The ATM Forum

Technical Committee

ATM Inter-Network Interface
Specification Version 1.1
(AINI 1.1)

af-cs-0125.001
September 2002

(Contents are Identical to af-cs-0125.002)

Preface to AINI 1.1

The AINI 1.1 specification is contained in af-cs-0125.002 and in af-cs-0125.001. The contents of both documents are strictly identical, the only difference being that af-cs-0125.001 contains revision marks to the existing AINI text of af-cs-0125.000. In the unlikely case of discrepancies between the two documents, the text of af-cs-0125.002 shall have precedence over the text of af-cs-0125.001.

This new version of the AINI specification, i.e., version 1.1, is comprised of:

- af-cs-0125.000, *ATM Inter-Network Interface (AINI) Specification* (July 1999)
- Updates to the original text to have it reference PNNI 1.1 (and so benefit from the updates contained in that specification)
- Any additional technical or editorial corrections or updates
- An updated "Mandatory and Optional Capabilities" table listing all currently specified AINI capabilities and referencing the associated AINI addenda

As a result, this specification supersedes af-cs-0125.000.

When AINI 1.1 is supported, any reference to af-cs-0125.000 in the AINI addenda listed below shall be understood as a reference to AINI 1.1 instead. Similarly, when AINI 1.1 is supported, any reference to UNI Signalling 4.0 [2] or PNNI 1.0 [3] in those addenda shall be understood as a reference to UNI Signalling 4.1 [6] or PNNI 1.1 [7], respectively.

One major difference between AINI 1.1 and af-cs-0125.000 is the discontinued specification of AINI / B-ISUP interworking. Sections and procedures related to this interworking that were contained in af-cs-0125.000 are not part of AINI 1.1. Similarly, sections and procedures related to this interworking that are contained in the addenda listed below do not apply to AINI 1.1.

The following addenda are not integrated in this specification and are applicable to AINI 1.1:

- af-cs-0140.000, *Network Call Correlation Identifier v1.0* (March 2000)
- af-cs-vmoa-0146.000, *Operation of the Bearer Independent Call Control (BICC) Protocol with SIG 4.0/PNNI 1.0/AINI* (July 2000)
- af-cs-0147.000, *UBR with MDCR Addendum to UNI Signalling 4.0, PNNI 1.0 and AINI* (July 2000)
- af-cs-0148.001, *Modification of Traffic Parameters for an Active Connection Signalling Specification (PNNI, AINI and UNI) – version 2.0* (May 2001)
- af-cs-0159.000, *Behavior Class Selector Signalling Version 1.0* (October 2000)
- af-cs-0167.000, *Guaranteed Frame Rate (GFR) Signalling Specification (PNNI, AINI and UNI), Version 1.0* (August 2001)
- af-cs-0173.000, *Domain-Based Rerouting for Active Point- to-Point Calls Version 1.0* (August 2001)
- af-cs-0176.000, *Loop Detection Version 1.0* (April 2002)
- af-cs-0181.000, *Signalling Congestion Control Version 1.0* (April 2002)
- af-cs-0182.000, *Call Processing Priority Version 1.0* (April 2002)

The main enhancements of AINI 1.1 over af-cs-0125.000 are the updated references to PNNI 1.1 and UNI Signalling 4.1. As a result, AINI 1.1 benefits from clarifications and enhancements introduced in those specifications (e.g. enhanced status enquiry, new codepoints for VBR.2 and VBR.3 in the Broadband bearer capability information element, support for the User-user information element, clarified Soft PVC procedures, better pass along procedures, new tagging indicator handling procedures, etc.).

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1 General

1.1 Scope

This document defines the ATM Inter-Network Interface ~~(AINI)~~ protocol version 1.1 (AINI 1.1) for use between ATM networks. The scope of the specification is limited to signalling that is the procedures for dynamically establishing, maintaining, and clearing ATM connections between ATM networks. The procedures are defined in terms of messages and information elements used to characterize the ATM connection.

The AINI 1.1 ~~protocol~~ specification is based on ATM Forum PNNI ~~signalling~~Signalling version 1.1.

The networks on either side of the AINI may be running any protocol internally. However, the goal in defining ~~this~~ the AINI 1.1 protocol is to facilitate interworking of ~~one~~ two networks running PNNI internally in disjoint PNNI routing domains ~~with another network running B-ISUP internally. The protocol also supports interworking of two networks running PNNI internally~~. In addition to defining the AINI 1.1 signalling protocol, this specification also defines protocol interworking between AINI 1.1 and PNNI (versions 1.1 and 1.0)~~, and between AINI and B-ISUP~~. Protocol interworking between AINI 1.1 and any other protocol is not considered in this specification.

The networks involved can either be ATM service provider (ASP) networks or private networks. These terms are defined in [9].

1.2   Capabilities at the AINI 1.1

The following table lists the capabilities supported by signalling at the AINI 1.1.

Table 1-1: Mandatory and Optional Capabilities

No.	Capabilities	Status	Defined In
1	Point-to-point calls	M	-
2	Point-to-multipoint calls	O	-
3	Signalling of Individual QoS parameters	~~O (Note)~~M	-
4	Crankback	O (Note)	-
5	Alternate routing as a result of Crankback	O	-
6	Associated signalling	O	-
7	Negotiation of ATM traffic descriptors	O	-
8	Switched Virtual Path (VP) service	O	-
9	Soft PVPC and PVCC support	O	-
10	ABR Signalling for point-to-point calls	O	-
11	Generic identifier transport (GIT)	O	-
12	Transport of Frame discard indication	O (Note)	-
13	AINI/PNNI interworking	O	-
14[1]	~~AINI/B-ISUP interworking~~	~~O~~	-
15	Security Signalling	O	-
16	Transported Address Stack	O	-
17	Generic Application Transport	O	-
18	End-to-end Connection Completion Indication	O	-
19	Soft PVC Frame Relay Endpoints	O	-
20	Enhanced Status Enquiry	O	-
21	OAM Traffic Descriptor	O	-
22	Network Call Correlation Identifier	O	af-cs-0140.000
23	UBR with MDCR	O	af-cs-0147.000
24	Modification of an Active Connection	O	af-cs-0148.001
25	Behavior Class Selector	O	af-cs-0159.000
26	Guaranteed Frame Rate (GFR) Signalling	O	af-cs-0167.000
27	Domain-Based Rerouting	O	af-cs-0173.000
28	Loop Detection	O	af-cs-0176.000
29	Signalling Congestion Control	O	af-cs-0181.000
30	Call Processing Priority	O	af-cs-0182.000

M: Mandatory
O: Optional

Note: Support is mandatory when AINI/ PNNI interworking is supported and optional otherwise.

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[1] To preserve the numbering of capabilities with the previous version of AINI, this row is intentionally left blank.

2 Addressing

Either one of the following two ATM address formats may be used across an ATM Inter-Network Interface:

1. Native E.164 numbers, as described in Section 3.2 of the ATM Forum Addressing: Reference Guide [9][ATM Forum, af ra 0106.000].

   or

2. ATM End System Addresses (AESAs), as defined in Section 3.1 of the ATM Forum Addressing: Reference Guide [9][ATM Forum, af ra 0106.000].

Although the protocol provides the means for ATM service providers to construct networks supporting all address formats, this does NOT imply that an ATM service provider is required to support all of them or that a customer is required to use all of them. In no case should any ATM Forum specification be interpreted as requiring an ATM service provider to use or to support or to accommodate any particular address type or address plan.

Further information and guidelines regarding the use of ATM addresses can be found in the ATM Forum Addressing: Reference Guide [9][ATM Forum, af ra 0106.000] and in the ATM Forum Addressing: User Guide [8][ATM Forum, af ra 0105.000].

3   AINI **1.1** Signalling Specification

Sections 3.1 through 3.6 of the ATM Inter-Network Interface specification are to be understood as a Delta document to section 6 of af-pnni-0055.002 ~~af pnni 0055.000~~, "Private Network-Network Interface specification version 1.1~~1.0~~ (PNNI 1.1 ~~1.0~~)", as modified by the following ATM-Forum documents:

~~af pnni 0075.000 [PNNI ABR Addendum],~~

- af-cs-0116.000, ~~[~~PNNI Version 1.0 Security Signaling Addendum~~]~~ [13],
- af-cs-0115.000, ~~[~~PNNI Transported Address Stack v1.0~~]~~ [12], and
- af-cs-0126.000, ~~[~~PNNI Addendum for Generic Application Transport Version 1.0~~]~~ [11]~~.~~,

~~af cs 0127.000, [PNNI SPVC Addendum version 1.0], and~~

~~af pnni 0081.000 [PNNI V1.0 Errata and PICS], section 3, items number 75 through 81.~~

All subsections of Section 6 of ~~PNNI V1.0~~PNNI 1.1 shall apply unless exceptions and modifications are explicitly described in this section of the AINI 1.1 specification. No other sections of ~~PNNI 1.0~~PNNI 1.1 apply. Applicability of the Annexes and Appendices of ~~PNNI V1.0~~PNNI 1.1 is described in sections 3.7 and 3.8, respectively.

The modified text constitutes the Signalling part of the AINI 1.1 specification.

Adaptation of Terminology:
For the purpose of adapting the PNNI terminology to the AINI, the following changes are made throughout section 3:

- "PNNI" is replaced by "AINI"
- "Network node" is replaced by "Network"

Changes to individual subsections:

- For clarity of exposition, all second level subsections of Section 6/PNNI 1.1 ~~V1.0~~ are mirrored in a corresponding subsection of Section 3/AINI 1.1 in the following.
- Lower level subsections are listed only when modified beyond the global changes mentioned above.
- Subsections of referenced documents, such as PNNI 1.1 ~~V1.0~~, are identified by the actual subsection number from that document, the document name, and the title of the subsections.
  For example, a modification to section 6.3.1.6 of PNNI 1.1 ~~V1.0~~ is identified by a statement labeled as "6.3.1.6 / PNNI 1.1~~1.0~~ SETUP".

PNNI 1.1 ~~V1.0~~ features not supported at the AINI 1.1:

- PNNI 1.1 ~~V1.0~~ Designated Transit List (DTL)
- ATM Anycast

Start of Delta Description to PNNI 1.11.0

6/PNNI 1.01.1   PNNI Signalling Specification

Replace all text with the following:

> This section contains the procedures to dynamically establish, maintain, and clear ATM connections across the ATM Inter-Network Interface (AINI) between two ATM networks. The procedures are defined in terms of messages and information elements used to characterize the ATM connection. The protocol is based on ATM Forum PNNI signalling version 1.1, which is itself based on ATM Forum UNI signalling version 4.1.

3.1   AINI Model

6.1/PNNI 1.01.1   PNNI Model

3.2   Overview of Call/connection control

6.2/PNNI 1.01.1   Overview of Call/connection control

3.3   Message functional definition and contents

6.3/PNNI 1.01.1   Message functional definition and contents

6.3.1/PNNI 1.01.1   Messages for ATM point-to-point call and connection control

The CO-BI SETUP, FACILITY, TRACE CONNECTION and TRACE CONNECTION ACKNOWLEDGE messages are not supported.

Add the following note after Table 6-1

> Note: See 6.3.2 /PNNI 1.01.1 for additional and modified messages and 6.4.7/PNNI 1.01.1 for additional information elements for the support of 64 kbit/s based ISDN circuit mode services (interworking with N-ISDN)

6.3.1.4/PNNI 1.01.1   RELEASE

The length of the Crankback information element is modified to 4 7.

6.3.1.5/PNNI 1.01.1   RELEASE COMPLETE

The length of the Crankback information element is modified to 4 7.

6.3.1.6/PNNI 1.01.1   SETUP

Reference to Note 6 regarding the Broadband repeat indicator information element is replaced by Note 1.

Note 6 is not applicable.

The Connection scope selection information element is not supported.

The Designated transit list information element is not supported.

Note 7 does not apply.

6.3.2.4/PNNI 1.01.1   RELEASE

Replace the first paragraph with the following text:

> This message is sent by a network to an adjacent network to indicate that it has cleared the connection and is waiting to release the call reference.

6.3.4.1/PNNI 1.01.1 ADD PARTY

Reference to Note 5 regarding the Broadband repeat indicator information element is replaced by Note 1.

Note 5 is not applicable.

The Designated transit list information element is not supported.

Note 6 does not apply.

6.3.4.4/PNNI 1.01.1 ADD PARTY REJECT

The length of the Crankback information element is modified to 4 7.

3.4 General message format and information element coding

6.4/PNNI 1.01.1 General message format and information element coding

6.4.2/PNNI 1.01.1 Protocol discriminator

Add the following text to the end of the section:

       Note: AINI signalling uses the same protocol discriminator as for PNNI signalling and BQSIG.

6.4.5.1/PNNI 1.01.1 Coding rules

Table 6-5:
    The maximum length of the Crankback information element is modified to 7.
    The Designated transit list information element is not supported.
    The Connection scope selection information element is not supported.
    The Facility information element is not supported.
    The Trace transit list information element is not supported.
    The Rerouting information element is not supported.
    Notes 6, 7 and 10 do not apply.

6.4.5.19/PNNI 1.01.1 Cause

The codepoint for cause #53 "Call cleared due to change in PGL" is not supported.

6.4.5.23/PNNI 1.01.1 Connection scope selection

This information element is not supported.

6.4.6.1/PNNI 1.0 Calling party soft PVPC or PVCC[2]

For the coding of this information element refer to "PNNI SPVC Addendum version 1.0".

6.4.6.2/PNNI 1.0 Called party soft PVPC or PVCC[3]

For the coding of this information element refer to "PNNI SPVC Addendum version 1.0".

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[2] 6.4.6.1/PNNI 1.1 applies unchanged.
[3] 6.4.6.2/PNNI 1.1 applies unchanged.

6.4.6.3/PNNI ~~1.0~~1.1 Crankback

Replace the first paragraph with the following text:

> The purpose of the Crankback information element is to indicate that crankback procedures have been initiated.

Modify as follows

> Crankback level (octet 5)

> > The Crankback level is always set to 255.

> Blocked transit type (octet 6)

> > The values of Blocked transit type are replaced with the following:

Bits 8 7 6 5 4 3 2 1	Meaning	Length of blocked transit identifier
0 0 0 0 0 0 1 0	call or party has been blocked at the succeeding end of this interface	0
1 1 1 1 1 1 1 1	call or party has been blocked at or beyond the succeeding node	0

> > All other codepoints are not supported.

> Blocked transit identifier (octet 6.1)

> > The blocked transit identifier is not present.

> Crankback cause (octet 7)

> > The following Crankback cause codepoints are not supported:
> > > #128 "next node unreachable",
> > > #129 "node is a restricted transit node",
> > > #160 "DTL Transit not my node ID".

> > Notes 1 and 2 are not supported.

> Crankback cause diagnostics (Octet 7.1)

> > The Crankback cause diagnostics field is not present.

6.4.6.4/PNNI ~~1.0~~1.1 Designated transit list

This Information Element is not supported.

3.5 Call/connection control procedures for ATM point-to-point calls

6.5/PNNI ~~1.0~~1.1 Call/connection control procedures for ATM point-to-point calls

Replace the first sentence of the second paragraph with the following text:

> Procedures based on ATM Forum PNNI ~~1.0~~1.1 signalling are used to establish ATM switched virtual connections. The PNNI ~~1.0~~1.1 signalling procedures for point-to-point calls are based on the procedures described in ATM Forum UNI Signalling and ITU-T Recommendation Q.2931.

6.5.1/PNNI ~~1.0~~1.1 Establishment of a signalling AAL

Remove the word "private" in the first sentence.

6.5.2.1/PNNI ~~1.0~~1.1 Call/connection request

~~Replace the last sentence of the second paragraph with the following text:~~

> ~~The ATM traffic descriptor and Broadband bearer capability information elements are mandatory in the SETUP message. According to Table 3-8/Q.2931, the Quality of Service parameter information element is mandatory in the SETUP message. From UNI 4.0 Signalling, Section 9.2, it follows that at least one of the Quality of service parameter or Extended QoS parameters information elements must be present. If the Quality of service parameter information element is not present, this means that no interworking with ITU-T protocols is desired.~~

The third paragraph ~~on ATM anycast~~ does not apply.

6.5.2.2/PNNI ~~1.0~~1.1 Connection identifier allocation/selection

At the end of item ii), add the following sentence:

> The signalling channel does not control virtual channels or virtual paths on another physical link.

Replace the last sentence of the first paragraph with the following text:

> The associated signalling procedures are used only when two networks are connected by a virtual path connection used as a logical link.

6.5.2.2.1/PNNI ~~1.0~~1.1 Associated Signalling

Replace the last paragraph with the following text:

> Call collision can occur when both sides of an interface simultaneously transfer SETUP messages indicating the same exclusive VPCI and VCI. In order to avoid call collision, for each AINI interface it must be defined via administration (based on mutual agreement between operators), which side is the assigning network, i.e. which network shall allocate the connection identifier (VPCI, VCI) values. A preceding side that is the assigning network shall include a Connection identifier information element in the SETUP message with option (b) (exclusive VPCI and exclusive VCI). A SETUP message from a preceding side, which is the non-assigning network, shall use option (a).

6.5.2.2.2.1/PNNI ~~1.0~~1.1 Allocation for switched virtual channels

Replace the last paragraph with the following text:

> Call collision can occur when both sides of an interface simultaneously transfer SETUP messages indicating the same exclusive VPCI and VCI. In order to avoid call collision, for each AINI interface it must be defined via administration (based on mutual agreement between operators), which side is the assigning network, i.e. which network shall allocate the connection identifier (VPCI, VCI) values. A preceding side that is the assigning network shall include a Connection identifier information element in the SETUP message with option (b) (exclusive VPCI and exclusive VCI). A SETUP message from a preceding side, which is the non-assigning network, shall use options (a) or (c).

6.5.2.2.2.2/PNNI ~~1.0~~1.1 Allocation for switched virtual paths

Replace the last paragraph with the following text:

> Call collision can occur when both sides of an interface simultaneously transfer SETUP messages indicating the same exclusive VPCI. In order to avoid call collision, for each AINI interface it must be defined via administration (based on mutual agreement between operators), which side is the assigning network, i.e. which network shall allocate the connection identifier (VPCI) values. A preceding side that is the assigning network shall include a Connection identifier information element in the SETUP message with option (d) (exclusive VPCI and no VCI). A SETUP message from a preceding side, which is the non-assigning network, shall use option (c).

6.5.2.3.3/PNNI ~~1.0~~1.1 Traffic parameter selection procedures

Replace "node" with "network".

6.5.2.3.5/PNNI ~~1.0~~1.1 QoS parameter selection procedures

Replace all text with the following:

Start of replacement text for 6.5.2.3.5/PNNI ~~1.0~~1.1

QoS requirements are signalled across AINI interfaces using one of the following methods:

1. Through the values of individual quality of service parameters, which are included in the Extended QoS parameters information element, and optionally the End-to-end transit delay information element;

2. In terms of QoS classes, which are signalled in the QoS parameter information element, and optionally through the value of the QoS related field cell transfer delay, which is signalled in the End-to-end transit delay information element;

3. Both of the above.

Note: Both the Extended QoS parameters information element and the QoS parameter information element can be present in the SETUP message, at least one of these has to be present (See section 9 of UNI Signalling ~~4.0~~4.1 for additional information).

The allowed set of individual QoS parameters and/or QoS classes in the SETUP message is determined by the ATM service category of the call.

6.5.2.3.5.1   Procedures at the preceding side

6.5.2.3.5.1.1   Handling of the QoS parameter information element

When the signalling protocol entity at the preceding side receives a setup ~~indication~~ request that includes a QoS parameter information element, it shall include a QoS parameter information element in the corresponding SETUP message.

~~When the signalling protocol entity at the preceding side belongs to an B-ISUP network and receives a setup indication that does not include a QoS parameter information element, it shall include a QoS parameter information element in the corresponding SETUP message with QoS class set to "unspecified".~~

6.5.2.3.5.1.2   Handling of the Extended QoS parameters information element and the End-to-end transit delay information element

When the signalling protocol entity at the preceding side receives a setup ~~indication~~request, in which no Extended QoS parameters information element is contained, then:

When the ATM service category of the call is CBR, real-time VBR, or non-real-time VBR, as an option, it may generate an Extended QoS parameters information element before progressing the call. A local mapping is used based on the service category and the forward and backward QoS class fields in the QoS parameter information element. In addition, an End-to-end transit delay information element may be generated as part of the above mapping, if it was not contained in the received setup ~~indication~~request.

When such a mapping is used:

-   All individual QoS parameters for which values are implied (from the QoS classes included in the QoS parameters information element and the ATM service category of the call) must be specified;

-   For each individual QoS parameter, if an acceptable value of a parameter is included and the end-to-end value of that parameter is determined by accumulation, then the corresponding cumulative value of the parameter shall also be included. All cumulative parameter values generated from the mapping must be initialized to zero before beginning processing of the individual QoS parameters;

-   The origin of each information element including one or more of the newly generated individual QoS parameters must be marked as an "intermediate network" (i.e., in the Extended QoS parameters information element the Origin field is set to "intermediate network", and in the End-to-end transit delay information element a "network-generated indicator" is included).

For each parameter contained in the Extended QoS parameters information element and/or the End-to-end transit delay information element, the preceding side shall take the following actions (whether the information element was contained in the received setup ~~indication~~ request or whether the information element was generated by the process described in the preceding paragraph):

1. Optionally increment the cumulative forward and backward values of the parameter to account for expected increases due to user data transfer within this network over the related connection, if known and not already accounted for.

2. Increment the cumulative forward value of the parameter to account for expected increases due to user data transfer over this link (from the preceding network to the succeeding network).

3. Determine if the highest/lowest acceptable values of that parameter can be supported. If no values {less than/greater than} or equal to the highest/lowest acceptable value can be supported, then the preceding side shall reject the call. If, in that case, the previous interface is a PNNI interface, the PNNI crankback procedures specified in PNNI 1.0, Annex B, section 8 shall be followed, using cause#49, "Quality of service unavailable", and the corresponding crankback cause.

If no acceptable value of an allowed individual QoS parameter for the corresponding ATM service category is specified (in the Extended QoS parameters or End-to-end transit delay information elements), then the default is that any value of the individual QoS parameter is acceptable and the preceding side shall continue to process the call.

If the preceding side is able to provide the acceptable values of all specified individual QoS parameters, the preceding side shall progress the call to the succeeding side and include all available QoS related information in the Extended QoS parameters information element and/or the End-to-end transit delay information element.

6.5.2.3.5.1.3   Additional requirements at the egress of an ATM Service Provider network

If the AINI is at the egress of an ATM Service Provider network, then:

When the ATM service category of the call is CBR, real-time VBR, or non-real-time VBR, the Extended QoS parameters information element is always provided before progressing the call (i.e. either method 1 or 3 described in section 6.5.2.3.5 shall be used).

6.5.2.3.5.2   Procedures at the succeeding side

6.5.2.3.5.2.1   Handling of the QoS parameter information element

If a QoS parameter information element is contained in the received SETUP message, the succeeding side does not make use of it and passes it on if the call is progressed.

If the QoS parameter information element is not contained in the received SETUP message and the succeeding side belongs to a B-ISUP network it is assumed that no interworking is desired and the call shall be rejected with cause #49, "Quality of service unavailable" (for more information see section 9.2.1 of UNI Signalling 4.0, af-sig-0061.00). In all other cases, the additional procedures in the section below are followed.

6.5.2.3.5.2.2   Handling of the Extended QoS parameters information element and the End-to-end transit delay information element

If no Extended QoS parameters information element is contained in the received SETUP message, the succeeding side may generate the information element following the procedures described in section 6.5.2.3.5.1
For each parameter contained in the Extended QoS parameters information element and/or the End-to-end transit delay information element (whether the information element was contained in the received SETUP message or whether the information element was generated), the succeeding side shall:

1. Increment the backward cumulative value of the parameter, if the parameter is cumulative, to account for the expected increases due to user data transfer over this link (from the succeeding network to the preceding network).

2. Optionally increment the cumulative forward and backward values of the parameter to account for expected increases due to user data transfer within all or part of this network over the related connection, if known and not accounted for when the call is progressed within this network.

3. Determine if the highest/lowest acceptable value of that parameter can be supported. If no values {less than/greater than} or equal to the highest/lowest acceptable value can be supported, then the succeeding side shall follow the crankback procedures specified in Annex A §5.5.1.3. A RELEASE or RELEASE COMPLETE message (depending on whether or not a CALL PROCEEDING message has been sent yet) shall be returned with cause #49, "Quality of service unavailable", and a Crankback information element with the corresponding crankback cause code.

If no acceptable value of an allowed individual QoS parameter for the corresponding ATM service category is specified (in the Extended QoS Parameters or End-to-end transit delay information elements), then the default is that any value of the individual QoS parameter is acceptable and the succeeding side shall continue to process the call.

6.5.2.3.5.2.3   <u>Additional procedures</u>

If the succeeding side is able to provide the requested Quality of Service (based on the information contained in the received SETUP message) the succeeding side shall continue to progress the call.

If the succeeding side is not able to provide the requested Quality of Service (based on the information contained in the received SETUP message) the succeeding side shall reject the call. A RELEASE or RELEASE COMPLETE message (depending on whether or not a CALL PROCEEDING message has been sent yet) shall be returned with cause #49, "Quality of service unavailable" and the corresponding crankback cause code when applicable.

End of replacement text for 6.5.2.3.5/PNNI ~~1.0~~1.1

6.5.2.3.6/PNNI ~~1.0~~1.1   Traffic parameter selection procedures for ABR connections

Replace the third paragraph with the following text:

> The negotiation procedures allow each network to adjust the parameters of a call as needed to protect the resources in that network and the quality of service commitments made to other connections.

Delete the fourth paragraph.

~~Add the following note:~~

> ~~Note: The PNNI ABR Addendum modifies this section.~~

6.5.2.3.7/PNNI ~~1.0~~1.1   Processing of Cumulative RM fixed round-trip time parameter for ABR connections

Replace all text with the following:

> The succeeding side shall adjust the cumulative RM fixed round-trip time parameter in the ~~ABR~~ ATC setup parameters information element. The amount of the adjustment is the sum of the forward and reverse direction fixed portion of the RM cell delay on the AINI, including the forward and reverse link propagation delays and any fixed processing delays at the AINI and within the switching system. The adjustment value, expressed in microseconds encoded as an integer, is added to the cumulative RM fixed round-trip time parameter.

> Note that the Cumulative ABR RM Fixed Round Trip Time parameter is adjusted only in SETUP message processing, not in CONNECT message processing.

~~6.5.2.4/PNNI 1.0 Call/connection proceeding[(4)]~~

~~Delete the last sentence of the paragraph following the Note.~~

6.5.2.6.1/PNNI ~~1.0~~1.1   Procedures for traffic parameter selection during call/connection acceptance

~~Replace "succeeding exchange" with "succeeding side".~~

Replace "node" with "network".

6.5.2.6.2/PNNI ~~1.0~~1.1   Procedures for negotiation of traffic parameters during call/connection acceptance

Replace "node" with "network".

~~Replace the references to Section 6.5.2.6.2/PNNI 1.0 at the end of the second and third paragraphs by references to Section 6.5.2.6.1/PNNI 1.0.~~

6.5.3/PNNI ~~1.0~~1.1   Call/connection clearing

The reference to "Annex B/PNNI ~~1.0~~1.1" is replaced by "Annex A/AINI 1.1".

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[4] 6.5.2.4/PNNI 1.1 applies unchanged.

6.5.3.2/PNNI ~~1.0~~1.1   Exception conditions

Replace the last sentence with the following text:

When the succeeding side has received a SETUP message, no response has previously been sent, and the succeeding side wants to reject the call/connection, it shall:

- respond with a RELEASE COMPLETE message,
- release the call reference, and
- enter the Null state.

6.5.6.5/PNNI 1.1   Message length error

The note at the end does not apply.

~~6.5.7.1/PNNI 1.0   Unexpected or unrecognized message type[5]~~

~~Replace the last paragraph with the following:~~

~~If the pass along request (bit 4) in the instruction field is set to "pass along request" in an unrecognized message and the interface has been configured to allow the pass along of unrecognized messages, the message shall be passed on without error checking, provided the next interface is a PNNI or AINI. Note that the default mode of operation is to allow the pass along of unrecognized messages with "pass along request".~~

~~The remaining error procedures in this section apply to unrecognized messages only if~~
~~the pass along request (bit 4) in the instruction field is set to "no pass along request", or~~
~~the pass along request (bit 4) is set to "pass along request" but the interface has been configured to not pass along unrecognized messages.~~

~~6.5.7.2/PNNI 1.0   Information element error[6]~~

~~Replace the last paragraph with the following:~~

~~If the pass along request (bit 4) in the instruction field is set to "pass along request" in an unrecognized information element and the interface has been configured to allow the pass along of unrecognized information elements, the information element shall be passed on in the message without error checking, provided the next interface is a PNNI or AINI. Note that the default mode of operation is to allow the pass along of unrecognized information elements with "pass along request".~~

~~The remaining error procedures in this section apply to unrecognized information elements only if~~
~~the pass along request (bit 4) in the instruction field is set to "no pass along request", or~~
~~the pass along request (bit 4) is set to "pass along request" but the interface has been configured to not pass along unrecognized information elements.~~

6.5.9/PNNI ~~1.0~~1.1   Network node call control requirements

This section is not applicable to AINI 1.1.

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[5] 6.5.7.1/PNNI 1.1 applies unchanged.
[6] 6.5.7.2/PNNI 1.1 applies unchanged.

3.6 Call/connection control procedures for point-to-multipoint calls

3~~3~~6.6/PNNI ~~1.0~~1.1 Call/connection control procedures for point-to-multipoint calls

6.6.2/PNNI ~~1.0~~1.1 Adding a party

The reference to "Annex B/PNNI ~~1.0~~1.1" in item 3 is replaced by "Annex A/AINI 1.1".

6.6.3/PNNI ~~1.0~~1.1 Party dropping

The reference to "Annex B/PNNI ~~1.0~~1.1" in item 3 is replaced by "Annex A/AINI 1.1".

3.7   Applicability of PNNI 1.01.1 Annexes to AINI 1.1

The following table gives a list of the Annexes to PNNI 1.01.1 and their applicability to AINI 1.1 signalling.

Table 3-1: Applicability of PNNI 1.01.1 Annexes

Annex A/PNNI 1.1, DTL:	N/A
Annex B/PNNI 1.01, Crankback procedures:	Superceded by Annex A/AINI 1.1
Annex C/PNNI 1.1, Soft PVC procedures:	Applies with the following changes: • Occurrences of "PNNI" are replaced by "AINI", except in Section 9.5. • Occurrences of "Network node" are replaced by "Network". Superceded by the PNNI SPVC Addendum, Version 1.0. Section 5 "Compatibility with Nodes Not Supporting This Feature" of the Addendum does not apply
Annex D/PNNI 1.01, Architectural constants:	N/A
Annex E/PNNI 1.01, Architectural variables:	N/A
Annex F/PNNI 1.01, Configuration of PNNI Hierarchy:	N/A
Annex G/PNNI 1.01, PNNI Minimum Subsets:	Superceded by Section 1.2
Annex H/PNNI 1.1, PNNI MIB:	N/A
Annex I/PNNI 1.1, PICS Proforma:	N/A
Annexes J to P/PNNI 1.1, GSS:	N/A
Annex Q/PNNI 1.1, Support of Admin Boundaries:	N/A
Annex R/PNNI 1.1, Enhanced Status Enquiry:	Applies with the following change: • Occurrences of "PNNI" are replaced by "AINI". • Occurrences of "node" are replaced by "network".
Annex S/PNNI 1.1, Explicitly Routed Calls:	N/A
Annex T/PNNI 1.1, OAM Traffic Descriptor:	Applies with the following change: • Occurrences of "PNNI" are replaced by "AINI". • Occurrences of "node" are replaced by "network".

3.8   Applicability of PNNI 1.01.1 Appendices to AINI 1.1

Appendices A through PI of PNNI 1.01.1 are not applicable to AINI 1.1 signalling.

End of Delta Description to PNNI 1.01.1

3.9   Delta Description to Transported Address Stack v1.0 Specification

2.3/TAS 1.0 CL-BI FACILITY Message

This section is not supported.

2.4/TAS 1.0 CO-BI SETUP Message

This section is not supported.

4.1.4/TAS 1.0 Messages for CdPN-Routed Message Rejection

Table 4.1-1: The last two rows of the table are not supported.

4.2/TAS 1.0 Interactions with DTL Roles

This section is not supported.

4.3/TAS 1.0 Additional GSS Procedures

This section is not supported.

6.3.4/TAS 1.0 Role – Transport Origination Point (TAS_MC1)

TASO_8 The questions on the FACILITY and CO-BI SETUP messages are not applicable.

4   Protocol Interworking at the AINI 1.1

This section describes the protocol interworking between AINI 1.1 and the protocols B-ISUP and PNNI 1.1 (or PNNI 1.0).

Three configurations are considered
PNNI → AINI → B-ISUP
B-ISUP → AINI → PNNI
PNNI → AINI → PNNI

Case 3 arises when routing information is not to be conveyed between two connected PNNI base networks. A fourth case (B-ISUP → AINI → B-ISUP) is not considered, since it is assumed that B-ISUP or the B-ISUP based B-ICI would be used as the interconnecting protocol in this case. However, the descriptions given below would not exclude this case.

The descriptions given are based on the approach of ITU-T Recommendation Q.2650, *Interworking between Signalling System No. 7/ Broadband ISDN User Part (B-ISUP), and Digital Subscriber Signalling System No. 2 (DSS2).*
It uses two main techniques to do this:
Mapping Tables: A descriptive mapping of messages and information elements/parameters used by the protocols interworking.
Message Sequence Charts: These are referred to as "Arrow Diagrams" in Q.2650. A set of message sequences for basic call procedures using these mappings.

To describe feature (service) interworking between the different protocols these will be complemented by procedural descriptions where necessary (usually in a note to the mapping tables).

The overall network scenarios are is shown in the following pictures.

It is acknowledged that the function of the *local exchange* and *exchange* switches may be embodied in a single implementation (e.g., interworking between a UNI and an AINI is defined as the transitive interworking of UNI ↔ PNNI ↔ AINI, but this transitive interworking may be implemented directly).
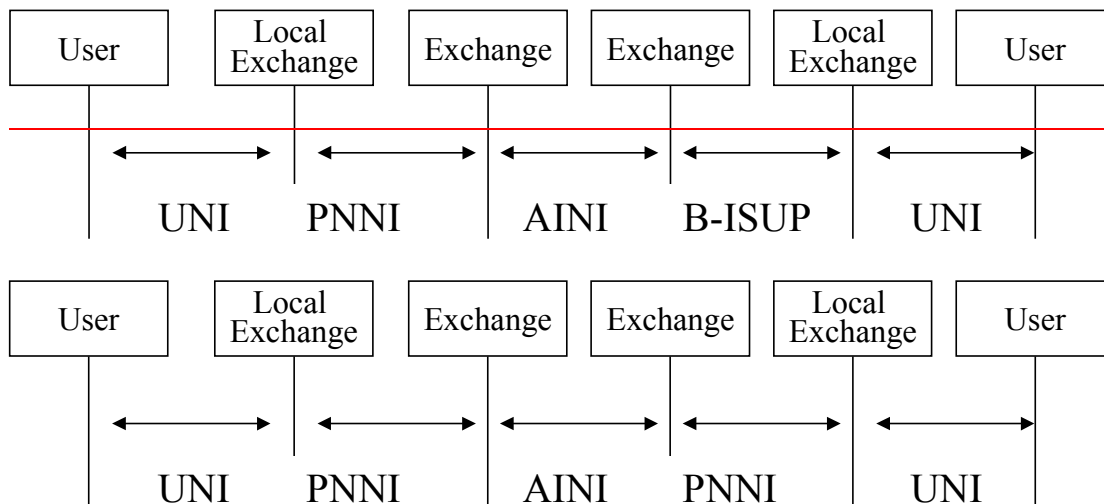
Figure 4-1: Interworking Scenarios

The focus of this specification is shown in the following picture:
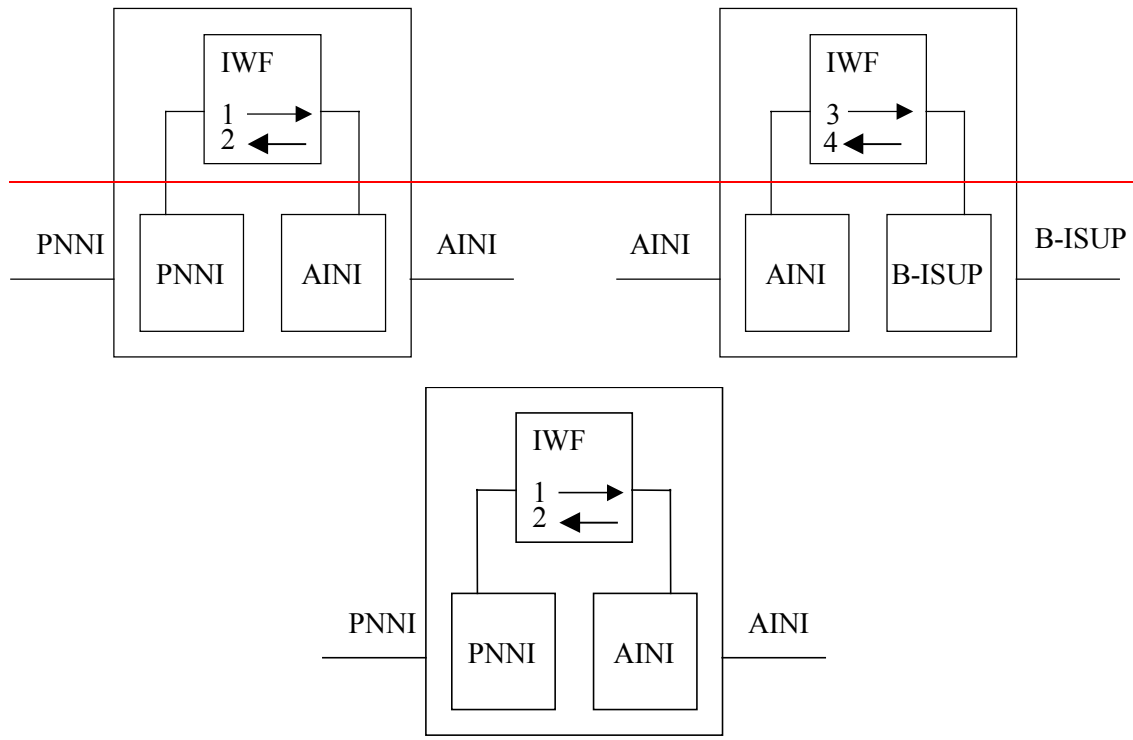
Figure 4-2: Interworking Functions

The ~~subsequent~~ following subsections describes the ~~two~~ Interworking Functions (IWF) shown above.
~~For each of them t~~Two directions of flow (input → output) are described: ~~according to which interface initiates the interaction:~~
1.   describing the direction from PNNI to AINI;
2.   describing the direction from AINI to PNNI.
~~describing the direction from AINI to B-ISUP;~~
~~describing the direction from B-ISUP to AINI.~~

~~Interworking is shown as arrow diagrams showing the message interworking, with tables being used to show the mapping of parameters. These tables also specify the mapping of information elements and parameters, which are carried by the concerned messages. The information elements and parameters that are of local significance only, i.e., are not mapped onto information elements and parameters in the other signalling system, are not shown.~~

~~**Handling of parameters and information elements which pertain to features not supported at the AINI:**~~

~~If optional they are generally discarded and the call is progressed (usually indicated by "not carried" in the mapping tables).~~
~~In all exceptional cases, specific action is indicated in a Note.~~

4.1   Interworking between AINI **1.1** and B-ISUP

This section has been deleted. Interworking between AINI 1.1 and B-ISUP is beyond the scope of this document.

4.2   Interworking between AINI 1.1 and PNNI

This section specifies the protocol interworking between PNNI 1.1 (or PNNI 1.0) and the ATM Inter-Network Interface version 1.1.

4.2.1   Mapping of messages:

All PNNI 1.0 messages are mapped to their equivalent counterparts in AINI 1.1, and all AINI 1.1 messages are mapped to their equivalent counterparts in PNNI 1.0, except those which are of local significance onlyfor the following.

4.2.1.1   Messages of local significance

Note that mMessages with local significance are not forwarded between an AINI and a PNNI interface and so there is no need to specify an interworking.

According to section 6.3 of PNNI 1.01.1 the following messages are of local significance:
- STATUS ENQUIRY
- STATUS
- RESTART
- RESTART ACKNOWLEDGE
- CALL PROCEEDING
- RELEASE COMPLETE (Note)
- DROP PARTY ACKNOWLEDGE

Note: This message may carry information of global significance when used as the first call-clearing message. As such, it is translated to the RELEASE message when the call is cleared in the backward direction towards the calling user.

4.2.1.2   Messages that are not supported

When one of the following messages is received at a PNNI interface that supports that message and it is progressed towards an AINI 1.1 interface, then:
- If the message is a CO-BI SETUP, the procedures for "onward routing not possible" of Section 26.9.2.2.2.1 of [10] apply.
- If the message is a TRACE CONNECTION, the procedures for trace destination interface of Section 5.3.1 of [16] apply.
- For all other messages, unless message specific procedures exist, the message shall be treated according to the message instruction indicators.

4.2.2   Mapping of information elements:

4.2.2.1   Information elements of local significance

The following Information Elements are of local (link-by-link) significance and are not mapped. Note that information elements with local significance are not forwarded between an AINI and a PNNI interface and so there is no need to specify an interworking:
- Call reference
- Call state
- Endpoint reference
- Endpoint state
- Connection identifier
- Restart indicator

4.2.2.2   Information elements that are not supported

The following PNNI ~~1.0~~ Information Elements are not supported at the AINI and are not carried at the AINI:
- Designated transit list (DTL)
- Connection scope selection
- Facility
- Trace transit list
- Rerouting

4.2.2.3   Mapping of the Crankback information element

The format of the Crankback information element in PNNI Signalling ~~1.0~~ is different from that in AINI 1.1 ~~(see section 3.5, subsection "6.4.6.3/PNNI 1.0 Crankback")~~. Therefore, no one-to-one mapping is applicable at the interworking points.

The exact mapping is shown in the following two tables.

4.2.2.3.1   Mapping of the Crankback information element from AINI 1.1 to PNNI

The fields within the transmitted PNNI Crankback information element are coded as follows:

Crankback Field	Octet	Contents
Crankback level	5	PNNI level of the DTL terminator
Blocked transit type	6	Blocked link
Blocked link's preceding node identifier (from Blocked transit identifier)	6.1 to 6.22	PNNI NodeId of the DTL terminator. This is the last NodeId of the topmost DTL received in the original setup indication from the PNNI network.
Blocked link's port identifier (from Blocked transit identifier)	6.23 to 6.26	The last PNNI PortId of the topmost DTL received in the original setup indication from the PNNI network
Blocked link's succeeding node identifier (from Blocked transit identifier)	6.27 to 6.48	PNNI NodeId of all zeroes
Crankback cause	7	Crankback cause from the received AINI Crankback information element
Crankback cause diagnostics	7.1 etc.	Omitted

4.2.2.3.2   Mapping of the Crankback information element from PNNI to AINI 1.1

The fields within the transmitted AINI 1.1 Crankback information element are set as follows:

Crankback Field	Octet	Contents
Crankback level	5	255
Blocked transit type	6	call has blocked at or beyond the succeeding node
Blocked transit identifier	6.1 etc.	Omitted
Crankback cause	7	Crankback cause from the received PNNI Crankback information element (Note)
Crankback cause diagnostics	7.1 etc.	Omitted

Note: PNNI Crankback cause codes are mapped to their AINI 1.1 equivalent values with the following exceptions:
                 #128 "next node unreachable" is mapped to #3 "destination unreachable";
                 #129 "node is a restricted transit node" is mapped to #3 " destination unreachable";
                 #160 "DTL Transit not my node ID" is mapped to #45 "no VPI/VCI available".

4.2.2.4   Other information elements

All other information elements are mapped to their equivalent counterparts.

5   References

[1]   ATM Forum, af-cs-0125.000 (1999), *ATM Inter-Network Interface (AINI) Specification*

[2]   ATM Forum, af-sig-0061.000 (1996), *ATM User-Network Interface (UNI) Signalling Specification Version 4.0*

[3]   ATM Forum, af-pnni-0055.000 (1996), *Private Network-Network Interface Specification Version 1.0 (PNNI 1.0)*

[4]   ATM Forum, af-pnni-0075.000 (1997), *PNNI ABR Addendum*

[5]   ATM Forum, af-pnni-0081.000 (1997), *PNNI v1.0 Errata and PICS*

[6]   ATM Forum, af-sig-0061.002 (2002), *ATM User-Network Interface (UNI) Signalling Specification Version 4.1*

[7]   ATM Forum, af-pnni-0055.002 (2002), *Private Network-Network Interface Specification Version 1.1 (PNNI 1.1)*

[8]   ATM Forum, af-ra-0105.000 (1999), *ATM Forum Addressing: User Guide*

[9]   ATM Forum, af-ra-0106.000. (1999), *ATM Forum Addressing: Reference Guide*

[10]   ATM Forum, af-cs-0102.000 (1998), *PNNI Addendum on PNNI/B-QSIG Interworking and Generic Functional Protocol for the Support of Supplementary Services*

~~ATM Forum, af-ra-0107.000 (1999), *Addressing Addendum for UNI Signalling 4.0*~~

~~ATM Forum, af-cs-0127.000 (1999), *PNNI SPVC Addendum version 1.0.*~~

[11] ATM Forum, af-cs-0126.000 (1999), *PNNI Addendum for Generic Application Transport Version 1.0*

[12] ATM-Forum, af-cs-0115.000 (1999*), PNNI Transported Address Stack Version 1.0*

[13] ATM Forum, af-cs-0116.000 (1999*), PNNI Version 1.0 Security Signaling Addendum*

[14] ITU-T, Recommendation Q.2931 (1995), *Digital Subscriber Signalling System No. 2 (DSS 2) - User-Network Interface (UNI) Layer 3 Specification for Basic Call/Connection Control*

[15] ATM Forum, af-cs-0140.000 (2000), *Network Call Correlation Identifier v 1.0*

[16] ATM Forum, af-cs-0141.000 (2000), *PNNI Addendum for Path and Connection Trace Version 1.0*

[17] ATM Forum, af-cs-vmoa-0146.000 (2000), *Operation of the Bearer Independent Call Control (BICC) Protocol with SIG 4.0/PNNI 1.0/AINI*

[18] ATM Forum, af-cs-0147.000 (2000), *UBR with MDCR Addendum to UNI Signalling 4.0, PNNI 1.0 and AINI*

[19] ATM Forum, af-cs-0148.001 (2001), *Modification of Traffic Parameters for an Active Connection Signalling Specifcation (PNNI, AINI and UNI) – version 2.0*

[20] ATM Forum, af-cs-0159.000 (2000), *Behavior Class Selector Signalling Version 1.0*

[21] ATM Forum, af-cs-0167.000 (2001), *Guaranteed Frame Rate (GFR) Signalling Specification (PNNI, AINI and UNI), Version 1.0*

[22] ATM Forum, af-cs-0173.000 (2001), Domain-Based Rerouting for Active Point-to-Point Calls Version 1.0

[23] ATM Forum, af-cs-0176.000 (2002), *Loop Detection Version 1.0*

[24] ATM Forum, af-cs-0181.000 (2002), *Signalling Congestion Control Version 1.0*

[25] ATM Forum, af-cs-0182.000 (2002), *Call Processing Priority Version 1.0*

~~ITU-T, Recommendation Q.2763 (1995*), Signalling System No. 7 - B-ISDN User Part (B-ISUP) - Formats and Codes.*~~

~~ITU-T, Recommendation Q.2764 (1995*), Signalling System No. 7 B-ISDN User Part (B-ISUP) - Basic call procedures.*~~

ITU-T, Recommendation Q.2650 (1995), *Interworking Between Signalling System No. 7/ Broadband ISDN User Part (B-ISUP) and Digital Subscriber Signalling System No. 2 (DSS2).*

ITU-T, Recommendation Q.2726.1 (1996), *B-ISDN user part – ATM end system address.*

ITU-T, Recommendation Q.2723.3 (1995), *Extensions to the B-ISDN User Part – Signalling capabilities to support traffic parameters for the Available Bit Rate (ABR).*

ITU-T, Recommendation Q.2723.1 (1996), *B-ISDN User Part – Support of additional traffic parameters for Sustainable Cell Rate and Quality of Service.*

ITU-T, Recommendation Q.2725.1 (1998), *B-ISDN User Part – Support of negotiation during connection setup.*

ITU-T, Draft new Recommendation Q.2767.1 (May, 1998), *Soft PVC Capability.*

ITU-T, Draft new Recommendation Q.2766.1 (May, 1998), *Switched Virtual Path Capability.*

ITU-T, Recommendation Q.2941.1 (1997), *Digital subscriber Signalling System No. 2 – Generic identifier transport.*

ITU-T, Recommendation Q.2726.4 (1997), *Extensions to the B-ISDN user part – Application generated identifiers.*

ITU-T, Recommendation Q.2722.1 (1996), *B-ISDN User Part – Network Node Interface specification for point-to-multipoint call/connection control.*

6   Annex A: Procedures for Crankback

This section describes the additional clearing procedures and behavior of AINI during crankback. Crankback is indicated by including a Crankback information element in the first call-clearing message (RELEASE, RELEASE COMPLETE, or ADD PARTY REJECT). These procedures are additional procedures to the clearing procedures described in Section 6.5.3/PNNI 1.0 1.1.

Note: This section corresponds to Annex B of PNNI version 1.01.1 and is adapted to the specific requirements of AINI.

6.1   Scope of Crankback procedures

A call received over an AINI signalling link that cannot be progressed beyond the receiving node may be subject to crankback. This specification indicates those cases where crankback is required. Whenever the specification indicates call clearing with specific cause codes, crankback shall not be performed unless stated explicitly.

Any call that progresses all the way to the called user and gets rejected by the called user will not be cranked back. 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 such cases, a RELEASE or RELEASE COMPLETE message with a Cause information element will be returned. This will result in the call being cleared all the way back to the calling user. These are not crankback situations, and no alternate routing is to be attempted in these cases.

Calls that get rejected when the node at which the subscriber is homed determines that the UNI to the called user cannot carry the call may be cranked back, similarly to cases where call rejection occurs at AINI interfaces, but in these cases crankback is not required.

The cases where crankback is used in AINI fall into two categories:
1. Reachability errors
2. Resource errors

In addition to these categories, it is possible for a call to be cranked back because the path selection at some node determines that there are no paths that meet the policy constraints. No specification of policy constraints is provided in this version of AINI, so definition of policy violations and crankback cause codes are not included in this specification.

6.2   Crankback cause

In case of call clearing, a Cause information element is mandatory in the first call-clearing message. In case of crankback, a Crankback information element must be included as well as the Cause information element. The Crankback information element must include a crankback cause code, which is used instead of the Cause information element by the preceding node of the AINI interface.

Note that the cause code in the Crankback information element may be updated whenever the crankback is propagated to a preceding node. Specifically, this may be done whenever cranking back beyond a node that received a "succeeding end blocked" crankback but was unable to successfully reroute the call.

6.2.1   Reachability errors

Generally, reachability errors indicate that a path to a destination could not be found. This applies to both transit network and called party destinations. This type of failure indicates that no path exists to the destination. It is different from finding a path that exists but does not satisfy the requested QoS; such failures are discussed in Section 6.2.2 as Resource Errors.

Whenever crankback occurs due to reachability errors, the blocked transit specified in the Crankback information element must be "call or party has been blocked at or beyond the succeeding node".

6.2.1.1   Destination unreachable and transit network unreachable

These cause codes are returned when a node receives a SETUP/ADD PARTY message and there is no connectivity from the node to the called party or transit network. In the case where no reachability information whatsoever exists in the node's routing table for the called party or transit network, the call shall be cleared with cause #2 "no route to specified transit network" or cause #3 "no route to destination".

6.2.2   Resource errors

6.2.2.1   Resource errors due to service category

Crankback can occur due to unsupported service category or bearer class. See sections 6.5.2.3.1/PNNI 1.01.1 and 6.5.2.7/PNNI 1.01.1 for further details.

6.2.2.2   Resource errors due to traffic and QoS parameters

The resources needed to support a call are calculated from the traffic parameters and/or QoS parameters included in the SETUP or ADD PARTY message. Resource Errors are used to signal that a path could not be found for the call to satisfy the requested traffic and QoS parameters.

Inability to satisfy the requested traffic and QoS parameters can be detected either during path selection, or during actual CAC. Calls received over an AINI signalling link that are rejected due to insufficient resources are always cranked back.

If the requested user cell rate(s) from the ATM traffic descriptor information element cannot be satisfied, the call will be cranked back with crankback cause #37, "user cell rate not available".

If no path can be found to satisfy the requested maximum CTD, peak-to-peak CDV, and/or CLR (in one and/or the other direction for a call), the call will be cranked back with cause and crankback cause #49, "QoS unavailable".

When blocking due to insufficient resources occurs, it must be determined whether blocking was due to insufficient resources at the succeeding end of the previous link (calls requesting similar resource requirements on other ports might be accepted), insufficient resources at the preceding end of the following link (calls requesting similar resource requirements on other ports might be accepted), or insufficient resources within or beyond the node itself (all calls requesting similar resource requirement from this node are likely to be blocked). Depending on the answer, the procedures in Section 6.3.1.3, 6.3.1.2, or 6.3.1.1, respectively, shall apply.

6.2.2.3   Resource errors due to VPCI/VCI allocation

When the preceding side is unable to allocate a VPCI (for SVPs) or a VPCI/VCI pair (for SVCs), the procedures of Section 6.3.1.2 shall be followed. If no alternate routing is attempted or if alternate routing fails, crankback cause #45 "No VPCI/VCI available" shall be used.

Resource errors due to VPCI/VCI allocation at the succeeding side result in crankback with cause #35 "Requested VPCI/VCI not available" or cause #45 "No VPCI/VCI available", as discussed in Sections 6.5.2.2.1/PNNI 1.01.1 and6.5.2.2.2/PNNI 1.01.1. Whenever VPCI/VCI resource errors occur at the succeeding side of an AINI interface, the blocked transit type in the Crankback information element must be set to "call or party has been blocked at the succeeding end of this interface".

6.3   Procedures for blocked transit

This section describes the procedures used for generating, interpreting, and modifying the blocked transit type. These procedures provide the mechanisms required to manage crankback from the point of blocking, through intermediate nodes, to one or more nodes that are allowed to choose alternate routes for the call.

Pseudocode for the procedures specified in this section is contained in Section 6.3.3. When there is an ambiguity in the narrative text, the pseudocode should be used to resolve the conflict. Where the text and the pseudocode are in disagreement, the text should be used as the prime source.

6.3.1   Procedures at the point of blocking

The procedures carried out at the point of blocking vary depending on whether crankback occurs due to problems at the input port, at the output port, or within the node itself. These procedures are discussed in Section 6.3.1.3, 6.3.1.2, and 6.3.1.1, respectively.

6.3.1.1   Blocking at a node

Upon blocking at a node, crankback procedures are initiated by sending an appropriate call/connection clearing message (RELEASE or RELEASE COMPLETE, or ADD PARTY REJECT) including a Crankback information element. The blocked transit type must be set to "call or party has been blocked at or beyond the succeeding node". The Crankback information element also contains the crankback cause subfield.

6.3.1.2   Blocking at the preceding end of a link

Link blocking can be determined at the preceding end of a link when connection admission control (CAC) within the node at the preceding end of the link determines that insufficient resources are available. If other links exist that can be used to progress the SETUP or ADD PARTY message received by this node, then alternate routing may be attempted.

If no alternate routing is attempted or if alternate routing fails, then the node at the preceding end of the link must crankback the call or party by sending an appropriate clearing message (RELEASE, RELEASE COMPLETE, or ADD PARTY REJECT) including a Crankback information element. The blocked transit type subfield must be set to "call or party has been blocked at or beyond the succeeding node".

6.3.1.3   Blocking at the succeeding end of a link

Link blocking can be determined at the succeeding end of a link when CAC within the node at the succeeding end of the link determines that insufficient resources are available. In this case, the node must crankback the call or party by sending an appropriate clearing message (RELEASE, RELEASE COMPLETE, or ADD PARTY REJECT) including a Crankback information element. The blocked transit type must be set to "call or party has been blocked at the succeeding end of this interface". The Crankback information element also contains the crankback cause subfield.

6.3.2   Receiving a clearing message with a Crankback information element

The crankback cause value received in a Crankback information element shall not be validated. If the received crankback cause is the only piece of information within the Crankback information element that is unrecognized, then the Crankback information element shall be treated as if it has valid contents.

Upon receiving a clearing message (RELEASE, RELEASE COMPLETE, or ADD PARTY REJECT) including a Crankback information element, a node first checks whether the blocked transit type indicates that the "call or party has been blocked at the succeeding end of this interface". In this case, the procedures of Section 6.3.2.1 must be followed. Otherwise, if the node has alternate links available over which the call can be alternate routed, then the node may forward the call over one of these available interfaces. Note that if the link to be used to retry the call leads to a neighbor that has already been used for this call the re-route attempt is unlikely to succeed. Otherwise, the node must crankback the call or party by sending an appropriate clearing message (RELEASE or ADD PARTY REJECT) including a Crankback information element with the received crankback cause over its previous interface (towards the calling party).

6.3.2.1   Receiving a clearing message indicating blocking at this interface

When a clearing message (RELEASE, RELEASE COMPLETE, or ADD PARTY REJECT) is received which includes a Crankback information element with blocked transit type indicating "call or party has been blocked at the succeeding end of this interface", the following procedures are carried out. If other links exist that can be used to re-route the call, then alternate routing may be attempted using any of these links. In addition, a SETUP message may only be resent on the blocked link with a different VPCI (for SVPs) or VPCI/VCI pair (for SVCs) if crankback cause #35 "Requested VPCI/VCI not available" is present. Otherwise, if no such other links are available, then the node is to treat the crankback as though the succeeding node has blocked the call and the procedures of Section 6.3.1.1 shall apply.

If no alternate routing is attempted or if alternate routing fails, then the node must continue to crankback the call or party. The blocked transit type subfield must be changed to indicate "call or party has been blocked at or beyond the succeeding node". After this change to Crankback information element has been made, the node shall send an appropriate clearing message (RELEASE or ADD PARTY REJECT) over its previous interface (towards the calling party).

6.3.3   Pseudocode for Crankback procedures

The operations required when blocking is detected at a node:
1)   Blocking was due to insufficient resources at the:
    a.   whole node:
        call or party clearing message is returned including:
        blocked transit type = call or party has been blocked at or beyond the succeeding node
    b.   preceding end of the following link:
        are other links available to use for alternate routing?
        b.1   yes: may try alternate links.
        b.2   no: call clearing message is returned including:
            blocked transit type = call or party has been blocked at or beyond the succeeding node
    c.   succeeding end of the previous link:
        call or party clearing message is returned including:
        blocked transit type = call or party blocked at succeeding end of interface.

The operations required when receiving a clearing message with a Crankback information element:
2)   does blocked transit type = call or party blocked at succeeding end of interface?
    a.   yes: is crankback cause "requested VPCI/VCI not available"?
        a.1   yes: retry SETUP on same link using different VPCI/VCI values
        a.2   no: are other links available to use for alternate routing?
            a.2.1   yes: try alternate links.
            a.2.2   no:
               call clearing message is returned including:
               blocked transit type = call or party has been blocked at or beyond the succeeding node

    b.   no: Is there an alternate link available for this call?
        b.1   yes: send SETUP or ADD PARTY on new path
        b.2   no:
            crankback to previous interface
            blocked transit type = call or party has been blocked at or beyond the succeeding node