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STANDARDIZATION SECTOR
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SERIES X: DATA NETWORKS AND OPEN SYSTEM COMMUNICATION

Public data networks – Network aspects

Address translation registration and resolution protocol

ITU-T Recommendation X.116

(Previously CCITT Recommendation)

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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.116 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.

CONTENTS

SUMMARY

This Recommendation defines a protocol for the exchange of alternative address related information between a DTE and an address resolution entity as defined in Recommendation X.115. This Recommendation complements Recommendation X.115 which defines the address translation capability in public data networks. The protocol defined in this Recommendation enables DTEs to register alternative addresses (e.g. addresses in formats other than X.121 or E.164). The ARE stores the registered information along with the addresses where DTEs are reachable and provides this information when queried by a DTE or a switching system to enable call establishment.

Recommendation X.116

ADDRESS TRANSLATION REGISTRATION AND RESOLUTION PROTOCOL

(Geneva, 1996)

1 Introduction

This Recommendation defines a protocol for the exchange of alternative address related information between a DTE and an Address Resolution Entity.

This Recommendation is applicable to:

a) DTEs which operate according to ISO/IEC 8208;

b) Address Resolution Entities which operate according to ISO/IEC 8208.

This Recommendation does not specify any protocol elements nor algorithms for facilitating routeing and relaying among AREs. Such functions are intentionally outside the scope of this Recommendation.

2 Reference Model Definitions

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.

2.1 Identical Recommendations | International Standards

– ITU-T Recommendation X.200 (1994) | ISO/IEC 7498-1:1994, *Information technology – Open Systems Interconnection – Basic Reference Model: the Basic Model.*

– ITU-T Recommendation X.213 (1995) | ISO/IEC 8348:1996, *Information technology – Open Systems Interconnection – Network service definition.*

– ITU-T Recommendation X.263 (1995) | ISO/IEC TR 9577:1996, *Information technology – Protocol Identification in the Network Layer*.

2.2 Additional references

– 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.*

– ISO/IEC 8208:1995, *Information technology – Data Communications – X.25 Packet Layer Protocol for Data Terminal Equipment.*

3 Definitions

3.1 Reference Model definitions

This Recommendation makes use of the following terms defined in Recommendation X.200 | ISO/IEC 7498-1:

a) Network Layer;

b) Network Service Access Point;

c) Network Service Access Point Address;

d) Network Point of Attachment;

e) Network Protocol Data Unit;

f) Routeing;

g) Subnetwork.

3.2 X.25 Definition

– Alternative Address.

3.3 Additional definitions

For the purposes of this Recommendation, the following definitions apply.

3.3.1 alternative address related information: Information about the alternative address of DTEs attached to a subnetwork defined in terms of the system types, Network Addresses present, Network Entity Titles present, and the correspondence between systems, X.121 or E.164 addresses and potential routes.

3.3.2 redirection information: Information supplied when a Call Request fails to achieve establishment of a connection, indicating an X.121 or E.164 address which could be used to establish such a connection.

3.3.3 address resolution entity: Supplier of information concerning address translation within a single network.

4 Abbreviations

For the purposes of this Recommendation, the following abbreviations apply.

4.1 Systems

ARE Address Resolution Entity

DTE Data Terminal Equipment

4.2 Protocol data units

ECQ-PDU DTE Configuration Query Protocol Data Unit

ENC-PDU DTE Notification Complete Protocol Data Unit

ESC-PDU DTE Connect Protocol Data Unit

ESH-PDU DTE Hello Protocol Data Unit

RD-PDU Redirect Protocol Data Unit

SCC-PDU ARE Configuration Complete Protocol Data Unit

SCR-PDU ARE Configuration Response Protocol Data Unit

SNC-PDU ARE Notification Complete Protocol Data Unit

SRN-PDU ARE Received Notification Protocol Data Unit

4.3 Miscellaneous

AA Alternative Address

BCD Binary Coded Decimal

NPA Network Point of Attachment (i.e. X.121 address or E.164 address)

PDU Protocol Data Unit

QOS Quality of Service

SNAcF Subnetwork Access Function

SNAcP Subnetwork Access Protocol

NPA defined in this Recommendation is referred to as SNPA in ITU-T Rec. X.213 | ISO/IEC 8348.

5 Address Translation Service Model

The network layer in the DTE and in the address translation service may be modeled as consisting of three sub-layers (see Figure 1):

- *ARE service sub-layer*: The modeling of this sub-layer permits the definition of a peer-peer ARE service function communication in support of the address translation service defined in Recommendation X.115.

- *Subnetwork-dependent mapping sub-layer*: This sub-layer operates over the Subnetwork Access Protocol (SNAcP) and is used to provide the capabilities assumed by the ARE service sub-layer. It permits to decouple the peer-peer communication between ARE service functions from the detailed operation of particular SNAcPs. The realization of this sub-layer may consist simply of a set of rules for manipulating the network access protocol and may not involve explicit exchange of PCI (Protocol Control Information). The modeling of this sub-layer provides for application of the peer-peer ARE service function communication over other subnetworking technologies. For example over a Frame Relay network, a new set of mapping rules need to be defined while peer-peer ARE service function communication remains unchanged.

- *Subnetwork Access Protocol (SNAcP):* The access protocol in this Recommendation is X.25 protocol, however, the access protocol could be a different protocol (e.g. Frame Relay). Annex A defines the mapping applicable to Recommendation X.25.

The above subdivision of the network layer into sub-layers is for modeling purposes and should not be interpreted as implying a particular implementation.

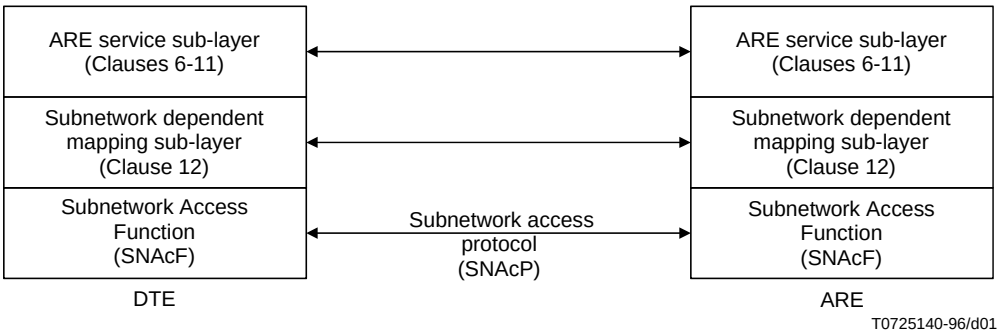
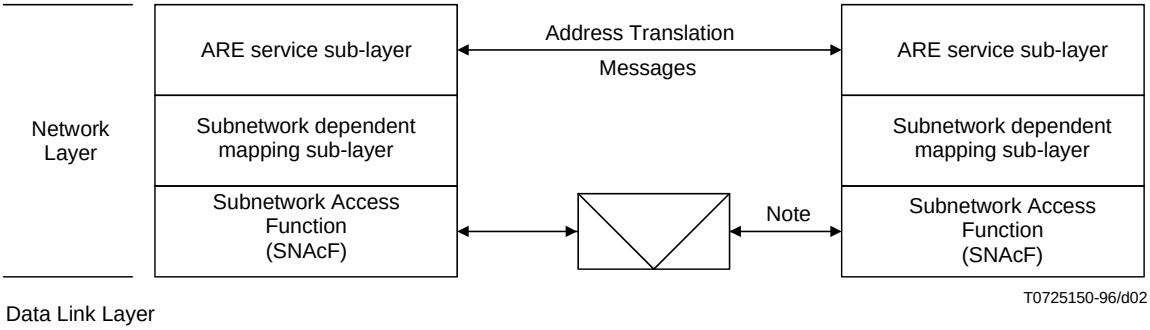


FIGURE 1/X.116

Subdivision of network layer into sub-layers

The ARE function can be realized in a single entity or can be distributed among several logical entities. As illustrated in Figure 2, the model applies irrespective of the location of the entity(ies) providing the address translation service (in a DCE, inside the network, in a DTE outside the network).



NOTE – Internal Protocol in case the ARE is inside the network or SNAcP in case the ARE is outside the network.

FIGURE 2/X.116

Realization of Address Translation service functionality

6 Overview of the protocol

The protocol specified in this Recommendation comprises two subsets:

a) the Alternative Address (related) Information subset;

b) the Redirection Information subset.

The functions of the Alternative Address Information subset are:

a) to enable DTEs to notify an ARE of the existence and reachability of their Alternative Addresses (AAs);

b) to enable DTEs to discover, for certain AAs, the addresses of systems on the network via which communications may potentially be completed.

The function of the Redirection Information subset is to enable DTEs which are attempting to establish a connection to be directed to a specific appropriate address via which the connection should be completed.

The two subsets are complementary in that the information obtained from the Redirection Information subset implicitly carries associated Alternative Address related Information, and in that the information obtained from the Alternative Address Information subset may be used to derive a suitable address and so avoid the need for use of the Redirection Information subset. The choice of which subset to use to obtain Alternative Address related Information for any individual instance of communication is a local DTE decision, which may be different for different instances of communication and may be varied freely during the DTE operation without impacting the ability to interwork.

6.1 The ARE function

An ARE is an entity which collects Alternative Address related information from DTEs, and which distributes Alternative Address related and redirection information to them.

NOTE – An ARE may also interact with Switching Systems but the details of such interactions are outside the scope of this Recommendation.

The function of an ARE may be carried out by one or more DTEs or SSs attached to the network. Where the network is one which itself acts on the X.25 protocol, it is also possible that some or all of the ARE operations may be performed by functions integrated within the network itself.

In order for a DTE to use this protocol, it requires knowledge of at least one address which can be used to access an ARE.

6.2 Overview of Alternative Address Information

The protocol exchanges which constitute the Alternative Address Information subset begin with the DTE establishing an X.25 connection to an ARE by issuing an X.25 Call Request. The first octet of the call user data contains a protocol identifier indicating the protocol defined in this Recommendation. When the ARE accepts the call, the DTE may then transmit to the ARE details of its Alternative Addresses. Once the information concerning all of its Alternative Addresses is transmitted, the DTE explicitly notifies the ARE that the notification is complete so that the ARE can ensure that all the information received is secure to the extent required for its use. The DTE may also request information about other Alternative Addresses from the ARE. For each requested Alternative Address the ARE supplies details of the NPA or NPAs on the network via which the Alternative Address(es) can be reached, and may also indicate optionally associated potential Quality of Service[1)]. Having received information about one Alternative Address, the DTE can request information about another. When it has all the information it requires, the DTE clears the call. The network may limit the number of queries about alternative addresses a DTE may request per unit of time. However, the limit on the number of queries is outside the scope of this Recommendation.

6.3 Overview of redirection information

The redirection information functions can be considered as two parts.

The first part takes place when a DTE is about to establish a connection according to ISO/IEC 8208, but does not have the information necessary to determine the appropriate address to which the Call Request should be transmitted. The action of the DTE in this case is simply to use the address of an ARE. The Call Request packet is constructed exactly in accordance with ISO/IEC 8208 and is transmitted to the ARE.

The DTE subsequently continues to operate the connection in accordance with ISO/IEC 8208. In the event that the ARE is a DTE attached to the network, rather than having functionality integrated within the network itself, it may:

- use the X.25 Call Deflection facility to deflect the call to an appropriate DTE or an SS;
- clear the call, supplying information about the appropriate NPA address which should be used for future attempts; or

if the ARE function is integrated within the network itself, then in addition to the above, it may be able to deliver the call to an appropriate NPA by other means (for example, by invoking the X.25 Call Redirection facility).

Since, therefore, the connection establishment may now be going to proceed satisfactorily without the originating DTE doing any further routeing operations, the DTE continues to process the connection in accordance with ISO/IEC 8208 unless a Clear Indication is received.

Receipt of a Clear Indication, in response to a Call Request, causes the second part of the redirection information procedure to take place. At this point, provided the cause and diagnostic codes in the clear indication packet show that the disconnection was not initiated by the user, the DTE checks whether there is user data in the packet containing information encoded according to this Recommendation indicating an appropriate network address via which a connection equivalent to that being rejected could be established. An equivalent connection is one between the same end points with optionally the same Quality of Service parameters. The DTE may use this information either to retry the connection establishment, according to the provisions of ISO/IEC 8208, or in establishing future equivalent connections.

7 The ARE address

The use of this protocol requires a DTE to be aware of at least an address at which an ARE can be reached. Local methods may be provided for determining such an address.

In the event that a DTE is aware of more than one address at which an ARE can be reached, the choice between them is a local matter.

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1) Quality of Service is for further study.

8 DTE Alternative Address Information subset

8.1 Protocol parameters

This clause defines parameters used in this protocol and, where applicable, specifies which values of these parameters are required to be supported by all conforming DTEs.

NOTE – Futher study is needed with respect to the issue raised above (i.e. values of parameters required to be supported by all conforming DTEs).

The ability to support values other than those specifically required, and the means of identifying that such a value is to be used in any particular instance, are local matters.

8.1.1 Response time

This is the time limit used by a DTE during operation of the protocol.

Any implementation of the Alternative Address Information subset shall be capable of supporting a response time value of 180 s, accurate to within ± 30 s.

8.1.2 Notification Retry Time

This is the time interval at which a DTE shall retry a failed attempt to convey its Alternative Address Information to an ARE.

Any implementation of the Alternative Address Information subset shall be capable of supporting a Notification Retry Time value of 900 s, accurate to within ± 120 s, if it supports any values of the Notification Required parameter other than that which indicates that notification is never required and that which indicates that no specific value is being suggested.

NOTE – There are no requirements on the support of Notification Retry Time by an implementation which does not support such values of the Notification Required parameter.

8.1.3 Notification Required

This parameter indicates the circumstances in which a DTE shall attempt to notify its Alternative Address(es) to an ARE.

Any implementation of the Alternative Address Information subset shall be capable of supporting a value of this parameter which indicates that notification is never required.

NOTE – Examples of other Notification Required parameter values which might optionally be supported include:

- A value indicating that notification is required each time the DTE is initialized and subsequently at the expiry of the time specified by the ARE at the end of each preceding notification.
- A value indicating that notification is required each time the DTE is attached to a different network.

It is emphasized that these are only examples – other values are permitted.

8.2 Protocol operation

This subclause specifies the protocol making use of the X.25 Packet Layer Procedures specified in ISO/IEC 8208. Subject to the provisions of ISO/IEC 8208, the choice of values for X.25 fields which are not specified in this subclause is a local matter.

8.2.1 Connection establishment

A DTE shall attempt to establish a connection whenever either of the following conditions is satisfied:

a) it needs to obtain Alternative Address related information from an ARE; or

b) the conditions specified in 8.1.3 make it necessary to notify Alternative Address information to an ARE,

provided that the DTE does not have a connection to an ARE already established or being established for use for Alternative Address Information.

A DTE shall not attempt to establish more than one connection to ARE from any one DTE-NPA at any one time.

A DTE shall attempt to establish a connection to the ARE by originating a virtual call in accordance with the procedures for virtual call set-up specified in ISO/IEC 8208. The address to which the Call Request shall be transmitted shall be one applicable to the ARE, as described in clause 7. The Fast Select facility shall be specified, indicating no restriction on response. The User Data to be transmitted with the Call Request packet shall contain an ESC-PDU.

If the virtual call set-up procedure succeeds, the DTE shall examine the User Data received with the Call Connected packet.

If this contains a valid SNC-PDU, then the DTE shall proceed to perform data transfer as specified in 8.2.3. Otherwise the DTE shall clear the call according to the procedures for virtual call clearing specified in ISO/IEC 8208 using a cause code of 0 and a diagnostic code of 242, and shall then act according to the procedure for failed connection establishment in 8.2.2.

If the virtual call set-up procedure fails, the DTE may retry it provided that the failure was due to a cause which, if it occurred in an attempt to establish a connection, would have been interpreted according to ISO/IEC 8208 as "connection rejection – transient condition". However, attempts to retry shall not continue for longer than the value of the Response Time parameter. When it has finished retrying, the DTE shall proceed as specified in 8.2.2.

8.2.2 Connection establishment failure procedure

When an attempt to establish a connection fails, if the DTE has knowledge of any alternative ARE address, it shall attempt to establish a connection to one which it has not previously tried in this establishment attempt.

When all known ARE addresses have been tried unsuccessfully:

a) If according to the provisions of 8.1.3 the DTE was due to notify its Alternative Address related information to an ARE, the attempt at notification shall be considered to have failed. Another attempt shall be made after the expiry of the Notification Retry Time.

b) If the DTE needed to obtain Alternative Address Information from the ARE, the time at which a further attempt is made (if any) or the invocation of other forms of action (e.g. fallback to default configuration, or use of Redirection subset as a basis for routeing) is a local matter.

8.2.3 Data transfer procedure

This subclause specifies the transfer of data once an acceptable connection to an ARE has been achieved.

This subclause requires transmission of a number of packets. Each packet shall be transmitted as a single M-bit sequence without the Q-bit set, according to the procedures for data transfer specified in ISO/IEC 8208.

This subclause also requires, in some circumstances, that the connection be abandoned before completion. This shall be done by clearing the call according to the procedures for virtual call clearing specified in ISO/IEC 8208, using a cause code of 0 and a diagnostic code of 242.

In the event that the virtual call is cleared (whether by the DTE itself abandoning the connection according to the provisions of this Recommendation, or as a consequence of the operation of ISO/IEC 8208 procedures) before the normal completion of the data transfer procedure specified in this subclause, the DTE shall follow the procedure for failed connection specified in 8.2.4.

In the event that a Reset Indication, an Interrupt packet, or Q-bit data is received at any time during the operation of the data transfer procedure, the DTE shall abandon the connection.

The data transfer procedure consists of 2 parts – Alternative Address notification and Alternative Address information collection. When the configuration notification procedure is applicable, it shall be carried out immediately following completion of connection establishment. When the Alternative Address information collection procedure is applicable, it shall be carried out after completion of the Alternative Address information notification procedure (or immediately if the Alternative Address notification procedure is not applicable). After completion of all applicable parts, the DTE shall follow the procedure for normal completion as specified in 8.3.

8.2.3.1 Alternative Address Notification

The Alternative Address Notification procedure is an optional procedure and, when implemented, its operation is controlled by the setting of the Notification Required parameter.

This procedure is applicable when (and only when) the following conditions are satisfied:

a) the Notification Required parameter is set to a value which indicates that the DTE should notify its Alternative Address(es) to the ARE at this time;

b) an attempt to notify Alternative Address(es) has not failed within the duration specified by the Notification Retry Time parameter.

The DTE shall start the procedure by transmitting one ESH-PDU for each Alternative Address reachable through its NPA. Following the ESH-PDUs it shall transmit an ENC-PDU. It shall then wait to receive an SRN-PDU. If the received SRN-PDU contains the Notification Required parameter, then the DTE shall extract and use this value as the next time interval prior to notification to the ARE. On receipt of the SRN-PDU, the Alternative Address Notification procedure is successfully completed.

NOTE 1 – After such successful completion, the value of the Notification Required parameter determines if and when this procedure will subsequently again be applicable.

After the transmission of the first ESH-PDU, if the SRN-PDU has not been received within a time equal to the Response Time parameter, the connection shall be abandoned.

NOTE 2 – The expiry of this time may be a result either of delays in transmitting the PDUs (e.g. because of flow control), or delay in response by the ARE.

If any data is received by the DTE before transmission of the ENC-PDU, or if any data is received which does not contain a valid SRN-PDU, the connection shall be abandoned.

8.2.3.2 Alternative Address Collection

The Alternative Address Collection procedure is an optional procedure and, when implemented, its operation is applicable whenever the DTE requires to obtain information from an ARE about the NPAs of systems which may be used to reach remote Alternative Addresses. This Recommendation does not impose any constraints on how often a DTE attempts to collect translated address information. However, networks may limit the number of queries about alternative addresses a DTE may request per unit of time.

The DTE shall transmit an ECQ-PDU specifying the Alternative Address for which it requires information. In response, it may receive a number of SCR-PDUs, containing information about NPAs through which the specific Alternative Address may be reached. The SCR-PDU may include an Address Mask parameter. This parameter may be used as described in 10.1.

The receipt of an SCC-PDU indicates that the information is complete; if no SCR-PDUs are received before the SCC-PDU, this indicates that no information is available for the specified Alternative Address. If the DTE requires information about further Alternative Addresses, it may then repeat the process provided that the Query Limit field in the SCC-PDU specifies that another query is allowed. If the Query Limit field specifies that no more queries are allowed, the DTE shall not transmit any more ECQ-PDUs. When the DTE has information for all the Alternative Addresses it requires, or the Query Limit disallows further queries, the alternative address collection function is successfully complete.

If a time greater than the Response Time parameter elapses after transmission of an ECQ-PDU and before receipt of the corresponding SCR or SCC-PDU, the connection shall be abandoned.

The following shall also cause the connection to be abandoned:

a) receipt of any data which does not contain a valid SCR or SCC-PDU;

b) receipt of any PDU before transmission of the first ECQ-PDU, or between receipt of an SCC-PDU and transmission of the next ECQ-PDU;

c) receipt of a PDU relating to an Alternative Address other than that for which the DTE has transmitted an ECQ-PDU on the connection and not received an SCC-PDU.

8.2.4 Failed Connection procedure

When a connection fails:

a) If the Alternative Address Notification procedure is applicable, then it shall be considered that the notification attempt has failed. (Consequently it will again be applicable when the time indicated by the Notification Retry Time parameter has expired.)

b) Any Alternative Address Information received in SCR-PDUs for which no corresponding SCC-PDU has been received is incomplete.

NOTE – It is a local matter whether the DTE will make use of incomplete data or whether it will discard it. Whether and when to make another attempt to obtain the remainder of incomplete data, or information still required for other Alternative Address(es), is also a local matter.

8.3 Normal Completion procedure

When the applicable data transfer procedures have been successfully completed, if the Query Limit field contained in the SCC-PDU indicated that no more query requests are allowed, then the DTE shall clear the call according to the virtual call clearing procedure specified in ISO/IEC 8208, using cause code 0 and diagnostic code 241. If the Query Limit field does permit another request, then the DTE shall do either a) or b) below:

a) It may clear the call immediately, using cause code 0 and diagnostic code 241.

b) It may retain the call for a time and subsequently use it for further data transfer functions as specified in 8.2.3 when these functions again become applicable. The maximum time for which a call may be retained without such further data transfer taking place is half the value of the Request Time parameter received in the SNC-PDU. Once this time has elapsed, the DTE shall clear the call with a cause code 0 and a diagnostic code 241. The DTE is not required to retain calls for this maximum time period; instead it may, as a local choice, clear the call at any convenient earlier time, still using cause code 0 and diagnostic code 241. During the time that the call is retained, the DTE shall continue to operate according to the procedures specified in ISO/IEC 8208. If a Data, Reset, or Interrupt packet is received, it shall clear the call with cause code 0 and diagnostic code 242. In the event that this occurs, or in the event that a Clear Indication is received or the operation of ISO/IEC 8208 procedures results in the call being cleared, it is a local matter whether and when to attempt to establish another call according to the procedures specified in 8.2.1.

The choice between a) and b), and the length of time for which calls are retained if action b) is chosen, are purely local matters and the DTE may freely vary them according to internal conditions without impact on interworking.

8.4 Use of Alternative Address Information

This Recommendation does not impose any constraints on how much of the information collected by a DTE is retained or used. A DTE may discard collected information at any time, and make a new request to collect the information again if it is subsequently required.

A DTE may at any time use local knowledge or any other method of determining the NPA to be used in establishing any connection to any Alternative Address, regardless of whether it has collected Alternative Address Information which would be applicable.

The Alternative Address Information obtained by this protocol is valid only subject to the following restrictions:

a) Alternative Address Information indicating which NPA address to use for establishing a connection is not valid unless it was supplied in information for the relevant Alternative Address and may optionally apply to a QOS range which includes the minimum acceptable QOS for the required network connection.

b) Alternative Address Information is not valid if the time since it was received is greater than that specified in the Holding Time field of the SCR-PDU which conveyed it.

c) Alternative Address Information which has already been collected is no longer valid once the DTE has again successfully collected complete alternative address information for the same Alternative Address, regardless of whether the Holding Time specified when the first information was collected has yet elapsed.

9 DTE redirection information subset

9.1 Invoking Redirection

This clause defines the procedure which shall be followed by a DTE in order to use the Redirection Information subset to select the NPA to which a connection request is to be sent. It is a local decision whether to use this procedure for any particular instance of communication, or whether to use previously obtained Redirection or Alternative Address Information or some other method.

In order to invoke Redirection, the DTE shall proceed with the connection establishment procedure as specified in ISO/IEC 8208, but shall use as the address to which the call is sent an address of an ARE as defined in clause 7.

NOTE – For example, the address of the ARE would be placed in the Called Address Field of the packet.

The DTE shall continue to process the connection in accordance with ISO/IEC 8208.

9.2 Receiving Redirection Information

This subclause describes the procedure to be followed in order to receive Redirection Information.

9.2.1 Redirect Information procedure for Clear Indications

A DTE which implements the Redirection Information subset shall follow this procedure whenever an attempt to establish a connection fails because a Clear Indication packet is received.

NOTE – This procedure is not restricted to calls which were originally transmitted to ARE in accordance with 9.1. This is because even if the address for a call was selected by other means, it may in fact be the address of a system with ARE functionality, or the call may have been redirected to an ARE.

The cause and diagnostic codes shall be examined to determine the corresponding values of disconnect indication Originator and Reason parameters according to the criteria specified in ISO/IEC 8208.

If the Originator value indicates higher layer initiated clear, then the procedure is complete – no redirection information is available. The DTE shall continue to follow the procedures specified in ISO/IEC 8208 for dealing with clear indications.

If the Originator value does not indicate higher layer initiated clear, the User Data field of the Clear Indication packet shall be examined.

If it contains a RD-PDU, and if the Network Connection Establishment Delay has not been exceeded, then the call shall be retried using the NPA address in the RD-PDU, unless that is the same as the NPA which was used for the failed call.

If the Clear Indication packet contains an RD-PDU but the Network Connection Establishment Delay has been exceeded, then the information from the RD-PDU may be saved for use in establishing future connections with the same Network Address and QOS, unless the NPA is the same as that which was used for the failed call in which case the information shall be discarded.

If the Clear Indication packet does not contain an RD-PDU, then it is recommended that if the call was originally transmitted to an ARE according to 9.1, the clearing cause code should be analysed in terms of the categories defined in Recommendation X.96. If it is a category D-code, then preference should be given to using a different address for subsequent access to a ARE, if other ARE addresses are available.

It is recommended that when a call which was transmitted to an ARE fails to be established without Redirection Information being received, the existence of any information about other possible ARE addresses which may be able to supply Redirection Information should be taken into account in determining whether to retry the call in accordance with ISO/IEC 8208.

The RD-PDU may include an Address Mask parameter. This parameter may be used as described in 10.1.

9.2.2 Recommended processing of Call Connected packets

It is recommended that when a DTE which implements the Redirection Information subset receives a Call Connected packet which completes a virtual call set-up initiated by transmission of a Call Request packet to an ARE, it should check whether the Call Connected packet indicates that the call was deflected (where applicable) or redirected. If so, it

may then record the address to which the call was eventually established, and may use this information in establishing subsequent connections with the same Alternative Address and optionally the same QOS, to save having to refer to the ARE.

However, a DTE which implements this recommendation shall cease to use information obtained in this way when an attempt to use it results in failure to establish a connection, other than because of connection rejected by the remote user.

NOTE – A DTE which implements this procedure and uses the recorded address for a subsequent connection is not required to use it for all such connections, but may use it for some instances of communication and not others, on the basis of local decisions.

9.3 Use of Redirection Information

This Recommendation does not impose any constraints on how much of the Redirection Information obtained by a DTE is retained or used. A DTE may discard received information at any time, and invoke redirection again for subsequent connections.

A DTE may at any time use local knowledge or any other method of determining the address to be used in establishing any connection to any Alternative Address, regardless of whether it has received Redirection Information which would be applicable.

The Redirection Information obtained by this protocol is valid only subject to the following restrictions:

a) Redirection Information indicating which address to use for establishing a connection is not valid unless it was supplied in information for the relevant Alternative Address and optionally applies to a QOS range which includes the minimum acceptable QOS for the required network connection.

b) Redirection Information is not valid if the time since it was received is greater than that specified in the Holding Time field of the RD-PDU which conveyed it.

c) An item of Redirection Information is no longer valid if an attempt to establish a connection using it fails other than through rejection by the remote user.

10 Address Masks

This clause describes a method of conveying additional information in SCR and RD-PDUs. The information is conveyed by means of the PDU field “Address Mask” whose significance is described below.

An ARE may optionally include in any SCR or RD-PDU an Address Mask field. A DTE receiving one of these PDUs containing this field shall either ignore this field, or shall process it according to the following subsection.

10.1 Address Mask

The Address Mask parameter indicates that the Forwarding Information applies to a larger population of Alternative Addresses than the original destination Alternative Address associated with the received SCR or RD-PDU. A DTE may choose to ignore this parameter.

NOTE – This is particularly true for alternative address(es) of the form NSAP Addresses and Internet Addresses.

The Address Mask establishes the equivalence class of Alternative Addresses to which the same Forwarding Information applies. In order to determine whether or not a potential destination Alternative Address falls within the equivalence class, an originating system aligns the potential destination Alternative Address with the Address Mask, padding the latter with trailing zero octets (binary 0000 0000) if necessary. If in all the bit positions where the Address Mask is “1” the trial destination Alternative Address matches the Alternative Address associated with the SCR or RD-PDU, then that trial destination Alternative Address belongs to the equivalence class described by the SCR or RD-PDU. In making routeing decisions, an exact Alternative Address match takes precedence over the use of equivalence classes. An exact match occurs when the trial Alternative Address is identical to the one associated with the SCR or RD-PDU, without considering any mask. If a destination Alternative Address is within more than one equivalence class, the choice of which to use, if any, is a local matter.

11 ARE procedures

The procedures to be followed in an ARE function which is integrated within an X.25 network are outside the scope of this Recommendation. This clause describes the procedures to be followed by a system attached to the X.25 network in order to perform an ARE function.

On receiving an Incoming Call packet, provided that it currently has resources available to accept the call, the ARE shall examine the first octet of the User Data field, and proceed as follows;

a) if there is no user data, or if the first octet has a value in the range 00000010 to 00111111, the ARE shall proceed as specified in 11.2;

b) if the first octet of user data has the value defined in 12.1.1, the ARE shall proceed as specified in 11.1;

c) for any other case, the action taken by the ARE is outside the scope of this Recommendation.

11.1 Processing of Alternative Address Information subset

11.1.1 Protocol parameters

This subclause defines parameters used in the protocol, and, where applicable, specifies which values of these parameters are required to be supported by all conforming systems. The ability to support values other than those specifically required, and the means of identifying that such a value is to be used in any particular instance, are local matters.

11.1.1.1 Request Time

This parameter indicates the time which the ARE will wait for requests from a DTE with which it has a connection established, or may indicate that it will wait an unlimited time.

Any ARE implementation shall be capable of supporting a request time value of 60 s, accurate to within ± 10 s.

11.1.2 Alternative Address Information procedure

If the User Data field of the Incoming Call does not contain a valid ESC-PDU, the ARE shall clear the call according to the procedures for virtual call clearing defined in ISO/IEC 8208, with a cause code of 0 and a diagnostic code 248.

If the call does not contain an unrestricted Fast Select facility, the ARE shall clear the call with a cause code of 0 and a diagnostic code 76.

If the ARE is temporarily unable to service configuration information, it shall clear the call with a cause code of 0 and a diagnostic code 244.

If the ARE is not willing to provide services to the calling ES, it shall clear the call with a cause code of 0 and a diagnostic 245.

Otherwise the ARE shall accept the call according to the procedure for call set-up specified in ISO/IEC 8208, transmitting a SNC-PDU in the User Data of the Call Connected packet. The Request Time field in the SNC-PDU shall be set to indicate the largest value which is permitted by the field encoding defined in 12.1.10 and which is not greater than the minimum time limit, if any, which the ARE will wait for requests from a DTE with which it has a connection established.

NOTE – The minimum time limit for which the ARE will wait for requests is determined by the value of the Request Time parameter making allowances for the degree of accuracy within which this parameter is implemented.

The ARE shall operate the virtual circuit according to the procedures for data transfer specified in ISO/IEC 8208. If it receives a Reset Indication, a Data packet with the Q-bit set, an Interrupt packet, or data which does not conform to the PDU formats specified in clause 12, it shall clear the call with a cause code of 0 and a diagnostic code 242.

If a time greater than the Request Time parameter elapses without receipt of an ESH or ECQ-PDU, the ARE shall clear the call with a cause code of 0 and diagnostic code 242.

On receiving ESH-PDUs, the ARE shall record the information from them.

NOTE 1 – The use made by the ARE of this information is outside the scope of this Recommendation.

NOTE 2 – Determination of routes on the basis of information obtained through the configuration notification function may, in some environments, introduce a security risk. It may be possible to mitigate such risk, as an administrative or local matter, by making use of features of the X.25 protocol which provide a degree of authentication, such as closed user groups.

After receipt of an ESH-PDU, if the ARE receives an ECQ-PDU before receiving an ENC-PDU, it shall clear the call with a cause code of 0 and a diagnostic code 243. It may but need not also do so if it receives more than one ESH-PDU specifying the same Alternative Address.

If a time greater than the Request Time parameter elapses after receipt of an ESH-PDU without receipt of an ENC-PDU or another ESH-PDU, the ARE shall clear the call with a cause code of 0 and a diagnostic code 242.

On receiving an ENC-PDU, the ARE shall ensure that all the information received from ESH-PDUs is secure to the extent required for its use, and shall then transmit an SRN-PDU in a single M-bit sequence according to the procedures specified in ISO/IEC 8208. The Notification Required parameter of the SRN-PDU shall be set to indicate the time for which it is suggested the DTE should wait, in the absence of a change in configuration or availability, before carrying out a further notification. If the ARE subsequently receives another ESH-PDU, it shall clear the call using a cause code of 0 and a diagnostic code 243.

If a time greater than Request Time elapses after transmission of an SRN-PDU without receipt of an ECQ-PDU, the ARE shall clear the call with a cause code of 0 and a diagnostic code 242.

On receiving an ECQ-PDU, if the ARE has information about NPAs on the subnetwork which may be used by the DTE to reach the specified Alternative Address, it shall transmit for each such NPA an SCR-PDU. When it has transmitted an SCR-PDU for each relevant NPA (or immediately if it has no information about any suitable NPAs), the ARE shall transmit an SCC-PDU. The Query Limit field of the SCC-PDU will be set by the ARE to indicate whether another query request is allowed.

After transmission of an SCC-PDU, if a time greater than Request Time elapses before receipt of another ECQ-PDU, the ARE shall clear the call with a cause code 0 and a diagnostic code 242.

If the ARE receives another ESC-PDU, or if it receives another ECQ-PDU before having transmitted the SCC arising from the previous one, or if it receives PDU other than those specified above, it shall clear the call using a cause code of 0 and a diagnostic code 243.

If the ARE receives another ECQ-PDU after having sent an SCC-PDU with the Query Limit field indicating no more query requests, it shall clear the call with a cause code of 0 and diagnostic code 242.

11.2 Processing of Redirection subset

The ARE shall determine the called Alternative Address identified by the Call Request packet, in accordance with ISO/IEC 8208. If this is the Address allocated to the ARE itself, the ARE shall deal with the network Connection in accordance with the procedures specified in ISO/IEC 8208.

If the Alternative Address is for another system to which the ARE is prepared to act as a Relay, it may do so.

If the Alternative Address is for another system, which can be reached by the originating DTE via another address on the same network with an acceptable Quality of Service, the ARE shall do one of the following:

a) If the Call Deflection facility is available for use on this call, the ARE may use it in accordance with the procedures defined in ISO/IEC 8208 to deflect the call to an appropriate address.

b) If the Call Deflection facility is not available, or if the ARE chooses not to use it, then it shall clear the call according to the procedures for virtual call clearing specified in ISO/IEC 8208, using cause code 0 and diagnostic code 230, and transmit an RD-PDU in the user data field of the Clear Request packet.

   However, if the Call Request packet did not have the Fast Select facility present, it shall clear the call without User Data, with cause 0 and diagnostic code 76.

If the ARE does not have information indicating an address via which the required network connection could be established, then it shall clear the call without User Data, with cause 0 and diagnostic code 232.

12 Structure and encoding of PDUs

The messages defined in clauses 6 through 11 are mapped as given in Annex A using the PDUs defined in this clause.

Annex A defines the mapping at various sub-layers, i.e. messages to PDUs, and PDUs to the corresponding SNAcP packets.

12.1 Parameters

PDUs shall contain at least the following parameters as ordered:

- the Protocol Identifier parameter;
- the Version Number parameter; and
- the PDU Type parameter.

All the other parameters listed appear in some PDUs only, as shown in 12.2.

12.1.1 Protocol Identifier

The value of this parameter shall be 1000 1010.

This parameter identifies this protocol.

12.1.2 Version Number

The value of this parameter is 0000 0010.

12.1.3 PDU Type

The PDU Type parameter identifies the type of the protocol data unit. Allowed values are given in Table 1.

All other PDU Type values are reserved.

TABLE 1/X.116

Valid PDU types

PDU types	Bits							
	8	7	6	5	4	3	2	1
ECQ-PDU	0	0	0	0	0	0	0	1
ENC-PDU	0	0	0	0	0	0	1	0
ESC- PDU	0	0	0	0	0	0	1	1
ESH- PDU	0	0	0	0	0	1	0	0
RD- PDU	0	0	0	0	1	0	0	0
SCC- PDU	0	0	0	0	1	0	0	1
SCR- PDU	0	0	0	0	1	0	1	0
SNC- PDU	0	0	0	0	1	0	1	1
SRN- PDU	0	0	0	0	1	1	0	0

12.1.4 Alternative Address

In an ESH-PDU this specifies a Alternative Address which is being notified as present and accessible in the ES. In an ECQ-PDU it specifies the Alternative Address for which information is to be collected. In SCR and SCC-PDUs it specifies the Alternative Address for which information is being supplied.

The Alternative Address parameter is encoded as shown in Figure 3.

The contents of this field shall be encoded using BCD encoding, character encoding, etc. per Table 5.3/X.25.

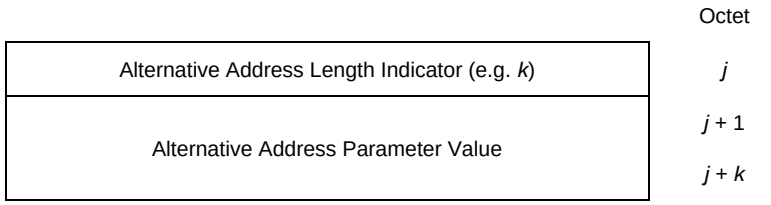

FIGURE 3/X.116

Alternative Address parameter

12.1.5 X.121 or E.164 Address

In SCR and RD-PDUs, this specifies an address which may be used to reach the required Alternative Address.

The Address parameter is encoded as shown in Figure 4.

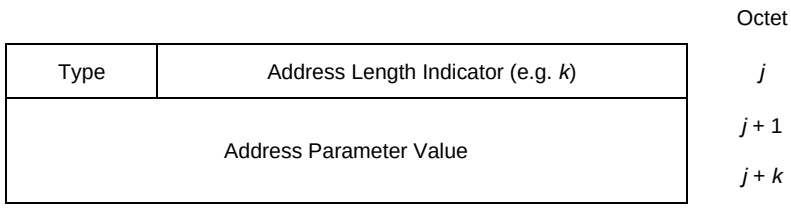

FIGURE 4/X.116

Address parameter

The Type field consists of 2 bits indicating the encoding format of the Address. It takes on the following values:

00 Encoding per this Recommendation

01 Reserved

10 Reserved

11 Local –For transitional use only

When the Type field is 00, the next 6 bits are the length of the Address Parameter Value. The following standard encodings are defined:

– When the address is carried in the access protocol as a sequence of semi-octets using BCD encoding, that sequence of semi-octets is encoded in the Address Parameter Value field, and if it is an odd number of semi-octets, a final semi-octet containing the value 1111 is added at the end.

12.1.6 QOS

In an SCR-PDU, this specifies the range of QOS over which the indicated NPA is applicable. In an ESH-PDU, this specifies the range of QOS that can be supported by the identified End System on the specified NPA.

Each QOS parameter is encoded as shown in Figure 5.

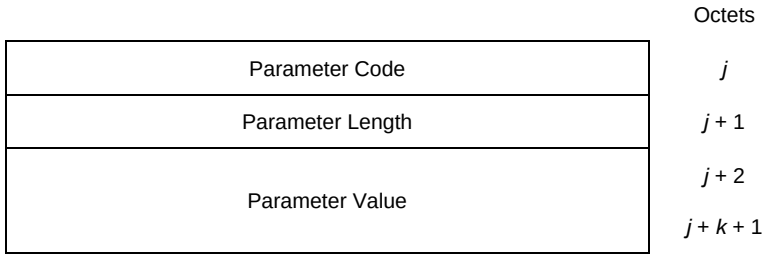

FIGURE 5/X.116

Encoding of QOS parameters

The *parameter code field* is coded in binary and, without extensions, provides a maximum of 255 different parameters. A parameter code of 255 (binary 1111 1111) is reserved for possible future extensions.

The *parameter length field* indicates the length, in octets, of the parameter value field. The length is indicated by a positive binary number, *k*, with a theoretical maximum value of 254. The practical maximum value of *k* is lower, and for each succeeding parameter the maximum value of *k* decreases.

The *parameter value field* contains the value of the parameter identified in the parameter code field.

The specific parameters given below are for further study in terms of their usage in the SCR and ESH-PDUs.

12.1.6.1 Throughput

When present, the Throughput QOS parameter indicates the range of throughput values applicable via the specified path.

Parameter Code: 0000 0001

Parameter Length: One (1) octet

Parameter Value: The four (4) most significant bits specify the maximum throughput according to the encoding specified in Table 18 of ISO/IEC 8208, and the four (4) least significant bits specify the minimum throughput according to the encoding specified in Table 18 of ISO/IEC 8208.

12.1.6.2 Transit Delay

When present, the Transit Delay QOS parameter indicates the maximum and minimum transit delay values to be expected via the specified path.

Parameter Code: 0000 0010

Parameter Length: Four (4) octets

Parameter Value: The first two (2) octets specify an integral number of seconds indicating the maximum transit delay to be expected, and the second two (2) octets specify an integral number of seconds indicating the minimum transit delay to be expected.

12.1.6.3 Priority

When present, the Priority QOS parameter indicates the maximum and minimum values for the priority of data on the connection, the priority to gain a connection, and the priority to keep a connection, respectively, to be expected via the specified path.

Parameter Code: 0000 0011

Parameter Length: Six (6) octets

Parameter Value: The first three (3) octets specify the maximum value for the priority of data on the connection, the priority to gain a connection, and priority to keep a connection, respectively. The following three (3) octets specify the minimum value for the priority of data on the connection, the priority to gain a connection, and the priority to keep a connection, respectively.

12.1.6.4 Protection

When present, the Protection QOS parameter indicates the maximum and minimum protection levels to be expected via the specified path.

Parameter Code: 0000 0100

Parameter Length: Variable

Parameter Value: Bits 8 and 7 of the first octet specify the protection format code where:

00 Reserved

01 Source-address specific

10 Destination-address specific

11 Globally unique

The remaining 6 bits are reserved and must be set to zero (0).

The second octet specifies the length *p*, in octets, of the maximum protection level to be expected. The actual value of the maximum protection level is placed in the following *p* octets.

The $p+2$ octet specifies the length *q*, in octets, of the minimum protection level to be expected. The actual value of the minimum protection level is placed in the following *q* octets.

12.1.7 Holding Time

In SCR and RD-PDUs, this is a two (2) octet parameter that specifies an integral number of seconds for which the conveyed information is valid. The binary value 0000 0000 0000 0000 indicates that there is no time limit imposed.

12.1.8 Address Mask

When present in SCR and RD-PDUs, this field contains an Address Mask for use as specified in 10.1.

The Address Mask parameter is encoded as follows:

Parameter Code: 1110 0001

Parameter Length: Variable, up to 20 octets

Parameter Value: A comparison mask of octets to be aligned with the Destination Address.

12.1.9 Query Limit

In SCC-PDUs, this field specifies whether the DTE is allowed to request Alternative Address Information about another Alternative Address, or whether no more requests are allowed for the existing connection.

The Query Limit parameter is encoded as a single octet where the binary value 0000 0000 indicates that no more queries are allowed, and the binary value 0000 0001 indicates that the DTE is allowed another query, if it wishes.

12.1.10 Request Time

In SNC-PDUs, this parameter indicates the time which the ARE will allow between requests from an ES. The binary value 0000 0000 indicates that no time limit is imposed.

The Request Time parameter is encoded as a single octet that specifies an integral number of seconds.

12.1.11 Notification Required

In SRN-PDUs, this parameter indicates the time interval that it is suggested the DTE should wait prior to notifying the ARE again.

The Notification Required parameter is a two (2) octet parameter that specifies an integral number of seconds as the time interval. The binary value 0000 0000 0000 0000 indicates that notification is not required. The binary value 1111 1111 1111 1111 indicates that no specific value is recommended.

12.1.12 Clear message

There is no PDU for a clear message as X.25 Clear Request packet is used for a clear message.

12.2 PDU Structure

All Protocol Data Units shall contain an integral number of octets. The octets in a PDU are numbered in increasing order starting from one (1). The bits in an octet are numbered from one (1) to eight (8), where bit one (1) is the low-order bit.

When consecutive octets are used to represent a binary number, the lower octet number has the most significant value.

NOTE – When the encoding of a PDU is represented using a diagram in this subclause, the following representation is used:

- octets are shown with the lowest numbered octet to the top, higher number octets being further to the bottom;
- within an octet, bits are shown with bit eight (8) to the left and bit one (1) to the right.

12.2.1 ECQ-PDU structure

The ECQ (DTE Configuration Query) PDU is formatted as shown in Figure 6.

	Octets
Network Layer Protocol Identifier	1
Version Number	2
PDU Type	3
Alternative Address Length Indicator	4
Alternative Address	5 *k*

FIGURE 6/X.116

ECQ-PDU structure

12.2.2 ENC (DTE Notification Complete) PDU structure

The ENC-PDU is formatted as shown in Figure 7.

	Octets
Protocol Identifier	1
Version Number	2
PDU Type	3

FIGURE 7/X.116

ENC-PDU structure

12.2.3 ESC (DTE Connect) PDU structure

The ESC-PDU is formatted as shown in Figure 8.

	Octets
Protocol Identifier	1
Version Number	2
PDU Type	3

FIGURE 8/X.116

ESC-PDU structure

12.2.4 ESH (DTE Hello) PDU structure

The ESH-PDU is formatted as shown in Figure 9.

	Octets
Protocol Identifier	1
Version Number	2
PDU Type	3
Alternative Address Length Indicator	4
Alternative Address	5 $k-1$
QOS (Further Study)	k $k+m$

FIGURE 9/X.116

ESH-PDU structure

12.2.5 RD-PDU structure

The RD (Redirect) PDU is formatted as shown in Figure 10.

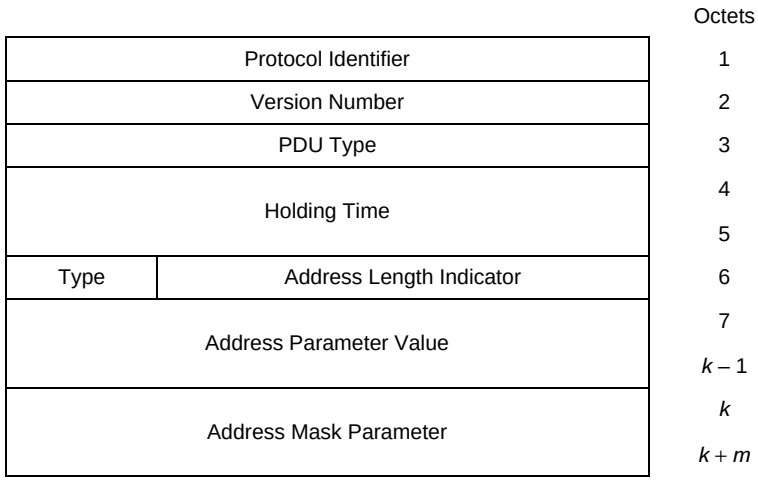

FIGURE 10/X.116

RD-PDU structure

12.2.6 SCC (ARE Configuration Complete) PDU structure

The SCC-PDU is formatted as shown in Figure 11.

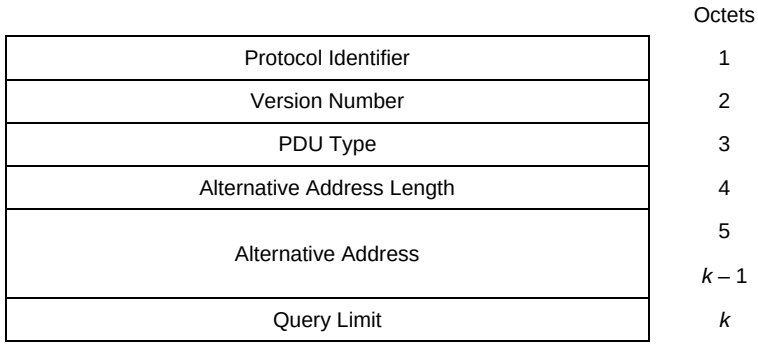

FIGURE 11/X.116

SCC-PDU structure

12.2.7 SCR (ARE Configuration Response) PDU structure

The SCR-PDU is formatted as shown in Figure 12.

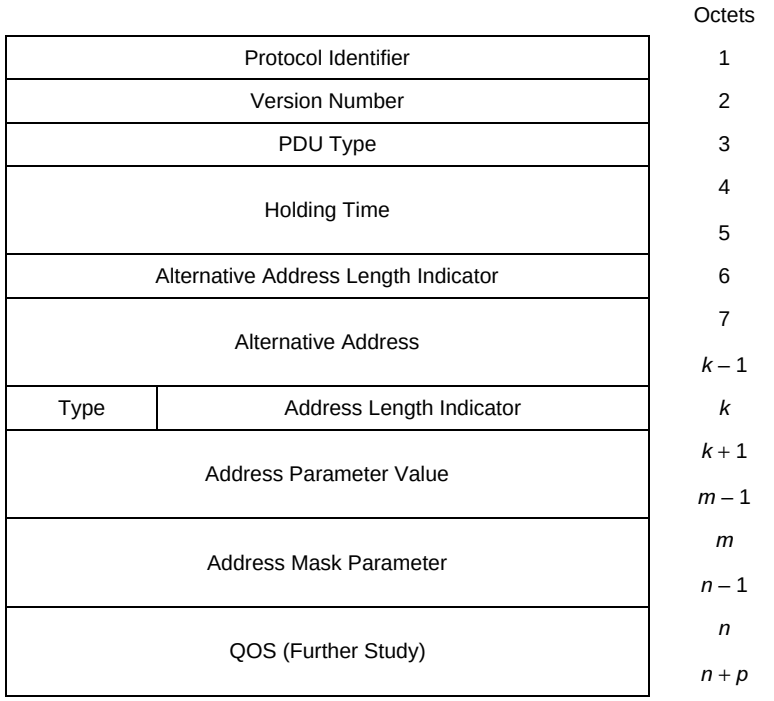

FIGURE 12/X.116

SCR-PDU structure

12.2.8 SNC-PDU structure

The SNC (ARE Notification) PDU is formatted as shown in Figure 13.

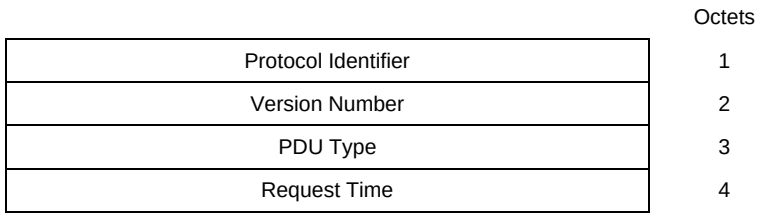

FIGURE 13/X.116

SNC-PDU structure

12.2.9 SRN-PDU structure

The SRN (ARE Received Notification) PDU is formatted as shown in Figure 14.

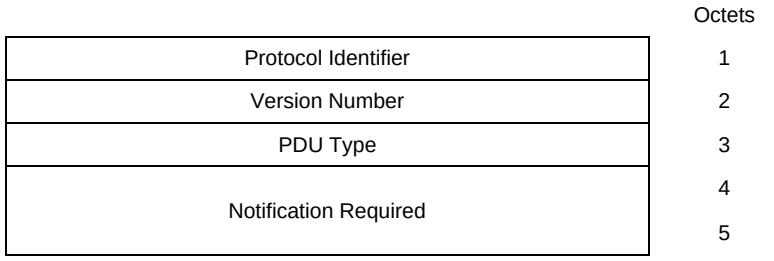

FIGURE 14/X.116

SRN-PDU structure

Annex A

Mapping X.116 messages to X.25 packets

ARE services sub-layer messages	Mapping sub-layer PDUs	X.25 packets
Establish Connection with the ARE	ESC	Call Request
Alternative Address Notification	ESH	Data Packet
Alternative Address Notification Complete	ENC	Data Packet
Alternative Address Collection	ECQ	Data Packet
ARE Received Notification	SRN	Data Packet
ARE Configuration Response	SCR	Data Packet
Connection Establishment Successful with the ARE	SNC	Call Connected
No more Queries from the ARE	SCC	Data Packet
Redirection Information	RD	Clear Indication
Clear	(12.1.12)	Clear Request

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