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**SERIES X: DATA NETWORKS AND OPEN SYSTEM
COMMUNICATION**

Interworking between networks – Satellite data
transmission systems

**Connection of VSAT systems with
Packet-Switched Public Data Networks
based on X.25 procedures**

ITU-T Recommendation X.361

(Previously CCITT Recommendation)

ITU-T X-SERIES RECOMMENDATIONS
DATA NETWORKS AND OPEN SYSTEM COMMUNICATION

PUBLIC DATA NETWORKS	X.1–X.199
Services and facilities	X.1–X.19
Interfaces	X.20–X.49
Transmission, signalling and switching	X.50–X.89
Network aspects	X.90–X.149
Maintenance	X.150–X.179
Administrative arrangements	X.180–X.199
OPEN SYSTEM INTERCONNECTION	X.200–X.299
Model and notation	X.200–X.209
Service definitions	X.210–X.219
Connection-mode protocol specifications	X.220–X.229
Connectionless-mode protocol specifications	X.230–X.239
PICS proformas	X.240–X.259
Protocol Identification	X.260–X.269
Security Protocols	X.270–X.279
Layer Managed Objects	X.280–X.289
Conformance testing	X.290–X.299
INTERWORKING BETWEEN NETWORKS	X.300–X.399
General	X.300–X.349
Satellite data transmission systems	X.350–X.399
MESSAGE HANDLING SYSTEMS	X.400–X.499
DIRECTORY	X.500–X.599
OSI NETWORKING AND SYSTEM ASPECTS	X.600–X.699
Networking	X.600–X.629
Efficiency	X.630–X.649
Naming, Addressing and Registration	X.650–X.679
Abstract Syntax Notation One (ASN.1)	X.680–X.699
OSI MANAGEMENT	X.700–X.799
Systems Management framework and architecture	X.700–X.709
Management Communication Service and Protocol	X.710–X.719
Structure of Management Information	X.720–X.729
Management functions	X.730–X.799
SECURITY	X.800–X.849
OSI APPLICATIONS	X.850–X.899
Commitment, Concurrency and Recovery	X.850–X.859
Transaction processing	X.860–X.879
Remote operations	X.880–X.899
OPEN DISTRIBUTED PROCESSING	X.900–X.999

For further details, please refer to ITU-T List of Recommendations.

FOREWORD

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

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

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1 (Helsinki, March 1-12, 1993).

ITU-T Recommendation X.361 was prepared by ITU-T Study Group 7 (1993-1996) and was approved under the WTSC Resolution No. 1 procedure on the 5th of October 1996.

NOTE

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

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CONTENTS

	<i>Page</i>
1 Scope	1
2 References	1
3 Abbreviations	2
4 Interconnection scenarios	2
4.1 General.....	2
4.2 Definitions	3
4.3 Interconnection scenarios	3
5 Interface requirements.....	5
5.1 Layer 1	6
5.2 Layer 2	6
5.3 Layer 3	6
5.4 OSI network layer service	7
5.5 Addressing information	7
5.6 Facilities information.....	8
Annex A – Connection quality guidelines.....	9
A.1 General.....	9
A.2 Base for the definition of the VSAT performance parameters	9
A.3 Delay performance.....	10
A.4 Throughput performance	16
A.5 Accuracy and dependability performance	17
A.6 Availability performance	17

SUMMARY

This Recommendation applies to private network implementations of VSAT systems. It describes their interconnection to PSPDNs via the X.25 protocol together with specifications for Quality of Service (QOS) levels compatible with the X.130-Series performance Recommendations on X.25/X.75 packet-switched performance.

CONNECTION OF VSAT SYSTEMS WITH PACKET-SWITCHED PUBLIC DATA NETWORKS BASED ON X.25 PROCEDURES

(Geneva, 1996)

1 Scope

This Recommendation describes the requirements for interconnecting a VSAT system [operating as a Private Data Network (PvtDN)] to a Packet-Switched Public Data Network for provision of the Data Transmission Service as defined in clause 3/Recommendation X.2.

VSAT systems may also be connected to Packet-Switched Public Data Networks using other scenarios. The interconnections under such scenarios are not covered by this Recommendation.

2 References

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

- ITU-T Recommendation X.2 (1996), *International data transmission services and optional user facilities in public data networks and ISDNs*.
- ITU-T Recommendation X.25 (1996), *Interface between Data Terminal Equipment (DTE) and Data Circuit-terminating Equipment (DCE) for terminals operating in the packet mode and connected to public data networks by dedicated circuit*.
- ITU-T Recommendation X.32 (1996), *Interface between Data Terminal Equipment (DTE) and Data Circuit-terminating Equipment (DCE) for terminals operating in the packet mode and accessing a Packet Switched Public Data Network through a Public Switched Telephone Network or an Integrated Services Digital Network or a Circuit Switched Public Data Network*.
- ITU-T Recommendation X.35 (1993), *Interface between a PSPDN and a private PSDN which is based on X.25 procedures and enhancements to define a gateway function that is provided in the PSPDN*.
- ITU-T Recommendation X.121 (1996), *International numbering plan for public data networks*.
- CCITT Recommendation X.134 (1992), *Portion boundaries and packet layer reference events: basis for defining packet-switched performance parameters*.
- CCITT Recommendation X.135 (1992), *Speed of service (delay and throughput) performance values for public data networks when providing international packet-switched services*.
- CCITT Recommendation X.136 (1992), *Accuracy and dependability performance values for public data networks when providing international packet-switched services*.
- CCITT Recommendation X.137 (1992), *Availability performance values for public data networks when providing international packet-switched services*.

- CCITT Recommendation X.138 (1992), *Measurement of performance values for public data networks when providing international packet-switched services*.
- CCITT Recommendation X.139 (1992), *Echo, drop, generator and test DTEs for measurement of performance values in public data networks when providing international packet-switched services*.
- ITU-T Recommendation X.213 (1995) | ISO/IEC 8348:1996, *Information technology – Open Systems Interconnection – Network service definition*.
- ITU-T Recommendation X.223 (1993), *Use of X.25 to provide the OSI connection-mode network service for ITU-T applications*.
- ITU-T Recommendation X.327 (1993), *General arrangements for interworking between Packet Switched Public Data Networks (PSPDNs) and private data networks for the provision of data transmission services*.

3 Abbreviations

For the purposes of this Recommendation, the following abbreviations are used:

BCD	Binary Coded Decimal
DCE	Data Circuit-terminating Equipment
DM	Disconnect Mode
DNIC	Data Network Identification Code
DTE	Data Terminal Equipment
FCS	Frame Checking Sequence
FRMR	Frame Reject Mode Response
ISDN	Integrated Services Digital Network
LAPB	Link Access Procedure Balanced
NTN	Network Terminal Number
OSI	Open Systems Interconnection
PNIC	Private Network Identification Code
PSDN	Packet-Switched Data Network
PSPDN	Packet-Switched Public Data Network
PVC	Permanent Virtual Circuit
PvtDN	Private Data Network
SABM	Set Asynchronous Balanced Mode
VSAT	Very Small Aperture Terminal (Terminal communicating via satellite with a very small aperture antenna)

4 Interconnection scenarios

4.1 General

A VSAT system is considered as a particular form of implementation of a Private Data Network (PvtDN). This type of PvtDN is a specific type of network covered by Recommendation X.327.

A VSAT DTE connected to the PSPDN shall appear to the PSPDN as a normal X.25 DTE. The PSPDN makes no allowance for, and has no knowledge of, the VSAT system.

The set of all the elements of a VSAT system which constitute this PvtDN is called hereafter the VSAT network.

4.2 Definitions

The following elements are identified in the connection and are shown in Figures 1 and 2:

A The applications (A) dialogue with each other by means of end-to-end protocols which are outside the scope of this Recommendation.

B The application running at the DTE (B) must implement a local interface to the remote VSAT (D). This interface is not subject to standardization. However, the guidelines related to connection quality defined in Annex A are based on the assumption that this interface satisfies Recommendation X.25.

C The remote VSAT provides an appropriate interface (C).

D The remote VSAT station (D) provides the communication over the satellite. The way in which this is done and the internal protocols of the VSAT network are outside the scope of this Recommendation. The layers 2 and 3 over the satellite links may be different from those at the PSPDN interface and at the DTE-B interface.

E The HUB station (E), in the case of a star network. This HUB is the central station with which all the remote VSATs communicate.

NOTE – Elements (D) and (E) may reside in the same physical equipment.

F The interface between the VSAT network and the PSPDN. This is a DTE (F) on the VSAT network side and may be implemented at either the HUB or at any of the remote VSAT stations.

G The PSPDN DCEs. These are customer connection points which offer an X.25 interface to the PSPDN. These occur on the interface to the VSAT network and also on the interface to the customer connected to the PSPDN.

H This is a generic PSPDN which may be made up of a number of national and possibly international portions. These portions are defined in Recommendation X.134 and their quality of service is defined in Recommendations X.135, X.136 and X.137, which provide worst case values.

I The remote DTE (I) of the customer connected to the PSPDN where the corresponding application runs.

J The store-and-forward gateway between the VSAT network and the PSPDN. This element takes the responsibility of delivering the messages received from either the remote DTE (B), or the remote DTE (I), to its counterpart.

4.3 Interconnection scenarios

Within the VSAT network it is possible to conceive two forms of connection (see Figures 1 and 2).

4.3.1 Real-time direct connection

In this scenario a real-time connection is established between the application served by one of the VSAT stations and the application served by a DTE connected to the PSPDN. The Switched Virtual Circuit (SVC) or the Permanent Virtual Circuit (PVC) over the PSPDN is extended over the VSAT network.

Two types of connection over the VSAT network are considered (see Figure 1):

- single hop connections which apply in mesh networks, i.e. those that allow the direct communication between remote VSATs, and on star networks in which the interface to the PSPDN is implemented exclusively at the HUB; the following two paths are identified in Figure 1:

A2→B→C→D1→S→D2→F2→G3→G4→I2→A3

A2→B→C→D1→S→D3→E→F1→G1→G2→I1→A1

- double hop connections which apply in star VSAT networks which implement the DTE interface to the PSPDN at a remote VSAT. In these cases all communications are routed via the HUB and therefore require two satellite hops; the following path is identified in Figure 1:

A2→B→C→D1→S→D3→E→D3→S→D2→F2→G3→G4→I2→A3

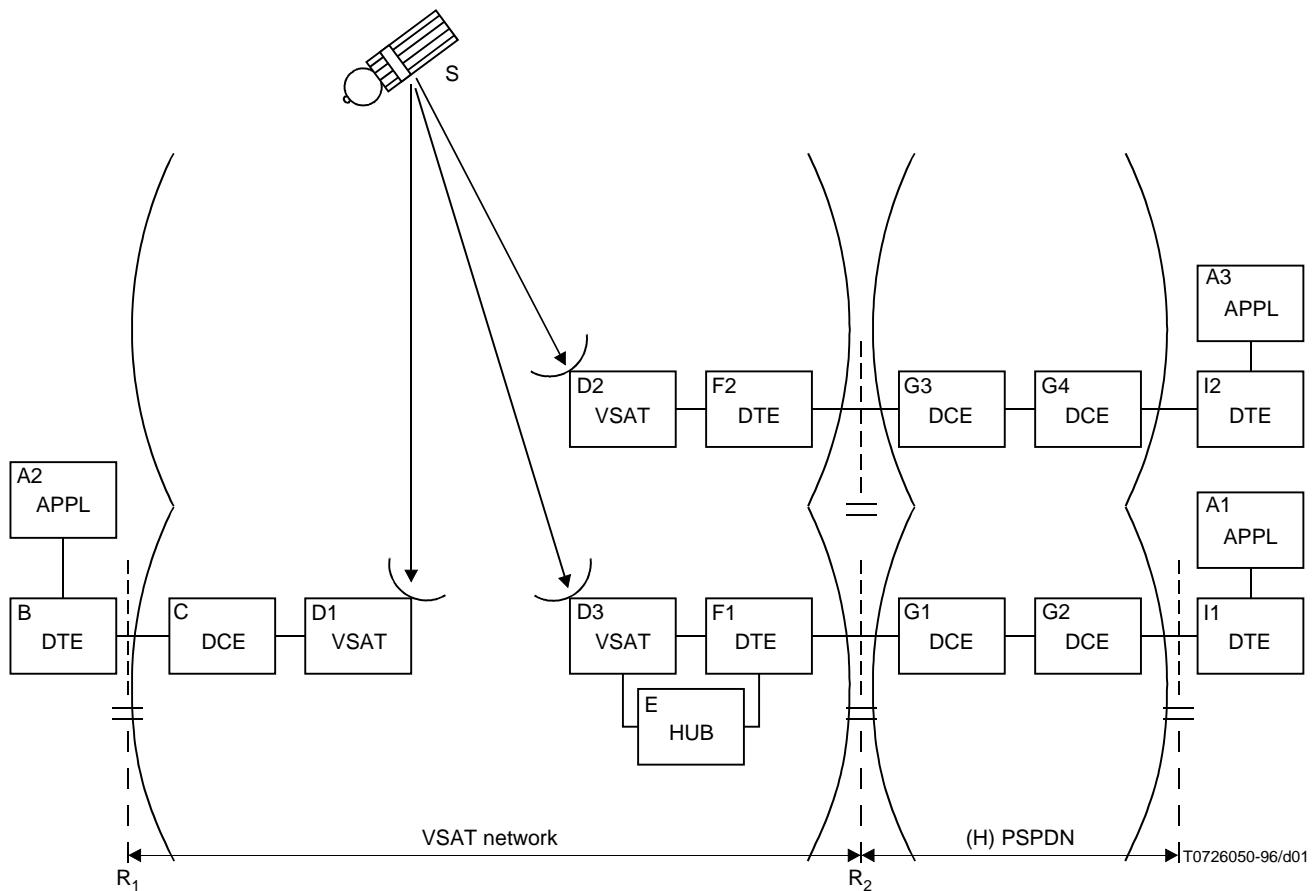


FIGURE 1/X.361

Real-time direct connection scenario

4.3.2 Store-and-forward

This scenario is depicted in Figure 2.

In this scenario the delivery to/from the remote DTE (B) is performed over the VSAT network to a store-and-forward gateway (J) connected to the PSPDN via a DTE (F). The delivery from/to the remote DTE (I) takes place from the gateway over the PSPDN as a separate transaction. This means there is no real-time interaction between the remote DTE (B) and the remote DTE (I).

The gateway function may incorporate protocol conversion at either low functional layers or high functional layers. Such conversion is outside the scope of this Recommendation.

From the PSPDN point of view the connection is performed with the applications residing in the gateway. As such, the services offered by the PSPDN and their quality of service is in no way affected by the VSAT network.

For the PSPDN, the DTE (F) to which the store-and-forward gateway is connected shall introduce no special requirements for addressing purposes. This function of the store-and-forward gateway is considered part of the user defined protocols and is therefore outside the scope of this Recommendation.

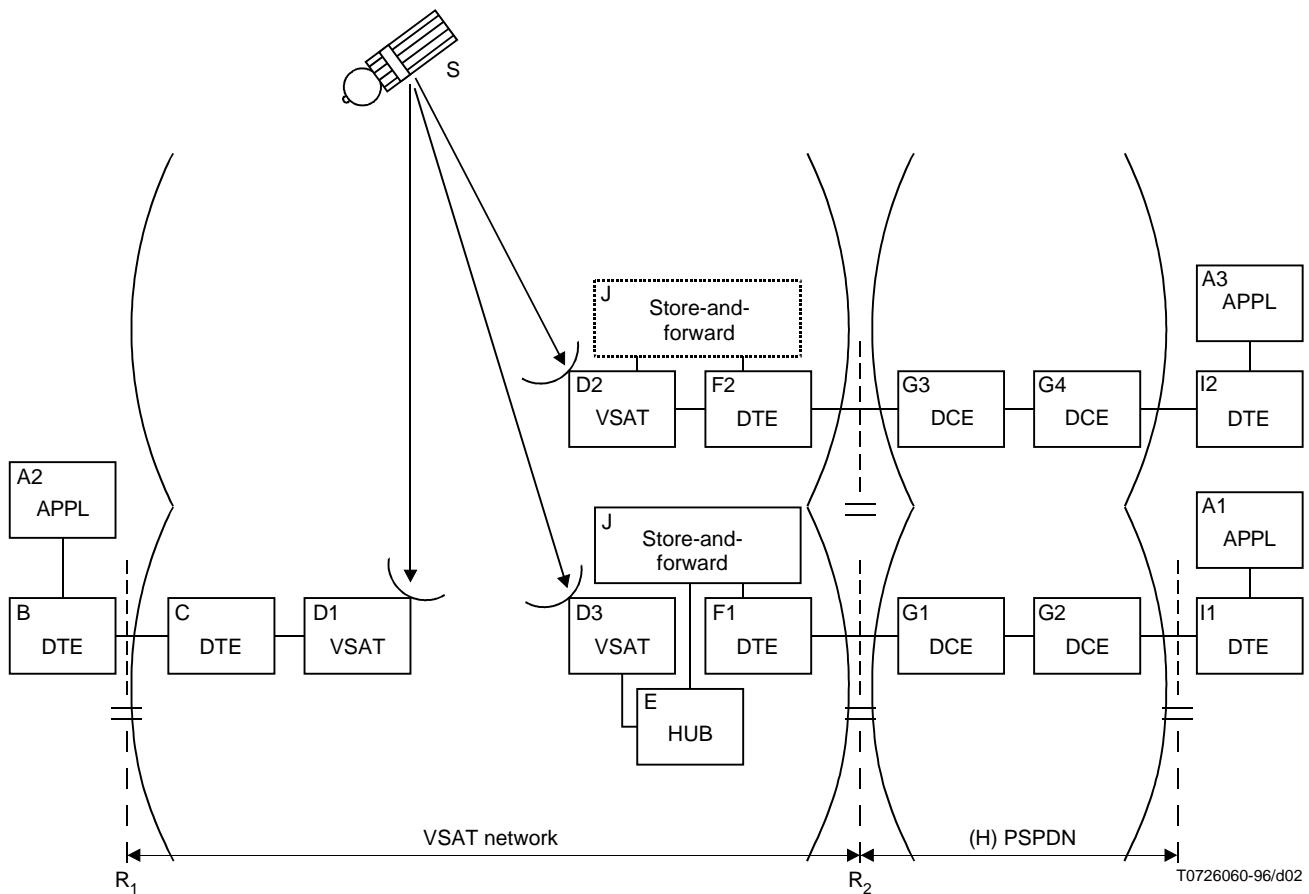


FIGURE 2/X.361
Store-and-forward gateway scenario

5 Interface requirements

The interface R2 provided by a VSAT network to be connected to a PSPDN shall comply with Recommendation X.25 for dedicated access or Recommendation X.32 for switched access.

NOTE 1 – Appendix V/X.25 provides guidelines for the appropriate selection of parameter settings on the X.25 link in order to maximize the efficiency of the link when the transmission is over channels with long round trip delay (satellite circuits).

NOTE 2 – To allow for terminals on the VSAT network to be addressed by DTEs on the PSPDN, numbering of VSAT DTEs should be in accordance with Recommendation X.121. Annex B/X.121 gives guidance on the use of Private Network Identification Codes to allow for the numbering/identification of terminals on private packet-switched data networks in harmony with the public network numbering plan.

NOTE 3 – Recommendation X.35 “Interface between a PSPDN and a private PSDN which is based on X.25 procedures and enhancements to define a gateway function that is provided in the PSPDN” also defines the gateway function that may be provided in a PSPDN to facilitate the interworking between a PSPDN and a Private PSDN. The functionality specified in Recommendation X.35 may be required to be implemented in the VSAT DTE (F) and HUB station.

5.1 Layer 1

Physical interface between the VSAT network DTE and the PSPDN is as specified in Recommendation X.25 or in Recommendation X.32.

5.2 Layer 2

5.2.1 LAPB set-up

Recommendation X.25 describes the possible methods of link set-up. The VSAT network should comply with the link set-up method according to Recommendation X.25. In case of switched access layer 2 address assignment procedures of Recommendation X.32 shall also apply.

5.2.2 Invalid information frames

A VSAT DTE may encounter two different reactions to an Information frame of greater than N1 bits, where N1 is as described in Recommendation X.25. The PSPDN DCE may either issue a frame reject with the P/F bit set to 1, or it may discard the frame. This will depend on its interpretation of the error involved and whether it waits to receive the FCS (Frame Checking Sequence) on detecting an over-length frame.

Therefore, the VSAT DTE should:

- a) correctly handle timer recovery due to a discard as in Recommendation X.25;
- b) correctly handle a FRMR with the P/F bit set to 1 as in Recommendation X.25.

5.2.3 Unsolicited responses

The DM (Disconnect Mode) response may be used by the DCE or DTE to request a link set-up to the other party. The reaction to this is defined in Recommendation X.25.

To react to other unsolicited responses a number of variations exist. Therefore, the VSAT DTE should:

- 1) be capable of handling the reactions of the PSPDN DCE to which it requires connection;
- 2) react to unsolicited responses by responding with either an SABM (Set Asynchronous Balanced Mode) frame, SABME (Set Asynchronous Balanced Mode Extended) frame or SM (Set Mode) frame, to reset the link, or with a DM frame to ask the DCE to initiate link set-up.

5.3 Layer 3

The interface from the VSAT network DTE to the PSPDN takes place over dedicated X.25 ports of the PSPDN. The access from the VSAT network to the PSPDN may take place over switched connections as defined in Recommendation X.32.

5.3.1 Call packet types

The VSAT DTE shall use call packet types as specified in Recommendation X.25. This may render certain facility negotiations, referred to in 5.6, impossible. In this case the VSAT DTE should avoid the use of those facilities.

5.3.2 Restart handling

The VSAT DTE should handle Restart packets, as specified in Recommendation X.25.

5.3.3 Reset handling

The VSAT DTE should handle Reset packets in a manner compatible with the PSPDN, as specified in Recommendation X.25.

5.3.4 Permanent virtual circuits

Within a PSPDN, the assignment of an X.25 Permanent Virtual Circuit (PVC) from a logical channel on one DTE to a logical channel on another DTE is performed by the PSPDN operator. Although a VSAT system is not required to support PVCs, if it does, the assignment of a PVC to the intended logical channel on the destination VSAT's DTE must be performed by the VSAT network operator.

An X.25 PVC is always in the data transfer state unless it is actually in the process of resetting. Call packets are not allowed on a PVC. Consequently, remote VSAT addresses from the PSPDN to the VSAT DTE should be passed within data packets. However, any such mechanism is outside the scope of this Recommendation.

5.3.5 Packet segmentation and reassembly

The X.25 flow control parameters (i.e. packet and window sizes) affect the efficiency of the throughput over the PSPDN. Since the protocols on either side of the VSAT DTE are completely independent they do not directly affect performance of the VSAT network. However, packet segmentation or reassembly may be carried out within the VSAT DTE in order to maximize performance on either or both sides of the interface.

5.4 OSI network layer service

Annex G/X.25 defines the facilities required to provide the OSI network layer service. These facilities should be implemented in the VSAT network when the VSAT network is required to carry it.

If the VSAT network is required to carry network layer service traffic, and if the PSPDN is not capable of supporting it, the VSAT DTE should implement a subnetwork-dependent convergence protocol as specified in ISO/IEC 8878.

5.5 Addressing information

There are a number of options for addressing particular remote VSAT DTEs from a PSPDN DTE. These are:

- Use of the address extension facility.
- Use of subaddress digits.
- Use of PNICS.

The selected alternative will depend on the DTE applications, the PSPDN capabilities and the VSAT network.

The method for addressing a PSPDN DTE from a VSAT DTE (i.e. calling into the public network from a terminal on a VSAT network) should conform to Recommendation X.25 (see 5.2.1/X.25).

5.5.1 Extended address facility

The Called Address Extension Facility is defined in Annex G/X.25. It allows up to 40 digits to be included in a facility field of a Call Request packet.

When calling from the PSPDN, the X.121 address of the VSAT DTE (F) is contained in the Address Block of the Call Request packet. Any subaddress of the remote VSAT DTE (B) is passed in the Called Address Extension parameter field.

The address shall be encoded as specified in Annex A of ITU-T Rec. X.213 | ISO/IEC 8348.

5.5.2 Use of subaddress digits

An X.121 address identifies the real point of attachment of a VSAT network to a PSPDN. An X.121 address has a maximum of 14 digits: a 4-digit Data Network Identification Code (DNIC) plus a Network Terminal Number (NTN) of up to 10 digits; or 3 digits Data Country Code (DCC) plus a Network Number (NN) of up to 11 digits. The X.121 number of the called DTE is carried in the Called Address Field of the Call Request Packet. Since some PSPDNs may use less than 10 digits to specify the Network Terminal Number, a number of “subaddress” digits may be carried in the Called Address Field. The subaddress digits are appended to the X.121 address and will be BCD encoded as specified in Recommendation X.25.

In order to address a remote terminal, the remote VSAT DTE (B) subaddress may be encoded as part of the Called Address Field of the VSAT DTE (F).

NOTE 1 – Most PSPDNs are capable of transferring at least two subaddress digits appended to the called X.121 address. The number of digits available for subaddressing depends on the PSPDN to which the VSAT is attached. The subaddress digits will generally be passed transparently by the public network.

NOTE 2 – Two subaddress digits allow up to one hundred terminals on the VSAT network to be addressed. If the VSAT network has more than one hundred terminals and only two subaddress digits are available, it is recommended that the use of a Private Network Identification Code (PNIC) be made in order to number the VSAT network terminals. In those cases, where the PSPDN does not support a PNIC capability, additional national numbers would have to be allocated to the VSAT DTE (F). The VSAT DTE (F) will then be required to decode the address accordingly to determine the remote VSAT DTE (B) address.

NOTE 3 – If multiple national numbers are used to identify the point of attachment of VSAT DTE (F), they should not form part of a Hunt Group or the VSAT DTE (F) will be unable to correctly determine the required VSAT DTE (B) address.

5.5.3 Use of Private Network Identification Codes (PNIC)

Annex B/X.121 provides guidance on the use of Private Network Identification Codes (PNICs) for numbering large private networks in accordance with the public network numbering plan. Individual terminals on the private network are identified by a valid X.121 address. A PNIC is assigned to a particular private network that is attached to the PSPDN. The PNICs are the first digits of the Network Terminal Number. PNICs consist of up to six digits and identify a point of attachment of a private network to the PSPDN. Some networks have variable length PNICs to cater for various size private networks. A six-digit PNIC allows four digits to be used to identify up to 10 000 terminals on the private network. A five-digit PNIC allows five digits to be used to identify up to 100 000 terminals on the private network.

5.6 Facilities information

5.6.1 X.2 facilities

The VSAT DTE should implement all the essential DTE Facilities specified in Table 5/X.2.

5.6.2 End-to-end transit delay facility

This facility is defined in Recommendation X.25. It may be used, if supported by the PSPDN, to inform the remote DTE (I) of larger than usual transit delays.

NOTE 1 – This facility is useful for the called DTE (I), connected to the PSPDN, to know the value of the transit delay.

NOTE 2 – It is also useful to the calling DTE (I) to fix a maximum value for the transit delay.

5.6.3 DCE facilities

Table 3/X.2 defines the optional user facilities of a packet-switched data transmission service. All these facilities are optional in that an X.25 DTE is not required to accept any of them. Some of these are marked as essential, meaning that all PSPDNs should be capable of providing these services. A VSAT network with the “essential” facilities implemented may provide greater interoperability when it provides an X.25 DCE interface to its DTEs. This allows the VSAT to provide a PSPDN-like service to its DTEs.

5.6.4 VSAT specific facilities

Additional facilities specific to VSAT networks can be envisaged such as:

- selective broadcast (narrowcast), where a message is broadcast to a certain group of remote VSATs;
- the use by the VSAT system of the throughput class negotiation and of the transit delay negotiation facilities, in order to optimize its internal resources.

The method of doing so is outside the scope of this Recommendation.

Annex A

Connection quality guidelines

A.1 General

The connection of a two-way VSAT network to a PSPDN network will have an effect on the overall quality provided. It is therefore desirable that the portion of the connection provided by the VSAT network should meet certain quality criteria.

Recommendations X.134, X.135, X.136 and X.137 provide an adequate set of parameters and worst case limits which are also applicable to the definition of quality of service parameters within a VSAT network.

Recommendations X.138 and X.139 specify techniques for the measurement of performance values of packet-switched public data networks. These techniques ensure statistically consistent and meaningful measurements are made. Verification of the speed of service performance parameters (call set-up delay, data packet transfer delay, throughput and call clearing delay) that are provided by the VSAT connection should be done in accordance with the techniques specified in Recommendations X.138 and X.139.

NOTE – Recommendations X.135 and X.139 define measurement conditions with packet window sizes of 2, which are not adequate when layers 2 and 3 of the X.25 interface are transmitted transparently through the satellite.

VSAT networks which are restricted in their connectivity to pre-agreed subsets of users of the PSPDN, for instance by invoking Closed User Group facilities, may not need to take account of these guidelines. VSAT networks which carry only traffic which is not sensitive to delay may not need to take account of these guidelines.

A.2 Base for the definition of the VSAT performance parameters

A.2.1 Portion boundaries

The definition of the connection portion and connection portion boundaries applicable to the connection of the VSAT network to the PSPDN is based on the principles defined in clause 2/X.134.

The VSAT network should be considered as a user provided portion of the connection. This portion of the connection is defined as lying between:

- 1) The local interface at the VSAT, which, for the purpose of these guidelines, should be according to Recommendation X.25.
- 2) The X.25 interface between the VSAT network and the PSPDN, as required in clause 5.

This is shown in Figure A.1, which is an extension of Figure 2/X.134.

A.2.2 Performance parameters

The definition of the performance of the user provided portion of the connection (VSAT network) shall be made with respect to the occurrence of performance related events.

Those events shall be as defined in Recommendation X.134 for the X.25 interface.

The user provided portion of the connection is expected to translate those events between the two portion boundaries, i.e. a Call Request Packet at the X.25 Interface of the remote terminal becomes an equivalent Call Request Packet at the X.25 interface to the PSPDN. The same applies for the other X.25 layer 3 packets.

The delay performance parameters and the throughput parameters are expressed in average and 95% values. The average value is the expected value of the distribution of the values. The 95% value is the value which is not exceeded by 95% of the values.

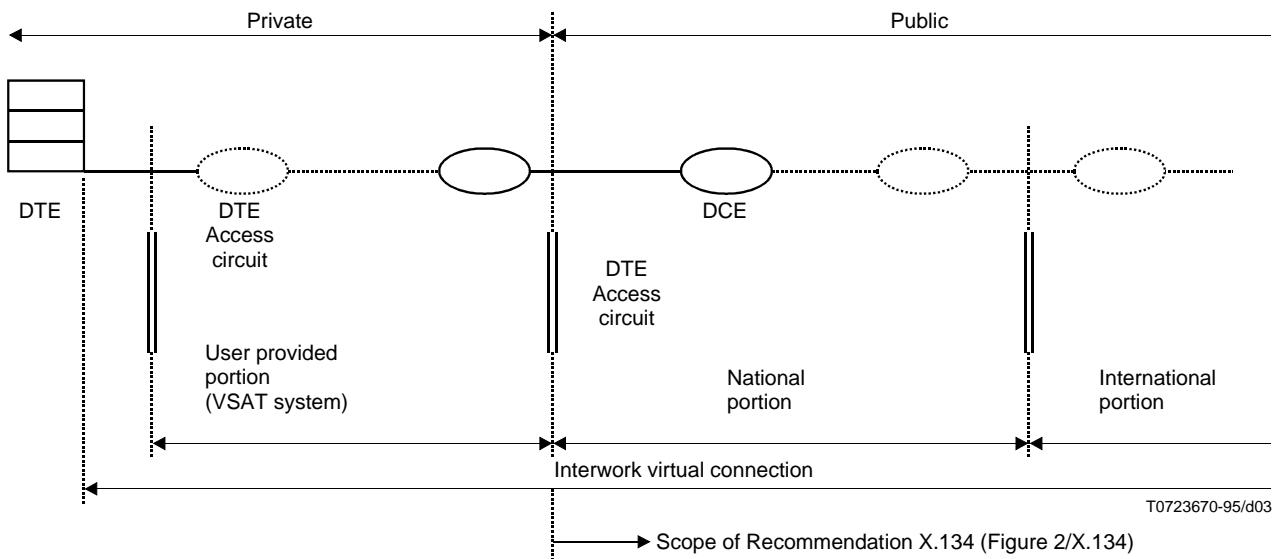


FIGURE A.1/X.361
Identification of the boundaries of the user provided portion of the connection

A.2.3 System load

The requirements of performance are defined for VSAT networks submitted to their nominal traffic load. This load is a characteristic of the VSAT network:

- 1) The throughput of established traffic. This shall be expressed in the number of packets per second and their size.
- 2) Call processing load. This shall be expressed as the number of call attempts and clear attempts handled by the system per unit of time (second, hour).

NOTE – The definition of this parameter is under study by the Telecommunication Standardization Study Groups.

A.2.4 System operational conditions

The performance requirements are defined for VSAT networks submitted to their nominal operational conditions, in particular nominal BER.

A.3 Delay performance

The VSAT network should meet the overall delay requirements given by A.3.1 through A.3.3.

The verification of the compliance with these requirements should take place under the following overall conditions:

- i) The VSAT is to be loaded with its nominal traffic load as specified in A.2.3.
- ii) The VSAT network DTE to PSPDN-interface is connected to a test-DCE via a standard X.25 line interface as used for customer service. The responding X.25 port of the remote VSAT under test is a DCE port. This DCE port will be connected to a test-DTE. The test-DCE and test-DTE could, for example, be protocol analysers.
- iii) The X.25 interface(s) shall be unloaded, i.e. all switched virtual circuits shall be in state p1 (ready), and, should permanent virtual circuits be defined, they may not be allowed to produce any kind of traffic on the interface.

- iv) The interface characteristics shall be as follows:
 - frame layer window size of 7;
 - default packet layer window size of 2;
 - default maximum data packet size of 128 octets;
 - all data packets shall be full, i.e. 128 bytes of user data;
 - D bit shall be set to 0.
- v) The test shall be performed in a configuration where the transmission delay of the DTE access circuit section, within the VSAT network, is at its maximum.

NOTE 1 – The delay performances have been determined for VSAT networks using the slotted Aloha technique with a typical load of 15%, and with mean repetition delays of 2 s for the first repetition, and 8 s for the following repetitions.

NOTE 2 – For VSAT networks using other techniques these delay performances are under study.

A.3.1 Call set-up delay

A.3.1.1 Specification

The call set-up delay applicable to this guideline should be as defined in Recommendation X.135.

The packet layer reference events applicable for the user provided section of the connection, as defined in A.2.1, are listed in Table A.1.

The objectives are based on the following assumptions:

- a) nominal traffic load is as defined in A.2.3;
- b) basic call not requiring any of the user selectable facilities defined in Recommendation X.25. The user data field is not used;
- c) the operation of the link layer does not meet either the busy condition (RNR) or the windows closed condition.

TABLE A.1/X.361

Packet layer reference events used to measure the call set-up delay

X.134 packet layer reference event Connection portion boundary	Packet Event Initial	Packet event final
Remote VSAT X.25 I/F Calling remote VSAT	2 (X.25)	3 (X.25)
Remote VSAT X.25 I/F Called remote VSAT	1 (X.25)	4 (X.25)
PSPDN-VSAT X.25 I/F Calling VSAT DTE	2 (X.25)	3 (X.25)
PSPDN-VSAT X.25 I/F Called VSAT DTE	1 (X.25)	4 (X.25)

The call set-up time in the user provided portion of the connection is the difference between the call set-up time at the boundaries that limit this portion of the connection. The call set-up times across the user provided portion of a connection shall not exceed the limits given in Table A.2.

TABLE A.2/X.361

Call set-up time required limits

Statistic	User provided portion
Average (ms)	2500 + X
95% (ms)	3500 + X

The value of X is given by $X = 400/R_1$ (ms) whose R_1 , expressed in kbit/s, is the data transmission bit rate of the access circuit between DTE (B) and DCE (C) in Figures 1 and 2.

A.3.1.2 Verification

Part 1: Verification of call set-up delay from a test-DCE connected to a specific VSAT. (The test-DCE simulates the Data Circuit terminating Equipment of the PSPDN.)

The following steps are carried out:

- The test-DCE transmits a Call Request packet on a free logical channel. Except for the necessary addressing facilities to address the specific VSAT, there should be no inclusion of any user facilities in the Call Request packet.
- The test-DCE waits for the corresponding Call Connected packet to arrive.
- The time between the start of the Call Request packet to the end of reception of the Call Connected packet is measured as the total call set-up time T_{cc-cr} .

If any unexpected packet layer protocol event or any unexpected link layer protocol event is received during a measurement, a new measurement is attempted.

The X.135 parameter call set-up delay is estimated from this value by eliminating irrelevant delays on the access line(s) and delays in test equipment using the following expression:

$$T_{cc-cr} - ([L_{cr} + L_{cc}] * 8/R_2) - d_p \text{ (ms)}$$

where:

- T_{cc-cr} is the total call set-up time in ms as per above;
 L_{cr} is the length of the Call Request packet in octets;
 L_{cc} is the length of the Call Connected packet in octets;
 R_2 is the data transmission bit rate, in kbit/s, of the access circuit between DTE (F) and DCE (G) in Figures 1 and 2;
 d_p is the processing delay(s) in the test-DCE and/or -DTE in ms.

In order to estimate the average value and the 95% value, with a sufficient degree of confidence, the measurement shall be repeated at least 1000 times.

Part 2: Verification of call set-up delay from a VSAT connected to a test-DCE.

Call Requests are generated by a test-DTE which is connected to the VSAT by means of a VSAT-DCE. The test procedure shall be as defined in verification, Part 1, except that it is now the test-DTE initiating the call set-up packets and the test-DCE that is the responding part.

In order to estimate the average value and the 95% value, with a sufficient degree of confidence, the measurement shall be repeated at least 1000 times.

A.3.2 Data packet transfer delay

A.3.2.1 Specification

The data packet transfer delay applicable to this guideline is defined as the time elapsed from the moment that a data packet causes a packet layer reference event in one of the boundaries of the user provided portion of the connection until the moment that the same data packet causes another packet layer reference event in the other boundary of the user provided portion of the connection.

The packet layer reference events applicable are defined in Table A.3.

TABLE A.3/X.361
**Packet layer reference events used to measure
the data packet transfer delay**

X.134 packet layer reference event	Packet event initial/final
Connection portion boundary	
Remote VSAT X.25 I/F/ PSPDN-VSAT X.25 I/F	10 a (X.25)
PSPDN-VSAT X.25 I/F/ Remote VSAT X.25 I/F	9 a (X.25)

The data packet transfer delay in the user provided portion of the connection shall not exceed the limits given in Table A.4.

All these values are based on the following assumptions:

- 1) nominal traffic load in the busy hour as specified in A.2.3;
- 2) user data field length of 128 octets;
- 3) link and packet layer windows in the DTE side open.

TABLE A.4/X.361
Data packet transfer delay required limits

Statistic	User provided portion
Average (ms)	1200 + Y for single hop
95% (ms)	2500 + Y for single hop

The value of Y is given by $Y = 1088/R_1$ (ms), where R_1 is the transmission bit rate, in kbit/s, of the PSPDN access circuit between DTE (B) and DCE (C) in Figures 1 and 2.

A.3.2.2 Verification of data packet transfer delay

The verification of the data transfer delay across the user provided portion of the connection may be performed in either one of the following two ways:

- 1) *Measuring the round trip delay of an echoed packet*

This method is applicable to systems in which data paths in both directions have the same statistical properties.

The following steps are carried out:

- the test-DCE makes a call to an echo function in the VSAT-application or in the test-DTE;
- one hundred data packets are transmitted from the test-DCE and the echoed packets are received while the transaction times T_{rtd} are measured.

Each measurement shall conform to the following:

- each data transfer period begins at the start of the transmission of the data packet and ends at the end of reception of the echoed packet, at the test-DCE interface;
- the entire period between the call set-up and end of the last transaction interval has no unexpected packet layer protocol events.

The X.135 parameter packet transfer delay is estimated by the following expression:

$$T_{rtd}/2 - L_p * 8/R_2 - d_p/2$$

where:

- T_{rtd} is the measured round trip delay in ms;
 L_p is the length of the test packet;
 R_2 is the data transmission bit rate, in kbit/s, of the access circuit between DTE (F) and DCE (G) of Figures 1 and 2;
 d_p is the processing delay(s) in the test-DCE and/or -DTE in ms.

The measurement is repeated a minimum of ten times.

2) *Measuring the time difference between generation and reception of the same packet*

This method involves measuring, in absolute terms, the time intervals between the instants of generation and arrival of the test packets.

This method is applicable to systems in which the data paths in either direction may not have the same statistical properties. In this case, measurements should be carried out in both directions.

The following procedures shall be followed:

- a test-DCE simulates the PSPDN;
- a remote VSAT interface is equipped with a test-DTE;
- there should be a method that permits the synchronization of the internal clocks of these two units.

A possible method may be the co-location of the remote VSAT and the simulated PSPDN interface, and then using two separate ports of the same protocol analyser to provide the test-DCE and test-DTE respectively.

Each measurement shall be carried out as follows:

- a call is established from the remote VSAT to the test-DCE;
- one hundred data packets should be transmitted in each direction;
- the generation time T_1 of each packet is recorded. This is the time of the transmission of the first bit following the closing flag of the data packet;
- the arrival time T_2 of each packet is recorded. This is the time of the reception of the first bit following the closing flag of the correctly received data packet;
- the difference $T_2 - T_1$ is the value of the data transfer delay for each data packet;
- the measurement is repeated a minimum of ten times.

A.3.3 Clear delay

A.3.3.1 Specification

The clear delay applicable to this Recommendation is defined as the time elapsed between the moment when a Clear Indication packet creates a packet layer reference event in a boundary of the user provided connection portion and the moment when the corresponding Clear Request or Clear Indication packet creates a packet layer reference event in the other boundary.

The packet layer reference events applicable are defined in Table A.5.

TABLE A.5/X.361
**Packet layer reference events used to measure
the Clear Indication delay**

X.134 packet layer reference event	Packet event initial/final
Connection portion boundary	
Remote VSAT X.25 I/F/ PSPDN-VSAT X.25 I/F	6 (X.25)
PSPDN-VSAT X.25 I/F/ Remote VSAT X.25 I/F	5 (X.25)

The Clear Indication delay in the user provided portion of the connection shall not exceed the limits given in Table A.6. Those limits are based on the following assumptions:

- 1) nominal traffic load as specified in A.2.3;
- 2) link and packet layer windows in the DTE side are open;
- 3) extended format of the Clear Request packet is not used.

TABLE A.6/X.361
Clear delay required limits

Statistic	User provided portion
Average (ms)	1200 + Z
95% (ms)	2500 + Z

The value of Z is given by $Z = 80/R_1$ (ms) where R_1 is the transmission bit rate, in kbit/s, at the access circuit between DTE (B) and DCE (C) of Figures 1 and 2.

A.3.3.2 Verification

The verification of the Clear delay across the user provided portion of the connection involves the measurement of the time of occurrence of the packet layer reference events 5 and 6 at two different interfaces. The fact that there may be internal reaction from the VSAT network following a Clear Request does not allow a measuring approach based on bouncing the events as defined for the verification procedures for Call Set-up and Data Packet transfer delay.

Therefore, the following direct measurement procedure shall be followed:

- a test-DCE shall simulate the PSPDN;
- a remote VSAT Interface shall be equipped with a test-DTE;
- there shall be a method that will allow the synchronization of the internal calendar clocks of these two units.

A possible method may be the co-location of the remote VSAT and the simulated PSPDN interface, and then using two separate ports of the same protocol analyser.

The measurements shall be carried out as follows:

- A call shall be established from the remote VSAT to the DCE simulating the PSPDN. A minimum of ten data packets shall be transferred in each direction.
- A Clear is initiated at the remote VSAT test-DTE. The instant T_1 is the time when the first bit following the closing flag of the Clear Request packet is sent. The instant T_2 is the time when the first bit after the closing flag of the successfully received Clear Request packet is detected.
- The difference $T_2 - T_1$ is the value of the Clear Delay.

In order to estimate the average value and the 95% value, with a sufficient degree of confidence, the measurement shall be repeated at least 1000 times.

A.4 Throughput performance

A.4.1 Specification

Throughput handled by a portion of a virtual connection is the number of user data bits correctly transferred in one way in a unit of time.

The packet layer reference events applicable to the calculation of the throughput shall be those defined in Recommendation X.135.

The throughput offered by the user provided portion of the connection in the most unfavourable conditions shall not be less than the limits given in Table A.7.

These limits are based on the following assumptions (see Recommendation X.135):

- 1) Nominal traffic load as defined in A.2.3.
- 2) Transmission bit rate of 9600 bit/s in the boundary circuit section between DTE (B) and DCE (C) of Figures 1 and 2.
- 3) Length of user data field: 128 octets. The requested throughput class shall be 9600 bit/s.
- 4) Packet layer window size equal to two. Link layer window size equal to seven in both boundaries.
- 5) Bit D is set to 0 (no end-to-end acknowledgement).
- 6) The values shall apply to both ways of the communication.
- 7) Full availability of the connection (in the sense defined in Recommendation X.137) during the observation period.
- 8) During the observation period no re-initializations, nor premature disconnections take place (as defined in Recommendation X.136).
- 9) The sizes of the samples of throughput capacity are 200 packets, or the amount transferred in two minutes (following either the first or second measurement technique of those defined in Recommendation X.135).

TABLE A.7/X.361

Throughput capacity required limits

Statistic	User provided portion
Average (bit/s)	2400
95% (bit/s)	2000

A.4.2 Verification of throughput performance

The transmitted throughput is defined as the average rate of user data across the calling X.25 interface to the called X.25 interface, expressed in bit/s.

The received throughput is defined as the average rate of user data across the calling X.25 interface from the called X.25 interface, expressed in bit/s.

To make a single measurement of transmitted throughput from the VSAT network, a test-DCE makes a call and generates data as defined in the specification to a drop function in the VSAT, either in the internal VSAT application or in the external test-DTE. This function is able to accept the data without causing any limitation in the throughput.

To make a single measurement of received throughput from the VSAT network, the test-DCE makes a call to a generator function in the VSAT, either in the internal VSAT application or in the external test-DTE. This generator function shall be able to generate data as defined above.

Each measurement shall conform to the following:

- the measured interval is between 55 and 65 seconds;
- the measured interval begins not less than ten seconds after the start of transmission, or successful receipt of the first data packet of data of the call;
- the entire period between the call set-up and end of the measurement interval has no premature Clear or Reset.

The transmitted throughput is calculated as the number of data packets sent during the measurement interval, multiplied by 1024 bits per packet and divided by the measurement interval length in seconds.

The received throughput is calculated as the number of data packets received during the measurement interval, multiplied by 1024 bits per packet and divided by the measurement interval length in seconds.

The measurement is repeated a minimum of ten times for each of the directions (transmitted and received throughput).

A.5 Accuracy and dependability performance

VSAT networks should aim to meet the accuracy and dependability requirements defined in Recommendation X.136 for the national type B portion of the connection.

A.6 Availability performance

VSAT networks should aim to meet the availability requirements defined in Recommendation X.137 for the national type B portion of the connection.

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