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Satellite Earth Stations and Systems (SES); The interconnection of Very Small Aperture Terminal (VSAT) systems to Integrated Service Digital Networks (ISDNs)

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Foreword

This ETSI Technical Report (ETR) was produced by the Satellite Earth Stations and Systems (SES) Technical Committee of the European Telecommunications Standards Institute (ETSI).

ETRs are informative documents resulting from ETSI studies which are not appropriate for European Telecommunication Standard (ETS) or Interim European Telecommunication Standard (I-ETS) status. An ETR may be used to publish material which is either of an informative nature, relating to the use or the application of ETSs or I-ETSs, or which is immature and not yet suitable for formal adoption as an ETS or an I-ETS.

Introduction

VSAT systems represent a particular form of implementation of private networks which due to the nature of implementation require specific considerations contained in this ETR.

This ETR addresses the following subjects in clauses 5 to 10:

- Network architecture aspects including:
  - a description of the public Integrated Services Digital Network (ISDN) reference configuration;
  - general principles and guidelines for the interworking of public and private ISDNs;
  - overall scenario for the interconnection of a Very Small Aperture Terminal (VSAT) based private ISDN to the public ISDN;
  - two cases of the overall scenario of interconnection:
    - interconnection of a VSAT based private ISDN with ISDN Private Branch Exchange (ISPBX) functionality to the public ISDN;
    - remote access to the public ISDN via a VSAT based private ISDN.

- services to be provided by the VSAT based private ISDN;

- protocol requirements (and recommendations) including:
  - protocol requirements for the interface to the public ISDN;
  - protocol recommendations for the interconnection of Terminal Equipments (TEs) to the VSAT based private ISDN;
  - protocol recommendations for communication within the VSAT based private ISDN.

- timer considerations related to the eventual incompatibility between ISDN protocols and VSAT based private ISDNs;

- addressing;

- network performance objectives for a VSAT based private ISDN as a Connection Element (CE).

In the following the expression VSAT network is equivalent to the expression VSAT based private ISDN.

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1 Scope

This ETSI Technical Report (ETR) explains how Very Small Aperture Terminal (VSAT) systems interconnect to Integrated Services Digital Networks (ISDNs).

The objective of this ETR is to ensure that VSAT networks as part of any ISDN connection;

- support standard ISDN services (bearer services, teleservices and supplementary services);
- present standard ISDN user-network interfaces; and
- meet relevant quality of service requirements.

2 References

This European Telecommunication Report (ETR) incorporates by dated or undated reference, provisions from other publications. These references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references subsequent amendments to, or revisions of, any of these publications apply to this ETR only when incorporated in it by amendments or revision. For undated reference the latest edition of the publication referred applies.

[1] CENELEC prENV 41004 (March 1991): "Reference configuration for connectivity relations of private telecommunication network exchanges".

[2] ITU-T Recommendation I.411 (1988): "ISDN User-Network Interfaces - Reference Configurations".

[3] ITU-T Recommendation I.412 (1988): "ISDN User-Network Interfaces - Interface structures and access capabilities".

[4] ITU-T Recommendation X.200 (1988): "Reference model of open systems interconnection for ITU-T applications".

[5] ITU-T Recommendation I.570 (1993): "ISDN to Private Network Interworking".

[6] ETR 010 (1993): "ISDN Standards Management (ISM); The ETSI basic guide on the European Integrated Services Digital Network (ISDN)".

[7] ETS 300 171 (1992): "Private Telecommunication Network (PTN); Specification, functional models and information flows; Control aspects of circuit mode basic services".

[8] ETS 300 173 (1992): "Private Telecommunication Network (PTN); Specification, functional models and information flows; Identification supplementary services".

[9] ETS 300 260 (1992): "Private Telecommunication Network (PTN); Specification, functional models and information flows; Call Transfer supplementary service".

[10] ETS 300 237 (1992): "Private Telecommunication Network (PTN); Specification, functional models and information flows; Name identification supplementary services; (Standard ECMA-163)".

[11] ITU-T Recommendation G.711 (1988): "Pulse code modulation (PCM) of voice frequencies."

[12] ITU-T Recommendation G.164 (1988): "Echo suppressors".

[13] ITU-T Recommendation G.165 (1988): "Echo cancellers".

[14] ETS 300 102-1 (1990) "Integrated Services Digital Network (ISDN); User-network interface layer 3; Specifications for basic call control".

[15] ETS 300 102-2 (1990): "Integrated Services Digital Network (ISDN); User-network interface layer 3; Specifications for basic call control; Specification Description Language (SDL) diagrams".

[16] ETS 300 125 (1991): "Integrated Services Digital Network (ISDN); User-network interface data link layer specification; Application of ITU-T recommendations Q.920/I.440 and Q.921/I.441".

[17] ETS 300 011 (1992): "Integrated Services Digital Network (ISDN); Primary rate user-network interface; Layer 1 specification and test principles".

[18] ETS 300 012 (1992): "Integrated Services Digital Network (ISDN); Basic user-network interface; Layer 1 specification and test principles".

[19] ETS 300 192 (1992): "Private Telecommunications Network (PTN); Signalling at the S-reference point Data Link Layer protocol".

[20] I-ETS 300 169 (1992): "Data link layer protocol for the D-channel of the interfaces at the reference point between terminal equipment and private telecommunications networks (Standard ECMA 105, third edition, June 1990)".

[21] CENELEC ENV 41007-1 (1991): "Definitions of Terms in Private Telecommunications Networks - Part 1: Definitions of general terms".

[22] ETS 300 172 (1992): "Private Telecommunications Network (PTN); Inter-exchange signalling protocol; Circuit mode basic services".

[23] I-ETS 300 170 (1992): "Private Telecommunications Network (PTN); Inter-exchange signalling; Data link layer protocol".

[24] ETS 300 153 (1992): "Integrated Services Digital Network (ISDN); Attachment requirements for terminal equipment to connect to an ISDN using ISDN basic access (Candidate NET 3 Part 1)".

[25] ETS 300 104 (1991): "Integrated Services Digital Network (ISDN); Attachment requirements for terminal equipment to connect to an ISDN using ISDN basic access; Layer 3 aspects". (The text of this ETS may be utilised, wholly or in part, for the establishment of NET 3 Part 2).

[26] ETS 300 156 (1992): "Integrated Services Digital Network (ISDN); Attachment requirements for terminal equipment to connect to an ISDN using ISDN primary rate access (Candidate NET 5)".

[27] ETS 300 189 (1992): "Private Telecommunication Network (PTN); Addressing".

[28] ETS 300 050 (1991): "Integrated Services Digital Network (ISDN); Multiple Subscriber Number (MSN) supplementary service; Service description".

[29] ITU-T Recommendation E.164 [Rev.1] (1991): "Numbering plan for the ISDN era".

[30] ITU-T Recommendation I.350 [Rev.1] (1993): "General aspects of quality of service and network performance in digital networks, including ISDN".

[31] ITU-T Recommendation I.353 (1993): "Reference events for defining ISDN performance parameters".

[32] ITU-T Recommendation G.821 (1990): "Error Performance of an international digital connection forming part of an integrated service digital network".

[33] CCIR Recommendation 614-2 (1994): "Allowable error performance for a hypothetical reference digital path in the fixed-satellite service operating below 15 Ghz when forming part of an international connection in an integrated service digital network".

[34] CCIR Recommendation 579-2 (1992): "Availability objectives for a hypothetical reference circuit and a hypothetical reference digital path when used for telephony using pulse-code modulation, or as part of an integrated service digital network hypothetical reference connection, in the fixed-satellite service".

[35] ITU-T Recommendation G.822 (1990): "Controlled slip rate objectives of an international digital connection".

[36] ITU-T Recommendation G.823 [Rev.1] (1994): "The control of jitter and wander within digital networks which are based on the 2048 kbit/s hierarchy".

[37] ITU-T Recommendation I.352 [Rev. 1] (1993): "Network performance objectives for connection processing delays in an ISDN".

[38] ETR 044 (1992): "Network Aspects (NA); Reference events for network performance parameters in an ISDN".

[39] ITU-T Recommendation I.354 (1993): "Network performance objectives for packet-mode communication in an ISDN".

[40] ETS 300 108 (1992): "Integrated Services Digital Network (ISDN); Circit-mode 64 kbit/s unrestricted 8 kHz structured bearer service category Service description".

[41] ETS 300 110 (1992): "Integrated Services Digital Network (ISDN); Circuit-mode 64 kbit/s 8 kHz structured bearer service category usable for 3,1 kHz audio information transfer Service description".

[42] ETS 300 062 (1991): "Integrated Services Digital Network (ISDN); Direct Dialling In (DDI) supplementary service Service Description".

[43] ETS 300 063 (1991): "Integrated Services Digital Network (ISDN); Direct Dialling In (DDI) supplementary service Functional capabilities and information flows".

[44] ETS 300 064: "Integrated Services Digital Network (ISDN); Direct Dialling In (DDI) supplementary service Digital Subscriber Signalling System No. one (DSS1) protocol".

[45] ETS 300 051 (1991): "Integrated Services Digital Network (ISDN); Multiple Subscriber Number (MSN) supplementary service Functional capabilities and information flows".

[46] ETS 300 052: "Integrated Services Digital Network (ISDN); Multiple Subscriber Number (MSN) supplementary service Digital Subscriber Signalling System No. one (DSS1) protocol".

[47] ETS 300 053 (1991): "Integrated Services Digital Network (ISDN); Terminal Portability (TP) supplementary service Service Description".

[48] ETS 300 054 (1991): "Integrated Services Digital Network (ISDN); Terminal Portability (TP) supplementary service Functional capabilities and information flows".

[49] ETS 300 055: "Integrated Services Digital Network (ISDN); Terminal Portability (TP) supplmentary service Digital Subscriber Signalling System No. one (DSS1) protocol".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this ETR, the following definitions apply:

HUB: The centralised node in VSAT star networks.

Measurement Point (MP): A 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 standardised protocols can be observed.

Measurement Point T (MPT): MPT is a MP located at the interface associated with a T reference point.

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

private VSAT network: A VSAT network which offers services to users which may be connected to the VSAT network using standardised or non-standardised interfaces.

VSAT based private ISDN: A VSAT network or part of a VSAT network which offers ISDN services to the users.

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

3.2 Abbreviations

For the purposes of this ETR, the following abbreviations apply:

3PTY	Three Party
AOC	Advice of Charge
CCBS	Completion of Call to Busy Subscriber
CCIR	International Radio Consultative Committee
CCITT	International Telegraph and Telephone Consultative Committee
CD	Call Deflection
CE	Connection Element
CFB	Call Forwarding Busy
CFNR	Call Forwarding No Reply
CFU	Call Forwarding Unconditional
CLIP	Calling Line Identification Presentation
CLIR	Calling Line Identification Restriction
CNIP	Calling Name Identification Presentation
CNIR	Calling/Connected Name Identification Restriction
COLP	Connected Line Identification Presentation
COLR	Connected Line Identification Restriction
CONF	Add On Conference Call
CONP	Connected Name Identification Presentation
CPE	Customer Premises Equipment
CT	Call Transfer
CTR	Common Technical Regulation
CUG	Closed User Group
CW	Call Waiting
DDI	Direct Dialling In
DSS1	Digital subscriber Signalling System No. 1
ECMA	European Computer Manufacturers Association
ETR	European Telecommunication Report
ETS	European Telecommunication Standard
FPH	Freephone
HOLD	Call Hold
HRDP	Hypothetical Reference Digital Path
HRX	Hypothetical Reference connection
HUB	The centralised node in VSAT star networks

IN	Identification Number
ISC	International Switching Centre
ISDN	Integrated Services Digital Network
ISDN NP	ISDN Numbering Plan
ISPBX	ISDN Private Branch Exchange
LAP-D	Link Access Procedure on the D-channel
MCID	Malicious Call Identification
MMC	Meet Me Conference
MOU	Memorandum of Understanding
MP	Measurement Point
MPI	Measurement Point at an ISC
MPT	Measurement Point at reference point T
MSN	Multiple Subscriber Number
NCS	Network Control Station
NT1	Network Termination 1
NT2	Network Termination 2
ONP	Open Network Provision
OSI	Open Systems Interconnection
PBX	Private Branch Exchange
PNP	Private Numbering Plan
PNP	Private Numbering Plan
PTN	Private Telecommunication Network
PTNX	Private Telecommunication Network Exchange
R	Interface reference point R
R-ISPBX	Remote ISDN Private Branch Exchange
R-VSAT	Remote Very Small Aperture Terminal
RE	Reference Event
S	Interface reference point S
SABME	Set Asynchronous Balanced Mode Extended
SRC	Strategic Review Committee
SUB	Subaddressing
T	Interface reference point T
T-ISPBX	Transit ISDN Private Branch Exchange
T-VSAT	Transit Very Small Aperture Terminal
TA	Terminal Adapter
TE	Terminal Equipment
TE1	Terminal Equipment type 1
TE2	Terminal Equipment type 2
TEI	Terminal Equipment Identifier
TP	Terminal Portability
UA	Unnumbered Acknowledgement
UI	Unit Interval
UUS	User-to-User Signalling
VSAT	Very Small Aperture Terminal

4 Network architecture aspects

4.1 Overall reference configuration

This subclause gives a general description of the ISDN reference configuration as described in the relevant ITU-T Recommendation I.411 [2] and ITU-T Recommendation I.412 [3]. The reference configurations covers the ISDN customer network and public/private ISDN interworking. Based on these configurations a reference configuration for the VSAT based private ISDN connection to the public ISDN is outlined.

4.1.1 ITU-T Recommendation I.411 and I.412

ITU-T Recommendation I.411 [2] describes the functional groups and reference configurations for the ISDN user-network interfaces, while ITU-T Recommendation I.412 [3] describes the interface structures to be used at the reference points S and T. The reference configuration from ITU-T Recommendation I.411 [2] is shown in figure 1.

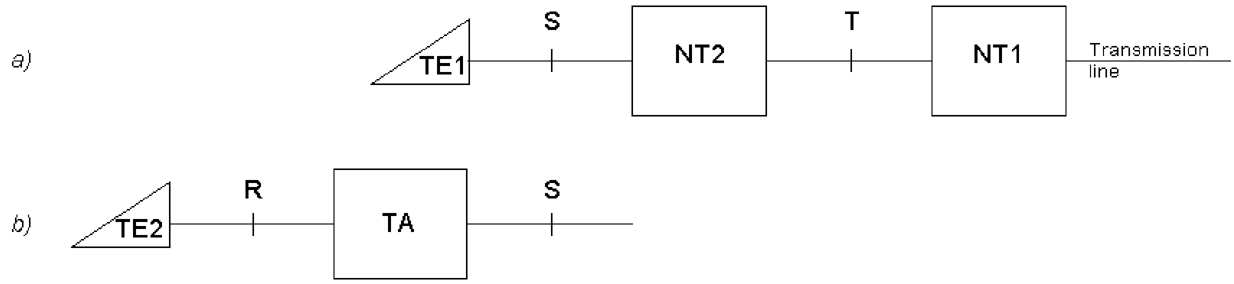


Figure 1: Reference configuration for the ISDN user-network interfaces (figure 1/ITU-T Recommendation I.411 [2])

The ISDN user-network interface recommendations apply to the physical interfaces at reference points S and T. At reference point R, physical interfaces in accordance with other recommendations (e.g. the ITU-T X-series interface recommendations) may be used.

Figure 1a) defines the reference configuration with the functional groups NT1, NT2 and TE1. Figure 1b) illustrates that TE1 may be replaced by the combination of TE2 and TA. The functional groups in figure 1 are explained in the following. In annex A is a list of the different possibilities for relating the VSAT network to the functional groupings and the reference points.

Network Termination 1 (NT1)

This functional group includes functions broadly equivalent to layer 1 (physical layer) of the Open Systems Interconnection (OSI) reference model. These functions are associated with the proper physical and electromagnetic termination of the network. NT1 functions are:

- line transmission termination;
- layer 1 maintenance functions and performance monitoring;
- timing;
- layer 1 multiplexing;
- interface termination.

NOTE 1: In many cases the NT1 will be part of the public ISDN, but this do not presuppose a particular regulatory situation in any country.

Network Termination 2 (NT2)

This functional group includes functions broadly equivalent to layer 1 and higher layers of the ITU-T Recommendation X.200 [4] reference model. Private Branch Exchanges (PBXs), local area networks, and terminal controllers are examples of equipment or combinations of equipment that provide NT2 functions. NT2 functions include:

- layer 2 and 3 protocol handling;
- layer 2 and 3 multiplexing;
- switching;
- concentrating;
- maintenance functions;
- interface termination and other layer 1 functions.

NOTE 2: The NT2 can be null and in this case the S and T reference point coincide.

Terminal Equipment (TE)

This functional group includes functions broadly belonging to layer 1 and higher layers of the ITU-T Recommendation X.200 [4] reference model. Digital telephones, data terminal equipment, and integrated work stations are examples of equipment or combinations of equipment that provide the functions. TEs can be connected to a Private Telecommunication Network (PTN) via an S reference point as defined in CENELEC prENV 41004 [1].

Terminal Equipment type 1 (TE1)

TE1 belongs to the TE functional group but with an interface that complies with the ISDN user-network interface recommendation.

Terminal Equipment type 2 (TE2)

TE2 belongs to the TE functional group but with an interface that complies with interface recommendations other than the ISDN interface recommendations or interfaces not included in the ITU-T Recommendations.

Terminal Adapter (TA)

This functional group includes functions broadly belonging to layer 1 and higher layers of the ITU-T Recommendation X.200 [4] reference model that allow a TE2 terminal to be served by an ISDN user-network interface. Adapters between physical interfaces at reference points R and S or R and T are examples of equipment or combinations of equipment that provide TA functions.

NOTE 3: Terminals connected to Private Telecommunication Networks (PTNs) via an S interface are called TEs in ETSI and not TE1s.

4.1.2 ITU-T Recommendation I.570: Public/Private ISDN interworking

ITU-T Recommendation I.570 [5] aims to provide general principles and guidelines for the interworking of public and private ISDNs.

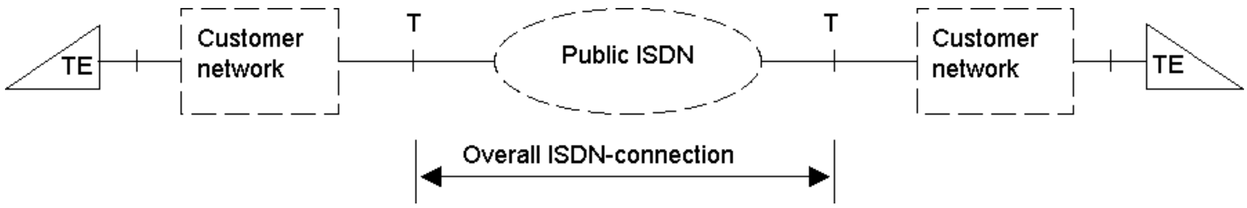


Figure 2: General ISDN reference configuration from ITU-T Recommendation I.570 [5]

Figure 2 (Figure 1/ITU-T Recommendation I.570 [5]) illustrates the overall division of functions involved in a communication across the ISDN. The customer network is connected to the Public ISDN via the reference point T. TEs are connected to the customer network using either ISDN or non-ISDN interfaces.

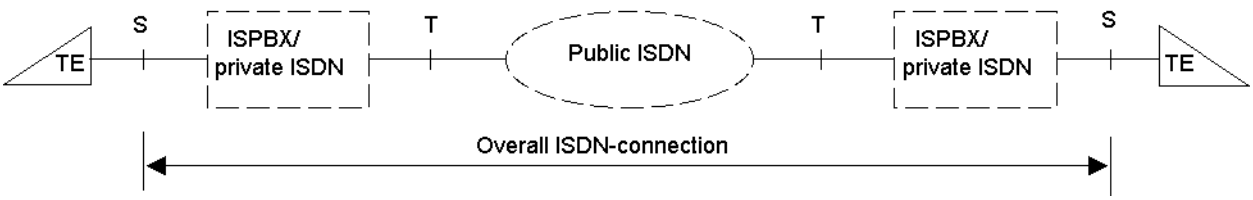


Figure 3: Overall ISDN reference configuration for a mixed ISPBX/public ISDN scenario

If the customer network is an NT2 in the form of an ISDN Private Branch Exchange (ISPBX) based network, the ISDN connection ends at the S reference point as shown in figure 3 (Figure 1a)/ITU-T Recommendation I.570 [5]). This is called the mixed ISPBX/public ISDN scenario.

4.1.3 Scenario for interconnection of VSAT networks to the public ISDN

4.1.3.1 Overall scenario for interconnection of VSAT networks to the public ISDN

This subclause specifies an overall interconnection scenario for how a VSAT network should be interconnected to the public ISDN.

The VSAT network represents a particular form for implementing a private network. Therefore a private VSAT network should be connected to the public ISDN using the general principles and guidelines for the interworking of public and private ISDNs described in ITU-T Recommendation I.570 [5].

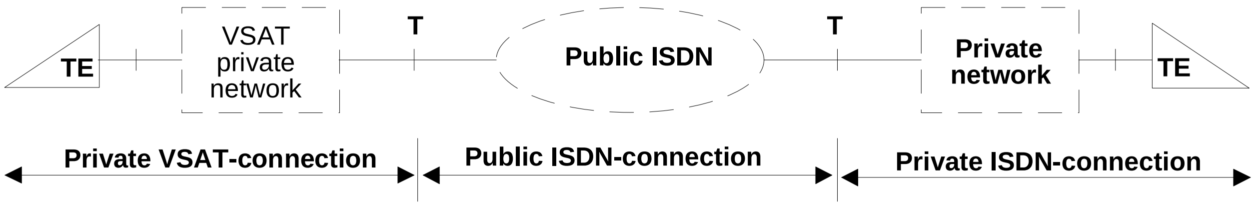


Figure 4: Overall scenario for interconnection of private VSAT networks to the public ISDN

Figure 4 shows how a private VSAT network is connected to the public ISDN when the scenario of figure 1 of ITU-T Recommendation I.570 [5] is used. It should be noted that the VSAT network is connected to the public network using the T-interface of the public ISDN. A terminal, TE, can be connected to the VSAT network using either an S interface, a coincident S/T interface or a non-ISDN interface.

In the case that TEs are connected to the VSAT network using non-ISDN interfaces the VSAT network is referred to as a *private VSAT network*. In the case that TEs are connected to the VSAT network using either an S interface or a coincident S/T interface 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 ETR. This ETR will only consider the case where ISDN terminals are connected to the VSAT network via an S interface or a coincident S/T interface.

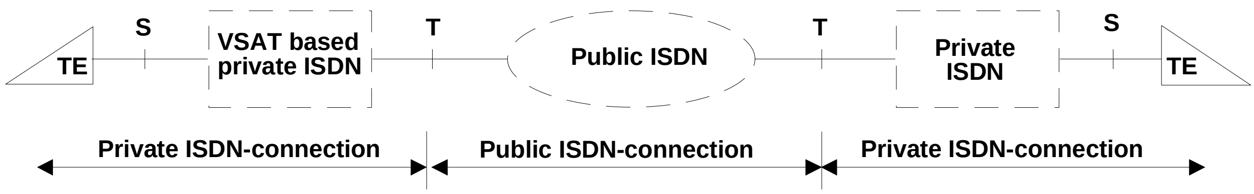


Figure 5: Overall scenario for interconnection of VSAT based private ISDN to the public ISDN

Figure 5 shows how a VSAT based private ISDN are connected to the public ISDN. This interconnection scenario is based on figure 1a in ITU-T Recommendation I.570 [5]. The figure also shows that TEs should be connected to the VSAT based private ISDN via an S interface or a coincident S/T interface. The coincident S/T interface occurs when no layer 2 and layer 3 functionality is 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 to be in line with ETSI standards for the interconnection of terminals to a private ISDN.

Figure 5 is a general overall scenario. When coming to the physical realisation ITU-T Recommendation I.412 [3] describes that one NT2 can be connected to more than one S and T reference points, i.e. the interface structure can consist of multiple connections on both the S and T interface of the VSAT based private ISDN in figure 5.

Multiple connection on the T-reference point will normally go to the same public ISDN, but in ITU-T Recommendation I.570 [5] is stated that a private ISDN can be connected to more than one public ISDN. One public ISDN can also connect to several private ISDNs, i.e. several VSAT based private ISDNs.

4.1.3.2 Reference configuration for the VSAT based private ISDN

In figure 6 is shown the reference configuration for the VSAT based private ISDN connected to the public ISDN. The reference configuration is based on figure 5 and will be used in this document.

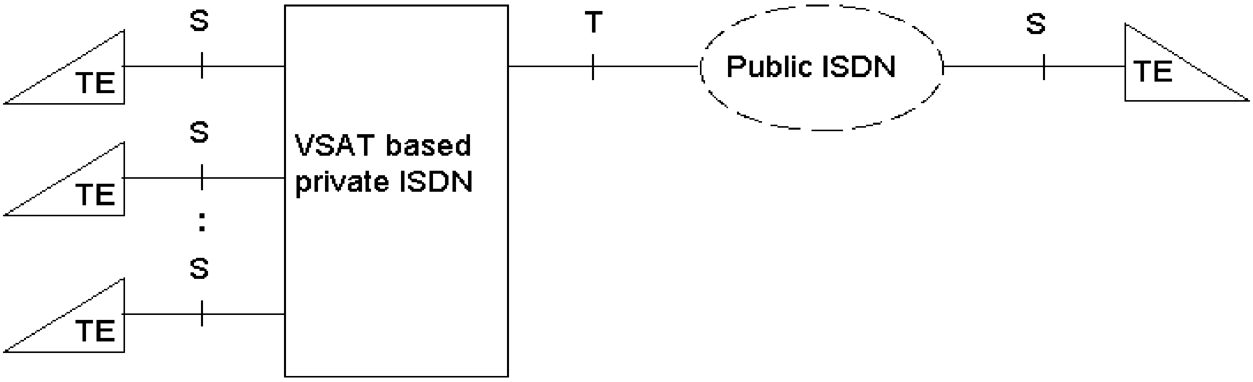


Figure 6: Reference configuration for the VSAT based private ISDN

Two subcases of the reference configuration are identified:

- Case 1: interconnection of a VSAT based private ISDN with ISPBX functionality to the public ISDN;

- Case 2: remote access to the public ISDN via a VSAT network.

The following two subclause specifies Case 1 and Case 2.

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

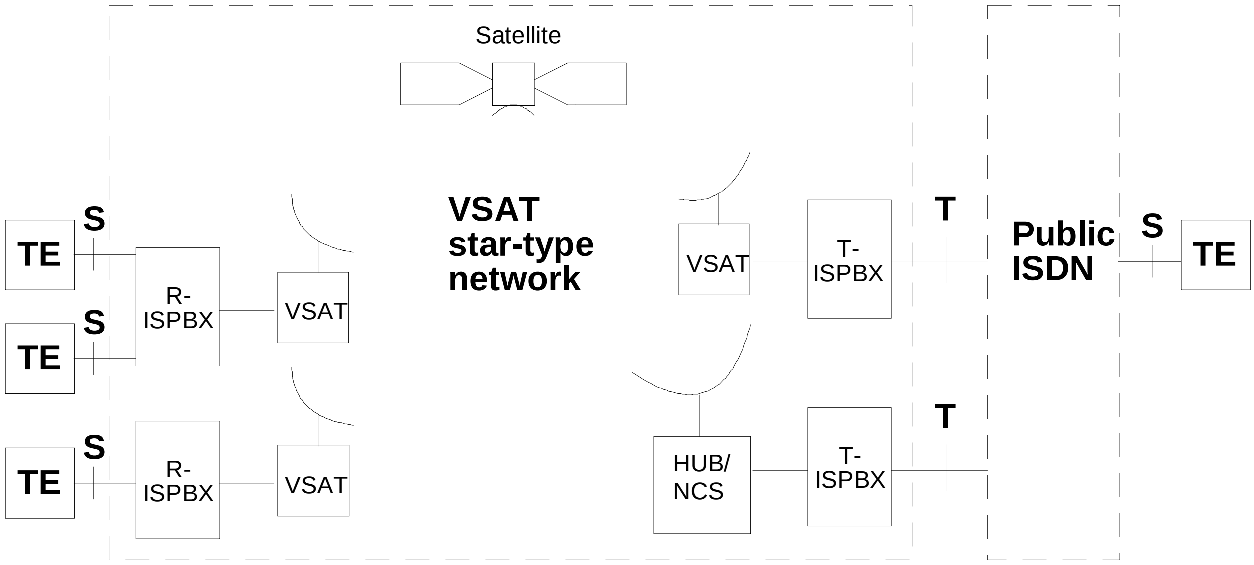
In this case the VSAT network includes ISDN Private Branch Exchange (ISPBX) functionality at all remote sites and at all sites which have access to the public ISDN. Because of this ISPBX functionality it will be possible for TEs connected to the VSAT network to communicate with either:

- TEs connected to the same VSAT;

- TEs connected to another VSAT in the VSAT network;

- TE1s connected to the public ISDN.

NOTE 1: The inclusion of ISPBX functionality at the remote sites does not necessarily imply that all ISPBX functionality are physically located at the remote sites.



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

Figure 7: Network architecture of a VSAT based private ISDN connected to the public ISDN

Figure 7 shows the architecture of Case 1: "Interconnection of a VSAT based private ISDN with ISPBX functionality to the public ISDN". The VSAT network in figure 7 has a star-type architecture.

The star-type VSAT network consists of VSATs, Remote ISDN Private Branch Exchanges (R-ISPBXs), one or several Transit ISDN Private Branch Exchanges (T-ISPBXs), a satellite, and a HUB. For illustrative reasons it is distinguished between a R-ISPBX and a T-ISPBX, where a 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 can be at a VSAT or/and at the HUB.

NOTE 2: 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.

NOTE 3: No additional routing functions are envisaged within the public ISDN. In the event of a failure within the private VSAT network affecting calls to or from a specific customer (or group of customers) connected to the private VSAT network, alternative routing is not expected.

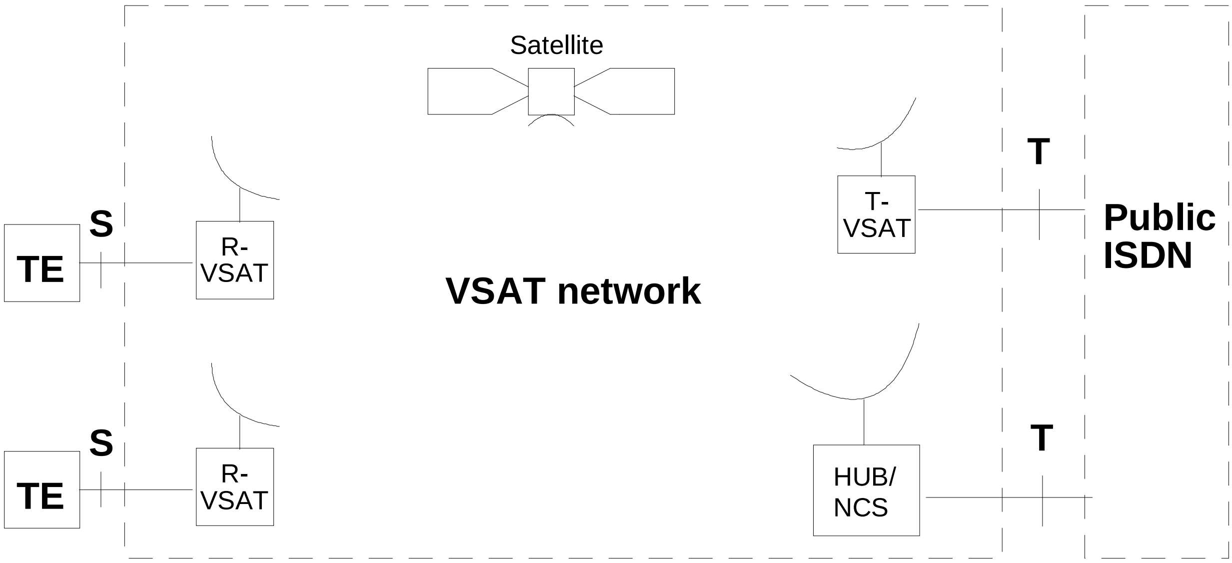
4.1.3.4 Case 2: Remote access to the public ISDN via a VSAT network

Case 2 is used to give access to ISDN from a remote site. The remote site may for example be a place where no interconnection to the public ISDN is offered by terrestrial network providers. In this case a VSAT network will be the natural way of offering interconnection to a public ISDN.

It should be noted that Case 2 is used to provide remote access to the public ISDN and *not* to provide ISPBX functionality at the remote sites. The result is that a TE connected to the VSAT network will only be capable of communicating with TE1s connected to the public ISDN or through the public ISDN to other TEs connected to the VSAT network.

In Case 2 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 and the interfaces between the TEs and the VSAT network are coincident S/T interfaces.

In some private VSAT network designs, the layer 2 within the private VSAT network may be included in the network and may be different to the layer 2 of its external S and T interfaces 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
T-VSAT= Transit Very Small Aperture Terminal

NOTE 1: If the VSAT network has a mesh-type architecture, instead of a star-type architecture; the network normally includes a NCS instead of a HUB.

NOTE 2: No additional routing functions are envisaged within the public ISDN. In the event of a failure within the private VSAT network affecting calls to or from a specific customer (or group of customers) connected to the private VSAT network, alternative routing is not expected.

Figure 8: Network architecture for remote interconnection of a terminal to the public ISDN via a VSAT mesh-type network

Figure 8 shows the architecture of Case 2: "Remote access to ISDN via a VSAT network".

The VSAT network consists of Remote Very Small Aperture Terminals (R-VSATs), Transit Very Small Aperture Terminals (T-VSATs), a satellite, and a HUB. For illustrative reasons it is distinguished between a R-VSAT and a T-VSAT, where a R-VSAT is a VSAT located at a remote site and a T-VSAT is a VSAT directly connected to the public ISDN. The VSAT network can also be connected to the public ISDN at the HUB.

4.2 Attachment requirements

The VSAT based private ISDN in figure 6 should be attached to the public ISDN using either:

- basic access; or

- primary rate access.

4.2.1 Attachment requirements for ISDN basic access

Currently the attachment requirements for terminal equipment to connect to ISDN using ISDN basic access are specified in NET 3. NET 3 consists of two parts:

- NET 3, Part 1 as specified in ETS 300 153 [24]; and

- NET 3, Part 2 as specified in ETS 300 104 [25].

NET 3 ([24] and [25]) is planned to be replaced with Common Technical Regulation 3 (CTR 3).

Since the ETS on interconnection of VSAT networks to the public ISDN is expected to be available after CTR 3 is published, it is suggested that this ETS makes reference to CTR 3 instead of NET 3 (ETS 300 153 [24] and ETS 300 104 [25]).

NOTE: CTR 3: will be a self-contained document which contains all necessary attachment requirements for terminal equipment which want to connect to the public ISDN using ISDN basic access.

4.2.2 Attachment requirements for ISDN primary rate access

Currently the attachment requirements for terminal equipment to connect to ISDN using ISDN primary rate access is specified in NET 5 (ETS 300 156 [26]).

NET 5 [26] is planned to be replaced with Common Technical Regulation CTR 4.

Following the same argumentation as for NET 3 (ETS 300 153 [24] and ETS 300 104 [25]) and CTR 3, it is suggested that the ETS on interconnection of VSAT networks to the ISDN makes reference to CTR 4 instead of NET 5 (ETS 300 156 [26]).

NOTE: CTR 4: will be a self-contained document which contains all necessary attachment requirements for terminal equipment which want to connect to the public ISDN using ISDN primary rate access.

5 Services

Basic services within an ISDN consist of bearer services and teleservices. A bearer service is defined only up to a certain layer, in any case no higher than layer 3. The definition of a teleservice also encompasses the higher layers up to layer 7 (although some of the layers may be empty or not specified, as with telephony, for example).

5.1 Public ISDN services

ETSI are in the process of specifying the European version of ISDN which is globally standardised by ITU-T. One of the goals for the standardisation process in ETSI is to form the basis for the implementation of a European ISDN which support a harmonised set of services across Europe.

The ETSI Strategic Review Committee (ETSI SRC) has proposed a set of services and standards that would need to be established for the European ISDN, see table 1. The star services in table 1 (indicated with a "*") should be considered as first priority services for introduction in the European ISDN. The services without a star should be considered as a second priority for introduction in the European ISDN.

Table 1: Services to be provided by the public ISDN (Table 1/ETR 010 [6])

Bearer Services: Circuit-mode 64 kbit/s unrestricted * Circuit-mode 3,1 kHz audio * Circuit-mode speech Packet-mode (X.31 case B) B- and D-channel
Teleservices: Telephony 3,1 kHz Facsimile group 4 class 1 Teletex Telephony 7 kHz ISDN syntax-based videotex Video telephony
Supplementary Services: Calling Line Identification Presentation (CLIP) * Calling Line Identification Restriction (CLIR) * Direct Dialling In (DDI) * Multiple Subscriber Number (MSN) * Terminal Portability (TP) * Call Waiting (CW) Completion of Calls to Busy Subscriber (CCBS) Closed User Group (CUG) User-to-user Signalling (UUS) Subaddressing (SUB) Three Party (3PTY) Advice of Charge (AOC) Connected Line Identification Presentation (COLP) Connected Line Identification Restriction (COLR) Malicious Call Identification (MCID) Add On Conference Call (CONF) Meet Me Conference (MMC) Freephone (FPH) Call Transfer (CT) Call Forwarding Busy (CFB) Call Forwarding No Reply (CFNR) Call Forwarding Unconditional (CFU) Call Deflection (CD) Call Hold (HOLD)

5.2 PTN services

For a private ISDN, termed Private Telecommunication Network (PTN) in ETSI, a set of standards have been developed by European Computer Manufacturers Association (ECMA) and adopted by ETSI. These includes standards for bearer services, teleservices and supplementary services to be supported by a PTN. The services specified to date and their references are listed in table 2.

Table 2: PTN services specified by ECMA

<u>Bearer Services:</u>	
Circuit-mode 64 kbit/s unrestricted	ETS 300 171 [7]
Circuit-mode speech	ETS 300 171 [7]
Circuit-mode 3,1 kHz audio	ETS 300 171 [7]
<u>Teleservices:</u>	
Telephony 3,1 kHz	ETS 300 171 [7]
Facsimile group 4	ETS 300 171 [7]
Teletex	ETS 300 171 [7]
Videotex	ETS 300 171 [7]
<u>Supplementary Services:</u>	
Calling Line Identification Presentation (CLIP)	ETS 300 173 [8]
Calling Line Identification Restriction (CLIR)	ETS 300 173 [8]
Call Handling (CT)	ETS 300 260 [9]
Calling Name Identification Presentation (CNIP)	ETS 300 237 [10]
Connected Name Identification Presentation (CONP)	ETS 300 237 [10]
Calling/Connected Name Identification Restriction (CNIR)	ETS 300 237 [10]

5.3 VSAT network services

The VSAT network should ideally support all possible services demanded by the market. To reach this goal services may be developed independently by each VSAT network manufacturer and then, if possible, interworked with the public ISDN services. This is however not an ideal solution.

The following clauses suggests an approach for the implementation of VSAT network services for Case 1 and Case 2.

5.3.1 VSAT network services for Case 1

Services should be provided along the following lines:

- star services should be provided as a first priority as specified in the recommendation part of this ETR;
- the VSAT network manufacturer should aim to provide the non-star services as a second priority;
- which second priority services to provide first should be dependent on market demands.
- when implementing the services of the VSAT network the PTN service specifications (see table 2) should be used if this exists;
- if no PTN service specification exists, the service specification of the public ISDN may be used.

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 ETS 300 171 [7];

- circuit mode 3,1 kHz audio bearer service according to the specification in ETS 300 171 [7].

5.3.2 VSAT network services for Case 2

The services provided by the public ISDN should be carried transparent through the VSAT network.

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 ETS 300 108 [40];

- circuit mode 3,1 kHz audio bearer service according to according to the specification in ETS 300 110 [41].

5.4 VSAT network bearer services

The bearer services defined in the following subclauses correspond to the circuit mode basic services defined by ETSI in ETS 300 171 [7]: "Private Telecommunication Network (PTN); Specification, functional models and information flows; Control aspects of circuit mode basic services".

5.4.1 Circuit mode 64 kbit/s unrestricted bearer service category

This bearer service category provides information transfer at 64 kbit/s without alteration between VSAT based private ISDN users. It may, therefore, be used to support various VSAT based private ISDN user applications. Examples include:

- speech;
- 3,1 kHz audio;
- multiple subrate information streams multiplexed into 64 kbit/s by the VSAT based private ISDN user;
- transparent access to a public or private X.25 network (X.31 Case A for access to a public X.25 network).

NOTE: Whilst speech and 3,1 kHz audio have been given as applications for this bearer service, it is recognised that no network provision can be made for the control of such items as echo and loss, as the network is unaware of the application in use.

This circuit mode bearer service category allows two VSAT based private ISDN users to communicate in a point to point configuration via the network using 64 kbit/s digital signals, in both directions continuously and simultaneously for the duration of a call.

5.4.2 Circuit mode speech bearer service

This bearer service category is intended to support speech.

User information conforms to ITU-T Recommendation G.711 (A-law or µ-law) [11]. The network may use processing techniques appropriate for speech such as analogue transmission, echo cancellation and low bit rate voice encoding. Hence, bit integrity is not assured. This bearer service category is not intended to support modem derived voice band data.

NOTE 1: A-law encoding is used by public ISDNs in Europe.

NOTE 2: If echo cancellers (or echo suppressors) are used they should follow ITU-T Recommendation G.164 [12] (or ITU-T Recommendation G.165 [13]).

This circuit mode bearer service category allows two VSAT based private ISDN users to communicate in a point to point configuration via the network using speech encoded into 64 kbit/s digital signals, in both directions continuously and simultaneously for the duration of a call.

5.4.3 Circuit mode 3,1 kHz audio bearer service

This bearer service category corresponds to the service which is currently offered in the PSTN. It provides for the transfer of speech and of 3,1 kHz bandwidth audio information such as voice band data via modems and facsimile groups 1, 2 and 3 information.

NOTE: The maximum modem bit rate that can be used by VSAT based private ISDN users in applications of this bearer service category depends on the modulation standard employed and on the transmission performance of the networks involved.

User information conforms to ITU-T Recommendation G.711 (A-law or µ-law) [11]. The network may use processing techniques appropriate for speech, provided they are appropriately modified or functionally removed prior to non-speech information transfer. The control of echo control devices, speech processing devices, is made by the use of disabling tones. Bit integrity is not assured.

This circuit mode bearer service category allows two VSAT based private ISDN users in a point-to-point configuration to communicate via the network using 3,1 kHz audio information encoded into 64 kbit/s digital signals, in both directions continuously and simultaneously for the duration of a call.

5.5 Supplementary services

5.5.1 Supplementary services for Case 1

Specification

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

- Calling Line Identification Presentation (CLIP) according to ETS 300 173 [8];

- Calling Line Identification Restriction (CLIR) according to ETS 300 173 [8];

- Direct Dialling In (DDI) according to ETS 300 062 [42], ETS 300 063 [43] and ETS 300 064 [44];

- Multiple Subscriber Number (MSN) according to ETS 300 050 [28], ETS 300 051 [45] and ETS 300 052 [46];

- Terminal Portability (TP) according to ETS 300 053 [47], ETS 300 054 [48] and ETS 300 055 [49].

Verification

Compliance with the specified supplementary service characteristics should be verified following the procedures specified below:

- Direct Dialling In (DDI) should be verified according to the specifications of ETS 300 064, Parts 3 to 6 [44];

- Multiple Subscriber Number (MSN) should be verified according to the specifications of ETS 300 052, Parts 3 to 6 [46];

- Terminal Portability (TP) should be verified according to the specifications of ETS 300 055, Parts 3 to 6 [49].

Verification of Calling Line Identification Presentation (CLIP) and Calling Line Identification Restriction (CLIR) is left for further study.

5.5.2 Supplementary services for Case 2

For Case 2 the supplementary services of the public ISDN should be offered transparently via the VSAT network.

5.6 Interworking considerations

In general, interworking between a VSAT based private ISDN bearer service and a bearer service provided by another network requires interworking functions, both for information transfer and for signalling.

5.6.1 Interworking with a public ISDN

When interworking with the same service in a public ISDN, the interworking function for information transfer is null. However, interworking has an impact on signalling.

5.6.2 Encoding law conversion

The VSAT based private ISDN can, as an option, provide A-law/µ-law conversion (see ITU-T Recommendation G.711 [11]) to permit interworking between terminals and interfaces to other networks which do not all conform to the same encoding law (A-law or µ-law).

NOTE: Although in general a network which uses µ-law encoding should provide A-law/µ-law conversion when interworking with networks which use A-law, this may not apply in the case of a private network using A-law and a public network using µ-law. Therefore even if the VSAT based private ISDN uses A-law and expects its terminals and other private networks to use A-law, it may need to provide A-law/µ-law conversion when interworking with public networks which use µ-law.

6 Protocols and interfaces

6.1 Signalling protocols for Case 1

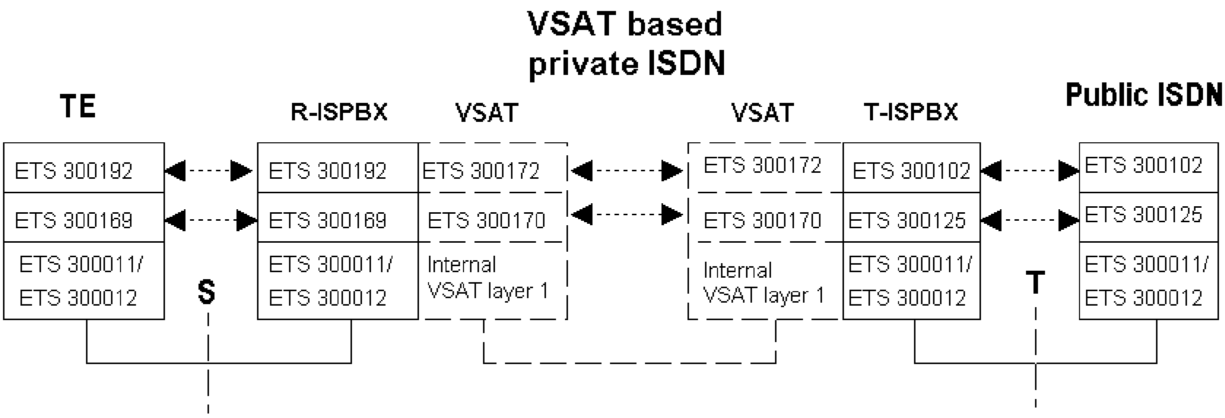


Figure 9: Protocol reference model for signalling in Case 1 when layer 1, layer 2 and layer 3 are terminated at the R-ISPBX and at the T-ISPBX

Figure 9 shows the protocol reference model for the signalling channel in Case 1 when layer 1, layer 2 and layer 3 are terminated at the R-ISPBX and at the T-ISPBX.

The VSAT network as a whole appears as an NT2 seen from the public ISDN. The result is that:

- the layer 3 connection at the T reference point is according to ETS 300 102-1 [14] and ETS 300 102-2 [15] which are the ETSI specification for basic call control for the ISDN user-network interface;

- the layer 2 connection at the T reference point is according to ETS 300 125 [16] which is the ETSI data link specification for the ISDN user-network interface;

- the layer 1 connection at the T reference point is according to ETS 300 011 [17] for primary rate access and according to ETS 300 012 [18] for basic rate access.

The protocols at the S reference point between a TE and the VSAT network should be as for the S reference point between a TE and a PTN. The result is that:

- the layer 3 signalling protocol at the S reference point should be according to ETS 300 192 [19];

- the layer 2 signalling protocol at the S reference point should be according to ETS 300 169 [20];

- the layer 1 connection at the T reference point should be according to ETS 300 011 [17] for primary rate access and according to ETS 300 012 [18] for basic rate access.

Although the choice of protocols within the VSAT network is not a topic for standardisation, the following protocols are good candidates to be used on the internal VSAT connection between the R-ISPBX and the T-ISPBX:

- ETS 300 172 [22] for layer 3 signalling in the support of circuit mode basic services;

- ETS 300 170 [23] for layer 2 signalling.

Since the VSAT network is used for communication between ISPBXs the VSAT network itself, excluding interface functionality to the TEs and to the public ISDN, can be looked upon as an intervening network according to the definition in ENV 41007-1 [21]. Therefore the ETS 300 172 [22] signalling protocol for circuit mode basic services and the ETS 300 170 [23] data link layer protocol, developed for inter-exchange signalling via an intervening network, are good candidates for signalling through the VSAT network.

The layer 1 connection within the VSAT network will be VSAT network specific.

6.2 Signalling protocols for Case 2

6.2.1 VSAT network with termination at layer 1 only

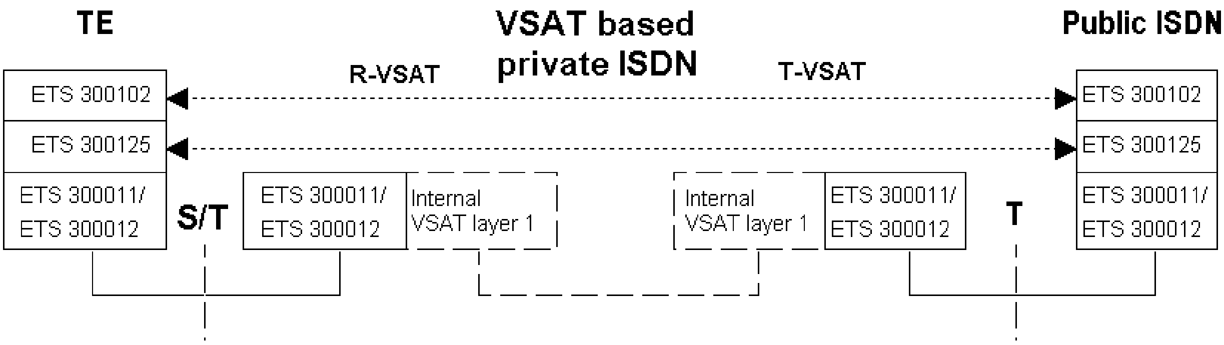


Figure 10: Protocol reference model for signalling in Case 2 when only layer 1 is terminated at the R-VSAT and at the T-VSAT

Figure 10 shows the protocol reference model for the signalling channel in Case 2 when only layer 1 is terminated at the R-VSAT and at the T-VSAT. As a result both layer 2 and layer 3 messages are transferred transparently through the VSAT network.

The VSAT network as a whole appears as a TE1 seen from the public ISDN. The result is that:

- the transparent layer 3 connection is according to ETS 300 102-1 [14] and ETS 300 102-2 [15];

- the transparent layer 2 connection is according to ETS 300 125 [16];

- the layer 1 connection at the T reference point is according to ETS 300 011 [17] for primary rate access and according to ETS 300 012 [18] for basic rate access;

- the layer 1 connection at the coincident S/T reference point should be according to ETS 300 011 [17] for primary rate access and according to ETS 300 012 [18] for basic rate access.

The layer 1 connection within the VSAT network will be VSAT network specific.

6.2.2 VSAT network with termination at layer 1 and 2

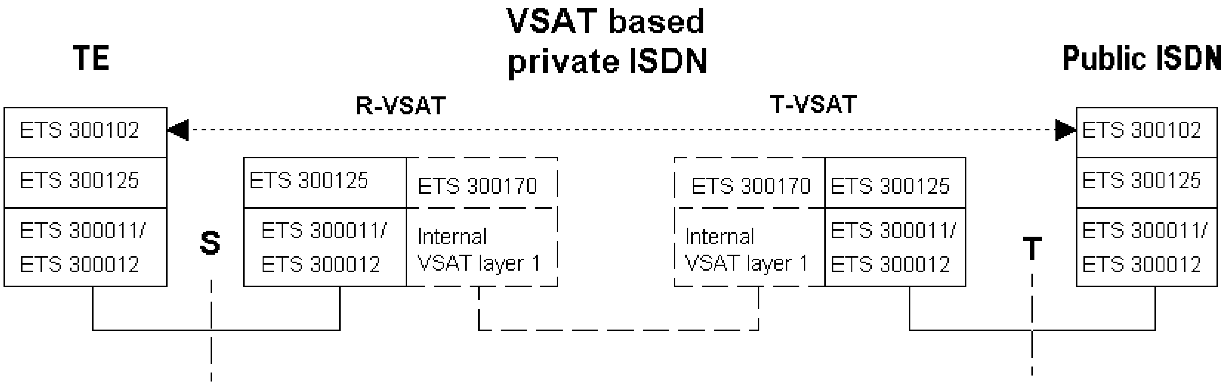


Figure 11: Protocol reference model for signalling in Case 2 when both layer 1 and layer 2 is terminated at the R-VSAT and at the T-VSAT

Figure 11 shows the protocol reference model for the signalling channel in Case 2 when both layer 1 and layer 2 are terminated at the R-VSAT and at the T-VSAT. This means that only layer 3 messages are transferred transparently through the VSAT network.

The VSAT network as a whole appears as a TE1 seen from the public ISDN. The result is that:

- the transparent layer 3 connection is according to ETS 300 102-1 [14] and ETS 300 102-2 [15];
- the layer 2 at the T reference point is according to ETS 300 125 [16];
- the layer 1 connection at the T reference point is according to ETS 300 011 [17] for primary rate access and according to ETS 300 012 [18] for basic rate access.

Using ETS 300 102-1 [14] and ETS 300 102-2 [15] for the transparent layer 3 signalling, the layer 2 protocol to support the layer 3 signalling at the S reference point should be according to ETS 300 125 [16]. Therefore the same layer 2 protocol will be used at both the S and the T interface.

The layer 1 connection at the S reference point should be according to ETS 300 011 [17] for primary rate access and according to ETS 300 012 [18] for basic rate access.

The choice of protocols within the VSAT network is not a topic for standardisation. It is however noted that ETS 300 170 [23] may be used for the layer 2 connection between the R-VSAT and the T-VSAT.

The layer 1 connection within the VSAT network will be VSAT network specific.

6.3 Basic rate and primary rate interfaces for Case 1 and 2

The physical layer for the S and T reference points should be either a Basic rate or Primary rate. The physical layer conveys the B and the D channels.

6.3.1 Basic rate

For basic rate the ETS 300 012 [18] defines the layer 1 characteristics of the user-network interface to be applied at the S and T reference points.

Figure 12 shows an example of an activation initiated from the TE side. The basis for figure 12 is Case 2: "VSAT network with termination at layer 1 only" (figure 10).

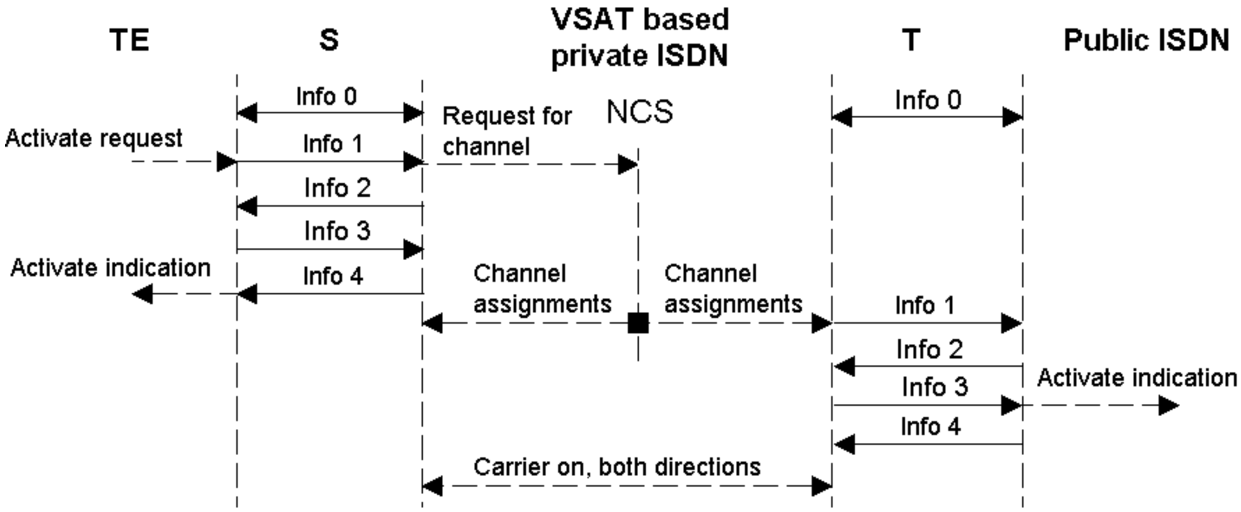


Figure 12: Activation of the S and T reference points (Basic rate)

On the physical layer the activation and deactivation is done using different info streams.

Info 0 (no signal) is the normal deactivated state. In figure 12 an activate request is initiated from the TE by sending an Info 1 instead of Info 0. The VSAT network should respond to this change in state by setting up the corresponding channels. The channel assignment starts also the activation procedure at the T interface. The change of states corresponding to the different info streams will normally go automatically on both the S/T and T the interface.

In the final activated state the TE sends Info 3 and receives Info 4. Both Info 3 and Info 4 are synchronised frames with operational data. Both sides of the VSAT network must be in this state and connected together with a fully transparent connection through the VSAT network before any information transfer is possible. In figure 12 the transparent connection is indicated with a dashed line marked: "Carrier on, both directions".

For Case 1 the ISPBX functionality may analyse the layer 2 and 3 information before any channel request is made in the VSAT network.

6.3.2 Primary rate

For primary rate the ETS 300 011 [17] defines the functional specification, the electrical characteristics and the frame structure for the S and T reference points. The frame is a 2 048 kbit/s stream with 30 B channels and one D channel. Each channel is 64 kbit/s.

With primary rate the physical layer will be activated permanently, i.e. the activation procedure with the different info streams shown in figure 12 does not exist. This implies that the only realistic solution for Case 2 is a permanent connection from the public ISDN through the VSAT network to the TE. For Case 1 two possibilities exist:

- permanent connection through the VSAT network;

- semi-permanent connection through the VSAT network.

In the latter case the ISDN signalling through the VSAT network will be established either permanently or on a per call basis, while the number of B-channels through the VSAT network will be allocated dynamically based on the actual traffic. Figure 15 shows a call set-up from the TE side with activation of layer 2.

7 Timer considerations

The following clauses present the timer considerations for each of the two VSAT cases presented in clause 5:

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

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

The discussion concerns the identification of eventual timer problems related to the use of Digital Subscriber Signalling system no. 1 (DSS1) at the T and at the S or coincident S/T interface. The discussion is only concerning call set-up since this is considered to be the most time-critical part for an ISDN call across a VSAT network.

7.1 Timer considerations for Case 1:

In the following subclauses the protocol reference model for Case 1 (figure 9) is used.

7.1.1 Layer 1

As layer 1 is terminated in both ends of the VSAT network, there are no time constraints related to layer 1 which can give problems when a satellite link is used. The layer 1 within the VSAT network will be VSAT network specific and therefore optimised to the different VSAT network implementations.

7.1.2 Layer 2

Layer 2 is also terminated at both ends of the VSAT network. Since all layer 2 parameters have only local significance, this means that there are no satellite delay problems related to the Link Access Protocol on the D-channel (LAP-D) protocol at the S and at the T interface.

Within the VSAT network either a manufacturer specific layer 2 protocol or a standardised protocol such as the data link layer protocol of ETS 300 170 [23] may be used.

ETS 300 170 [23], which is based on ETS 300 125 [16], is a symmetrical protocol developed for inter-exchange signalling. All system parameters of ETS 300 170 [23] which is relevant for the timer discussion in this document are the same as in ETS 300 125 [16]. Also the layer 2 establishment procedure of ETS 300 170 [23] is done in the same way as for LAP-D of ETS 300 125 [16].

Figure 13 assumes that the data link protocol of ETS 300 170 [23] is used within the VSAT network.

7.1.3 Layer 3

Layer 3 is terminated in both ends of the VSAT network.

Layer 3 at the T reference point it is specified in ETS 300 102-1 [14] and ETS 300 102-2 [15] which are the ETSI specification for basic call control for the ISDN user-network interface. The layer 3 at the S reference point is specified in ETS 300 192 [19].

Connections through the VSAT network can be either:

a) permanent;

b) established on demand based on the actual traffic;

c) establish on a per call basis.

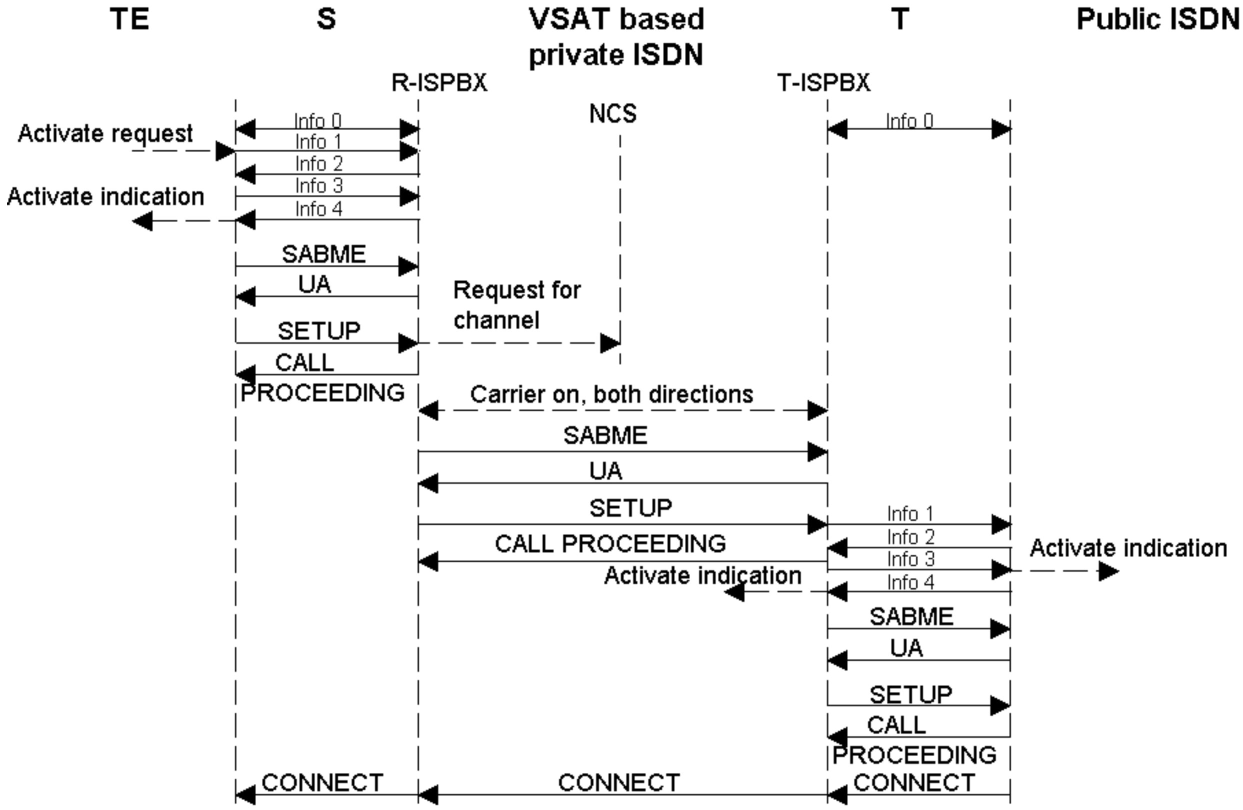


Figure 13: Example of call set-up with activation of layer 1 (basic rate) and establishment of layer 2 and 3 for the VSAT network of Case 1

Figure 13 shows an example of a call from a VSAT network TE to the public ISDN, where the connection through the VSAT network is established on a per call basis. The SETUP message is used to trigger the establishment of a channel through the VSAT network. The call set-up ends when the CONNECT message is received by the TE.

NOTE 1: Figure 13 does not include a layer 2 interaction for TEI assignment. See annex B for explanation of TEI assignment procedure.

Figure 13 assumes that the protocol of ETS 300 172 [22], developed for inter-exchange signalling, is used for layer 3 signalling within the VSAT network. ETS 300 172 [22] has a layer 3 establishment procedure which is similar to the layer 3 establishment procedure of ETS 300 102-1 [14].

NOTE 2: Figure 13 is based on the assumption that signalling channels for ISDN related signalling are established on a per call basis. This is however only one of several possible implementations. The signalling channel for ISDN related signalling may for example be carried by an aloha channel.

7.1.4 Critical timers for Case 1

Only the layer 3 timers may be critical for Case 1. The potential critical timers are listed in table 3.

Table 3: Potential critical layer 3 timers

Timer	Description	Default value
T303	Time between SETUP sent and acknowledgement received	4s
T310	Time between CALL PROCEEDING received and ALERTING, CONNECT, DISCONNECT or PROGRESS received	10s

T303 is started when the SETUP message is sent and stopped when either the ALERTING, CONNECT, SETUP ACKNOWLEDGEMENT, CALL PROCEEDING or RELEASE COMPLETE message is received. If T303 expires the set-up message can be retransmitted once.

NOTE: This retransmission facility means that the VSAT network may gain extra time for the call set-up. But using more than 4s to respond to the first SETUP message means that the protocol can not take advantage of the possibility to successfully retransmit a SETUP message which is errored due to error conditions in the network.

In figure 13 the message CALL PROCEEDING is used as a local acknowledgement to the SETUP message at the S interface, at the T interface and within the VSAT network. This means that no timer problem will arise because of timer T303. If no immediate local acknowledgement is sent before the CONNECT message, a total of two times T303 (8s) will be available before the CONNECT will have to be received.

T310 is started when the CALL PROCEEDING message is received and stopped when either the ALERTING, CONNECT, DISCONNECT or PROGRESS message is received. For the call set-up case of figure 13, T310 is the time between the CALL PROCEEDING and the CONNECT message. Since T310 is normally 10s, the VSAT network is not expected to have any difficulties with this timer.

7.2 Timer considerations for Case 2:

In the following subclauses the protocol reference models for Case 2 (figures 10 and 11) are used.

7.2.1 Layer 1

As for Case 1, layer 1 is terminated in both ends of the VSAT network. Therefore, there is no time constraints related to layer 1 for Case 2.

7.2.2 Layer 2

a)

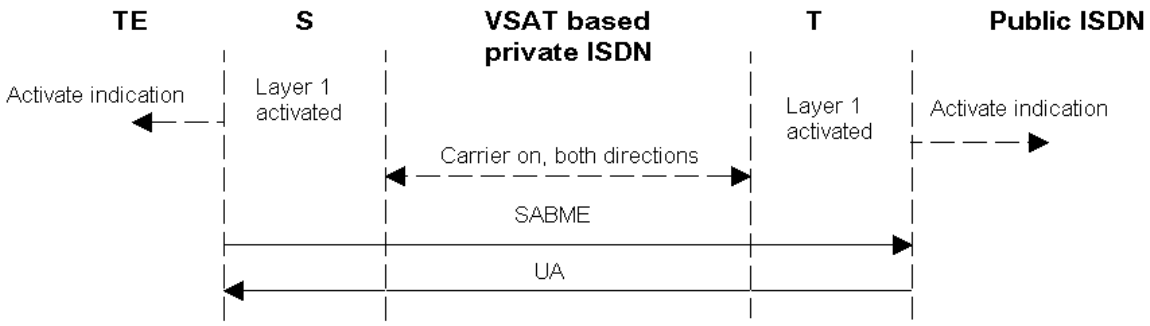


Figure 14 (a): Without retransmission of SABME

b)

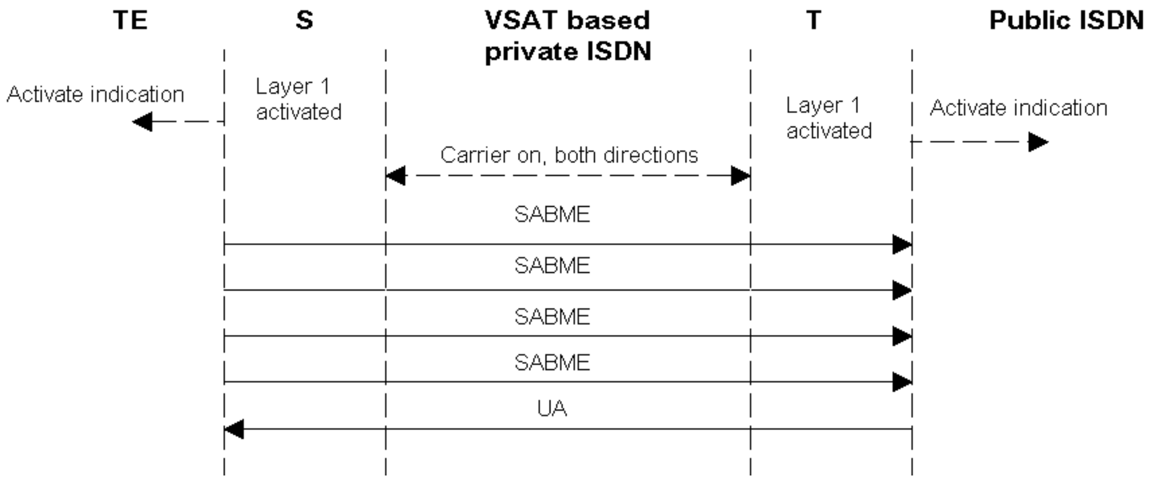


Figure 14 (b): With three retransmissions of SABME

Figure 14: Layer 2 establishment for the case when only layer 1 is terminated within the VSAT network

Figure 14 is valid for the case when only layer 1 is terminated within the VSAT network and layer 2 and 3 is transported transparently though the VSAT network. The figure shows that the layer 2 establishment is done by the exchange of the Set Asynchronous Balanced Mode Extended (SABME) command and the Unnumbered Acknowledgement (UA) message between the TE and the public ISDN. The figure assumes that layer 1 is already established between the TE and the public ISDN. For a more detailed explanation of layer 1 activation/establishment, see figure 12 of subclause 7.3.

Figure 14 (b) illustrates that SABME commands can be retransmitted a total of 3 times if no UA is received.

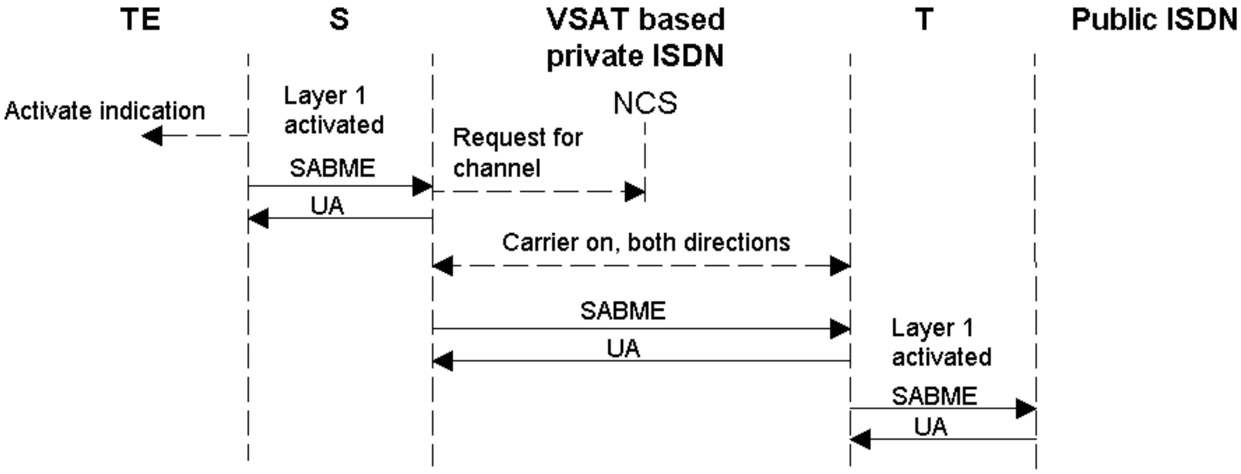


Figure 15: Layer 2 establishment for the case when both layer 1 and 2 are terminated within the VSAT network

If the VSAT network terminates layer 1 and 2, the SABME command may be used to trigger the request for channels in the VSAT network. After allocation of channels layer 2 of the VSAT network is established by the SABME-UA interaction. At last the layer 1 at the T interface is activated (if not activated) and the layer 2 of the T interface is established. This is shown in figure 15.

7.2.3 Layer 3

In figure 16 a call is set up from the TE side. Basic rate access on the T and the S or coincident S/T interface is assumed. The activation of layer 1 is shown with the different info streams. Layer 2 is established as shown in figure 15. The establishment of layer 3 starts with the sending of a SETUP message from the TE. The public ISDN responds with CALL PROCEEDING and CONNECT. All layer 3 messages are transferred transparently through the VSAT network.

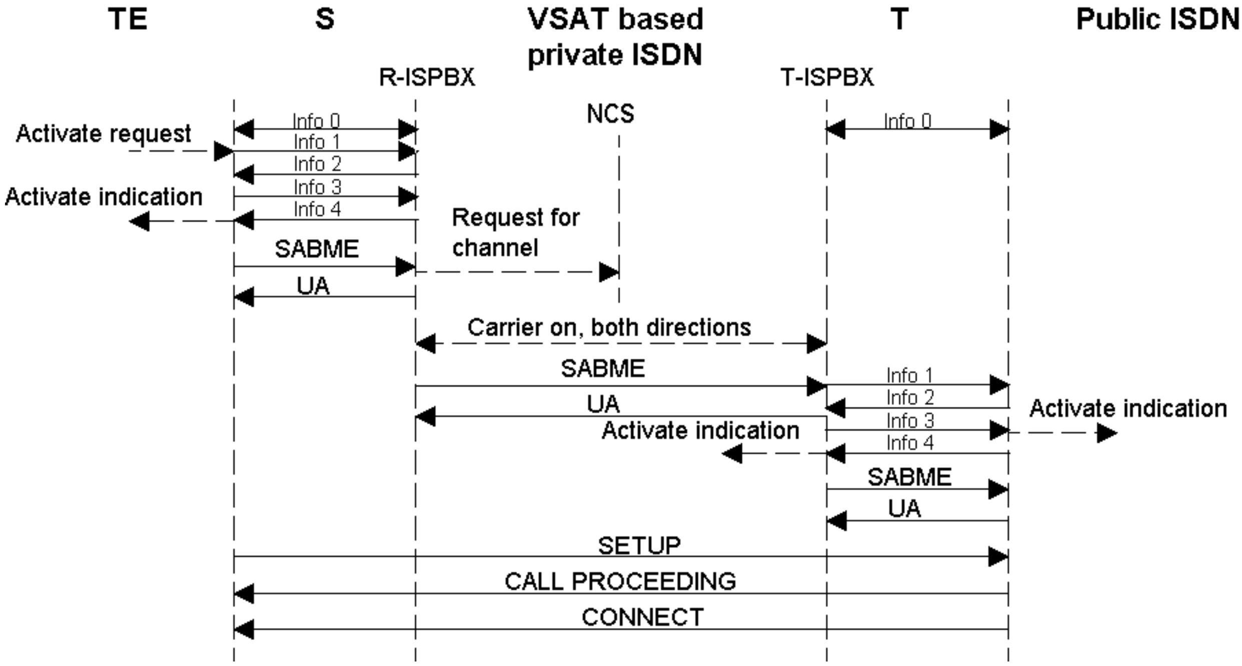


Figure 16: Example of call set-up with activation of layer 1 (basic rate) and establishment of layer 2 and 3

7.2.4 Critical timers for Case 2

For the case that only layer 1 is terminated within the VSAT network, the critical timers are related to layer 2. Layer 2 timers are listed in table 4 and other layer 2 parameters are listed in table 5.

Table 4: Layer 2 timers

Timer	Description	Default value
T200	Time between transmission and acknowledgement of a frame	1s
T201	The minimum time between retransmission of the TEI identity check message	1s
T202	The minimum time between the transmission of TEI identity request message	2s
T203	The maximum time allowed without frames being exchanged	10s

Table 5: Other layer 2 parameters

Counter	Description	Default value
N200	Maximum number of retransmissions of a frame	3
N202	Maximum number of transmissions of the TEI identity request message	3

For the case of having only layer 1 termination within the VSAT network, T200 will be the critical timer. The VSAT network should respond to the SABME command within 1 s (T200) and if no response is received, the SABME will be retransmitted. The maximum number of retransmissions are 3 according to N200. If still no response is received after 3 retransmissions, the call will be disconnected. This gives a total of 4 s which can be used by the VSAT network and the entities in both ends to acknowledge the SABME command. With approximately 600 ms used for layer 2 set-up (including one interaction via satellite and processing delay in the public ISDN), a maximum of 3,4 s is left for the establishment of a VSAT layer 1 connection via satellite. This *may* cause problem for some VSAT networks, but is believed to be sufficient in most cases.

NOTE: The retransmission facility may also be used to successfully retransmit a SABME command which is errored due to error conditions in the network.

The layer 3 timer T303 is related to the layer 2 parameters using the following formula:

$$T303 = (N200 + 1) \text{ seconds},$$

where N200=3 is the default value of the layer 2 parameter N200. This means that there exists no layer 3 timer problem in the case where only layer 1 is terminated within the VSAT network. The reason is that the time constraint will be on layer 2 since the transparent layer 2 will be established within a maximum of N200+1=4 s=T303.

In the case that both layer 1 and 2 is terminated within the VSAT network, there will be no timer problem related to layer 2. The layer 3 time constraints will be as for Case 1. This means that a total time of 8 s is available from a SETUP is being sent over the VSAT network to an acknowledgement (for example CALL PROCEEDING) being received. During this time layer 1, 2 and 3 should be set up across the VSAT network. Using approximately:

- 600 ms for layer 2 establishment (one interaction via satellite); and

- 600 ms for layer 3 establishment (one interaction via satellite),

there is approximately 6,8 s left to establish the VSAT network on layer 1. This is believed to be sufficient in most cases.

8 Addressing

ETS 300 189 [27] serves as a general and common reference for all addressing recommendations in PTNs. Addressable entities, numbering plans, multiple subscriber number arrangements and terminal interchangeability are described in the following subclauses.

8.1 VSAT based private ISDN addressable entities

Depending on the numbering plan(s) employed, a VSAT based private ISDN will be able to assign an appropriate number to each of its addressable entities.

An addressable entity can be associated with, but need not be limited to:

- a single access of the VSAT based private ISDN;

- several accesses of the VSAT based private ISDN;

- an internal entity of the VSAT based private ISDN.

A particular number can fulfil only one of the functions.

A VSAT based private ISDN may be able to assign more than one number to the same access of the network, in accordance with the Multiple Subscriber Number supplementary service, see ETS 300 050 [28].

8.2 Numbering plans

Private telecommunication networks employ numbering plans, i.e. the addresses used within their addressing domains are numbers.

The addressing domain of a VSAT based private ISDN is assumed to be the whole VSAT based private ISDN.

Depending on the choice of the VSAT based private ISDN Authority, the configuration management allows the employment of the following numbering plans as native VSAT based private ISDN numbering plans:

- the ISDN Numbering Plan according to ITU-T Recommendation E.164 [29], hereafter referred to as "ISDN NP"; or
- a Private Numbering Plan, hereafter referred to as "PNP"; or
- an implicit Numbering Plan; or
- any combination of these numbering plans.

Figure 17 shows the relationships between the PNP and the ISDN NP.

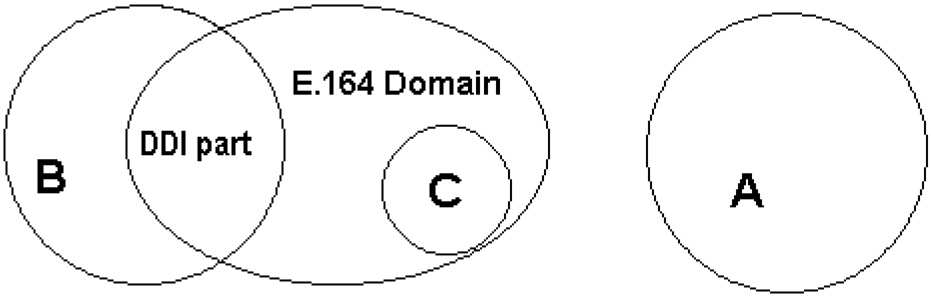


Figure 17: Employment of PNP and/or ISDN NPs in VSAT based private ISDN NPs (figure B.1/ETS 300 189 [27])

Domain A employs a PNP exclusively, which means that its VSAT based private ISDN does not provide any addressable entity that could be directly reached from the public ISDN.

Domain B employs a PNP and the ISDN NP, such that each addressable entity within the area named: "DDI part" has a number from each numbering plan.

In the extreme, all addressable entities in the domain can have a number from each numbering plan.

Assuming that a VSAT based private ISDN typically is connected to the public ISDN numbering domain via its DDI supplementary service, or that, if not so, the VSAT based private ISDN authority may choose at any time to have DDI provided, a VSAT based private ISDN will have to be prepared to conform to two numbering plans in parallel, namely:

- its own PNP which, in principle, allows the use of the same digits or digit sequences as in the public ISDN, however, with a different significance; and

- the public ISDN NP.

NOTE: Each of the addressable entities are not needed to be a member of both numbering plans.

Interworking between both numbering plans will be simplified if the PNP number digits form a subset of the ISDN number digits, i.e. when the last significant digits of both numbers are identical. Otherwise, mapping between the VSAT based private ISDN and the public ISDN numbering plan will be more complex and will require the VSAT based private ISDN users to publish both numbers separately for intra-VSAT based private ISDN and for public ISDN communication.

Domain C employs the ISDN numbering plan exclusively, which means that no addressable entity can be operated in this domain with a number of a significance different from that of the ISDN NP. Although such a restriction is conceivable in theory, it is very unlikely in practice, since such a concept would preclude also any private network specific or abbreviated number.

8.3 Multiple Subscriber Number (MSN) arrangements

8.3.1 MSN description

MSN arrangements allow the use of numbers to identify addressable entities beyond the access at the S reference point. These can be:

- different applications within a given TE; and/or

- different TEs attached to an access with a point-to-multipoint configuration.

MSN can be arranged for basic and primary rate accesses.

A terminal supporting the MSN supplementary service has the capability of being programmed with, and of storing, the digits and parameters of the Multiple Subscriber Number or Numbers which the terminal is to serve. How this information is given to the memory of the TE is a function of the TE's configuration management entity and is beyond the scope of this ETR.

A description of the MSN Supplementary Service can be found in ETS 300 050 [28].

8.3.2 Parameters of the MSN arrangement

The parameters of the MSN arrangement relate to each number individually and are independent of the access(es) to which the number(s) are assigned.

For each VSAT based private ISDN access a default Identification Number (IN) is defined, to be used by the network if its screening process on TE provided Identification Numbers fails.

The number of MSN supported by a VSAT based private ISDN on a particular basic or primary rate access, or by a terminal, depends on their implementations.

9 Network performance objectives

The purpose of this clause is to describe some network performance requirements that will insure that the VSAT network connected to the public ISDN gives no major service degradation neither to the users connected to the VSAT network nor to the users connected to the public ISDN.

9.1 General aspects

According to ITU-T Recommendation I.350 [30], the definition of network performance is a statement of the performance of the Connection Element (CE) or a concatenation of CEs employed to provide a service. In this respect the VSAT network is a CE (VSAT CE) with the performance boundaries at the S and T interfaces (see figure 19).

9.2 Network performance circuit mode objectives

ITU-T Recommendation I.350 [30] sets up nine generic performance parameters in the form of a 3x3 matrix (figure A-1/I.350 [30]). Three protocol-independent communication functions are identified in the matrix: access, user information transfer and disengagement. These general functions correspond to connection set-up, data transfer and clearing of 64 kbit/s connections conforming to recommended ISDN protocols. Each function is considered with respect to three general performance concerns (or "performance criteria"): speed, accuracy and dependability. These express, respectively, the delay or rate, degree of correctness, and degree of certainty with which the function is performed.

In addition to ITU-T Recommendation I.350 [30], ITU-T Recommendation I.353 [31]: "Reference events for defining ISDN performance parameters" defines physical Measurement Points (MPs) and performance-significant Reference Events (REs) related to protocols and performance objectives.

9.2.1 Error performance

The ITU-T Recommendation G.821 [32] specifies error performance parameters and objectives of an international digital 64 kbit/s circuit-switched connection forming part of an ISDN. The 64 kbit/s circuit-switched connection referred to is an all-digital Hypothetical Reference Connection (HRX) which encompasses a total length of 27,500 km.

In table 6 (table 1/ITU-T Recommendation G.821 [32]) the error performance classification is defined.

Table 6: Error performance objectives for international ISDN connections

Performance classification	Objective
(a) (Degraded minutes)	Fewer than 10 % of one-minute intervals to have a bit error ratio worse than $1 \cdot 10^{-6}$
(b) (Severely errored seconds)	Fewer than 0.2 % of one-second intervals to have a bit error ratio worse than $1 \cdot 10^{-3}$
(c) (Errored seconds)	Fewer than 8 % of one-second intervals to have any errors (equivalent to 92 % error-free seconds)
NOTE: The figures applies only when the link is available	

Notes in ITU-T Recommendation G.821 [32] allocates a block allowance of 20 % of the permitted degraded minutes (a) and errored seconds (c), and a block allowance of 0.02 % severely errored seconds (b) to satellite systems.

Using ITU-T Recommendation G.821 [32] as a basis CCIR Recommendation 614-2 [33] has converted the error performance objectives into objectives for the bit error ratio. The CCIR Recommendation 614-2 [33] recommends:

- that the bit error ratio at the output (i.e. at either end of a two-way connection) of a satellite Hypothetical Reference Digital Path (HRDP) and forming part of a 64 kbit/s ISDN connection should not exceed during the available time the values given below:

  1×10^{-7} for more than 10 % of any month;
  1×10^{-6} for more than 2 % of any month;
  1×10^{-3} for more than 0.03 % of any month.

9.2.2 Availability performance

The unavailability performance for fixed-satellite service due to equipment and propagation are given in CCIR Recommendation 579-2 [34]. A provisional value of 0,2 % of a year is assigned to the equipment unavailability objective, whilst a suggested value of 0,2 % of the worst month is proposed for the propagation unavailability performance for an HRDP.

The CCIR Recommendation 579-2 [34] defines also the unavailability time:

That a link in a fixed satellite service defined between the ends of the HRDP should be considered unavailable if one or more of the conditions below exist at either of the receiving ends of the link for 10 consecutive seconds or more. (A period of unavailable time begins when one of the conditions below persists for a period of 10 consecutive seconds. These 10 s are considered to be unavailable time. The period of unavailable time terminates when the same condition ceases for a period of 10 consecutive seconds. These 10 s are considered to be available time.):

- the digital signal is interrupted (i.e. alignment or timing is lost);
- the bit error ratio, averaged over 1 s, exceeds 10^{-3}.

9.2.3 Slip rate performance

ITU-T Recommendation G.822 [35]: "Controlled slip rate objectives of an international digital connection", deals with end-to-end controlled octet slip rate objectives for 64 kbit/s international digital connections. The objectives are presented for various operational conditions in relation to the evaluation of connection quality. The end-to-end slip rate performance objectives should satisfy the service requirements for telephone and non-telephone service on a 64 kbit/s digital connection in an ISDN. The slip rate objective for an international end-to-end connection are stated with reference to the standard digital HRX.

The slip rate objectives are reproduced in the following table 7 (table 1/ITU-T Recommendation G.822 [35]):

Table 7: Controlled slip performance on a 64 kbit/s international connection or bearer channel

Performance category	Mean slip rate	Proportion of time
(a)	≤ 5 slips in 24 hours	> 98,9 %
(b)	> 5 slips in 24 hours and ≤ 30 slips in 1 hour	< 1,0 %
(c)	> 30 slips in 1 hour	< 0,1 %
NOTE: Total time ≥ 1 year		

A VSAT CE should not contribute with more than 40 % of the slip rate objectives in table 7 for performance category (b) and (c).

9.2.4 Jitter performance

ITU-T Recommendation G.823 [36]: "The control of jitter and wander within digital networks which are based on the 2048 kbit/s hierarchy", provides guidelines for the control of jitter in digital networks, including: a maximum network limit that should not be exceeded at any hierarchical interface; a consistent framework for the specification of individual digital equipment; and sufficient information and guidelines for organisations to measure and study jitter accumulation in any network configuration.

Based on ITU-T Recommendation G.823 [36] the STC BT, have set up the following jitter performance parameters with verifications included:

Jitter tolerance at the input port of a VSAT CE:

The input port functions as specified with jitter produced by combining the two components A and B of band limited white noise shown in table 8. Each component is derived by passing white noise through a linear first order band pass filter with cut-off frequencies as shown in table 8 and modulating the input signal to produce the level of jitter shown in table 8.

NOTE: This is based on ITU-T Recommendation G.823 [36]. White noise is used for modulation in order to simulate output from terminal equipment.

Table 8: Input jitter tolerance

Band limited white noise	Measurement filter bandwidth		Amplitude of jitter produced by band limited white noise component
Component	Lower cut-off (high pass)	Upper cut-off (low pass)	Unit Interval (UI) peak-to-peak (maximum)
A	20 Hz	600 Hz	0,25 UI
B	3 kHz	20 kHz	0,05 UI

Maximum jitter at the output port of the VSAT CE:

The maximum jitter at the output port of the VSAT CE is not allowed to exceed the values specified in table 9 with input jitter as specified for the input port, when measured by first order linear filters with the defined cut-off frequencies.

Table 9: Maximum jitter at the output port

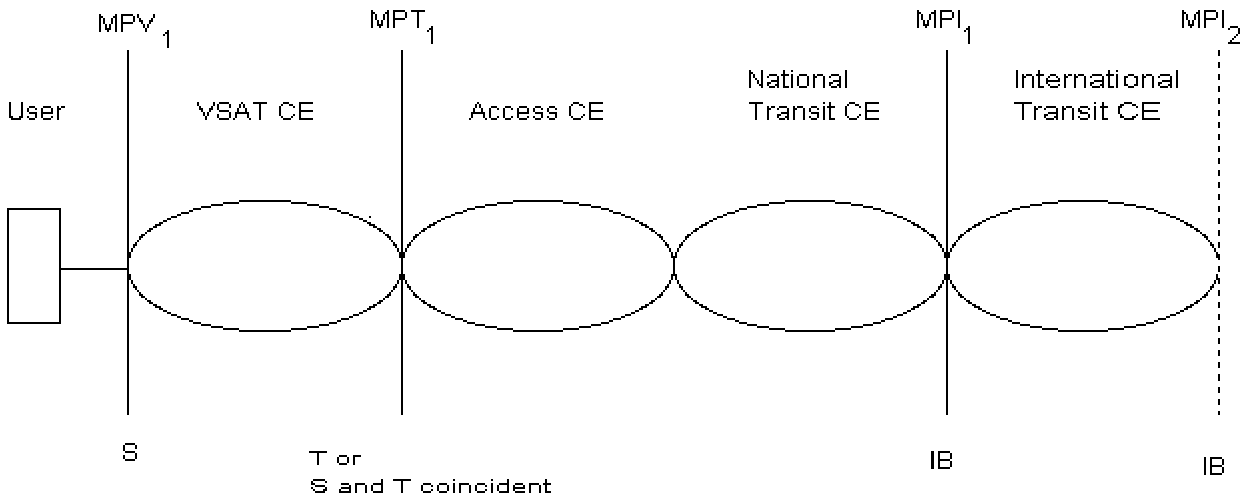
Measurement filter bandwidth		Output jitter
Lower cut-off (high pass)	Upper cut-off (low pass)	UI peak-to-peak (maximum)
20 Hz	20 kHz	0,25 UI
3 kHz	20 kHz	0,05 UI

9.2.5 Synchronisation

In order to meet the slip rate and jitter requirements an appropriate synchronisation strategy should be used.

9.3 Network performance processing delay objectives

Figure 18 shows the general reference configuration for defining network performance parameters for a VSAT CE. Compared to the general reference configuration in ITU-T Recommendation I.352 [37] a VSAT CE has been added.



CE = Connection Element
MPI_1 = Measurement Point I_1
MPI_2 = Measurement Point I_2
MPT_1 = Measurement Point T_1
MPV_1 = Measurement Point V_1
IB = International Switching Centre (ISC) Boundary

Figure 18: General reference configuration

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.

9.3.1 Performance-significant reference events

Performance-significant reference events are defined in ETR 044 [38] and in ITU-T Recommendation I.354 [39]. This subclause presents the performance-significant reference events relevant for this ETR.

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 an 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 19 (figure 1/ETR 044 [38]) conceptually illustrates the two classes of reference events and indicates the measurement points at which entry and exit events are intended to be observed.

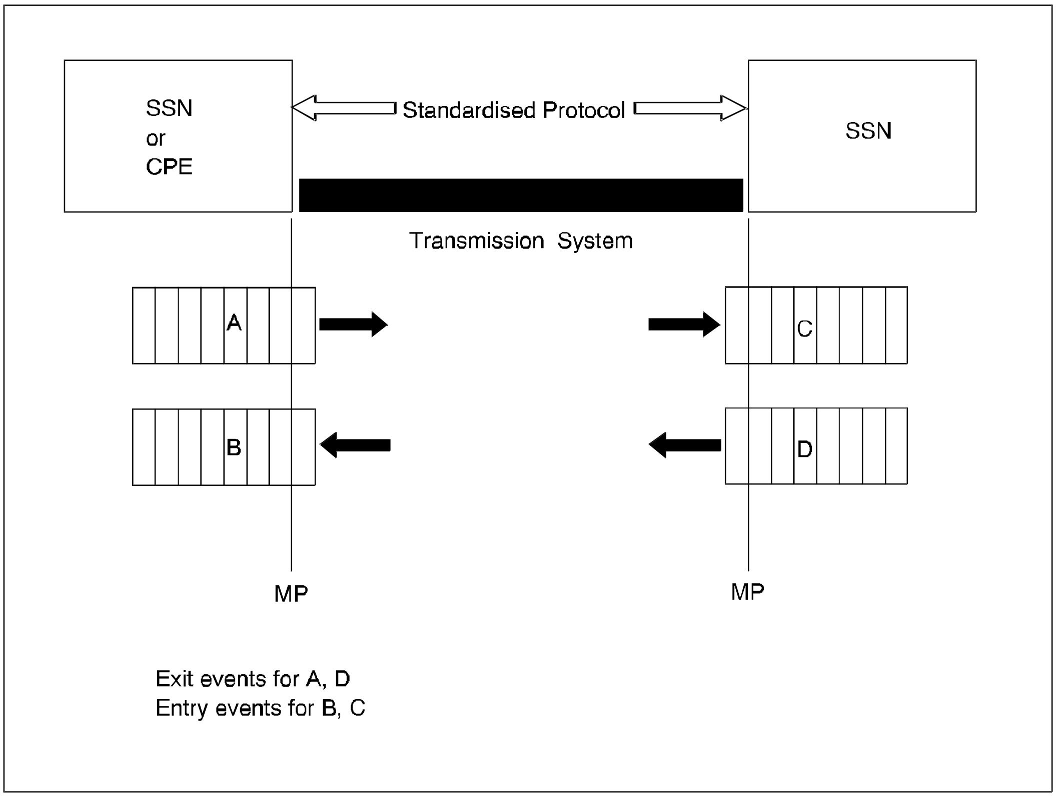


Figure 19: Example entry and exit reference events

The difference between the entry and exit events observed are statistical distributed delay values. There are recommendations for the average and 95 % values. The average value is the average of the distributed delay values. The 95 % is the delay value which should be satisfied for at least 95 % of all delays.

Table 10 (table 2/ETR 044 [38]) lists performance significant DSS1 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 DSS1 layer 3 message transferred, and the resulting state of the DSS1 layer 3 interface.

NOTE 1: For this subclause DSS1 layer 3 refers to the variant of the public DSS1 layer 3 which is specified for PTNs.

Table 11 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 10 or 11 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 DSS1 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 DSS1 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 retransmission occurs, the exit event occurs with the first transmission, and the entry event occurs with the last transmission.

Table 10: Performance-significant reference events based on DSS1 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 2: In Case 2, DSS1 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 10 are applicable.

Table 11: 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 3: 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 11 are applicable.

9.3.2 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 ETS.

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).

9.3.3 Connection processing delay recommendations

9.3.3.1 Connection set-up delay

Specification

The connection set-up delay for the VSAT CE is defined between measurement point MPV_1 and MPT_1 using performance-significant reference events. Table 12 identifies the DSS1 layer 3 start and ending reference events. For each boundary, starting event and ending event is 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 set-up information means that all set-up information is conveyed in the SETUP message, while overlap sending means that set-up information is conveyed not only in the SETUP message, but also in the consequential INFOrmation messages.

Table 12: 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

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;

d_2 = connection set-up delay at measurement point MPT_1.

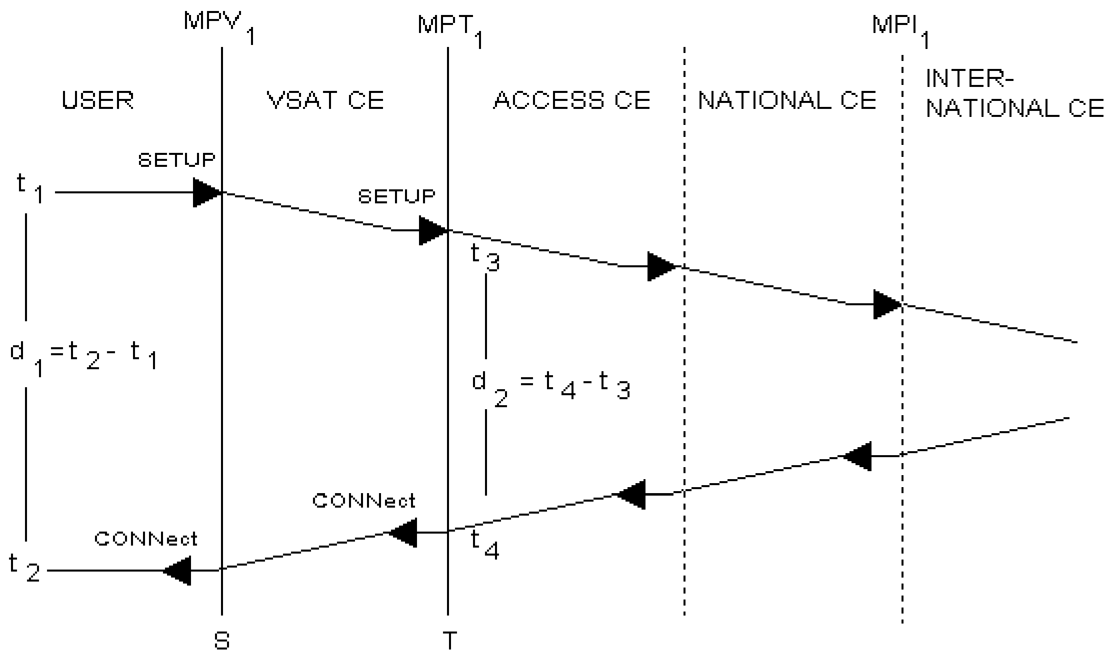


Figure 20: Reference arrow diagram for measuring connection set-up delay

Figure 20 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 20 only case i) is shown.

The connection set-up delay of the VSAT CE should not exceed the values given in table 13.

Table 13: Connection set-up delay for the VSAT CE

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

Verification

Test configuration:

Figure 21: 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:

$$D_{SETUP} = d_1 - d_2 = (t_2 - t_1) - (t_4 - t_3),$$

should be measured a 100 times.

The mean and 95 % value should then be calculated based on all 100 measurements.

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.

9.3.3.2 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 CE is defined between measurement point MPV_1 and MPT_1 using performance-significant reference events. Table 14 identifies the DSS1 layer 3 start and ending reference events. For each boundary, starting event and ending event is 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 14: 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)	P5b
MPV_1	P2b (overlap sending)	P5b
MPT_1	P1a (en bloc)	P5b
MPT_1	P2b (overlap sending)	P5b

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.

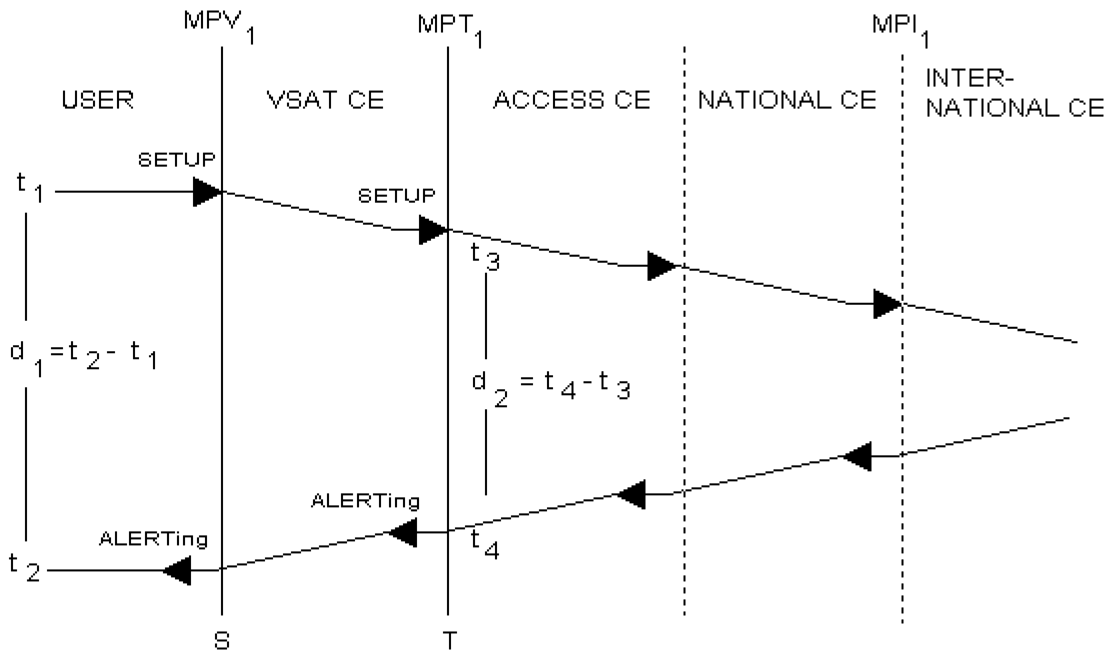


Figure 22: Reference arrow diagram for measuring alerting delay

Figure 22 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 22 only case i) is shown.

The alerting delay of the VSAT CE should not exceed the values given in table 15.

Table 15: Alerting delay for the VSAT CE

Statistics	Alerting delay
Mean	3700 ms
95 %	4700 ms

Verification

Test configuration: see figure 21.

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 100 times.

The mean and 95 % value should then be calculated based on all 100 measurements.

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.

9.3.3.3 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 CE is defined between measurement point MPV_1 and MPT_1 using performance-significant reference events. Table 16 identifies the DSS1 layer 3 start and ending reference events.

Table 16: Performance-significant reference events for measuring disconnect delay

Measurement point	Performance-significant reference events	
	Starting event code	Ending event code
MPV_1 and MPT_1	P8a (Clearing End)	P8b (Cleared End)

If the VSAT User is the clearing end, the disconnect delay between measurement point 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 = $(t_2 - t_1)$

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 point 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 = (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.

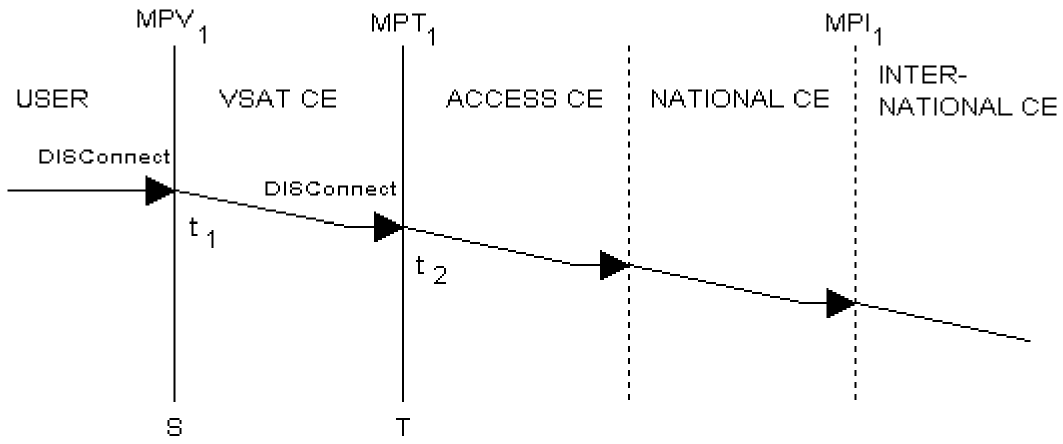


Figure 23: Reference arrow diagram for measuring disconnect delay

Figure 23 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 23 only case i) is shown.

The disconnect delay of the VSAT CE should not exceed the values given in table 17.

Table 17: Disconnect delay of the VSAT CE

Statistics	Disconnect delay
Mean	1250 ms
95 %	1750 ms

Verification

Test configuration: see figure 21.

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 100 times.

The mean and 95 % value should then be calculated based on all 100 measurements.

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.

9.3.3.4 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 18 identifies the DSS1 layer 3 start and ending reference events.

Table 18: 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	P8b
MPV_1 or MPT_1 (Cleared Party)	not applicable	not applicable

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 T interface = d = $(t_2 - t_1)$

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.

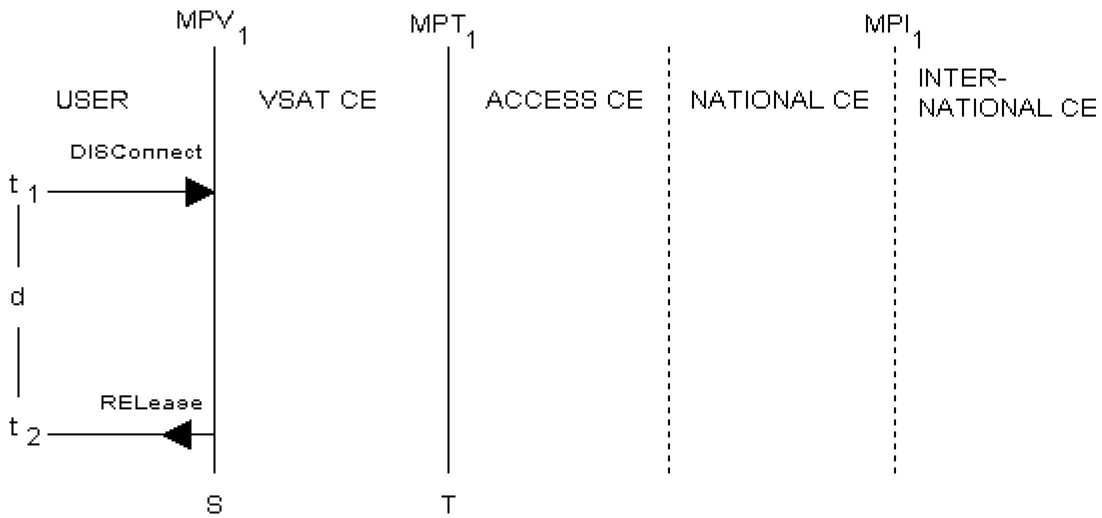


Figure 24: Reference arrow diagram for measuring release delay

Figure 24 shows an arrow diagram which illustrates how the release delay is measured for a VSAT CE. The disconnect 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 24 only case i) is shown.

The release delay of the VSAT CE should not exceed the values given in table 19.

Table 19: Release delay of the VSAT CE

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

Verification

Test configuration: see figure 21.

The VSAT CE release delay given by:

$$D_{REL} = (t_2 - t_1),$$

should be measured a 100 times.

The mean and 95 % value should then be calculated based on all 100 measurements.

9.3.4 Packet mode delay recommendations

9.3.4.1 Packet mode call set-up delay

Specification

The packet mode call set-up delay for the VSAT CE is defined between measurement point MPV_1 and MPT_1 using performance-significant reference events. Table 20 identifies the X.25 layer 3 start and ending reference events. For each boundary, starting event and ending event are defined.

Table 20: 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

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.

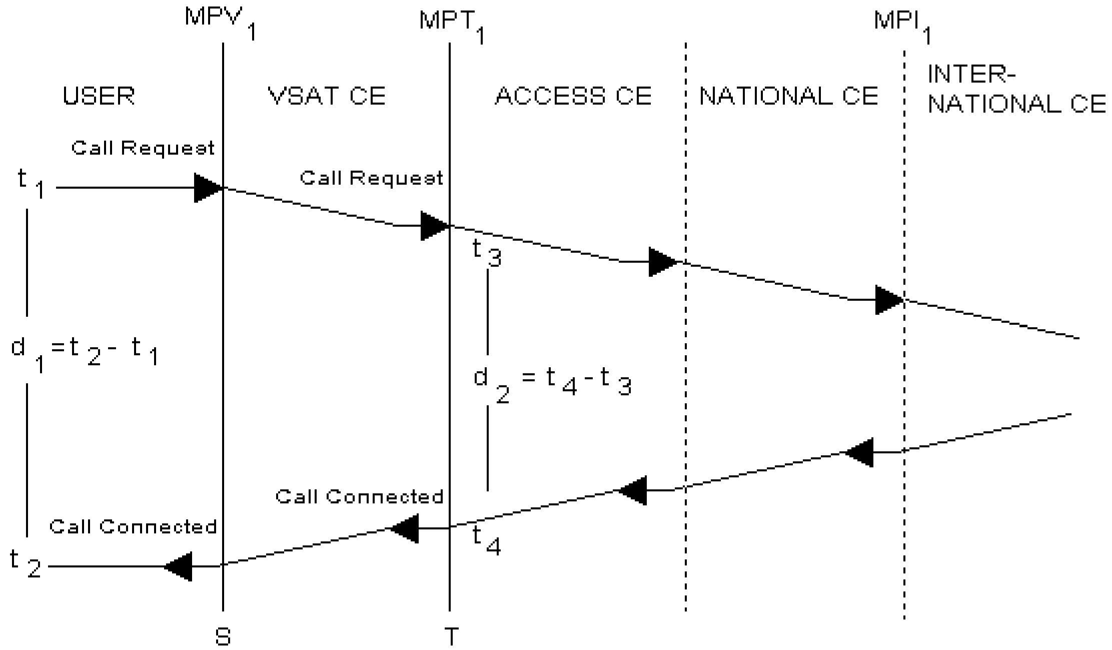


Figure 25: Reference arrow diagram for measuring packet mode call set-up delay

Figure 25 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 25 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 21.

Table 21: 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: see figure 21.

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 100 times.

The mean and 95 % value should then be calculated based on all 100 measurements.

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.

9.3.4.2 Packet mode clear request/clear indication delay

Specification

Packet mode clear request/clear indication delay for the VSAT CE is defined between measurement point MPV_1 and MPT_1 using performance-significant reference events. Table 22 identifies the X.25 layer 3 start and ending reference events.

Table 22: 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 point 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 = $(t_2 - t_1)$

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.

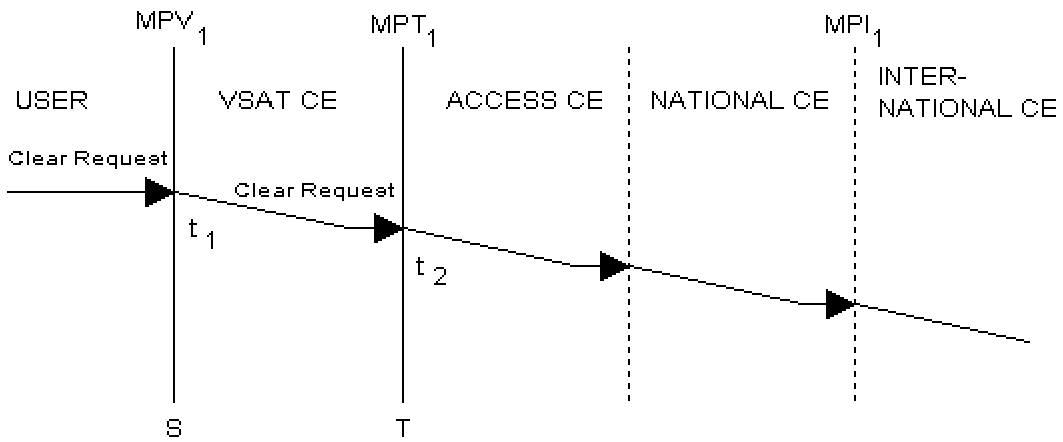


Figure 26: Reference arrow diagram for measuring packet mode clear request delay

Figure 26 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 point 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 = $(t_2 - t_1)$

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.

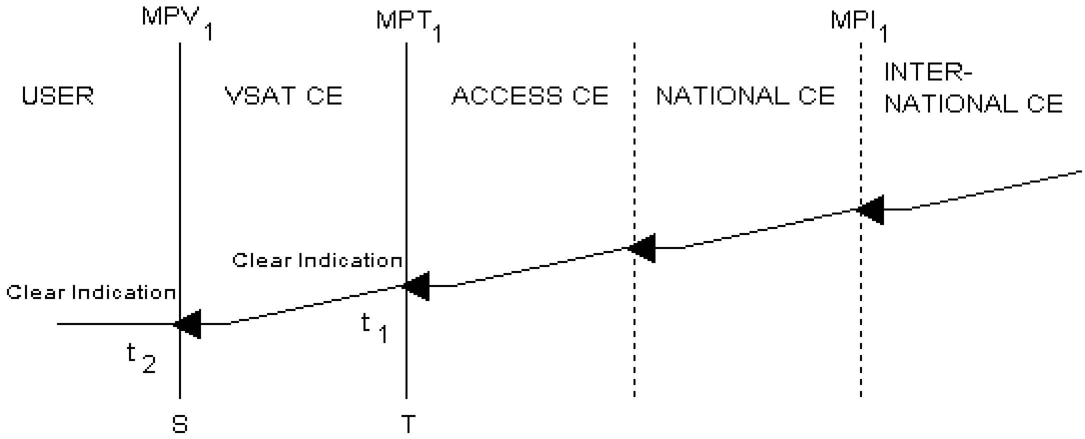


Figure 27: Reference arrow diagram for measuring packet mode clear indication delay

Figure 27 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 23.

Table 23: 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: see figure 21.

I) Verification of packet mode clear request delay:

The VSAT CE packet mode clear request delay given by:

$$D_{\text{Clear Request}} = (t_2 - t_1),$$

should be measured a 100 times.

The mean and 95 % value should then be calculated based on all 100 measurements.

II) Verification of packet mode clear indication delay:

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

9.3.4.3 Packet mode data transfer delay

Specification

Packet mode data transfer delay for the VSAT CE is defined between measurement point MPV_1 and MPT_1 using performance-significant reference events. Table 24 identifies the X.25 layer 3 start and ending reference events.

Table 24: 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 point 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 = $(t_2 - t_1)$

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.

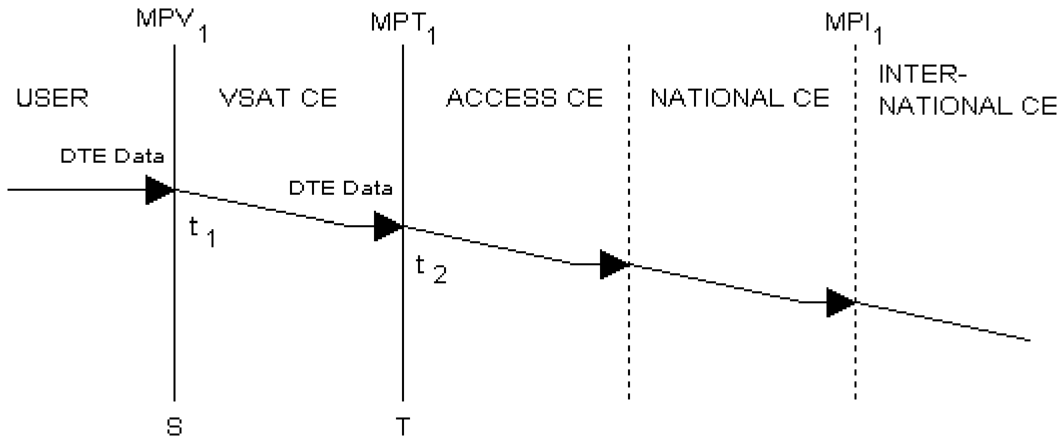


Figure 28: Reference arrow diagram for measuring packet mode data transfer delay when the VSAT user is the data transfer source

Figure 28 shows an arrow diagram which illustrates how the packet mode data transfer delay is measured between measurement point 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 point MPV_1 and MPT_1 is defined as the length of time that starts when a DCE data packet creates a performance-significant reference event at MPT_1 and ends when that DCE data packet creates a performance-significant reference event at MPV_1.

The packet mode data transfer delay of this case is therefore = $(t_2 - t_1)$

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.

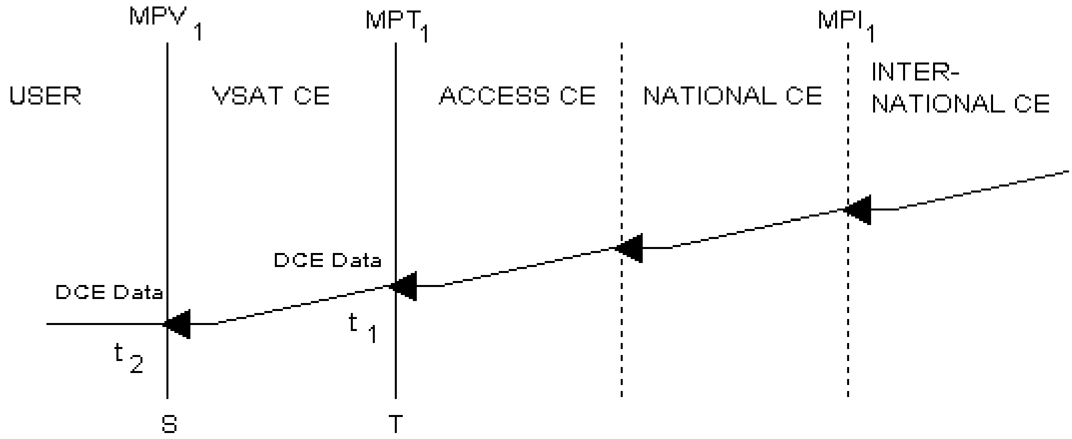


Figure 29: Reference arrow diagram for measuring packet mode data transfer delay when the VSAT user is the data transfer destination

Figure 29 shows an arrow diagram which illustrates how the packet mode data transfer delay is measured between measurement point 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 25 for both directions for packets with a user data field of 128 octets.

Table 25: 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: see figure 21.

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 100 times.

The mean and 95 % value should then be calculated based on all 100 measurements.

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.

Annex A: SAT network and ISDN reference configurations

The VSAT network may be included in the ISDN reference configuration in the following ways:

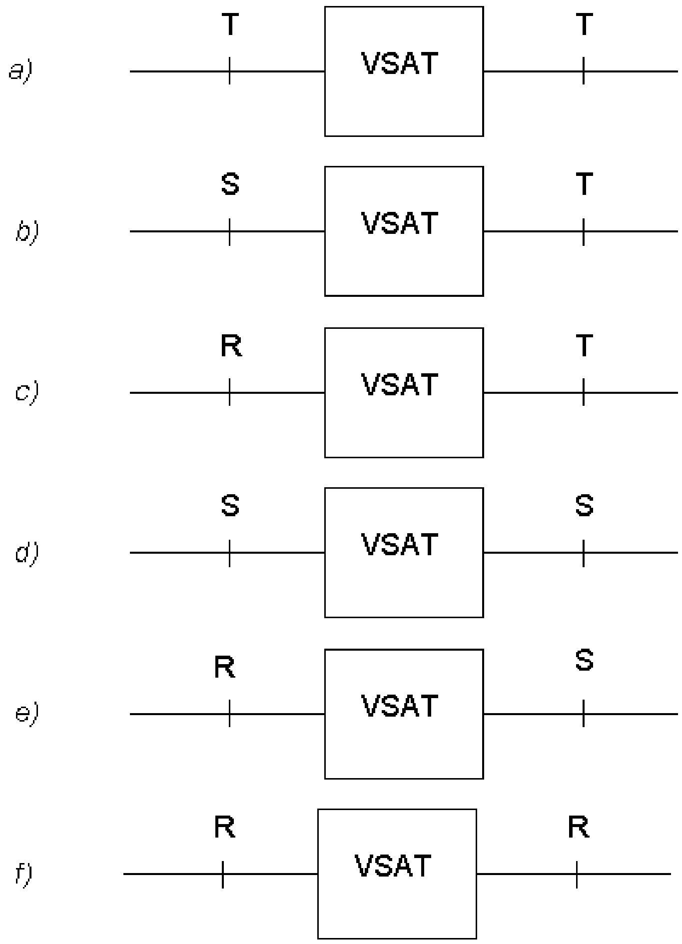


Figure A.1: Reference configurations for the VSAT network

In figure A.1 (a) and A.1 (d) the VSAT network is an ISDN T or S repeater.

In figure A.1 (b) the VSAT network must be considered as a NT2.

In figure A.1 (c) the VSAT network must be considered as a TA+NT2, i.e. figure A.1 (b) and A.1 (e) connected together.

In figure A.1 (e) the VSAT network must be considered as a TA.

In figure A.1 (f) the VSAT network must be considered as a non ISDN functional group.

Assuming that non ISDN functional groups and adaptation functions are outside the scope of this ETR, the only relevant reference configuration for a VSAT based ISDN is the one in figure A.1 (b). In figure A.1 (a) and A.1 (d) the S and T reference points are repeated on both side of the VSAT network. This can also be seen as a special case of figure A.1 (b) where the NT2 is null and the S and T reference point coincide.

Annex B: LAP-D TEI assignment procedure

ETS 300 125 [16] describes the TEI assignment procedure for LAP-D. For the considerations in this ETR the following should be noted:

- in special cases where the TE1 has not got a terminal address, the network exchanges information of this address by sending the "TEI assignment" and "TEI acknowledgement" before the SABME. The procedure is called automatic TEI assignment and is shown in figure B.1;
- in figure B.1 the layer 1 is assumed activated and a transparent connection (carrier on, both direction) is established.

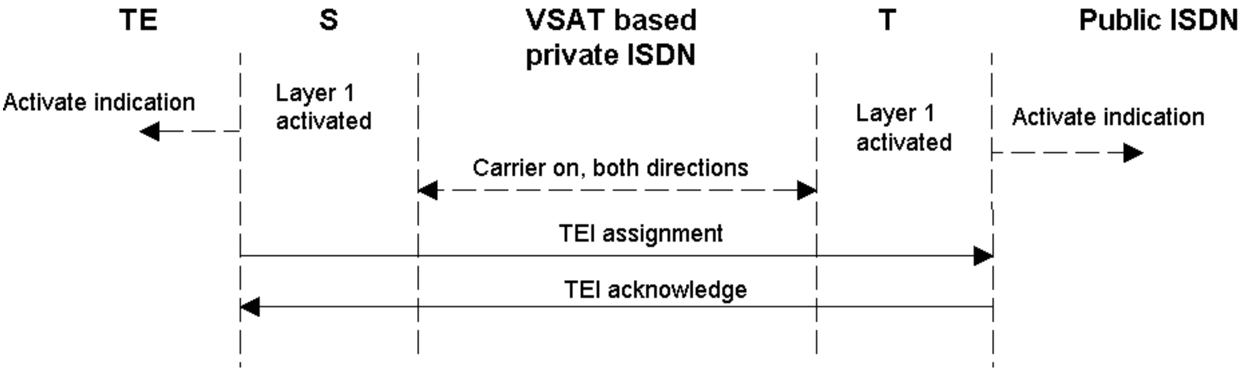


Figure B.1: Automatic TEI assignment procedure

The TEI assignment procedure is always activated by the terminal.

Timer T202, equal to 2s, is started when the TEI assignment message is sent and stopped when the TEI acknowledge message is received. If the TEI acknowledge message is not received within 2s, the TEI assignment message is retransmitted. This can be done a maximum of 3 times. Therefore a total of 8s can be used by the VSAT network to respond to the TEI assignment request.

NOTE: If the layer 2 protocol is according to ETS 300 170 [23], the automatic TEI assignment procedure will not be used.

Annex C: Terminal interchangeability

Terminals can be designed that will be compatible with both public ISDNs offering interfaces conforming to ETS 300 102-1 [14] and PTNs offering interfaces conforming to ETS 300 192 [19].

History

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