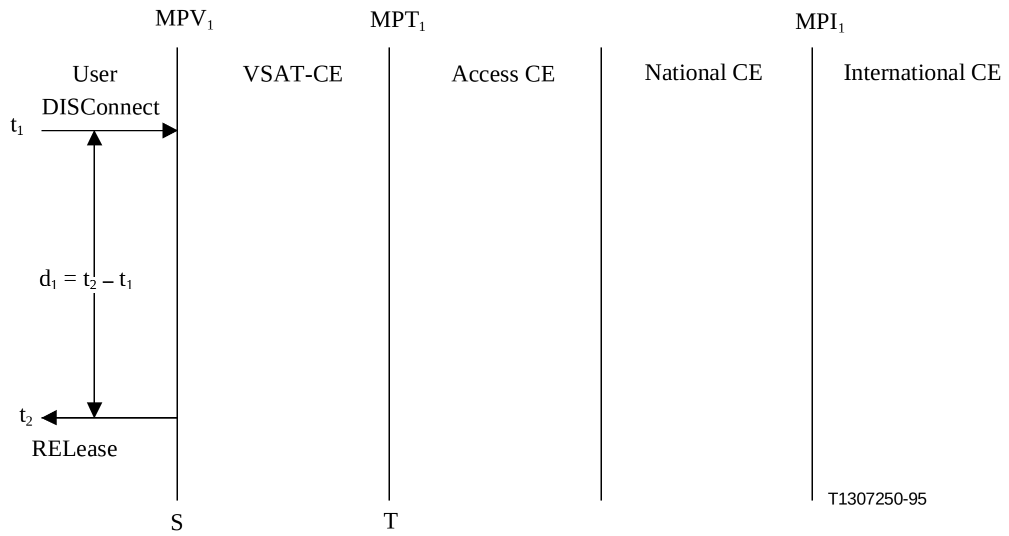


Figure A.9/I.571 – Reference arrow diagram for measuring release delay

Figure A.9 shows an arrow diagram which illustrates how the release delay is measured for a VSAT-CE. The release delay should be measured for two different cases:

– Case i) For calls where the VSAT user is the clearing end. In this case, the measurement should be done at measurement point MPV_1.

– Case ii) For calls where the VSAT user is the cleared end. In this case, the measurement should be done at measurement point MPT_1.

In Figure A.9, only Case i) is shown.

The release delay of the VSAT-CE should not exceed the values given in Table A.11.

The values that are defined are average and 95% value. The average value is the expected average of the distribution of the release delays. The 95% value is the delay value which should be satisfied for at least 95% of all releases.

Table A.11/I.571 – Release delay of the VSAT-CE

Statistics	Release delay
Mean	(For further study)
95%	(For further study)

Verification

Test configuration:

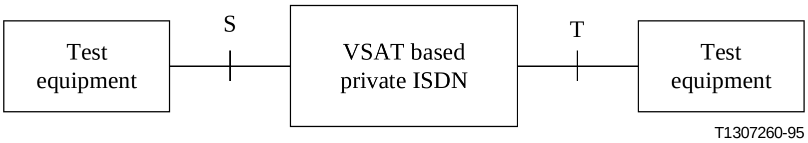


Figure A.10/I.571 – Test configuration

Test equipment should be connected to both ends of the VSAT based private ISDN. The test equipment may be protocol analysers.

The VSAT-CE release delay, given by $D_{REL} = (t_2 - t_1)$, should be measured a sufficient number of times to guarantee with a high degree of confidence that the delay objectives are met.

A.4.4 Packet mode delay Recommendations

Objective parameters and values in this subclause are defined in Recommendation X.135.

A.4.4.1 Packet mode call set-up delay

Specification

The packet mode call set-up delay for the VSAT-CE is defined between measurement points MPV_1 and MPT_1 using performance-significant reference events. Table A.12 identifies the X.25 layer 3 start and ending reference events. For each boundary, starting event and ending event are defined.

Table A.12/I.571 – Performance-significant reference events for measuring packet mode call set-up delay

Measurement point	Performance-significant reference events	
	Starting event code	Ending event code
MPV_1	2	3
MPT_1	2	3
MPT_1	1	4
MPV_1	1	4

The additional packet mode call set-up delay caused by the VSAT-CE can be determined by measurements at measurement points MPV_1 and MPT_1.

The difference in the values is the packet mode call set-up delay contributed by the VSAT-CE = $(d_1 - d_2)$, where:

d_1 = packet mode call set-up delay at measurement point MPV_1;

d_2 = packet mode call set-up delay at measurement point MPT_1.

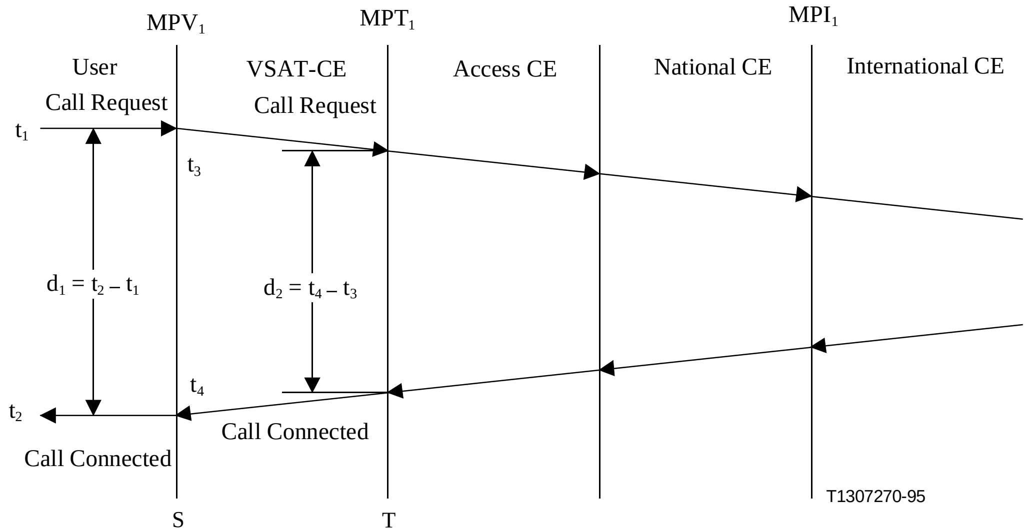


Figure A.11/I.571 – Reference arrow diagram for measuring packet mode call set-up delay

Figure A.11 shows an arrow diagram which illustrates how the packet mode call set-up delay is measured for a VSAT-CE. With reference to the figure, d_1 is defined as the time difference $(t_2 - t_1)$, and d_2 is defined as the time difference $(t_4 - t_3)$.

The call set-up delay should be measured in both directions:

– Case i) From MPV_1 to MPT_1.

– Case ii) From MPT_1 to MPV_1.

In Figure A.11, only the case from MPV_1 to MPT_1 is shown.

The packet mode call set-up delay of the VSAT-CE should not exceed the values given in Table A.13.

The values that are defined are average and 95% value. The average value is the expected average of the distribution of the packet mode call set-up delays. The 95% value is the delay value which should be satisfied for at least 95% of all packet mode call set-ups.

Table A.13/I.571 – Packet mode call set-up delay for the VSAT-CE

Statistics	Call set-up delay
Mean	2500 ms + X
95%	3500 ms + X

The value of X is given by X = 400/R ms, where R is the data transmission rate expressed in kbit/s.

Verification

Test configuration:

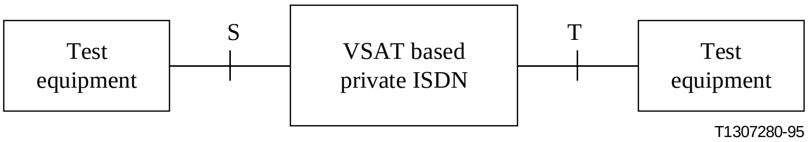


Figure A.12/I.571 – Test configuration

Test equipment should be connected to both ends of the VSAT based private ISDN. The test equipment may be protocol analysers.

i) Verification of packet mode call set-up delay from MPV_1 to MPT_1

The VSAT-CE packet mode call set-up delay, given by $D_{Call\ set\text{-}up} = d_1 - d_2 = (t_2 - t_1) - (t_4 - t_3)$, should be measured a sufficient number of times to guarantee with a high degree of confidence that the delay objectives are met.

ii) Verification of packet mode call set-up delay from MPT_1 to MPV_1

The same procedure as for the call set-up delay from MPV_1 to MPT_1 should be used.

A.4.4.2 Packet mode clear request/clear indication delay

Specification

Packet mode clear request/clear indication delay for the VSAT Connection Element (CE) is defined between measurement points MPV_1 and MPT_1 using performance-significant reference events. Table A.14 identifies the X.25 layer 3 start and ending reference events.

Table A.14/I.571 – Performance-significant reference events for measuring packet mode clear request/clear indication delay

Measurement point	Performance-significant reference events	
	Starting event code	Ending event code
MPV_1 and MPT_1	6 (VSAT user clearing end)	6 (VSAT user clearing end)
MPV_1 and MPT_1	5 (VSAT user cleared end)	5 (VSAT user cleared end)

If the VSAT user is the clearing end, the packet mode clear request delay between measurement points MPV_1 and MPT_1 is defined as the length of time that starts at time when a Clear Request packet creates a performance-significant reference event at MPV_1 and ends when that Clear Request packet creates a performance-significant reference event at MPT_1.

The packet mode clear request delay of this case is therefore equal to $(t_2 – t_1)$, where:

t_1 = time of occurrence for the performance-significant reference event at measurement point MPV_1;

t_2 = time of occurrence for the performance-significant reference event at measurement point MPT_1.

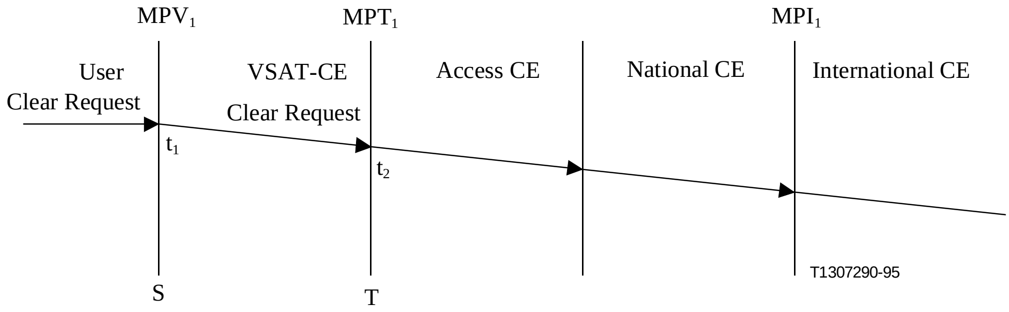


Figure A.13/I.571 – Reference arrow diagram for measuring packet mode clear request delay

Figure A.13 shows an arrow diagram which illustrates how the packet mode clear request delay is measured for a VSAT-CE.

If the VSAT user is the cleared end, the packet mode clear indication delay between measurement points MPV_1 and MPT_1 is defined as the length of time that starts when a Clear Indication packet creates a performance-significant reference event at MPT_1 and ends when that Clear Indication packet creates a performance-significant reference event at MPV_1.

The packet mode clear indication delay of this case is therefore equal to $(t_2 – t_1)$, where:

t_1 = time of occurrence for the performance-significant reference event at measurement point MPT_1;

t_2 = time of occurrence for the performance-significant reference event at measurement point MPV_1.

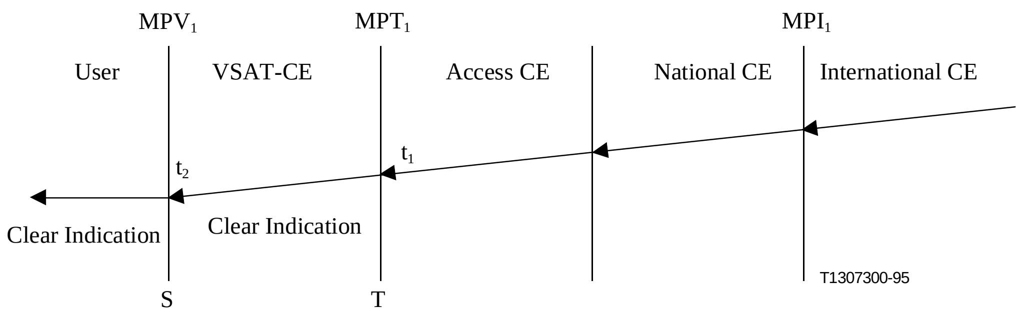


Figure A.14/I.571 – Reference arrow diagram for measuring packet mode clear indication delay

Figure A.14 shows an arrow diagram which illustrates how the packet mode clear indication delay is measured for a VSAT-CE.

The packet mode clear request and the packet mode clear indication delay of the VSAT-CE should not exceed the values given in Table A.15.

The values that are defined are average and 95% value. The average value is the expected average of the distribution of the packet mode clear request/clear indication delays. The 95% value is the delay value which should be satisfied for at least 95% of all packet mode clear requests/clear indications.

Table A.15/I.571 – Packet mode clear request/clear indication delay of the VSAT-CE

Statistics	Packet mode clear request/clear indication delay
Mean	1200 + Z ms
95%	2500 + Z ms

The value of Z is given by Z = 80/R ms, where R is the data transmission rate expressed in kbit/s.

Verification

Test configuration:

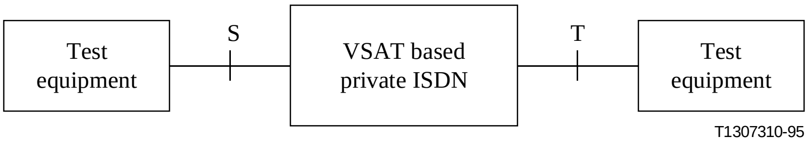


Figure A.15/I.571 – Test configuration

Test equipment should be connected to both ends of the VSAT based private ISDN. The test equipment may be protocol analysers.

i) Verification of packet mode clear request delay

The VSAT-CE packet mode clear request delay, given by $D_{Clear\ Request} = (t_2 – t_1)$, should be measured a sufficient number of times to guarantee with a high degree of confidence that the delay objectives are met.

ii) Verification of packet mode clear indication delay

The same procedure as for the packet mode clear request delay should be used.

A.4.4.3 Packet mode data transfer delay

Specification

Packet mode data transfer delay for the VSAT Connection Element (CE) is defined between measurement points MPV_1 and MPT_1 using performance-significant reference events. Table A.16 identifies the X.25 layer 3 start and ending reference events.

Table A.16/I.571 – Performance-significant reference events for measuring packet mode data transfer delay

Measurement point	Performance-significant reference events	
	Starting event code	**Ending event code**
MPV_1 and MPT_1	10a (VSAT user is data transfer source)	10a (VSAT user is data transfer source)
MPV_1 and MPT_1	9a (VSAT user is data transfer destination)	9a (VSAT user is data transfer destination)

If the VSAT user is the data transfer source, the packet mode data transfer delay between measurement points MPV_1 and MPT_1 is defined as the length of time that starts at time when a DTE data packet creates a performance-significant reference event at MPV_1 and ends when that DTE data packet creates a performance-significant reference event at MPT_1.

The packet mode data transfer delay of this case is therefore equal to $(t_2 – t_1)$, where:

t_1 = time of occurrence for the performance-significant reference event at measurement point MPV_1;

t_2 = time of occurrence for the performance-significant reference event at measurement point MPT_1.

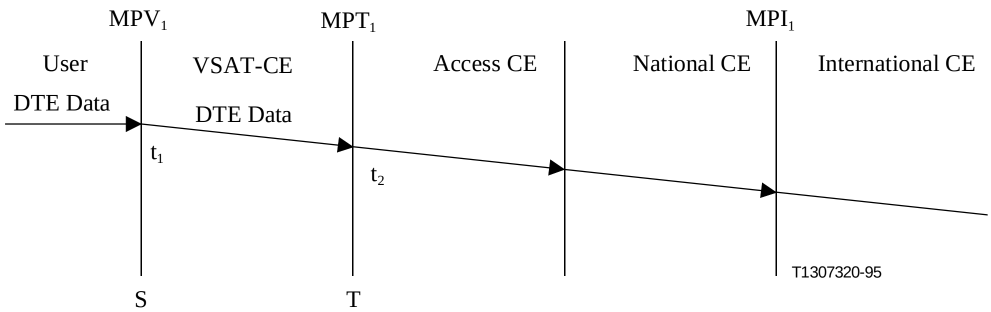


Figure A.16/I.571 – Reference arrow diagram for measuring packet mode data transfer delay when the VSAT user is the data transfer source

Figure A.16 shows an arrow diagram which illustrates how the packet mode data transfer delay is measured between measurement points MPV_1 and MPT_1 when the VSAT user is the data transfer source.

If the VSAT user is the data transfer destination, the packet mode data transfer delay between measurement points MPV_1 and MPT_1 is defined as the length of time that starts when a DTE data packet creates a performance-significant reference event at MPT_1 and ends when that DTE data packet creates a performance-significant reference event at MPV_1.

The packet mode data transfer delay of this case is therefore equal to $(t_2 – t_1)$, where:

t_1 = time of occurrence for the performance-significant reference event at measurement point MPV_1;

t_2 = time of occurrence for the performance-significant reference event at measurement point MPT_1.

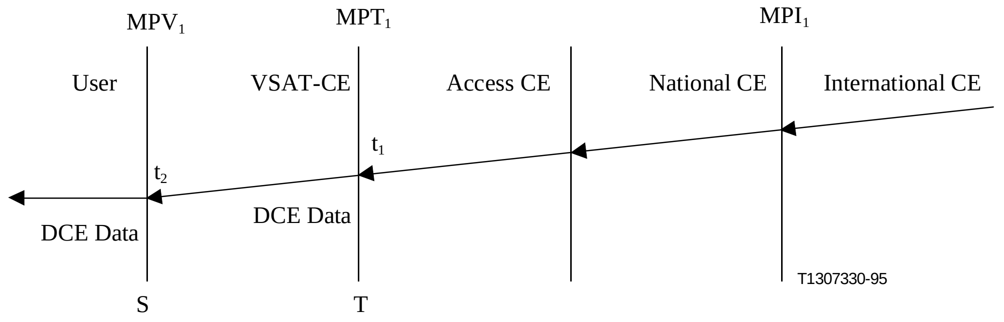


Figure A.17/I.571 – Reference arrow diagram for measuring packet mode data transfer delay when the VSAT user is the data transfer destination

Figure A.17 shows an arrow diagram which illustrates how the packet mode data transfer delay is measured between measurement points MPV_1 and MPT_1 when the VSAT user is the data transfer destination.

The packet mode data transfer delay of the VSAT-CE should not exceed the values given in Table A.17 for both directions for packets with user data field of 128 octets.

The values that are defined are average and 95% value. The average value is the expected average of the distribution of the packet mode data transfer delays. The 95% value is the delay value which should be satisfied for at least 95% of all packet mode data transfer delays.

Table A.17/I.571 – Packet mode data transfer delay of the VSAT-CE

Statistics	Packet mode data transfer delay
Mean	1200 + Y ms
95%	2500 + Y ms

The value of Y is given by Y = 1080/R ms, where R is the data transmission rate expressed in kbit/s.

Verification

Test configuration:

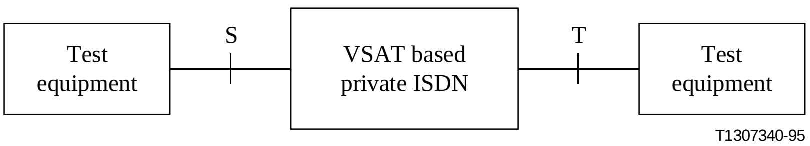


Figure A.18/I.571 – Test configuration

Test equipment should be connected to both ends of the VSAT based private ISDN. The test equipment may be protocol analysers.

i) Verification of data transfer delay when the VSAT user is the data transfer source

The VSAT-CE packet mode data transfer delay, given by $D_{DTE\ Data} = (t_2 - t_1)$, should be measured a sufficient number of times to guarantee with a high degree of confidence that the delay objectives are met.

ii) Verification of packet mode clear indication delay

The same procedure as for the case when the VSAT user is the data transfer source should be used.

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