



The ATM Forum
Technical Committee

**Interim Inter-switch
Signaling Protocol (IISP)
Specification v1.0**

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1 Introduction

This document contains the specification of Interim Inter-switch Signaling Protocol (IISP) for the Private Network-Node Interface (PNNI) in ATM networks. It is built upon the ATM Forum UNI 3.1 Specification with optional support of the UNI 3.0, and allows for some base level capability at the PNNI while the PNNI Phase 1 Protocol Specification is being finalized.

The protocol described in this document is in force only until such time as the PNNI Phase 1 Specification has been accepted by the ATM Forum membership. At that time, this document shall be superceded by the PNNI Phase 1 Specification.

1.1 Scope

The scope of this document is to provide a standard specification of the IISP functionalities. It does not cover a full-fledged specification for all the functionalities needed for PNNI. This is left to be specified in the PNNI Phase 1 Specification.

The scope of this document includes

- IISP Objectives
- IISP Reference Model
- IISP Addressing and Configuration
- IISP Signaling • IISP Routing

1.2 Symbols/Abbreviations

| | |
|------|---|
| AFI | Authority and Format Identifier |
| ES | End System |
| IE | Information Element |
| IISP | Interim Inter-switch Signaling Protocol |
| ILMI | Interim Local Management Interface |
| MIB | Management Information Base |
| NSAP | Network Service Access Point |
| PNNI | Private Network-Node Interface QoS Quality of Service |
| TNS | Transit Network Selection |
| UNI | User to Network Interface |
| UPC | Usage Parameter Control |

1.3 Document Organization

| Section | Title | Description |
|------------|------------------------------|--|
| 1. | Introduction | Outlines overall objectives and the IISP reference model. |
| 2. | Physical Layer | Defines the Physical layer functionalities and parameters. |
| 3. | ATM Layer | Defines the ATM layer functionalities and parameters. |
| 4. | ILMI | Defines the use of ILMI protocol functionalities. |
| 5. | Traffic Management | Describes use of ATM traffic management functions. |
| 6. | Addressing and Configuration | Describes the schemes for address assignment and configuration options. |
| 7. | IISP Signaling | Describes the signaling procedures based on the ATM Forum UNI 3.1 Specification. |
| 8. | IISP Routing | Describes the routing aspects of IISP. |
| Appendix A | Routing Scenario | Describes an example routing scenario. |
| Appendix B | Routing Guidelines | Describes routing guidelines. |

1.4 IISP Objectives

As an interim solution that would allow customers some level of multi-vendor switch interoperability the IISP specification has the following objective:

- It is a protocol that builds upon the existing UNI 3.1 (optionally on UNI 3.0) signaling protocol with minimal changes.

1.5 Reference Model

Figure 1-1 shows the IISP reference model. Note that the interface between two private switching systems is termed IISP to avoid any possible confusion with the PNNI.

Figure 1-2 depicts the Switching System Architecture comprising the IISP. Note that the nature or definition of the Management Interface is outside of the scope of this Specification.

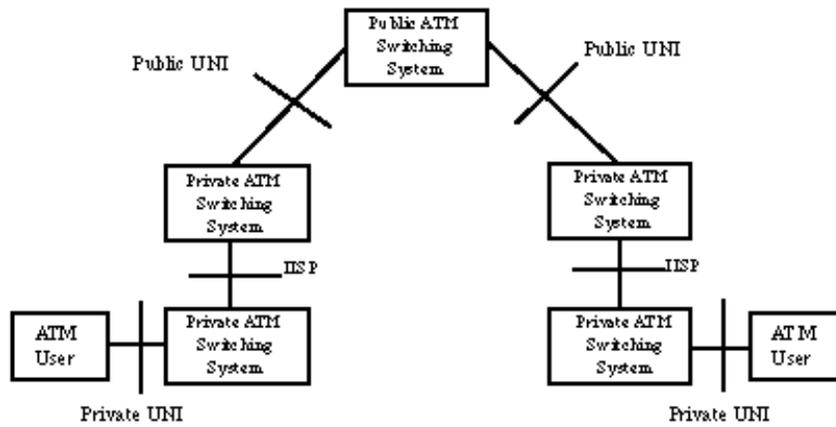


Figure 1-1 ATM Interim Inter-switch Signaling Protocol (IISP) Reference Model

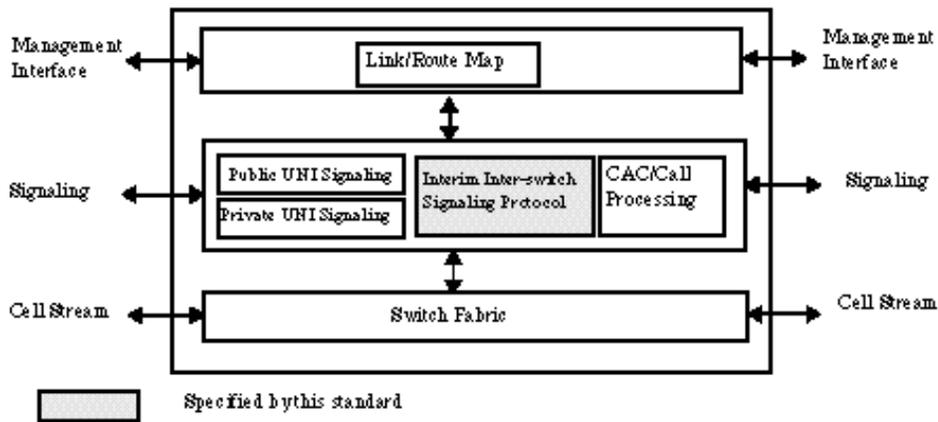


Figure 1-2 Interim Inter-switch Signaling Protocol (IISP) Switching System Architecture

2 Physical Layer

All of the physical layer interfaces specified in the ATM Forum UNI 3.1 Section 2 will be available at the IISP Interface.

3 ATM layer

Refer to the ATM Forum UNI 3.1 Specification, Section 3.

Note that the cell format used across the IISp link shall be the UNI cell format. The procedures of the UNI 3.1, Section 3 shall be followed.

4 ILMI

The ILMI procedures shall not be used across an IISP link. In particular, address registration procedures shall not be employed.

5 Traffic Management

Refer to the ATM Forum UNI 3.1 Specification, Sections 3.5 and 3.6.

Usage of the policing function (such as the Usage Parameter Control) is optional.

6 Addressing and Configuration

6.1 Configuration

This section summarizes the mandatory configuration settings required for an IISP link. The Management Interface necessary to achieve the configuration settings themselves is outside of the scope of this specification.

6.1.1 VCI/VPI Ranges

To ensure interoperability, all IISP based switching systems must be able to accept and establish calls within the following default VPI/VCI ranges:

VPI = 0
VCI range 32-255

Generation and acceptance of other VPI/VCI values shall be allowed but not required.

6.1.2 Address Table

This is specified in 6.2.

6.1.3 IISP Type

Each IISP link shall be configurable either as the user side or the network side of the IISP protocol.

6.2 Addressing

The IISP protocol shall support use of any of the NSAP-encoded Private Network Address format as specified in Section 5.1.3.1 of the UNI 3.1 Specification. Addressing considerations for a Public UNI shall be as described in the Annex A of UNI 3.1 Specification. An IISP switching system shall support a routing table which consists of entries of the form:

<ATM address, address length, interface index>

where:

- The ATM address is a 20-octet string defined by the UNI 3.1 Specification.
- The address length in bits is an integer value between 0 to 104 (inclusive) and 152 (exclusive). This is used for a best-match comparison (see below). A length value of 0 will match all routing table lookup requests (i.e., a default route).
- The interface index is a unique identifier for an interface on the switching system. The interface can either be a physical port or a permanent Virtual Path connection. It is used to identify the “next hop” on the path to the destination. The interface index is a local port identifier, and may be defined differently from the atmPortIndex object in the UNI 3.1 ILMI MIBs.

At each hop along the path to the destination switching system, the call setup procedure consults the intermediate switching system's routing table. The destination address is compared to the routing table entries using the length (number of significant bits) stored with the entry. An entry in the routing table matches the destination address when N bits of the two addresses are equivalent where N is the number of significant bits.

When using variable length address matching it is possible to have more than one match for any destination address. For example, a routing table could consist of the following entries:

<ATM address 4700:0005:1234:0000:0000, length 48, interface index 5>

<ATM address 4700:0005:1234:5600:0000, length 56, interface index 9>

Given a call request to destination address 4700:0005:1234:5678:9123, both routing table entries match the destination address but the one with the longest length should be chosen.

7 IISP Signaling

7.1 Introduction

The IISP Specification is based on the UNI 3.1 signaling protocol (with optional support of the UNI 3.0 protocol through bilateral configuration arrangements), with minor changes intended to minimize the additional development effort, yet allow the inter-switch connectivity in private networks, in a multivendor environment. Consequently, at a specific link, one switching system plays the role of the user side, and the other plays the role of the network side, as defined in the UNI 3.1 Specification. The roles are assigned manually, such that one end of the link terminates at a “user line card” of one switching system and the other end terminates at a “network line card” of the other switching system. There are no restrictions regarding the roles that a switching system can play at different links, i.e., a switching system can play one role at one link, and another role at another link. Moreover, a transit switching system can play one role at the incoming side of a call, and the same role or another role at the outgoing side of the same call.

The UNI 3.1 Specification differentiates between the origination side (at the calling party) and the destination side (at the called party) of a call. For the IISP links, such differentiation is not necessary, however, to maintain synergy with the UNI 3.1 Specification, the different Sections are preserved with the understanding that they apply according to the direction in which the call is traveling, i.e., from the user side to the network side versus from the network side to the user side.

The use of PVCs across IISP links is supported similar to those at the UNI 3.1 links. Call collisions on an IISP link (due to assignment of identical VPI/VCI by two Switching Systems to calls occurring simultaneously) are eliminated by allowing only the “network side” to assign VPI/VCI values.

7.2 Procedural Updates for Point-to-Point Signaling

The following are the variations to the point-to-point signaling Sections of the UNI 3.1 Specification to support the IISP interface. In some instances, the user side of a switching system may have to perform internal procedures based on the network side specifications (such instances are presented below).

5.3/UNI 3.1

This Section uses the terminology “calling user” and “called user”. For the purposes of the IISP, both terms should be considered as the “user side”.

Section 5.5/UNI 3.1

The terms calling party, calling user, called party, and called user should all be considered as the user side.

Transit Network Selection (TNS) support is optional at this interface.

The two applicable cases when the TNS is supported, showing UNI 3.1 Annex D procedures, are illustrated in Figure 7-1 below.

(A) When a group of private switching systems or a private network connected to more than one public ATM carriers, with the support of TNS, the TNS IE is handled by the IISP entity (network-side as well as the user-side) in accordance with the Section D.2 of Annex D.

(B) When a group of private switching systems or a private network does not support TNS, the IE should be handled in accordance with the Section D.1 of Annex D.

Section 5.5.1.1/UNI 3.1

At the end of this Section, at the final expiry of Timer T303, the user side shall internally clear the call and proceed as specified on the network side in Section 5.5.2.5.4/UNI 3.1 (i.e., the switching system playing the role of the user side shall initiate call clearing towards the originator), where the cause value should be # 3, “no route to destination”. Note that no new SETUP messages will be generated on each expiry of the Timer T303.

Section 5.5.1.3/UNI 3.1

Replace the term network by the term switching system; the decision to support a certain Quality of Service (QoS) is determined by the switching system since there is no network-wide coordination among switching systems to determine the capability of the succeeding switching systems.

Section 5.5.1.7/UNI 3.1

The last line should read: At this point an ATM connection is established for this interface.

Section 5.5.2.4/UNI 3.1

Replace cause code #47 by cause code #37, as stated in Section 5.5.1.3/UNI 3.1. Add the last paragraph of Section 5.5.1.3/UNI 3.1 to this Section, after changing the term network into the term user.

Section 5.5.2.5.1.1/UNI 3.1

The last four paragraphs of this Section do not apply since this interface is not the actual end user. These paragraphs should be replaced by Sections 5.5.1.4/UNI 3.1 and parts of Section 5.5.1.5/UNI 3.1 after modifying them to make them apply to user side. The replacement text is as follows:

Upon receiving the SETUP message, the user side determines that the call information received from the network side is invalid (e.g., invalid number), then the user side shall initiate call clearing in accordance with Section 5.5.2.5.3/UNI 3.1 with a cause such as the following:

- #1 “unassigned (unallocated) number”;
- #3 “no route to destination”;
- #22 “number changed”;
- #28 “invalid number format (address incomplete)”.

If the user side determines that a requested service is not authorized or is not available, the user side shall initiate call clearing in accordance with Section 5.5.2.5.3/UNI 3.1 with one of the following causes:

- #38 “network out of order”;
- #57 “bearer capability not authorized”;
- #58 “bearer capability not presently available”;
- #63 “service or option not available, unspecified”; or
- #65 “bearer service not implemented”.

Note, however, that there are specific conditions under which particular Cause IEs shall be returned as described in Section 8.

Section 5.5.2.5.1.2/UNI 3.1

This Section is not applicable.

Section 5.5.2.5.4/UNI 3.1

Change cause codes to cause # 3, “no route to destination”.

Section 5.5.2.6/UNI 3.1

The second paragraph is not applicable.

7.3 Procedural Updates to Point-to-Multipoint Signaling

The following are the variations to the point-to-multipoint signaling Sections of the UNI 3.1 Specification to support the Interim Inter-Switch Signaling Protocol (IISP). Unless explicitly stated, the use of the terms calling party, called party, the Root, remote users shall take the definition as in UNI 3.1.

Section 5.6/UNI 3.1 Call/Connection Control Procedures for Point-to-Multipoint Calls

First Note of this Section - The use of “network” shall be considered to mean “network switching system”.

Second Note of this Section - Does not apply to the IISP specification.

Section 5.6.1/UNI 3.1 Adding a party at the Originating interface

Add the following paragraph:

“The procedure described in this Section shall apply to an interface where the call/connection is progressing from a user side implementation to a network side implementation.”

Section 5.6.1.1/UNI 3.1 Set up of the first party

The term “Root (terminal)” should be considered as “the user side”.

The following modifications are made to clarify the procedure, they do not represent changes to the UNI 3.1 procedure.

First paragraph starting with “The setup of the first party ...” - the phrase does not apply to the IISP, replace with the following:

“The network shall transfer a SETUP message with a new call reference value across the interface if the link-state is either Null or in a clearing state. When a SETUP message is used, the procedures of UNI 3.1 for call set-up as described in Section 5.5 for point-to-point calls; in particular only messages of the basic UNI 3.1 messages listed in Table 5-2 Messages for ATM Call and Connection Control and no messages specific to point-to-multipoint control, such as ADD PARTY will be used. The link-states for the call change

according to the call state changes as described in Section 5.5. For each additional party in the call, if the routing table returns an interface index which already has the same call, the ADD PARTY message is used. If the message does not have the same call, then the SETUP is used”.

Third paragraph starting with “The SETUP message” - replace with the following to clearly state the procedure Section to set the Endpoint Reference.

“The SETUP message sent by the user side Root (terminal) must contain the Endpoint Reference value set according to Section 5.4.8.1/UNI 3.1 to zero for the first party and with the Broadband bearer capability information element indicating point-to-multipoint in the user plane connection configuration field.”

Section 5.6.1.2/UNI 3.1 Adding a Party

The terms “calling party” and “Root” shall be considered as user side.

The following text represent a procedure change in user side procedure:

First paragraph starting with “The calling party ...” - the UNI 3.1 user side procedure does not handle multiple ADD-PARTY messages, add the text to the end of first paragraph:

“If there is one and only one party in the Add Party Initiated party-state and the link is not yet in the Active link-state, additional ADD PARTY requests shall be queued by the user until the link either becomes active or is cleared. At this point the queued ADD PARTY requests are treated as if they had just arrived. If the user is unable to queue any additional ADD PARTY requests, the user shall clear the party toward the calling user with cause #92, “Too many pending ADD PARTY requests. ”

Second last paragraph starting with “If a user receives a RELEASE ...” - Adding pending parties of the connection can not be optional in a network switching system, the user side shall use the procedure as specified on network side in Section 5.6.2.1/UNI 3.1 (i.e. adding pending party shall be made mandatory procedure in user side).

Last paragraph starting with “If the user does not ...” - User side must implement the option, therefore, this paragraph shall be ignored.

Section 5.6.1.3/UNI 3.1 Invalid Call/Connection Control Information or Service Request in the ADD PARTY message

After cause #47 - add the following

#49 “Quality of Service unavailable”

#37 “User cell rate not available”

Section 5.6.1.5/UNI 3.1 Add Party Connected

The terms “calling user” and “Root” shall be considered as “the user side”. In the revised text below, the term “calling user” shall be considered as the “the Root” of the point-to-multipoint connection.

The following text represents procedure changes to the user side implementation.

At the end of the first paragraph starting with “Upon receiving an indication ...” - add the following text to conform the add party to the calling user:

“The user shall initiate procedure to confirm the add-party as specified on the network side implementation in Section 5.6.2.7/UNI 3.1 (i.e. sending an ADD PARTY ACKNOWLEDGE message towards the calling user).”

Last paragraph starting with “If timer T399 expires...” - needs to clear the network connection toward the calling user, replacement text is as follows:

“If timer T399 expires, the user shall internally clear the party and proceed as specified on the network side in Section 5.6.2.5.3/UNI 3.1 (i.e. the user shall initiate procedures to send an ADD PARTY REJECT message toward the calling user with cause #3 “no route to destination”. After sending the ADD PARTY REJECT message, if there are no remaining parties in the Active or Add Party Received party-state then the user shall send a RELEASE message to the network. The cause used in the release message is #31, “Normal unspecified.”)

Section 5.6.1.6/UNI 3.1 Add Party Rejection

End of Section - the UNI 3.1 user side procedure does not clear party request toward calling user since it is not a network switching system. In this scenario, the user side implementation of a network switching system shall perform the network side procedure as specified in Section 5.6.2.5.2/UNI 3.1.

Section 5.6.2.1/UNI 3.1 Incoming add party request

The following text is modified to clarify the procedure, it does not represent changes to the UNI 3.1 procedures.

Third paragraph starting with “When a SETUP ...” - the current text does not clearly state the procedure Section number to set the Endpoint Reference. Replace with the following:

“When a SETUP message is used the point-to-point procedure of Section 5.52 of UNI 3.1 shall be used except that the Endpoint reference information element and broadband bearer capability information element must be included in the message and the party-states are tracked. The value of the Endpoint Reference shall be set according to Section 5.4.8.1/UNI 3.1. The user plan connection configuration field of Broadband bearer capability information element shall be set to point-to-multipoint.”

Fourth paragraph starting with “The network shall transfer ...” - the following text to clarify information to be included in the converted SETUP message, add to the end of paragraph:

“Information which are mandatory in the SETUP message, i.e., bandwidth, bearer capability and QoS, shall be the same as those contained in the original SETUP message, although these are not contained within the ADD PARTY message.”

Section 5.6.2.3/UNI 3.1 Connection identifier (VPCI/VCI) allocation/selection — destination

Add the following text to the end of the paragraph to clarify the procedure of conflicting VPCI/VCI allocations.

“If the connection identifier information element is included in the ADD PARTY message, the user shall ignore it.”

Section 5.6.2.4/UNI 3.1 QoS and Traffic parameter selection procedures

Add the following text to the end of the first paragraph to clarify the procedure of conflicting VPCI/VCI allocations.

“If the QoS and the ATM user cell rate information elements are included in the ADD PARTY message, the user shall ignore them.”

Second paragraph starting with “If the user is not able to ...” - the user shall check the available resources as specified on network side in Section 5.6.1.3/UNI 3.1, replacement text is as follows:

“If the user does not implement a requested bearer service or is not able to support the requested ATM user cell rate or QoS class, the user shall reject the Add Party request, returning an ADD PARTY REJECT message with cause #58 “bearer capability not presently available”, #47, “Resources unavailable, unspecified” or cause #49, “Quality of Service unavailable”, respectively ”.

Section 5.6.2.5.1.1/UNI 3.1 Procedures when the user is an ATM endpoint

The last four paragraphs of this Section do not apply since this interface is not the actual end user. These paragraphs shall be replaced with Section 5.6.1.3/UNI 3.1 after modifying the text to make the them apply to user side. The replacement text is as follows:

If the user receives an ADD PARTY message, the user shall enter Add Party Received party-state.

If the user determines that the called party information received from the network is invalid (e.g., invalid number), then the user will send an ADD PARTY REJECT message and enter Null party-state. The cause used in rejection is specified below.

- #1 “unassigned (unallocated) number”;
- #3 “no route to destination”;
- #22 “number changed”;
- #28 “invalid number format (incomplete number)”

Similarly, if the user determines that a requested service is not authorized, not implemented, or is not available, the user shall send an ADD PARTY REJECT message with one of the following causes:

- #38 “network out of order”
- #57 “bearer capability not authorized”
- #58 “bearer capability not presently available”
- #63 “service or option not available, unspecified”, or
- #65 “bearer service not implemented”

If the user can determine that access to the requested resource is authorized and available, the user shall progress the call.

Section 5.6.2.5.1.2/UNI 3.1 Procedures when the user is not an ATM endpoint

This Section is not applicable to the IISP Specification.

Section 5.6.2.5.2/UNI 3.1 Called user rejection of incoming call establishment

The term “called user” shall be considered as the user side.

Section 5.6.2.5.3/UNI 3.1 Call failure

Change the cause code #18 “no user responding” to #3 “no route to destination”.

Section 5.6.2.6/UNI 3.1 Call/Connection accept

Add the following text to the end of the Section:

“This message indicates to the network that an additional party has been added to the connection.”

Section 5.6.3.2/UNI 3.1 Exception conditions

Bullet b) - replace with the following text to clarify the procedure.

b. In response to an ADD PARTY message, the user or network can reject an ADD PARTY request by responding with an ADD PARTY REJECT provided no other response has previously been sent. In addition, after sending the ADD PARTY REJECT message, if there are no remaining parties in the Active or Add Party Received party-state then the user or network shall send a RELEASE message across the interface to the user. The cause used in the RELEASE message is #31, "Normal unspecified."

Section 5.6.5.4/UNI 3.1 Message type or message sequence errors

Third paragraph - needs to specify procedure for both user and network side, replace the text by the following:

"Whenever the network or user receives an unexpected DROP PARTY ACKNOWLEDGE message, the network side receives the message shall: initiate normal party clearing procedures toward the remote user with the cause indicated in the received DROP PARTY ACKNOWLEDGE message by the user or, if not included, cause #111, "protocol error, unspecified"; release the endpoint reference; stop all timers; and enter the Null party-state. Whenever the user receives an unexpected DROP PARTY ACKNOWLEDGE message, the user shall: release the endpoint reference; stop all timers; and enter the Null party-state. If no parties remain in the Active, Add Party Initiated or Add Party Received party-state on the call at the interface when either side receives the DROP PARTY ACKNOWLEDGE message, the side receiving the DROP PARTY ACKNOWLEDGE shall disconnect the bearer virtual channel and send a RELEASE message."

Section 5.6.5.7.1/UNI 3.1 Mandatory information element missing

First paragraph - needs to specify procedure for both user and network side, replace the text by the following:

"When an ADD PARTY message is received which has one or more mandatory information elements missing, an ADD PARTY REJECT message with cause #96, "mandatory information element is missing" shall be returned. After sending the ADD PARTY REJECT message, if there are no remaining parties in the Active or Add Party Received party-state, then the network shall send a RELEASE message shall be sent across the interface to the user. The cause used in the RELEASE message is #31, "Normal unspecified." "

Section 5.6.5.7.2/UNI 3.1 Mandatory information element content error

First paragraph - needs to specify procedure for both user and network side, replace the text by the following:

“When an ADD PARTY message is received which has one or more mandatory information elements with invalid content, an ADD PARTY REJECT or RELEASE message, as appropriate, with cause #100, “invalid information element contents” shall be returned. After sending the ADD PARTY REJECT message, if there are no remaining parties in the Active or Add Party Received party-state, then the network shall send a RELEASE message shall be sent across the interface to the user. The cause used in the RELEASE message is #31, “Normal unspecified.” ”

Section 5.6.5.8.1/UNI 3.1 Unrecognized information element

Fourth paragraph and bullet (a), (b) - the following text clearly state the procedures that need to be performed when the error occurs. This modified text does not represent change to the UNI 3.1 procedure. The replacing text is as follows:

If a clearing message contains one or more unrecognized information elements, the user or the network shall process the received clearing message the error is reported to the local user in the following manner:

- a. When a DROP PARTY message is received which has one or more unrecognized information elements, the recipient shall use procedures specified in Section 5.6.3.3 and 5.6.3.4/UNI 3.1 on receipt of an ADD PARTY message with the exception that a DROP PARTY ACKNOWLEDGE or RELEASE message with cause #99, “information element non-existent or not implemented”, shall be returned. The cause information element diagnostic field, if present, shall contain the information element identifier for each information element which was unrecognized.
- b. When a DROP PARTY ACKNOWLEDGE message is received which has one or more unrecognized information elements, the recipient shall initiate normal party clearing procedures toward the remote user with the cause #31 “normal unspecified”; stop all timers; release the endpoint reference and enter the Null party-state. No action shall be taken on the unrecognized information.

Section 5.6.5.11/UNI 3.1 Status enquiry procedure

Sixth paragraph starting with “If timer T322 ..” - the term “the network” shall be considered as the network switching system since the procedure applies to both network side and user side.

8 IISP Routing

8.1 IISP Routing Classification

IISP assumes no exchange of routing information between switching systems. It uses a fixed routing algorithm with static routes. Routing is done on a hop-by-hop basis by making a best match of the destination address in the call setup with address entries in the next hop routing table at a given switching system. Entries in the next hop routing table are configured by the user. The Management Interface to configure this table is beyond the scope of this specification.

The next hop routing table has entries consisting of the triplet: <ATM address, address length, interface index> where the ATM address is a 20-octet string defined by the UNI 3.1 Specification. The length is an integer value specifying the number of significant bits that need to be taken into account while comparing the destination ATM address from the call setup with the table entry. The interface index is a unique identifier for an interface on the switching system. For further details on next hop table matching see Section 6.

Appendix B presents guidelines on how the next hop routing tables may be generated.

Upon a request from the signaling function, the IISP routing function provides the following information:

- return the interface index over which the call should be routed in order to reach the destination

If no match in the next hop table is found, the IISP routing function indicates that fact to the signaling function which in turn should generate a RELEASE COMPLETE message with rejection cause: #3 “no route to destination”.

If a match is found in the next hop table, the IISP routing function shall verify that the interface identified by the interface index in the routing entry is active for routing calls over it. If not, the IISP routing function indicates that fact to the signaling function which in turn should generate a RELEASE COMPLETE message with rejection cause: #38 “network out of order”.

In the case where the Call Admission Control is implemented a call can still be rejected even if a match is found in the next hop table.

8.2 Support for Parallel Links

In the case when the next hop towards the destination is reachable through a number of parallel links, a local decision has to be made at the switching system to determine which link should be used. There can be a multitude of schemes and algorithms to implement such selection. The scheme used could depend on such variables as the peak and sus-tained cell rate of the call and thus is a matter of local implementation and therefore is not described in this Specification.

8.3 Support for Link Failures

In the event of an IISP link failure, all SVC calls through that link shall be cleared per the procedures of Section 5.5.6.10/UNI 3.1.

8.4 Call Admission Control Support

Support for Call Admission Control (CAC) is optional. The use of CAC does not guarantee QoS on an end-to-end basis; it is only local. The switching system CAC decides whether to admit or reject a call on a selected link. In case of a call rejection by the CAC the rejection cause in the RELEASE COMPLETE message should be stated. Two possible causes can be generated depending the condition detected by the CAC:

- 1) #49 "Quality of Service unavailable"
- 2) #37 "user cell rate unavailable"

Upon the receipt of a call setup message the first step is to consult the IISP routing function for a match in the next hop routing table. In case such a match is found and a selected interface index is returned, additional constraints are verified by the CAC for that interface (if present). The verification of these constraints will determine whether the user requested cell rate and the QoS are available on that interface. If the constraints are satisfied, the signaling call setup message is transmitted over that interface to the next hop on the path to the destination. Failure to satisfy either of the constraints results to the rejection of the call.

8.5 Support for Alternate Routes

Alternate routes can be configured into the routing tables in such a way as to be selected when the interface selected by the first match is in the inactive state.

The Management Interface must support the next hop table configuration such that routes leading to loops are avoided. Guidelines for alternate route configurations are out of the scope of this document.

In the event of a failure to proceed with a call setup due to any cause, the switching system experiencing the failure shall clear the call as described Sections 8.2-8.5 above. The call control procedures for alternate routing, if any, of such cleared calls are a matter of local implementation.

Appendix A: Example IISP Routing Scenario

This Appendix shows an example of routing tables with ATM addresses for a network configured according to the guidelines stated in Appendix B.

The following is an example of a 12 switching system private network organized in a hierarchical way.

The organization of the hierarchy in the example reflects the prefix assignments at various levels. The prefixes for each hierarchical area are denoted in Figure A-1. Further it is assumed that there are two pairs of End Systems (ESs) that establish connections. The first ES (source) ES1_s generates the call to the ES (destination) ES1_d. The convention adopted for the notation of the ATM address are bytes separated by the “.” symbol. The AFI selected for the example is 39. The call is routed on the following path:

```
ES1_s -> (39.0.0.0.0.0.1.1.0.0.1.1)->
(39.0.0.0.0.0.1.1.0.0.3.1)->(39.0.0.0.0.0.1.1.0.0.3.3)->
(39.0.0.0.0.0.1.1.0.0.3.4)->(39.0.0.0.0.0.1.0.2.0.0.1)->
(39.0.0.0.0.0.1.0.2.0.0.2)-> ES1_d
```

Similarly the call from ES2_s is routed on the following path:

```
ES2_s -> (39.0.0.0.0.0.1.1.0.0.2.3)->
(39.0.0.0.0.0.1.1.0.0.2.2)->(39.0.0.0.0.0.1.1.0.0.3.1)->
(39.0.0.0.0.0.1.1.0.0.3.3)-> ES2_d
```

For a clearer picture, we assume (without any loss of generality) that the routing will be implemented via next hop tables which will select for each call setup the shortest path in the presented network. In other words, it is routing on paths with the smallest number of hops.

There are many ways that the tables can be configured. We will take advantage of the aggregation of ATM prefixes that occurs at the various areas and hierarchical boundaries. This reduces the number of entries that need to be configured in the next hop routing table. If the amount of table entries (and the amount of configuration required) is of no concern, then specific un-aggregated entries may be included in the next hop routing table to generate explicit paths.

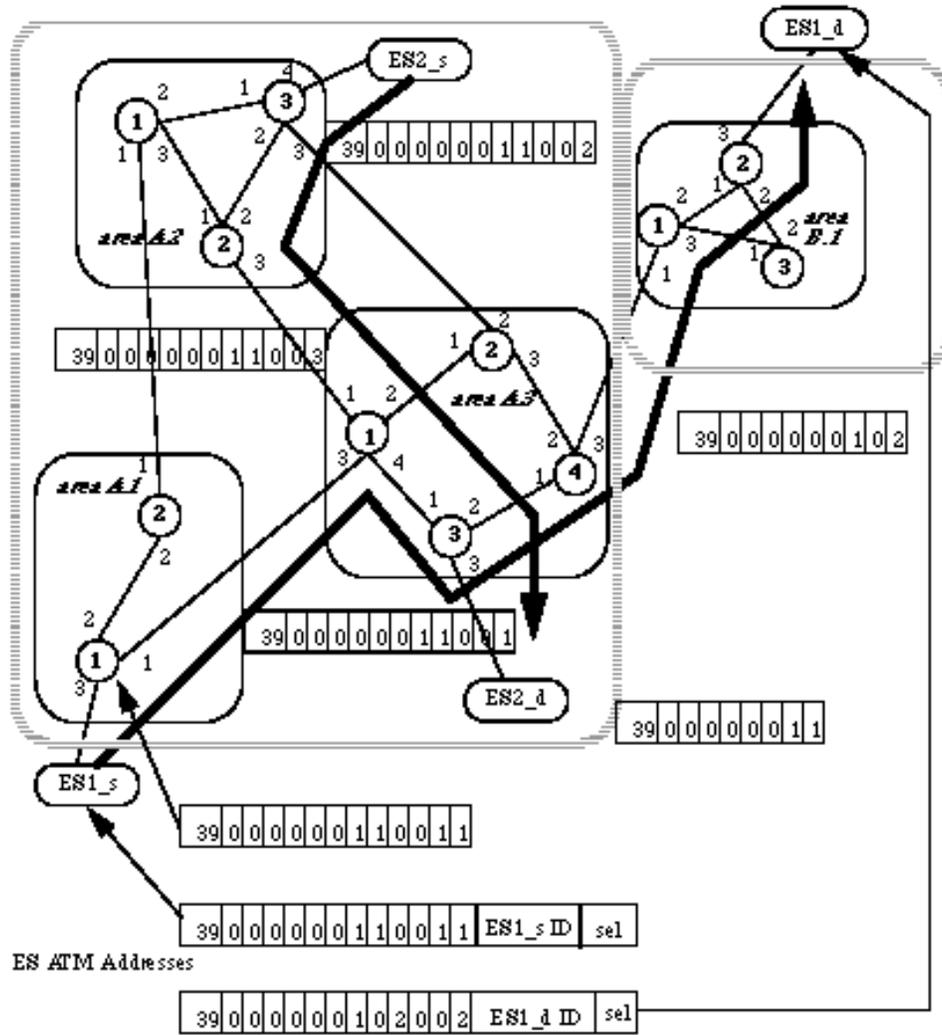


Figure A-1 IISIP Routing Example

Here are the next hop routing tables for the switches from the topology presented in Figure A-1. Switching systems are identified by their Prefix (an example of such a prefix for

the switching system to which ES1_s is connected is given in Fig. A-1). Further it has been assumed that the ES1_s, ES1_d, ES2_s, ES2_d values are as follows: 0.0.1.1.1.1; 0.0.1.1.1.2; 0.0.1.1.1.3; 0.0.1.1.1.4 . The “Length” entry in the routing tables contains the number of significant bits of the destination ATM address to be compared with the Destination ATM Address entry and the “Intf.” entry contains the interface index to be used for routing to the destination.

Area A.1**Switching System (39.0.0.0.0.0.1.1.0.0.1.0)**

| Destination ATM Address | Length | Intf. |
|--|--------|-------|
| 39.0.0.0.0.0.0.1.1.0.0.1.1.0.0.1.1.1.1.0 | 152 | 3 |
| 39.0.0.0.0.0.0.1.1.0.0.1.2 | 104 | 2 |
| 39.0.0.0.0.0.0.1.1.0.0.2 | 96 | 2 |
| 39.0.0.0.0.0.0.1.1.0.0.3 | 96 | 1 |
| 39.0.0.0.0.0.0.1.0.2 | 80 | 1 |

Switching System (39.0.0.0.0.0.1.1.0.0.1.2)

| Destination ATM Address | Length | Intf. |
|----------------------------|--------|-------|
| 39.0.0.0.0.0.0.1.1.0.0.1.1 | 104 | 2 |
| 39.0.0.0.0.0.0.1.1.0.0.2 | 96 | 1 |
| 39.0.0.0.0.0.0.1.1.0.0.3 | 96 | 1 |
| 39.0.0.0.0.0.0.1.0.2 | 80 | 1 |

Area A.2**Switching System (39.0.0.0.0.0.1.1.0.0.2.3)**

| Destination ATM Address | Length | Intf. |
|--|--------|-------|
| 39.0.0.0.0.0.0.1.1.0.0.2.3.0.0.1.1.1.3.0 | 152 | 4 |
| 39.0.0.0.0.0.0.1.1.0.0.2.2 | 104 | 2 |
| 39.0.0.0.0.0.0.1.1.0.0.2.1 | 104 | 1 |
| 39.0.0.0.0.0.0.1.1.0.0.3 | 96 | 3 |
| 39.0.0.0.0.0.0.1.1.0.0.1 | 96 | 1 |
| 39.0.0.0.0.0.0.1.0.2 | 80 | 3 |

Switching System (39.0.0.0.0.0.1.1.0.0.2.2)

| Destination ATM Address | Length | Intf. |
|----------------------------|--------|-------|
| 39.0.0.0.0.0.0.1.1.0.0.2.3 | 104 | 2 |
| 39.0.0.0.0.0.0.1.1.0.0.2.1 | 104 | 1 |
| 39.0.0.0.0.0.0.1.1.0.0.3 | 96 | 3 |
| 39.0.0.0.0.0.0.1.1.0.0.1 | 96 | 1 |
| 39.0.0.0.0.0.0.1.0.2 | 80 | 3 |

Switching System (39.0.0.0.0.0.1.1.0.0.2.1)

| Destination ATM Address | Length | Intf. |
|----------------------------|--------|-------|
| 39.0.0.0.0.0.0.1.1.0.0.2.3 | 104 | 2 |
| 39.0.0.0.0.0.0.1.1.0.0.2.2 | 104 | 3 |
| 39.0.0.0.0.0.0.1.1.0.0.3 | 96 | 3 |
| 39.0.0.0.0.0.0.1.1.0.0.1 | 96 | 1 |
| 39.0.0.0.0.0.0.1.0.2 | 80 | 1 |

Area A.3**Switching System (39.0.0.0.0.0.1.1.0.0.3.1)**

| Destination ATM Address | Length | Intf. |
|----------------------------|--------|-------|
| 39.0.0.0.0.0.0.1.1.0.0.3.2 | 104 | 2 |
| 39.0.0.0.0.0.0.1.1.0.0.3.3 | 104 | 4 |
| 39.0.0.0.0.0.0.1.1.0.0.3.4 | 104 | 4 |
| 39.0.0.0.0.0.0.1.1.0.0.2 | 96 | 1 |
| 39.0.0.0.0.0.0.1.1.0.0.1 | 96 | 3 |
| 39.0.0.0.0.0.0.1.0.2 | 80 | 4 |

Switching System (39.0.0.0.0.0.1.1.0.0.3.2)

| Destination ATM Address | Length | Inf. |
|--------------------------|--------|------|
| 39.0.0.0.0.0.1.1.0.0.3.1 | 104 | 1 |
| 39.0.0.0.0.0.1.1.0.0.3.3 | 104 | 1 |
| 39.0.0.0.0.0.1.1.0.0.3.4 | 104 | 3 |
| 39.0.0.0.0.0.1.1.0.0.2 | 96 | 2 |
| 39.0.0.0.0.0.1.1.0.0.1 | 96 | 1 |
| 39.0.0.0.0.0.1.0.2 | 80 | 3 |

Switching System (39.0.0.0.0.0.1.1.0.0.3.3)

| Destination ATM Address | Length | Inf. |
|--|--------|------|
| 39.0.0.0.0.0.1.1.0.0.3.3.0.0.1.1.1.4.0 | 152 | 3 |
| 39.0.0.0.0.0.1.1.0.0.3.2 | 104 | 2 |
| 39.0.0.0.0.0.1.1.0.0.3.1 | 104 | 1 |
| 39.0.0.0.0.0.1.1.0.0.3.4 | 104 | 2 |
| 39.0.0.0.0.0.1.1.0.0.2 | 96 | 1 |
| 39.0.0.0.0.0.1.1.0.0.1 | 96 | 1 |
| 39.0.0.0.0.0.1.0.2 | 80 | 2 |

Switching System (39.0.0.0.0.0.1.1.0.0.3.4)

| Destination ATM Address | Length | Inf. |
|--------------------------|--------|------|
| 39.0.0.0.0.0.1.1.0.0.3.1 | 104 | 1 |
| 39.0.0.0.0.0.1.1.0.0.3.3 | 104 | 1 |
| 39.0.0.0.0.0.1.1.0.0.3.2 | 104 | 2 |
| 39.0.0.0.0.0.1.1.0.0.2 | 96 | 2 |
| 39.0.0.0.0.0.1.1.0.0.1 | 96 | 1 |
| 39.0.0.0.0.0.1.0.2 | 80 | 3 |

Area B.1**Switching System (39.0.0.0.0.0.1.0.2.0.0.1)**

| Destination ATM Address | Length | Intf. |
|-----------------------------|--------|-------|
| 39.0.0.0.0.0.0.1.0.2.0.0.2. | 104 | 2 |
| 39.0.0.0.0.0.0.1.0.2.0.0.3. | 104 | 3 |
| 39.0.0.0.0.0.0.1.1 | 72 | 1 |

Switching System (39.0.0.0.0.0.1.0.2.0.0.2)

| Destination ATM Address | Length | Intf. |
|--|--------|-------|
| 39.0.0.0.0.0.0.1.0.2.0.0.2.0.0.1.1.1.2.0 | 152 | 3 |
| 39.0.0.0.0.0.0.1.0.2.0.0.1. | 104 | 1 |
| 39.0.0.0.0.0.0.1.0.2.0.0.3. | 104 | 2 |
| 39.0.0.0.0.0.0.1.1 | 72 | 1 |

Switching System (39.0.0.0.0.0.1.0.2.0.0.3)

| Destination ATM Address | Length | Intf. |
|-----------------------------|--------|-------|
| 39.0.0.0.0.0.0.1.0.2.0.0.2. | 104 | 2 |
| 39.0.0.0.0.0.0.1.0.2.0.0.1. | 104 | 1 |
| 39.0.0.0.0.0.0.1.1 | 72 | 1 |

Appendix B: Routing Guidelines

An implication of the IISP is that the paths on which the virtual circuits are routed are configured manually. It is also assumed that the routing function is hop by hop. Thus a set of next-hop routing tables (one for each switching system) needs to be configured. It should be noted that not every set of arbitrary paths from a single source to a single destination can be implemented via a set of next hop routing tables. Paths should be selected in such a way that they could be implemented via the next hop routing tables.

The method presented below is an example, although not the only way to generate such tables:

As exactly the same network topology for the calculation of the shortest path tree at each switching system is used, the next-hop tables generated on the basis of such trees will lead to a set of next-hop routing tables that lead to paths that are loopless (moreover, they are the shortest paths lead-ing to the selected destination).