The ATM Forum

Technical Committee

ATM Bi-Level Addressing Document, Version 1.0

AF-RA-0164.000

April 2001

The ATM Forum
Worldwide Headquarters
1000 Executive Pkwy. #220
St. Louis, MO 63141
Tel: +1-314-205-0200
Fax: +1-314-576-7989

Preface

Acknowledgements:

The Routing and Addressing working group was chaired by Ethan Mickey Spiegel and recently by Ather J. Chaudhry. This work was started in the Interworking among ATM Networks Ad Hoc working group chaired by Bob Epley. Tom Shaver edited the *ATM Bi-Level Addressing Document*. The minutes at related working group meetings were recorded by a number of individuals, including Bob Epley and Tim Dwight. Finally, the editor thanks the working group chairs for Control Signaling (Gert Öster) and Directory and Name Services (Joann J. Ordille) who oversaw the process of bringing this specification to completion.

The following people made significant technical contributions to the *ATM Bi-Level Addressing Document*:

Tim Dwight

Bob Epley

Joel Halpern

Juha Heinanen

Gerhard Maegerl

Shawn McAllister

Joann Ordille

Thomas Shaver

Vinai Sirkay

Ethan Mickey Spiegel

Katie Taaffe

Albert Wan

David Wells

Greg Wetzel

Key Words:

This specification uses three levels for indicating the degree of compliance necessary for specific functions, procedures, or coding. They are indicated by the use of key words as follows:

- **Requirement:** "Shall" indicates a required function, procedure, or coding necessary for compliance. The word "shall" used in text indicates a conditional requirement when the operation described is dependent on whether or not an objective or option is chosen.
- **Objective:** "Should" indicates an objective which is not required for compliance, but which is considered desirable.
- **Option:** "May" indicates an optional operation without implying a desirability of one operation over another. That is, it identifies an operation that is allowed while still maintaining compliance.

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1. Introduction

1.1 Motivation

As ATM Service Provider (ASP) networks grow and interconnect, each ASP may need to be able to route calls to any customer of any ASP in the world. Given that each ASP is expected to have its own address prefix and that many customers may have their own address prefixes, this worldwide connectivity could overwhelm an ASP's ability to provision and maintain routes. In particular, its routing tables may exceed resource limits – an ASP scalability issue. Furthermore, attempts to restrict the number of addresses supported may limit the flexibility of a customer to use multiple ASPs. ATM Bi-Level addressing tackles these scalability and flexibility problems by allowing an ASP to move processing of most of the address prefixes to an external database, leaving the switch to support a more manageable set of address prefixes.

1.2 Overview

This informative document describes the ATM 'Bi-Level' addressing concept and examples. It contains addressing rules and recommendations for ATM Service Provider (ASP) and private networks. It also references normative ATM Forum documents as needed. This document has been prepared by the ATM Forum to assist equipment manufacturers, designers, implementers and operators of ATM Service Provider and private ATM networks. It specifically covers addressing throughout ATM networks.

ATM Bi-Level addressing involves the use of two ATM called party addresses to establish a call over one or more ATM networks. The concepts presented will discuss appropriate procedures for the use of these addresses as well as any necessary ATM address translation. Examples are included to show how this concept can be applied in a number of important applications. One application is for interworking among multiple networks, where the core set of networks routes only on ATM Service Provider addresses, and the networks on the edges use customer owned ATM addresses. This allows for both scalability in the core networks and flexibility of address management in edge networks. Another application is to transport, over an ATM network, ATM addresses that are not part of that ATM network's internal ATM addressing scheme. This allows the network's internal routing to be independent of all external addressing schemes. Other applications may be possible but are not discussed in this document.

The reader should be familiar with the following ATM addressing documents: the ATM Forum Addressing User Guide [AF-RA-0105.000] and the ATM Forum Addressing Reference Guide [AF-RA-0106.000].

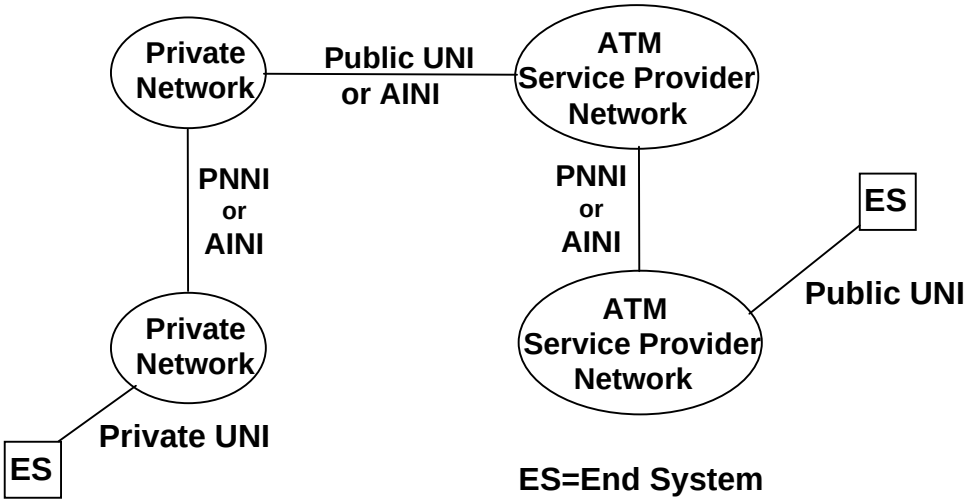
1.3 Scope

This document describes ATM bi-level addressing for Private UNI, Public UNI, PNNI and AINI ATM interfaces. ATM bi-level addressing for B-ICI or B-ISUP interfaces is beyond the scope of this document.

This document does not contain any normative procedures. Relevant normative procedures are described in existing specifications: PNNI Transported Address Stack [AF-CS-0115.000] and ATM Name System, V2.0 [AF-DANS-0152.000].

2. Reference Configuration

The following reference configuration is provided to assist the reader to visualize the possible interworking scenarios that will be referred to throughout this document.



Note: The Private Networks are PNNI Networks.

Figure 2-1 Reference Configuration

See the ATM Forum Addressing User Guide [AF-RA-0105.000] and the ATM Forum Addressing Reference Guide [AF-RA-0106.000] for further information on this reference model and its implications for private networks and ASP networks.

3. ATM Bi-Level Addressing Concept

This section describes the ATM bi-level concept. An overview is followed by a more detailed description of the individual components of ATM bi-level addressing. The section concludes with some examples of bi-level addressing.

3.1 ATM Bi-Level Addressing - Overview

This section contains a simple description and example of ATM bi-level addressing and defines the addressing terminology used. More details are provided in subsequent sections of this document.

The ATM bi-level addressing concept allows one or more ATM networks to route call setup messages across the networks by putting a new routing address in the Called party number information element while transporting the received called party number in another information element. This is illustrated in Figure 3-1. In this figure, the ingress node in the ATM network initiates bi-level addressing by translating received called party number Z to address X, which is then used for routing across the ATM network. The ATM network's egress node terminates bi-level addressing by restoring Z to the Called party number information element.

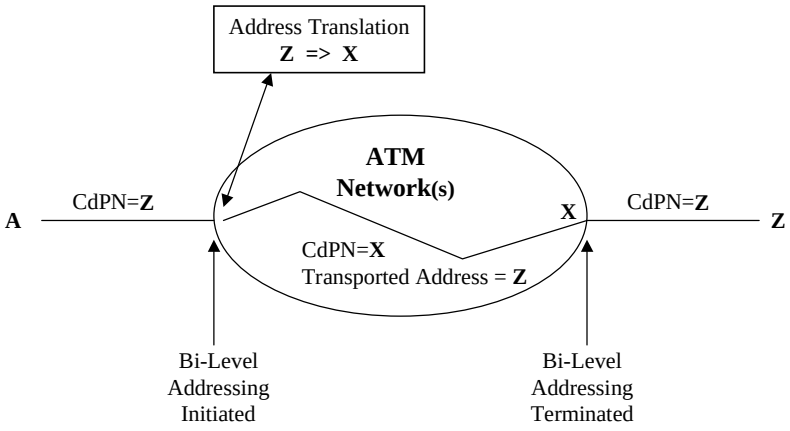


Figure 3-1 ATM Bi-Level Addressing Concept

Bi-level addressing requires the following two items:

1) An address translation service - Given a particular received routing address that is not routable in a given ATM network, this allows a new, interim routing address to be determined. The ATM Name System (ANS) [AF-DANS-0152.000] will be discussed in this document as the address translation service. Other address translation services are beyond the scope of this document.

2) A protocol element for encapsulating the received non-routable address and transporting this address until it is needed for later use - The Transported address stack (TAS) [AF-CS-0115.000] and the Called party subaddress information elements are used for this purpose.

Bi-level addressing supports both single and multihomed destinations.

3.1.1 ATM Bi-Level Addressing – Globally Addressed Network

The Globally Addressed network application of bi-level addressing is for end system and private network interworking across one or more ATM Service Providers (ASPs).

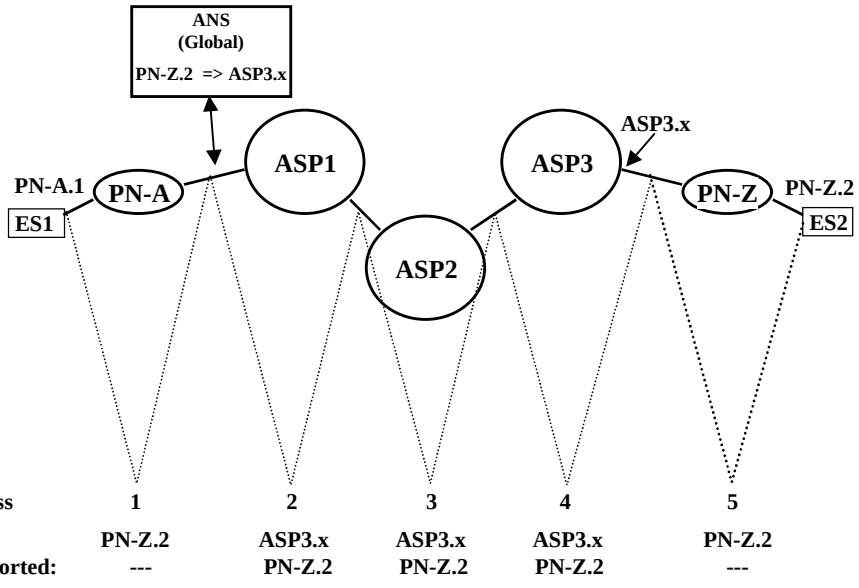
Bi-level addressing allows ATM service providers to route only on service provider addresses, thus providing scalability, while allowing users the flexibility to administer their own address space.

The Globally Addressed network case distinguishes the following two kinds of ATM addresses for bi-level operation:

ATM WAN Address – The ATM WAN address identifies an interface, between an ASP network and a private network or end system, that has been configured to terminate bi-level operation. This is an ASP address. It is assumed that ASP networks will be able to route on each other's addresses.

ATM Local (User) Address – The ATM Local (User) address identifies the interface to an end system from an ATM network. The ATM Local (User) address is an address from the customer's addressing plan - either a Customer Owned address or one obtained from the customer's ATM service provider. This address may not be routable across the global ASP internetwork. Note that if the ATM Local (User) address is an ASP address, ATM bi-level operation is not required for end to end connectivity

Transit ASP networks transport ATM Local (User) addresses while routing on ATM WAN addresses. ATM WAN addresses are directly or indirectly (e.g. through address translation – see Section 3.3.5) routable through all ASP networks. The interface identified by an ATM WAN address is likely to be at the edge of the ATM Service Provider cloud. The Globally Addressed Network application is illustrated in Figure 3-2.



Notes: ASP1, ASP2 & ASP3 route on address ASP3.x but not on address PN-Z.2.
ASP3.x is an ATM WAN address, and PN-Z.2 is an ATM Local (User) address.

Figure 3-2 Globally Addressed Network Example

3.1.2 ATM Bi-Level Addressing – Internally Addressed Networks

The Internally Addressed network application of bi-level addressing allows a network's internal routing to be independent of all external addressing schemes.

Internally Addressed networks route using a private, internal addressing scheme that is not generally advertised to other networks and may not have significance in other networks. Any address that is carried in the Called party number information element entering an Internally Addressed network is considered to be an external address. All external addresses are mapped to a corresponding internal address for routing across an Internally Addressed network. The approach described in this document uses an ATM Name System [AF-DANS-0152.000] to map external addresses to internal addresses for transport across an Internally Addressed network. The ATM Name System (ANS) used for this purpose is an integral part of the Internally Addressed network, and the internal address data might not have significance outside of the Internally Addressed network. See Section 4.5 in [AF-DANS-0152.000].

Internally Addressed networks can be ATM Service Provider (ASP) networks or private ATM networks.

A given call can transit multiple Internally Addressed networks.

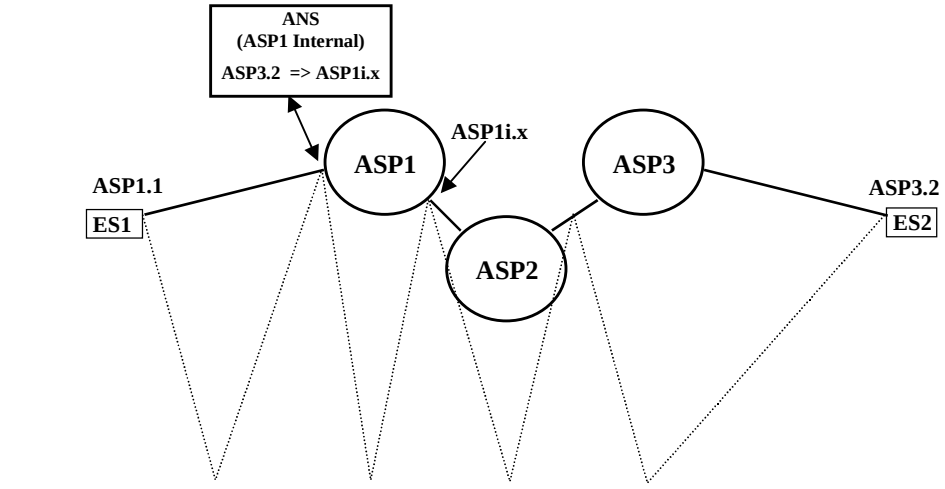
Although there are many similar components, the Internally Addressed network case is separate from the Globally Addressed network case. As the example in Section 3.3.5 shows, the two can be used together.

The Internally Addressed network case distinguishes the following two kinds of ATM addresses for bi-level operation:

ATM Network Internal Address – An ATM Network Internal address identifies an interface at the edge of the internally addressed network, that has been configured to terminate bi-level operation. This is an address assigned according to this network's internal addressing plan. Although the ATM Network Internal address need not be a globally unique registered address, it must be routable (i.e., have topological significance) in the networks participating in the internal private addressing scheme. All other ATM addresses are considered external. The ATM Network Internal address does not have significance outside of the internally addressed network, so it is not relevant whether it is an ASP address or a customer owned address.

ATM Network External Address – An ATM Network External address is any address that is carried in the Calling party number or Called party number information element entering an Internally Addressed network. Throughout this document, unless otherwise specified, this term refers to the Called party number information element entering an Internally Addressed network. ATM Network External addresses must be transported across Internally Addressed ATM networks. The ATM Network External address is a globally unique address that can be a Customer Owned address or an ATM Service Provider address. Note that all ATM Network External addresses must be mapped to ATM Network Internal addresses to be transported across Internally Addressed networks.

Internally Addressed networks transport ATM Network External addresses while routing on ATM Network Internal addresses. The Internally Addressed Network application is illustrated in Figure 3-3.



Notes: ASP2 & ASP3 route on address ASP3.2.
But ASP1, an Internally Addressed Network, does not route on ASP3.2.
For ASP1, ASP3.2 is an ATM External Address, and ASP1i.x is an ATM Internal Address

Figure 3-3 Internally Addressed Network Example

3.1.3 ATM Bi-Level – Two Address Types (ATI & ADP)

This section defines general addressing terms for the two addresses used in ATM bi-level addressing that will be used though out the rest of the document and in reference [AF-DANS-0152.000]. These terms are:

ATM Terminating Interface (ATI) Address – The ATI address is the bi-level address that identifies the terminating interface where the current instance of ATM bi-level addressing is to end. The ATI address is the routing address in the current ATM bi-level call setup. For the Globally Addressed network case, the ATI is the ATM WAN address. For the Internally Addressed network case, the ATI is the ATM Network Internal address.

The ATI address must be routable (i.e. have topological significance) through all networks from the point where it is added to the call or party, until the interface identified by this address is reached. An ATI address is a specific instance of the address of a transport termination point as defined in TAS [AF-CS-0115.000].

ATM Destination Point (ADP) Address – The ADP address is a bi-level address that identifies a subsequent destination interface. The ADP address is transported to the interface identified by the ATI address, where the current instance of ATM bi-level addressing ends; at this point, the address that has been functioning as an ADP address is restored to be used as the call setup routing address. For the Globally Addressed network case, the ADP address is the ATM Local (User) address. For the Internally Addressed network case, the ADP address is the ATM Network External address.

The ADP address should be routable (i.e. have topological significance) through all networks from the point where the current instance of ATM bi-level ends and the ADP address is restored as the routing address to continue call setup. During bi-level operation, this address can be transported in the Transported Address Stack [AF-CS-0115.000] or the Called Party Subaddress.

Table 3-1 summarizes how the ATM Terminating Interface and ATM Destination Point are used in the Globally Addressed and Internally Addressed network cases.

	Globally Addressed Network *Across multiple ATM service providers using globally advertised addresses*	**Internally Addressed Network** *Across a network or networks using a private, internal addressing scheme*
ATM Terminating Interface (ATI) Address *The current routing address identifying a terminating interface*	**ATM WAN Address** *An ASP address identifying a terminating ASP interface to a private network or end system*	**ATM Network Internal Address** *An internal address identifying a terminating internal network interface*
ATM Destination Point (ADP) Address *Transported address identifying a subsequent destination interface*	**ATM Local Address** *A CO address Identifying the interface to the destination end system*	**ATM Network External Address** *Any address that is carried in the Called party number information element entering an Internally Addressed network*

Table 3-1 ATM Bi-Level – Two Addresses, Two Network Types

3.2 ATM Bi-Level Addressing Components

3.2.1 Single Level ATM Addressing

Bi-level addressing is compatible with ATM 'Single Level' addressing where only a single ATM routing address is needed during end to end call setup. Single level addressing occurs when the originating user uses the destination address for the terminating user and when all intermediate network nodes know how to progress the call using this address. This would be the case if the call is local (so that an ATM Terminating Interface address is not necessary) or when this address is an ASP address. In this case the Called Party Number would contain the initial routing address during the entire call setup procedure.

In ASP networks, ATM single level addresses must be ATM Service Provider addresses that have global end to end significance.

For Internally Addressed networks, single level addresses are not supported, since the ATM Network Internal addresses do not have significance outside of the Internally Addressed network. All addresses received by the Internally Addressed network would be ATM Network External addresses to the Internally Addressed network. These ATM Network External addresses would use bi-level operation to transit the Internally Addressed network.

Another case where single level addressing applies is when the Transit network selection (TNS) information element is used to route the call to an ATM Service Provider network that is known to be capable of progressing the call.

3.2.2 ANS Registration and Dynamic Update

The binding between a given ATM Destination Point Address (ADP) and one or more ATM Terminating Interface (ATI) addresses is kept in the ATM Name System (ANS), as described in Section 4.5 in [AF-DANS-0152.000]. The ANS supports registration and dynamic update of this information. Registration is the normal process for creating the binding information in the ANS, and dynamic update allows for prompt change of this information. This registration and update are usually done by authorized personnel or by network devices with appropriate authority. See Appendix B, "Usage Scenarios" in [AF-DANS-0152.000].

For the Globally Addressed network case, the ATM Terminating Interface addresses will be ATM WAN addresses that are placed in the global ANS, which is accessible by other ANS or Internet DNS users.

For Internally Addressed networks, the ATM Terminating Interface address will be an ATM Network Internal address that is placed in the internal ANS accessible only by authorized users/devices of the Internally Addressed network. This information can be shared outside of an Internally Addressed network, but this is beyond the scope of this document.

3.2.3 ATM Bi-Level Addressing Initiation

If a network device is unable to progress a call based on the ATM address provided in the call setup message, then it can initiate bi-level operation or, if necessary, can forward the call to a network node or device capable of initiating bi-level operation. The specifics of when to initiate bi-level addressing are left to the implementer. Possible options include: a) always performing an ANS lookup to see if one or more ATI addresses can be obtained, b) performing a lookup if the called party number does not match any prefixes in the routing table, c) performing a lookup only if the called party number matches one of a provisioned list of prefixes, and d) performing a lookup only if the address fails to match any of a list of provisioned prefixes.

Initiation of bi-level addressing is composed of two parts: lookup and selection.

3.2.3.1 ATI Address Lookup

At least one ATM Terminating Interface (ATI) address is needed for bi-level operation. If an appropriate ATI address is not known, then a 'lookup' or 'resolution' is needed. ATI address lookup can be done by a capable network device, an end system, a capable private network node, or a capable ASP network node. The lookup is based on an ATM Destination Point (ADP) address. An ANS, ADP to ATI address lookup is used to find one or more appropriate ATI addresses. In addition, ATM end systems that can handle names can do an ANS name to address lookup to determine the proper ADP Address, before using that address to look up the ATI address. Refer to Sections 4.3, 4.5 and 9 in [AF-DANS-0152.000] for more details. An ASP network may have means other than the ANS to resolve ATI addresses; however, this is beyond the scope of this document.

Reducing ATM address resolution lookup time for ATM bi-level operation will minimize the impact on the ATM signaling process. ATM Terminating Interface resolution information cached on the local ANS will keep the resolution time to a minimum for these queries. Network administrators who have frequent or important interaction with other networks can use the ANS notification and incremental zone transfer procedures (Refer to Section 5 in [AF-DANS-0152.000] for more details) to accomplish this.

3.2.3.2 ATI Address Selection

The same capable network device that initiated the start of bi-level operation and the initial ANS lookup does the selection of an ATM Terminating Interface (ATI) address. If one or more ATI addresses are known, then the capable device selects one ATI address to begin ATM bi-level operation. Once a capable device initiates the selection of ATI addresses, the capable network device must take the responsibility to manage bi-level operation. This includes handling any retries if the call attempt using the selected ATI address attempt fails and other ATI addresses are available. There are some cases when ATM bi-level retries should not be attempted, even though other ATI addresses are available. For example, any ATM bi-level call that progresses all the way to the called user and gets rejected by the called user should not be retried. This includes rejections by the called user that happen when a problem is discovered at the called user's end of the UNI, as well as rejections from within the endpoint or user system.

In some cases, it may be desirable for one device to do the lookup or resolution of ATI addresses and a subsequent device to do bi-level address selection. This would allow a capable device to do the bi-level ANS lookup and a subsequent node (that may be more capable of making a better routing decision) to do the actual selection and management of bi-level addressing. However, this would require signaling protocol extensions to carry the set of candidate ATI addresses, returned by ANS, to the selection point. This capability is for future work. Separation of bi-level initiation and selection is beyond the scope of this document.

3.2.3.3 Initiation for Globally Addressed Networks

For Global Internetworking, the capable network device initiating bi-level addressing can be an end system, private network node or ATM Service Provider node. The global ANS will be used to determine appropriate ATM WAN addresses to continue the call. The lookup can be based on an ATM Local (User) address using an ADP to ATI ANS lookup to find a list of appropriate ATM WAN addresses using the ANS subtree, "ATI.ATMA.INT" [AF-DANS-0152.000]. ATM end systems that handle names can do an ANS name to address lookup to determine the proper ATM Local (User) address if needed. The global ANS is used for this lookup as well as for the subsequent ATM Local (User) address to ATM WAN address lookup.

The Transit network selection information element (TNS IE) can be used to route a call to an ATM Service Provider network that is known to be capable of initiating bi-level addressing.

3.2.3.4 Initiation for Internally Addressed Networks

For Internally Addressed networks, a separate ANS, not part of the global ANS, will be used. Since the ATM Network Internal addresses are not used outside of the Internally Addressed network, external devices or nodes will not have access to this ANS. The Internal ANS may access information from the Global ANS, but this interaction is beyond the scope of this document. The Internally Addressed network performs the ANS ADP to ATI address lookup to find a list of appropriate ATM Network Internal addresses. This lookup uses the ANS subtree, "ATI.ATMA.INT" [AF-DANS-0152.000].

3.2.4 ATM Bi-Level Addressing Termination

At the terminating interface identified by the ATM Terminating Interface (ATI) address, the ATI address must be removed from the call setup message and replaced with the ATM Destination Point (ADP) address. The address can be removed on either side of the terminating interface.

The capable Globally Addressed network device that terminates bi-level operation is a node on one side of the terminating interface, either the ASP side or the private network side.

The capable Internally Addressed network node that terminates bi-level operation must be an Internally Addressed network egress border node.

3.2.5 ATM Bi-Level Address Transport

The ATM Terminating Interface (ATI) address is carried in the Called party number information element (CdPN IE) during call setup.

This document recommends that the Transported address stack information element (TAS IE) be used to transport ATM Destination Point (ADP) addresses during call setup. The TAS IE can also be used to transport calling party information. Currently the TAS IE is only defined for the PNNI and AINI interfaces. The TAS IE will be specified for the Private UNI and Public UNI in the future.

Details on the Transported Address Stack can be found in the document "PNNI Transported Address Stack, Version 1.0, af-cs-0115.000" [AF-CS-0115.000]. The TAS IE has been defined to be a stackable element and can be used by multiple processes. Because it operates as a stack, multiple instances of TAS must have nested invocations, and the rules defined in the TAS IE specification must be closely followed. The operation as a stack is what allows for Globally Addressed networks and Internally Addressed networks to be used together, since this use results in the transport of multiple ADP addresses (see Section 3.3.5).

The Called party subaddress information element (CdPSA IE) can also be used to transport an ADP address during call setup. The subaddress information elements should be used when the TAS information element is not defined, such as at the Public and Private UNI. Note that there may be regulatory restrictions on the use and generation of the CdPSA IE. Further discussion of the use of the CdPSA IE is beyond the scope of this document.

3.2.6 Rehoming

In some cases, it may be necessary to rehome a private network interface and change the binding of a given ATM Destination Point (ADP) address prefix to a different ATM Terminating Interface (ATI) address in the local ANS. A significant delay may occur before other, remote ANS devices can learn of the updated information.

There are four near term suggestions that should be considered when rehoming networks to help ensure updated information is available throughout the ANS:

1. Retain connections to both the "old" and "new" interfaces after updating the ANS system with the "new" ATI address information, and later remove the "old" ATI address information. A respective ADP address can be reached via either interface during any ANS update time, or even longer. Removal of the "old" interface would complete the rehoming.
2. Register both old and new bindings in ANS and rely on retries from the ATM bi-level selection point.
3. Use an "Enhanced ANS caching" approach, where the ATM bi-level initiation device can "learn" that the local, cached information is not good. This device can then ask the local ANS device to query the appropriate authoritative ANS device for the latest information.
4. ANS binding information is managed from a single authoritative ANS device. This information can have an associated time-to-live (TTL) value that tells remote ANS devices how long this information should be kept. Normally, the TTL value can be quite long for information that is not expected to change frequently. However, well before a planned rehoming operation, the authoritative ANS device can be configured with

short TTL values for the binding information that is to be changed. Other ANS devices will learn to update from the authoritative ANS in shorter time intervals as indicated by the TTL value. The binding information can then be changed and learned quickly by other ANS devices. After an appropriate period of time the respective TTL values may be restored to normal values.

Other approaches such as Call Redirection, where the destination private network provides a list of one or more alternate ATI addresses in the "call clearing" message for calls that cannot be completed, could be defined in the future.

3.3 Rehoming may also be performed for a group of addresses, typically a portion of a network, or for end systems.ATM Bi-level Examples

In general, bi-level addressing can be initiated by an end system, by a capable private network node, or by a capable ATM Service Provider network node. Under the Internally Addressed network case, bi-level addressing can be initiated only by an Internally Addressed network node, since the ANS is an integral part of the Internally Addressed network. In this document, the term 'initiating' ATM bi-level addressing means the point at which both the lookup of ATM Terminating Interface addresses is done and the selection of one ATM Terminating Interface address is made to continue the call.

The first three examples (User Initiated, Private Network Initiated, and ASP Network Initiated) are presented as they apply to ATM bi-level addressing for the Globally Addressed network case. See Figure 3-4. The fourth example presented, Internally Addressed network Initiated ATM Bi-Level Addressing, applies to one or more networks (Private or ASP) that operate on a single internal ATM addressing plan. The final example shows nested invocations of bi-level addressing.

The case where single level addressing is sufficient and bi-level addressing is not needed has been discussed. Single level addressing applies to all the subsequent examples for the Globally Addressed network case (see below).

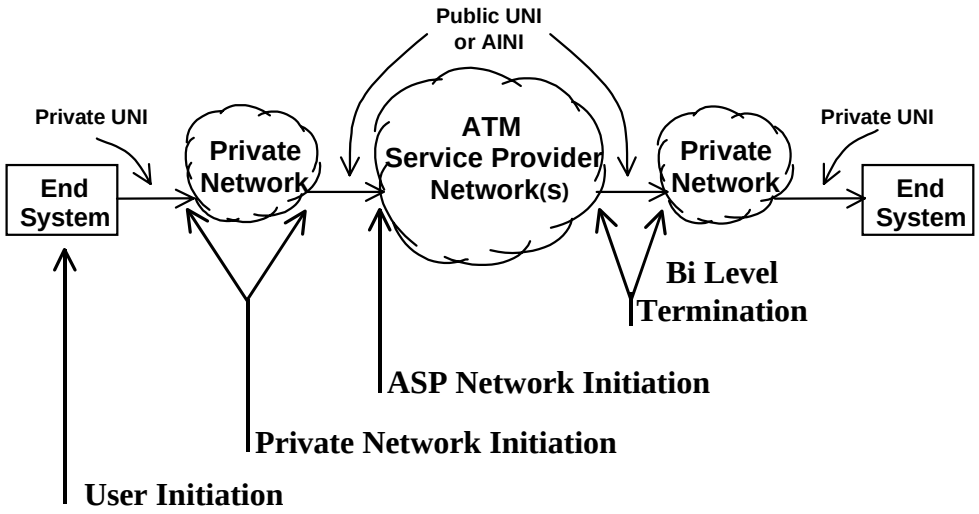


Figure 3-4 Bi-Level Initiation for Globally Addressed Networks

3.3.1 User Initiated ATM Bi-level Addressing

User Initiated bi-level can be used for the Globally Addressed network case but does not apply for an Internally Addressed network (since in an Internally Addressed network, a capable border node, not an end system, must

initiate bi-level operation). The following examples present bi-level operations that are possible at the user end system.

3.3.1.1 ATM WAN Address Lookup

The user needs one or more ATM WAN addresses to initiate ATM bi-level operation. If the user does not know or have these addresses, the user can do one of the following:

1. If the user does not know or have an ATM Local (User) address, the user can do an ANS Name to ATM Local address lookup. If this lookup is successful, it will yield the ATM Local address of the called party. The user can then do an ADP to ATI ANS Local to WAN address lookup. If this lookup is successful, it will yield one or more appropriate ATM WAN addresses for reaching the called party. The possibility exists that the lookup may yield no ATM WAN addresses.
2. If the user has an ATM Local (User) address, the user can do an ADP to ATI ANS Local to WAN address lookup. If this lookup is successful, it will yield one or more appropriate ATM WAN addresses for reaching the called party. The possibility exists that the lookup may yield no ATM WAN addresses.

3.3.1.2 ATM WAN Address Selection

If the user has not obtained any ATM WAN addresses, the user places the ATM Local address in the CdPN IE of the outgoing call setup message (i.e., single level addressing is used for this call), or the user rejects the call.

If the user has obtained one or more ATM WAN addresses, the user selects one ATM WAN address, placing it into the CdPN IE. The ATM Local address goes in the CdPSA IE. In the future, it may be possible to use the TAS IE instead of the CdPSA IE. If call or party establishment using this ATM WAN address fails, the user is responsible for handling all retries using other ATM WAN addresses returned by ANS.

The WAN address identifies an interface between the ASP network and the destination private network or end system. Promotion of the ATM Local (User) Address from the CdPSA IE to the CdPN IE at this interface is typically done by the destination private network, but may be done by the ATM Service Provider.

3.3.2 Private Network Initiated ATM Bi-level Addressing

The following examples present bi-level operations that are possible at a capable private network node. These examples are based on the Globally Addressed network case. The case of network initiated ATM bi-level in Internally Addressed networks is covered in a subsequent example.

If an incoming call can be routed within the private network, or if an ATM service provider address is received in the CdPN IE, the node can do single level routing, i.e., simply route on the CdPN. Procedures for determining that the received address is an ASP address are not specified in this document. However, some alternatives are suggested in Section 3.2.3. The following procedures are for the case where the received CdPN is not known to be an ATM Service Provider address and the node does not know a proper ATM WAN address.

3.3.2.1 ATM WAN Address Lookup

A capable network node may obtain a list of one or more ATM WAN addresses by doing an ADP to ATI ANS lookup. If this lookup is successful, it will yield one or more appropriate ATM WAN addresses for reaching the called party. The possibility exists that the lookup may yield no ATM WAN addresses. Note that ANS name lookup is not applicable in Private Network initiated bi-level operation since in general, the private network does not receive the destination name in call or party establishment messages.

3.3.2.2 ATM WAN Address Selection

If a capable network node has not obtained any ATM WAN addresses from the ANS lookup, it places the ATM Local address in the CdPN IE of the outgoing call setup message (i.e., single level addressing is used for this call), or it rejects the call.

If a capable network node has obtained ATM WAN addresses, it selects one ATM WAN address and places it into the CdPN IE. The ATM Local address will go in the TAS IE or CdPSA IE. If call or party establishment

using this ATM WAN address fails, the node is responsible for handling retries using other ATM WAN addresses returned by ANS.

The WAN address identifies an interface between the ASP network and the destination private network or end system. Promotion of the ATM Local (User) address from the TAS IE or CdPSA IE to the CdPN IE is done at this interface by the ATM Service Provider or by the destination private network.

3.3.3 ASP Network Initiated ATM Bi-level Addressing

The following examples present bi-level operations that are possible at a capable ATM Service Provider node. These examples are based on the Globally Addressed network case. The case of network initiated ATM bi-level in Internally Addressed networks is covered in a subsequent example.

If an ATM Service Provider address is received in the CdPN IE, a capable network node can do single level routing, i.e., simply route on the CdPN. Procedures for determining that the received address is an ASP address are not specified in this document. However, some alternatives are suggested in Section 3.2.3. The following procedures are for the case when the received CdPN is not known to be an ATM Service Provider address and the node does not know a proper ATM WAN address. These procedures are most likely to be implemented on the ingress node of the ASP network.

3.3.3.1 ATM WAN Address Lookup

A capable network node may obtain one or more ATM WAN addresses by doing an ADP to ATI ANS address lookup. If this lookup is successful, it will yield one or more appropriate ATM WAN addresses for reaching the called party. The possibility exists that the lookup may yield no ATM WAN addresses. Note that ANS name lookup is not applicable in network initiated ATM bi-level operation, since in general, the ATM Service Provider network does not receive the destination name in call or party establishment messages.

3.3.3.2 ATM WAN Address Selection

If a capable network node has not obtained any ATM WAN addresses from the ANS lookup, it places the ATM Local address in the CdPN IE of the outgoing call setup message (i.e., single level addressing is used for this call), or it rejects the call.

If a node has obtained ATM WAN addresses, it selects one ATM WAN address and places it into the CdPN IE. The ATM Local address will go in the TAS IE. If call or party establishment using this ATM WAN address fails, the node is responsible for handling all retries using other ATM WAN addresses returned by ANS.

The WAN address identifies an interface between the ASP network and the destination private network or end system. Promotion of the ATM Local (User) address from the TAS IE to the CdPN IE is done at this interface by the ATM Service Provider or by the destination private network.

3.3.4 Internally Addressed Network ATM Bi-level Addressing

The Internally Addressed network can be either an ASP or private network. Any ATM address received by an Internally Addressed network in the CdPN IE is considered an ATM Network External address. This ATM Network External address can be a Customer Owned address, an ATM Service Provider address or even some other ATM address. These procedures are most likely to be implemented on the ingress node of the Internally Addressed network.

3.3.4.1 ATM WAN Address Lookup

A capable network node may obtain a list of one or more ATM Network Internal addresses by performing an ADP to ATI ANS address lookup. If this lookup is successful, it will yield one or more appropriate ATM Network Internal addresses for reaching an egress port of the Internally Addressed network(s). The possibility exists that the lookup may yield no ATM Network Internal addresses, in which case the call should be ended. Note that ANS name lookup is not applicable in a network initiated ATM bi-level operation since in general, the network does not receive the destination name in call or party establishment messages.

3.3.4.2 ATM WAN Address Selection

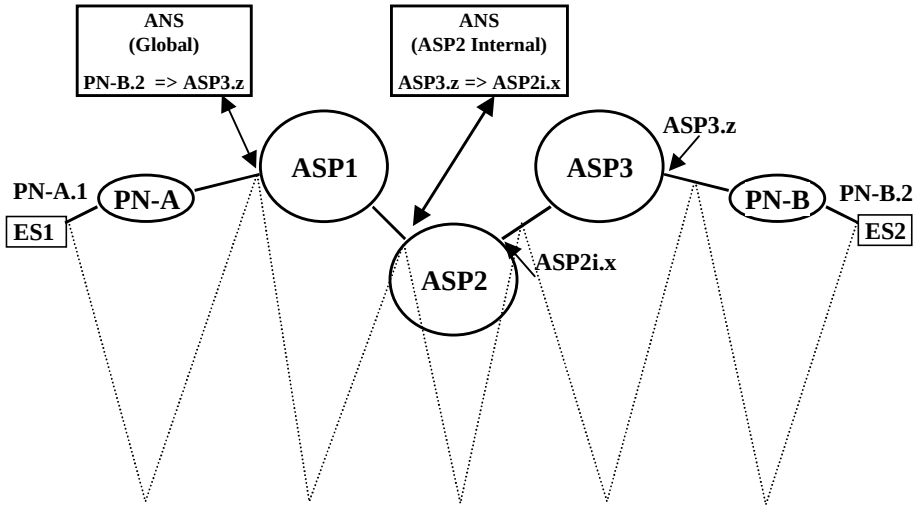
If a capable network node has obtained ATM Network Internal addresses, it selects one ATM Network Internal address and places it into the CdPN IE. The ATM Network External address will go in the TAS IE. If call or party establishment using this Network Internal address fails, the node is responsible for handling retries using other Network Internal addresses returned by ANS.

Promotion of the ATM Network External address from the TAS IE to the CdPN IE is done at the terminating ATM internal interface at the edge of the Internally Addressed network.

3.3.5 Nested Invocations of Bi-level Addressing

For global internetworking, an ATM call may have to traverse multiple ASP networks. Each one of these networks is able to route based on the ATM WAN address received in the CdPN IE. However, this does not mean that each one must route on the ATM WAN address internally. Instead it can use the procedures for Internally Addressed networks. This leads to nested invocations of bi-level addressing, resulting in multiple ADP addresses. This is illustrated in Figure 3-5.

Figure 3-5 Nested Invocations of Bi-level Addressing



The following steps are shown. Note that the steps are described using ATI/ADP notation instead of WAN/User (Local) and Internal/External notation.

Step 1 - ES1 is placing a call to ES2. It places ADP address PN-B.2 in the CdPN field, and PN-A routes the call to ASP1.

Step 2 – ASP1 does a global ANS translation, mapping the ADP address PN-B.2 to an ATI address ASP3.z. The ADP address PN-B.2 is placed on the Transported Address Stack, and the ATI address ASP3.z is placed in the CdPN field. ASP1 routes this call to ASP2 using address ASP3.z.

Step 3 – ASP2 is an Internally Addressed network that has its own internal addressing scheme and does not route on ASP3 addresses. ASP2 does an internal ANS translation, mapping ASP3.z to ATI address ASP2i.x, which identifies an interface from its network to ASP3. Notice that ASP3.z, which had been acting as an ATI

address, is now functioning as an ADP address. ASP2 places ASP3.z on the Transported Address Stack (on top of PN-B.2) and ASP2i.x in the CdPN field. ASP2 routes the call to ASP2i.x.

Step 4 - At ASP2i.x, ASP2 replaces address ASP2i.x in the CdPN field with address ASP3.z, which is removed from the TAS, leaving only address PN-B.2 in the TAS. The call is routed to ASP3. ASP3 routes the call to ASP3.z.

Step 5 –At ASP3.z, ASP3 replaces address ASP3.z in the CdPN field with address PN-B.2 from the TAS (which is now removed from the call because it is empty). The call is routed across PN-B to ES2.

4. Acronyms

The following acronyms are used in this document:

ADP	ATM Destination Point
AINI	ATM Inter-Network Interface
ANS	ATM Name System
ASP	ATM Service Provider
ATI	ATM Terminating Interface
ATM	Asynchronous Transfer Mode
B-ICI	B-ISDN Inter-Carrier Interface
B-ISUP	Broadband ISDN User Part
CdPN	Called Party Number
CdPSA	Called Party Subaddress
CgPN	Calling Party Number
CgPSA	Calling Party Subaddress
ES	End System
PN	Private Network
PNNI	Private Network Network Interface
TAS	Transported Address Stack
TNS	Transit Network Selection
TTL	Time To Live
UNI	User Network Interface
WAN	Wide Area Network

5. References

1. AF-RA-0105.000, ATM Forum Addressing: User Guide version 1.0, (November 1998).
2. AF-RA-0106.000, ATM Forum Addressing: Reference Guide, (January 1999).
3. AF-CS-0115.000, PNNI Transported Address Stack, Version 1.0, (May 1999).
4. AF-DANS-0152.000, ATM Name System V2.0, (July 2000).