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DATA NETWORKS AND OPEN SYSTEM COMMUNICATIONS

PUBLIC DATA NETWORKS – NETWORK ASPECTS

DEFINITION OF ADDRESS TRANSLATION CAPABILITY IN PUBLIC DATA NETWORKS

ITU-T Recommendation X.115

(Previously “CCITT Recommendation”)

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.115 was prepared by ITU-T Study Group 7 (1993-1996) and was approved under the WTSC Resolution No. 1 procedure on the 10th of April 1995.

NOTE

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

ITU-T X-SERIES RECOMMENDATIONS

DATA NETWORKS AND OPEN SYSTEM COMMUNICATIONS

(February 1994)

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SUMMARY

This Recommendation provides definition of the address translation service, the service provided to its customers, the functions at the network interface and functions within the network when providing this service. The address translation service provides customers the ability to use addresses in formats other than X.121 or E.164 (e.g. user friends addresses like mnemonic addresses, etc.). The addresses can be any of the alternative addresses defined in Recommendation X.25. The network will translate the address in the *Call Request* packet to the desired address to complete the call.

INTRODUCTION

This Recommendation provides a definition of the address translation service, the services provided to its customers, the functions at the network interface and the functions within the network when providing the service.

Recommendation X.121 specifies the numbering plan for Public Data Networks (PDNs), Recommendation E.164 specifies the numbering plan for the Integrated Services Digital Network era. Recommendation X.122/E.166 defines the general procedures applicable to numbering plan interworking between ISDNs and PSPDNs; ISDNs and PSTNs; and PSPDNs and PSTNs. "A DTE on a PDN is identified by an international data number, which consists of the Data Network Identification Code (DNIC) of the PDN, followed by Network Terminal Number (NTN) of the called DTE/DCE interface, or the Data Country Code (DCC) followed by the National Number."

Recommendation X.25 allows the called DTE address to conform to the formats described in Recommendations X.121, Recommendation E.164 or an *alternative address.* Recommendation X.25 specifies a set of *Altenative Addressing* facilities that enables a calling DTE to use an alternative address to identity the called DTE when establishing a virtual call. An alternative address is defined as one that does not conform to the formats defined in Recommendations X.121 and X.301. The alternative addresses are for example, OSI NSAP address, MAC address, etc. In addition, Recommendation X.25 includes *Call Deflection and Call Redirection* facilities.

Recommendation X.35 presents different PSPDN/PSPvtDN interworking routing alternatives. Among the many alternatives that are discussed in X.35, the most relevant routing strategy is the case where routing is based on a non-X.121 PSPvtDN DTE Address. This is because the addresses assigned to DTEs on the PSPvDN need not be from the PSPDN numbering plan. The addresses assigned to DTEs in PSPvtDN can be an OSI NSAP address or from a PSPvtDN addressing plan. The PSPDN in this case may desire to offer a capability to route the call either on the PSPvtDN numbering plan or on the OSI NSAP address rather than requiring "two stage dialling".

This Recommendation defines the service that can be provided by PSPDNs to its customers (i.e. DTEs or PSPvtDNs), the requirements on DTEs when using this service and the functions that must be provided in PSPDNs to offer such a service.

This Recommendation does not specify the interface specifications or the protocol elements that would be used to provide the address translation service.

Recommendation X.115

DEFINITION OF ADDRESS TRANSLATION CAPABILITY IN PUBLIC DATA NETWORKS

(Geneva, 1995)

1 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.

- CCITT Recommendation E.164 (1991), *Numbering plan for the ISDN era*.
- CCITT Recommendation T.50 (1992), *International Reference Alphabet (IRA) – Information technology – 7-bit coded character set for information interchange*.
- ITU-T Recommendation X.25 (1993), *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*.
- CCITT Recommendation X. 121 (1992), *International numbering plan for public data networks*.
- CCITT Recommendation X.122/E.166 (1992), *Numbering plan interworking for the E.164 and X.121 numbering plans*.
- CCITT Recommendation X.213 (1992) ISO/IEC 8348:(1993), *Information technology – Open Systems Interconnection – Network service definition.*
- ITU-T Recommendation X.301 (1993), *Description of the general arrangements for call control within a subnetwork and between subnetworks for the provision of data transmission services*.
- ISO/IEC 646:1991, *Information technology – ISO 7-bit coded character set for information interchange.*
- ISO/IEC TR 9575:1990, *Information technology – Telecommunications and information exchange between systems – OSI Routing Framework*.
- ISO/IEC 10030:1990, Information technology – Telecommunications and information exchange between systems - End System Routing Information Exchange Protocol for use in conjunction with ISO 8878.
- ISO/IEC 10039:1991, *lnformation technology – Open Systems Interconnection – Local area networks – Medium Access Control (MAC) service definition.*
- ISO/IEC 10747:1994, *Information technology – Telecommunications and information exchange between systems – Protocol for exchange of inter-domain routing information among intermediate systems to support forwarding of ISO 8473 PDUs*.

2 Definitions

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

2.1 Address Translation Service: A service that enables the network to route calls to the proper X.121/E.164 address when the called address specified is not an X.121/E.164 address.

2.2 Administrative Domain: A collection of *End Systems, Intermediate Systems, and subnetworks* operated by a single organization or administrative authority.

2.3 Border Intermediate System: An *Intermediate System* that runs the protocol specified in ISO/IEC 10747, has at least one *inter-domain link* attached to it, and may optionally have intra-domain links attached to it.

2.4 **End System**: An abstraction of a real system which fulfills the requirements of an open system and includes the functions of the Network Layer and the layers above the Network Layer.

2.5 **Inter-domain Link:** A real (physical) or virtual (logical) link between *Border Intermediate Systems* in different *Administrative Domains.*

2.6 **Intermediate System**: An abstraction of a real system providing a network-relay function.

2.7 **Network Entity Title**: A name that is used to identify unambiguously a Network entity in an *End System or Intermediate System.*

2.8 **Network Service Access Point (NSAP); NSAP:** A point at which the OSI Network service is made available to a Network service user by the Network service provider.

2.9 **NSAP address:** The information that the OSI Network service provider needs to identify a particular *Network Service Access Point.*

2.10 **Real subnetwork**: A collection of equipment and physical media which forms an autonomous whole and which can be used to interconnect real systems for purposes of communication.

2.11 **Routing**: A function within a layer which translates the title of an entity or the service-access-point-address to which the entity is attached into a path by which the entity can be reached.

2.12 **Routing domain:** A set of *End Systems and Intermediate Systems* which operate according to the same routing procedures and which is wholly contained within a single *Administrative Domain.*

2.13 **Subnetwork:** An abstraction of a *real subnetwork.*

2.14 **Subnetwork address:** Refers to the point at which a real *End System, real subnetwork, or* interworking unit is attached to a *real subnetwork,* or to the point at which the subnetwork service is offered within an *End System or Intermediate System.*

3 Abbreviations

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

ARE	Address Resolution Entity
BIS	Border Intermediate System
DNIC	Data Network Identification Code
DCE	Data Circuit-terminating Equipment
DTE	Data Terminal Equipment
ES	End System
ESH	End System Hello
IDRP	Inter Domain Routing Protocol
IS	Intermediate System
ISDN	Integrated Service Digital Network
ISH	Intermediate System Hello
LAN	Local Area Network
MAC	Medium Access Control
NA	Network Address
NET	Network Entity Title
NLRI	Network Layer Reachability Information
NPDU	Network Protocol Data Unit
NSAP	Network Service Access Point
NTN	Network Terminal Number
OSI	Open Systems Interconnection

PDU	Protocol Data Unit
PSPDN	Packet Switched Public Data Network
PSPvtDN	Packet Switched Private Data Network
PDN	Public Data Network
PSTN	Public Switched Telephone Network
RD	Routing Domain
RDC	Routing Domain Confederation
RDI	Routing Domain ldentifier
SNPA	Subnetwork Point of Attachment

4 Address Translation Service

The Address Translation Service depicted in Figure 1 shows a DTE that wishes to communicate with another DTE using the alternative address in the call request packet[1)] which is resolved by an entity called the Address Resolution Entity (ARE) into an address that is consistent with the format specified in Recommendations X.121 or E.164.

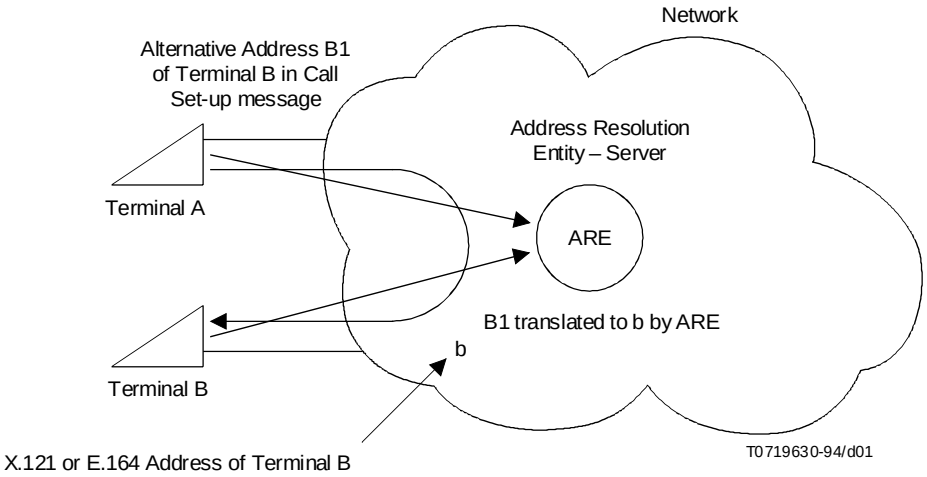


FIGURE 1/X.115

Address Translation Service

The address translation service depicted in Figure 1 shows the service as a single logical entity (that is, the address resolution entity). In practice, the address translation entity may be single or distributed, and may reside inside or outside of a network. The address resolution entity (or address resolution entities when distributed) may be on the same network as the DTEs accessing it or on different networks. Figures 2, 3 and 4 provide some implementation examples. These examples are not meant to be exhaustive and other implementations are possible.

1) The use of X.25 Call Request Packets, etc. is for illustrative purposes only. This Recommendation is equally applicable to other Public Data Network environments.

The address translation service may require an inter-networking capability to allow address resolution entities on separate networks to communicate with each other as depicted in Figure 4. The communication between various address resolution entities in different networks is provided in such a manner that the DTEs perceive the service as being provided by a single logical entity.

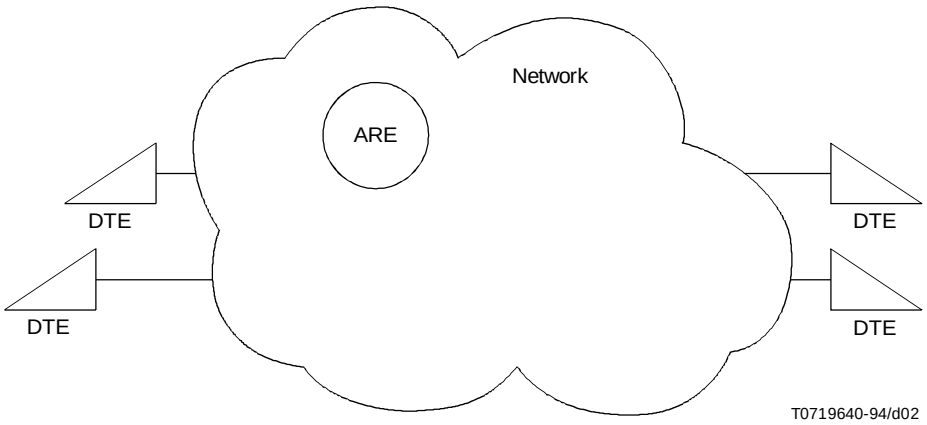


FIGURE 2/X.115

Address Translation Service
(address resolution entity within the network)

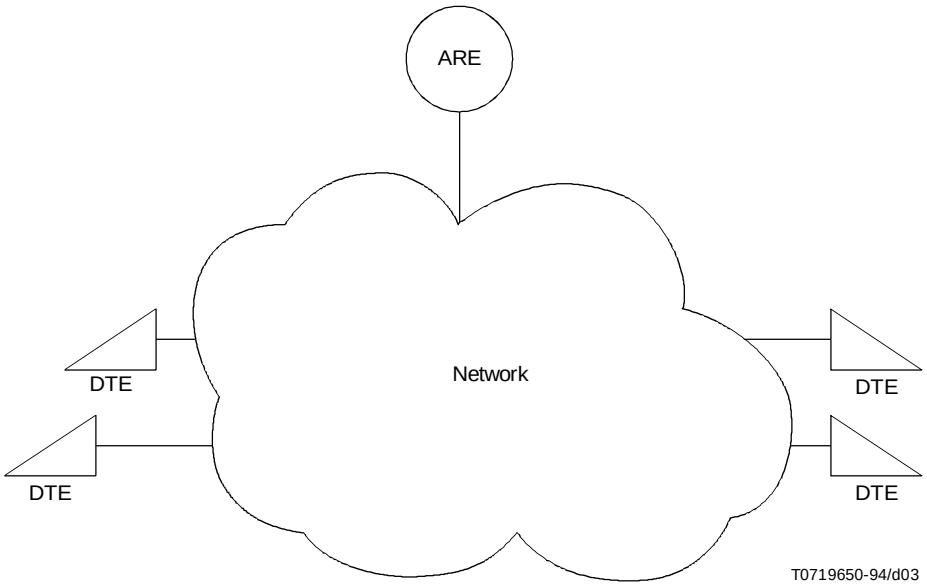


FIGURE 3/X.115

Address Translation Service
(address resolution entity outside the network)

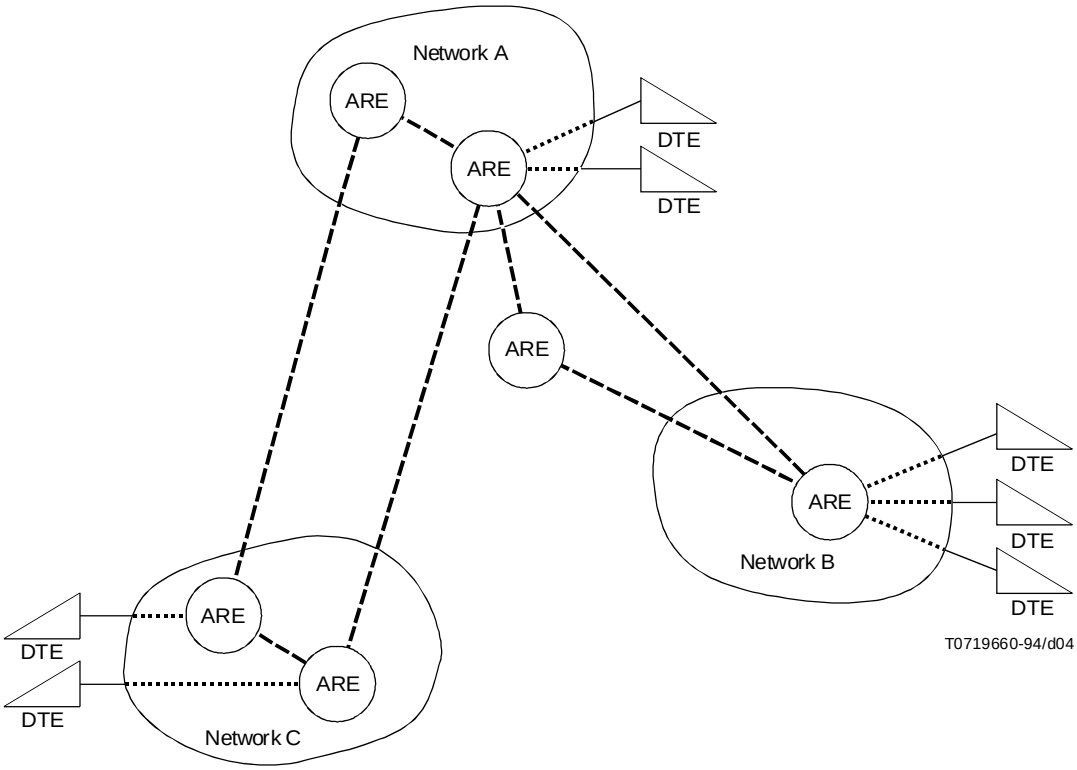


FIGURE 4/X.115

Examples of ARE implementations

5 Address Translation Service overview

The Address Translation Service provides a user with the capability to use different forms of addresses to identify a called DTE. The different address forms that a user may use to identify the called DTE are:

- OSI NSAP addresses coded per CCITT Rec. X.213 ISO/IEC 8348;
- MAC addresses coded per ISO/IEC 10039;
- lnternet addresses coded per Request for Comments (RFC) 1166; and
- Mnemonic addresses (i.e. Character Strings) coded per CCITT Rec. T.50 ISO/IEC 646.

The DCE on receipt of a call request packet containing an alternative address is required to translate the alternative address to the format defined in Recommendation X.121 or E.164 as the basis on which to route the call.

As shown in Figure 5, DTE A wishes to communicate with DTE B and uses the alternative address of DTE B in the call request packet. Upon determination that the called party address is not in the format specified in Recommendation X.121 or E.164. the address resolution entity is queried by the DCE to determine the exact address (e.g. X.121) that must be used to complete the call.

To support communication of DTE A and DTE B, the address translation service can be viewed as operating in four phases:

1) *Registration Procedures* – Translations of alternative addresses to X.121 or E.164 addresses are provided to the ARE.

2) *Query Procedures* – A DTE may query the ARE for address translations for later use.

3) *Information Dissemination Procedures* – AREs may optionally interact with one another for disseminating address translations; and

4) *Invocation Procedures* – DTE A uses the alternative address of DTE B in appropriate packets. This may result in the DCE making a query of the ARE for the translation of the alternative address.

Further detail on these phases is provided clause 6.

6 Operation of Address Translation Service

The operation of an address translation service requires information necessary for proper routing to flow into the address resolution entity. Once the service has collected the necessary information it can offer address translation to DTEs for all reachable addresses on the network. However, if the service is interested in offering translation for addresses reachable on different networks, the service may be required to disseminate the collected information to other service providers and, similarly, collect information from other service providers about reachable addresses on those networks. This is shown in Figure 5c).

Thus, depending on the service, it may or may not be required to disseminate collected information to address resolution entities that partake in providing address translation service.

The following subclauses deal with the aspects of information collection and dissemination.

The DTEs (wishing to make use of the address translation service) need to register all information necessary for the service (i.e. the address resolution entity). In addition, there are a number of other functions that should be available in networks. These functions within the network and the requirements on DTEs necessary to make address translation service operational are described below.

Appendix I provides a functional view of the address translation service.

Appendix II contains examples of applications which may be appropriate for address translation.

6.1 Functions within the networks

Networks wishing to offer address translation service should:

– offer means for DTEs to register the alternative addresses;

– offer X.25 alternative addressing usage subscription facility;

– provide the capability to translate the alternative address into an appropriate format (e.g. X.121) to route the virtual call properly; and

– optionally provide the capability to disseminate the collected information related to alternative addresses to where it is needed [e.g. share the collected alternative address related information with the other network service provider(s)] and, similarly, collect information from other service provider(s) vital for address translation.

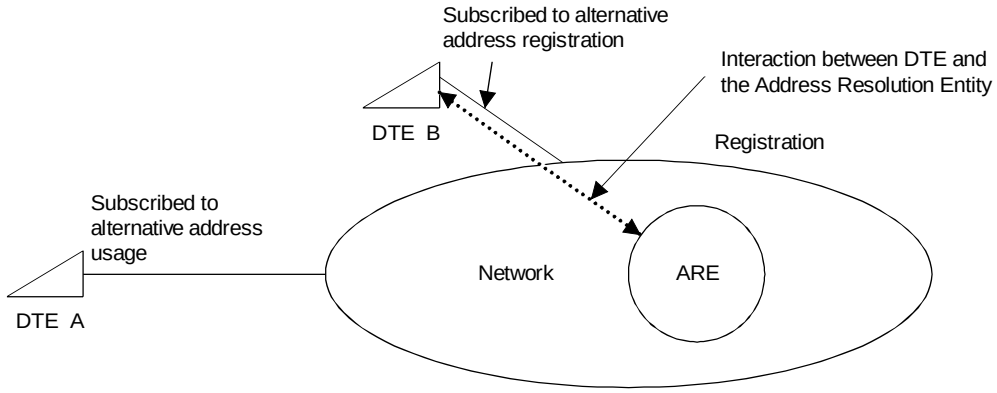
The information that needs to be collected by networks offering such a service may be:

– form(s) of alternative address;

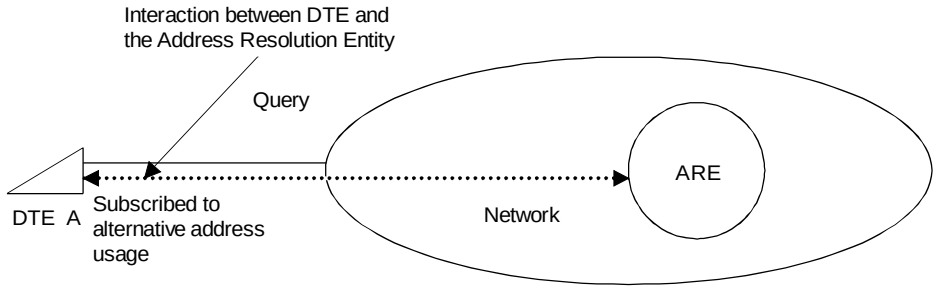
– alternative address/addresses applicable for the interface; and

– if the alternative address has a global significance.

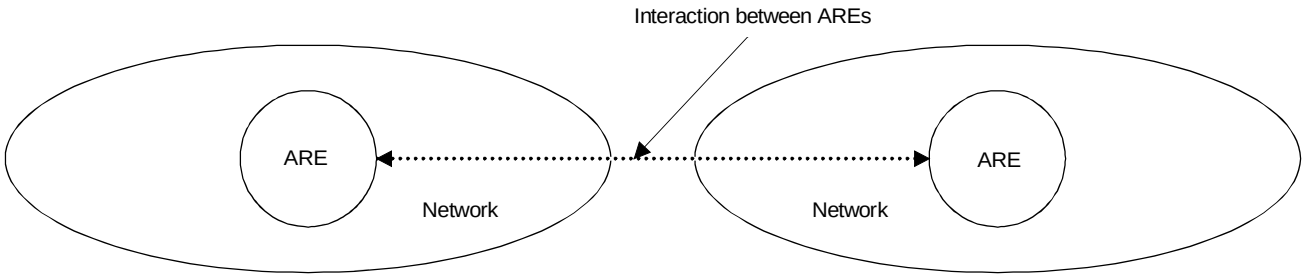
NOTE 1 – Some networks may offer a limited address translation service, e.g. support only the OSI NSAP address as the alternative address.



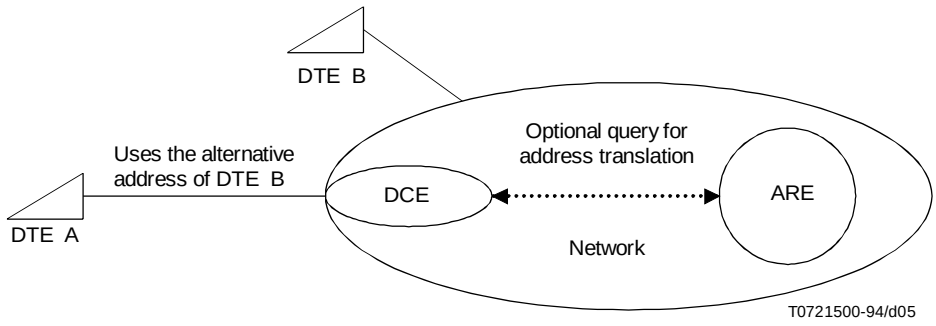
a) Alternative Address Registration Procedures



b) Query Procedures



c) Information Dissemination Procedures



d) Invocation Procedures

FIGURE 5/X.115

An example of the use of Address Translation Service

The Address Resolution Entity (independent of how it is realized) should be reachable at a predetermined address (well known to DTEs that wish to make use of address translation service) that can be used by all DTEs to register alternative address related information for address translation.

NOTE 2 – An Address Resolution Entity is a logical entity and can be physically realized by one or more systems inside or outside the network.

6.2 Requirements on DTEs

The DTEs wishing to make use of the address translation service should support the following:

- subscribe to pertinent alternative address related facilities:
  - alternative address usage subscription facility; and/or
  - alternative address registration related facilities;
- use of the address block to carry alternative address; and
- support of Address Extension facility.

6.3 Information collection during the registration phase

The different ways in which the information for address translation can be collected by the address resolution entity are:

- through system management;
- use of dynamic on-line protocols.

ISO/IEC 10030 is an example of dynamic on-line procedure for collection of information and is discussed in Appendix III.

6.4 Information dissemination

As indicated above, in order to route calls properly, there may be a need to share information collected (e.g. the reachability information) between various AREs that partake in providing address translation services, ISO/IEC 10747 is an example of a routing protocol that can be used for dissemination of reachability information between AREs that are interested in providing address translation service. ISO/IEC 10747 is discussed in Appendix IV.

7 Service capabilities

The following capabilities may be provided by address translation service:

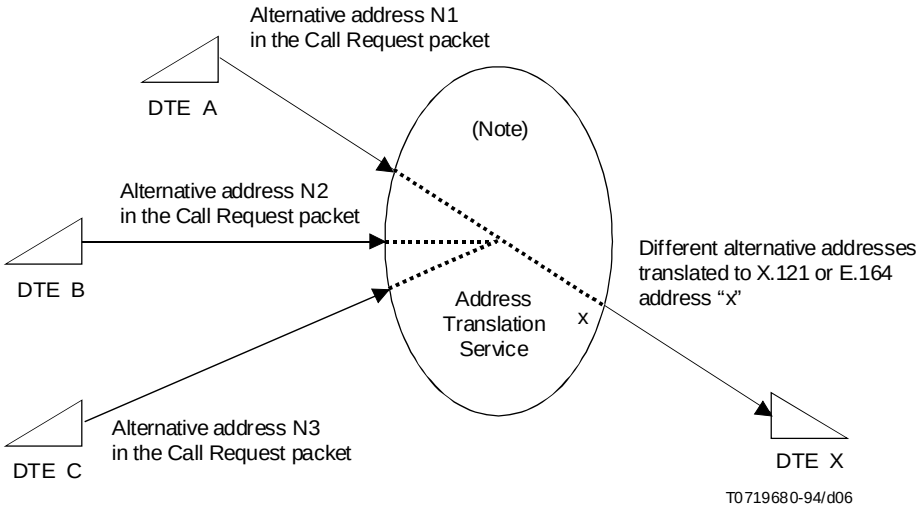
- the alternative address is of the form N-to-l (e.g. N alternative addresses map to one X.121 or E.164 address);
- the alternative address is of the form 1-to-N (e.g. one alternative address maps to N different X.121 or E.164 addresses);
- the alternative address has a global significance;
- dependent on time-of-day, etc. (as in the voice world);
- dependent on other parameters in the packet (e.g. Quality of Service).

The following subclauses provide information on the capabilities of address translation service.

7.1 N-to-1 translation

This capability in the address translation service provides the calls to be routed to a specific X.121 or E.164 address for “N” different alternative addresses. In this case “N” different alternative addresses map to a single X.121 or E.164 address.

An example of this is depicted in Figure 6.



NOTE – "N" alternative addresses are translated to a unique X.121 or E.164 address "x" to reach DTE X.

FIGURE 6/X.115

N-to-1 Address Translation

7.2 1-to-N translation

This capability in the address translation service provides the calls to be routed to N different X.121 or E.164 addresses for a single alternative address. In this case a single alternative address maps to "N" different X.121 or E.164 addresses in a manner similar to the operation of a Hunt Group.

An example of this is depicted in Figure 7.

7.3 Global significance for alternative address

As the name suggests, the alternative address has a global significance and is translated to a specific X.121 or E.164 address no matter where that alternative address is used at a given point in time (i.e. any DTE may use this alternative address) in a call request packet. It is conceivable to have a variation of this service by coupling it to Time-of-Day translation.

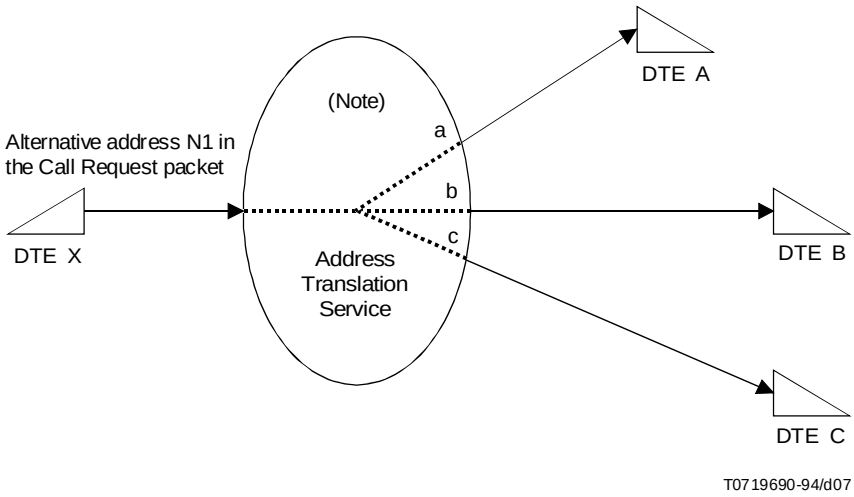
The use of this form of an alternative address is depicted in Figure 8.

NOTE – Global significance may be limited to a specific public data network or to all public data networks that participate in providing such a service and have administrative arrangements for registering alternative addresses.

7.4 Time-of-day translation

This capability in the Address Translation Service allows calls to be routed based on time of the day, e.g. calls made to an address N1 are routed to a specific X.121 or E.164 address between 9:00 and 17:00 hours and routed to a different X.121 or E.164 address at all other times in the day.

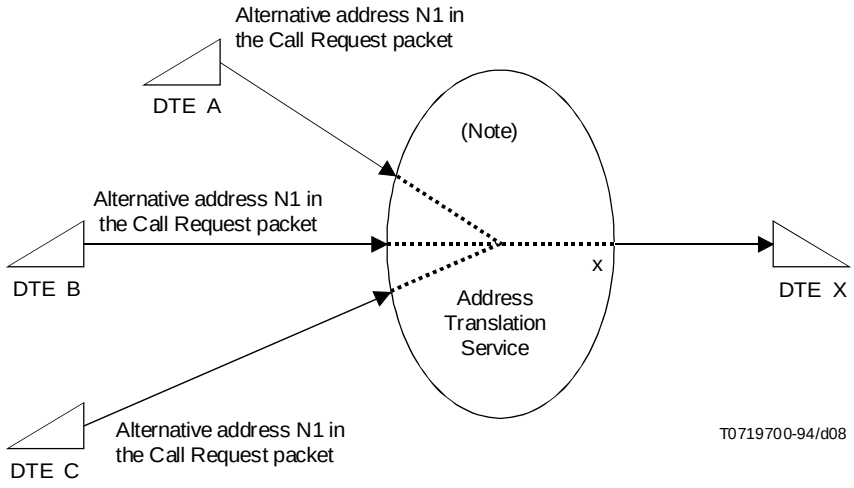
The use of this form of an alternative address is depicted in Figure 9.



NOTE – An alternative address "N1" is translated to one of a number of X.121 or E.164 address (e.g. a, b and c) to reach DTE A, B or C, respectively.

FIGURE 7/X.115

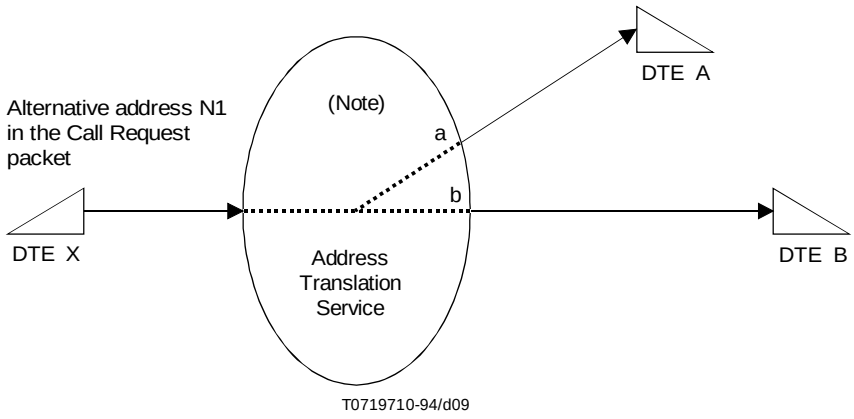
1-to-N Address Translation



NOTE – The alternative address "N1" is translated to a specific X.121 or E.164 address (i.e. x) to reach DTE X regardless of the interface used.

FIGURE 8/X.115

Alternative address with global significance



NOTE – Alternative address N1 translated to X.121 or E.164 address a between 9:00 and 17:00 hours. Alternative address N1 translated to X.121 or E.164 address b at other times during the day.

FIGURE 9/X.115

An example of Time-of-day translation which is of the form 1-to-N translation

Appendix I

Provision of Address Translation Service In PSPDN environments

(This appendix does not form an integral part of this Recommendation)

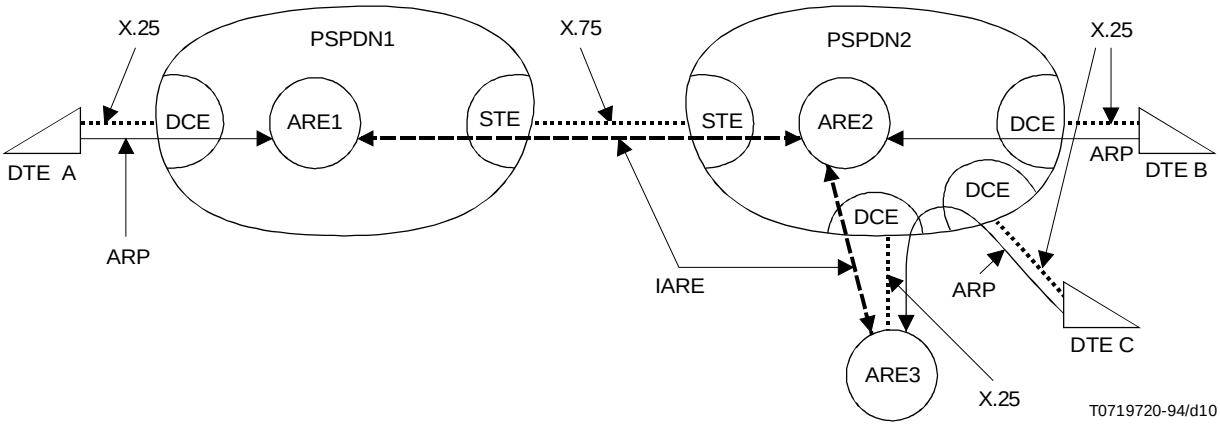
The Address Translation Service defined in this Recommendation is designed to work over a variety of technologies. This appendix provides a functional view of how this service could be provided in a PSPDN environment. The description here is not meant to imply a particular implementation but given to provide a description of the components necessary to provide the address translation service defined in this Recommendation.

Figure I.1 depicts the functional components of the Address Translation Service. For completeness and clarity, various components associated with (e.g., DTE A to DTE B) communications in a PSPDN environment are shown, These include the DTE themselves, the DCEs which they access, the STEs connecting PSPDN1 and PSPDN2, and the associated protocols (X.25 for PSPDN access, X.75 for PSPDN to PSPDN connection, etc.). In the case of address translation service, several additional components need to be considered.

In Figure I.1, two DTEs (DTE A and DTE B) are involved in a call. To support this service all AREs must cooperate in providing the service. In this case, ARE1 and ARE2 are “standatone” systems that are connected to other systems using some network-specific internal protocol. On the other hand, ARE3 is not provided by either of the PSPDNs but is necessary for communication with DTE C. As such, it is outside of the PSPDN and, therefore, is also a DTE.

Each DTE that wishes to make use of this service communicates directly with an ARE using the protocol for address registration. Several DTEs can register with an ARE.

To support the global address translation service, the AREs need to communicate among themselves. This is accomplished using an Inter-ARE ([ARE) protocol.



ARP Address Resolution and Registration Protocol
IARE Inter-address Resolution Entity Protocol

FIGURE I.1/X.115

Functional view of Address Translation Service

Appendix II

Mapping applications into Address Translation Service

(This appendix does not form an integral part of this Recommendation)

This appendix provides examples of applications which may be appropriate for address translation service. These examples are provided to show how some of the options described in this Recommendation can be used to satisfy specific application needs. The implementations described are given for example only.

An example of *1-to-N* address translation capability is illustrated in Figure II.1. The example shows a multi-homed host. Calls to this host use the alternative address "X" associated with it, which is translated by PSPDN1 into one of the N different X.121 addresses, including into an address on PSPDN2.

An example of *N-to-1* capability is illustrated in Figure II.2, where a LAN with multiple stations is connected to a PSPDN via a gateway. Calls destined to any of the stations on the LAN must be via the gateway which has the unique X.121 address of "x".

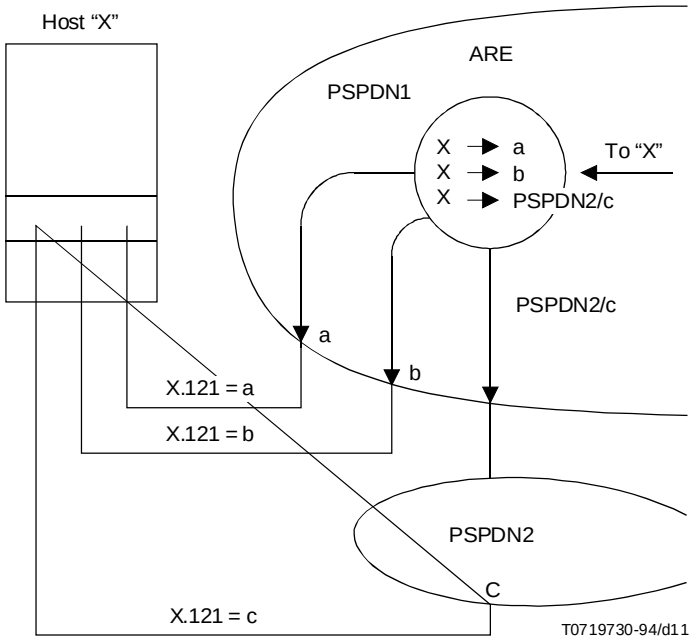


FIGURE II.1/X.115

Use of alternative addressing capability (1-to-N mapping) to provide multi-homing capability

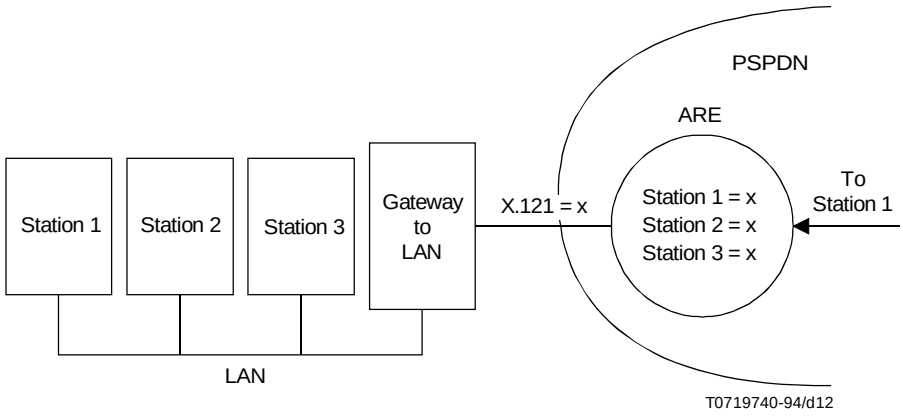


FIGURE II.2/X.115

Use of alternative addressing capability (N-to-1 mapping)

Appendix III

A Protocol for registration of alternative address related information

(This appendix does not form an integral part of this Recommendation)

As indicated in the main body of this Recommendation, ESs (DTEs) wishing to make use of address translation service will be required to furnish information to the address translation service so as to enable the calls to be routed properly. ISO/IEC has standardized a routing protocol (ISO/IEC 10030) that can be used for collection of addressing related information from DTEs.

ISO/IEC 10030 is routing protocol that enables End Systems (ESs) and intermediate Systems (ISs) to exchange configuration and routing information to facilitate the operation of the routing and relaying functions of the Network Layer. ISO/IEC 10030 addresses the aspects of Network Layer routing that are concerned with communication between ESs and ISs on the same subnetwork[2)]. The protocol defined in IS0/IEC 10030 relies upon the provision of connection-mode underlying service (i.e. X.25). ISO/IEC 10030 specifies:

- procedures for transmission of configuration and routing information between network entities residing in ESs and network entities in ISs;
- the encoding of the Protocol Data Units (PDUs) used for transmission of the configuration and routing information; and
- procedures for correct interpretation of protocol control information.

ISO/IEC 10030 does not specify any protocol elements or algorithms for facilitating routing and relaying among ISs.

ISO/IEC 10030 has a number of functions, however, only a subset of functions is necessary for address translation. This subset is:

- Configuration Notification by End Systems;
- Record Configuration by Intermediate Systems;
- Configuration Collection by End Systems; and
- End System Redirection Information.

Many of the protocol functions are timer based.

A subset of functions from ISO/IEC 10030 can be used between the Address Resolution Entity and DTEs for collection of information from the DTEs regarding alternative addresses (e.g. reachability information).

Appendix IV

Protocol for Dissemination of Information between Different AREs

ISO/IEC 10747, inter Domain Routing Protocol (IDRP), is a routing protocol used by Boundary Intermediate Systems (BISs) to acquire and maintain information for the purpose of routing Network Protocol Data Units (NPDUs) between different routing domains. ISO/IEC 10747 specifies:

- the procedures for exchange of inter-domain reachability and path information between BISs;
- the procedures for maintaining inter-domain routing information bases within a BIS; and
- the encoding of protocol data units used to distribute inter-domain routing information between BISs.

2) The ISO uses the term “subnetwork” instead of “network” to avoid the confusion with the Network Layer.

As indicated above IDRP is a general purpose routing protocol and discusses among others the following (that are particularly relevant for use in address translation service):

- routing policy;
- types of routing domains;
- advertisement and storage of routes; and
- routing information exchange.

With respect to the overall OSI architecture IDRP is located within the Network Layer and operates in conjunction with ISO 8473. In particular, IDRP Protocol Data Units (PDUs) are encapsulated as the data portion of ISO 8473 NPDUs for conveyance between BISs. A BIS that participates in IDRP exchanges routing information with its neighbouring BISs in the form of IDRP UPDATE PDUs. The IDRP routing information dissemination algorithm that controls the exchange of routing information between BISs is based on the technique of incremental updates, where after an initial exchange of complete routing information, a pair of BISs exchange only changes to that information.

IDRP also provides mechanisms to monitor the status of a BIS to BIS connection. Changes in the physical inter-domain connectivity result in changes of the IDRP connection between BISs. That enables support for dynamic routing, where routes adapt to changes in inter-domain topology.

ISO/IEC 10747 can be operated between Address Resolution Entities in different networks for dissemination of collected information (e.g. reachability information).