Network-to-Network FR/ATM SVC Service Interworking Implementation Agreement

FRF. 18

Frame Relay Forum Technical Committee
April 2000

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1.0 Introduction

1.1 Purpose

This document is an implementation agreement on Switched Virtual Connection (SVC) service interworking between Frame Relay and Asynchronous Transfer Mode (ATM) technologies at the Network-to-Network Interface (NNI). The agreements herein were reached by the Frame Relay Forum and are based on the documents referenced in section 2.0.

Except as noted, these agreements will form the basis of conformance test suites produced by the Frame Relay Forum.

This document may be submitted to other bodies involved in ratification of implementation agreements and conformance testing to facilitate multi-vendor interoperability.

1.2 Scope and Overview

Service interworking applies when a Frame Relay service user interworks with an ATM service user, and the ATM service user performs no Frame Relay specific functions, and the Frame Relay service user performs no ATM specific functions. All interworking is performed by the interworking function (IWF).

Frame Relay/ATM service interworking over PVCs at the user-to-network interface (UNI) and at the NNI is documented in FRF.8[3]. This implementation agreement extends the functionality in FRF.8 to provide for Frame Relay/ATM SVC interworking at the NNI.

The key issues addressed by this contribution include the translation of Frame Relay SVC NNI signaling to ATM SVC NNI signaling. Frame Relay SVC NNI signaling is based on FRF.10.1 [1]. ATM SVC NNI signaling is based on the Private Network-Network Interface Specification (PNNI 1.0 [2]) and its errata (PNNI V1.0 Errata and PICS [14]).

It is intended that, as additional feature annexes are added to PNNI 1.0 by the ATM Forum, this implementation agreement will be updated with annexes as well (provided the features are accepted for FR/ATM interworking by the Frame Relay Forum).

1.3 Definitions

Must, Shall, Mandatory, or Required	the item is an absolute requirement of the implementation agreement.
Should	the item is highly desirable.
May or Optional	the item is not compulsory, and may be followed or ignored according to the needs of the implementer.
Not Applicable	the item is outside the scope of this implementation agreement.
Network-to-Network Interface (NNI)	the NNI is concerned with the transfer of C-Plane and U-Plane information between two network nodes belonging to two different Frame Relay or ATM networks.

Local Significance	call control message is relevant only at the local NNI.
Global Significance	call control message is relevant at the local NNI, other NNIs, and UNIs related to the call.

1.4 Acronyms

AAL	ATM Adaptation Layer
ABR	Available Bit Rate
AESA	ATM Endsystem Address
AR	Access Rate
ATM	Asynchronous Transfer Mode
Bc	Committed Burst
BCD	Binary Coded Decimal
BCOB	Broadband Connection-Oriented Bearer
Be	Excess Burst
B-CPE	Broadband Customer Premises Equipment
B-ICI	Broadband Inter Carrier Interface
CBR	Constant Bit Rate
CIC	Carrier Identification Code
CIR	Committed Information Rate
CLP	Cell Loss Priority
CPE	Customer Premises Equipment
CPCS	Common Part Convergence Sublayer
C-Plane	Control Plane
DCC	Data Country Code
DLCI	Data Link Connection Identifier
DE	Discard Eligibility
DNIC	Data Network Identification Code
DSP	Domain Specific Part
DTL	Designated Transit List
EFCI	Explicit Forward Congestion Indicator
EIR	Excess Information Rate
FECN	Forward Explicit Congestion Notification
FMIF	Frame Mode Information Field
FR	Frame Relay
FRF	Frame Relay Forum
FRFTC	Frame Relay Forum Technical Committee
FR-CPE	Frame Relay Customer Premises Equipment
GAT	Generic Application Transport
ICD	International Code Designator
IDP	Initial Domain Part
IE	Information Element
ITU	International Telecommunication Union
IWF	Interworking Function
MBS	Maximum Burst Size
NNI	Network to Network Interface
NSAP	Network Service Access Point
OA&M	Operations, Administration, and Maintenance

PCR	Peak Cell Rate
PNNI	Private Network to Network Interface
PTSE	PNNI Topology State Elements
PVC	Permanent Virtual Connection
PVCC	Permanent Virtual Channel Connection
PVPC	Permanent Virtual Path Connection
QoS	Quality of Service
SCR	Sustainable Cell Rate
SDU	Service Data Unit
SPVC	Switched Permanent Virtual Connection
SPVCC	Soft Permanent Virtual Channel Connection
SPVPC	Soft Permanent Virtual Path Connection
SSCS	Service Specific Convergence Sublayer
SVC	Switched Virtual Connection
SVP	Switched Virtual Path
TBD	To Be Determined
U-Plane	User Plane
UBR	Unspecified Bit Rate
UNI	User to Network Interface
VBR	Variable Bit Rate
VBRnrt	Non-Real-Time Variable Bit Rate
VBRrt	Real-Time Variable Bit Rate
VCI	Virtual Channel Identifier
VPI	Virtual Path Identifier

2.0 References

[1] FRF.10.1 – Frame Relay Network-to-Network SVC Implementation Agreement, April 2000.

[2] ATM Forum - Private Network-Network Interface Specification (Version 1.0), March 1996.

[3] FRF.8.1 - Frame Relay/ATM PVC Service Interworking Implementation Agreement, February 2000.

[4] ATM Forum, ATM Forum Addressing Reference Guide, af-ra-0106.000, February 1999.

[5] ITU Recommendation E.164 - Numbering Plan for the ISDN Era.

[6] ITU Recommendation E.166 - Numbering Plan Interworking in the ISDN Era.

[7] ITU Recommendation X.121 - International Numbering Plan for Public Data Networks.

[8] ATM Forum - Traffic Management Specification (Version 4.0), April 1996.

[9] ATM Forum - UNI Signaling Specification (Version 4.0), April 1996.

[10] ITU Recommendation Q.2931 - B-ISDN DSS2 UNI Layer 3 Specification for Basic Call/Connection Control, February 1995.

[11] IETF RFC 2427 - Multiprotocol Interconnect over Frame Relay, September 1998.

[12] IETF RFC 1483 - Multiprotocol Encapsulation over AAL5, July 1993.

[13] ATM Forum - UNI Signaling Specification (Version 3.1), September 1994.

[14] ATM Forum - PNNI V1.0 Errata and PICS, af-pnni-0081.000, May 1997.

[15] ITU Recommendation Q.850 – Usage of Cause and Location in the DSS1 and the SS7 ISDN User Part, March 1993.

[16] ITU Recommendation Q.2610 – B-ISDN Usage of Cause and Location in B-ISDN User Part and DSS2, February 1995.

[17] ATM Forum, PNNI Generic Application Transport Addendum Straw Ballot Text, str-cs-pnni-gat-01.01, February 1999.

[18] ITU-T, Digital Subscriber Signalling System No. 2 (DSS2) - Signalling specification for Frame Relay service, ITU-T Recommendation Q.2933 (07/96).

[19] ATM Forum, PNNI SPVC Addendum (Version 1.0 Final Ballot), af-cs-0127.000, April 1999.

3.0 Frame Relay/ATM PVC Service Interworking

Sections of the *Frame Relay/ATM PVC Service Interworking Implementation Agreement* (FRF.8.1) shall also apply to this implementation agreement. These sections address Frame Relay frame -to - ATM cell parameter mapping, traffic management, link integrity, protocol encapsulation, and address resolution. The applicable sections are the following:

4.0	Frame Relay/ATM Service Interworking Parameters Mapping (and its subsections)
5.1	Traffic Management
5.2.1.1	Link Integrity Verification (Paragraph 1 only)
5.3	Upper Layer User Protocol Encapsulation (and its subsections)
5.4	Address Resolution
6.0	Operations for the Common Part of the AAL Type 5

In FRF.8.1 section 4.2, the selection of mode 1 or mode 2 for the discard eligibility (DE) - to - cell loss priority (CLP) mapping shall be as defined in Annex A of this document.

In FRF.8.1 section 4.3, mode 1 mapping of Forward Explicit Congestion Notification (FECN) - to - Explicit Forward Congestion Indicator (EFCI) shall be provided by the IWF. It is an implementation option to provide mode 2 as a configurable selection at the IWF.

In FRF.8.1 section 5.3, transparent (mode 1) and translation (mode 2) modes are defined for processing the encapsulation of upper layer protocol PDUs. If the IWF supports translation mode, detection of the encapsulation method shall be as defined in section 4.8 of this document.

3.1 ATM Operations, Administration, and Maintenance (OA&M) Interworking

ATM SVC OA&M signaling has no counterpart on the FR SVC side of the IWF. While OAM alarm surveillance (OA&M F5 AIS and RDI cells) - to - LMI translation is supported for PVCs per FRF.8.1, there is no FR SVC equivalent. In addition, there is no FR equivalent for OA&M connectivity (loopback) verification. Until equivalent FR SVC standards are developed for OA&M signaling, OA&M cells shall be terminated at the IWF: the IWF shall detect AIS cells and generate RDI cells; and the IWF shall either loopback or remove OA&M loopback cells depending on the value in the cell's loopback indication field.

4.0 Frame Relay/ATM SVC Service Interworking

Figure 1 illustrates service interworking between Frame Relay and ATM SVCs at the NNI. As shown, the IWF is best defined using the Frame Relay and ATM SVC protocol stack models. Specifically, the signaling translation performed by the IWF is explained by defining the translations between the FRF.10.1 and the ATM PNNI signaling protocols.

Figure 1 does not imply any particular physical location for an IWF. The IWF may be contained within a single device or within multiple devices. As shown in example A in Figure 1, the IWF may be an entity separate from the Frame Relay and ATM networks. Or, as shown in examples B and C, the IWF may be an integral part of the ATM or Frame Relay network. In the case of example B, it is not necessary for the network to actually generate ATM NNI signaling messages. Likewise in example C, it is not necessary for the network to generate Frame Relay NNI signaling

messages. However, in order to unambiguously define the translations, this implementation agreement defines the translations between the FRF.10.1 and the ATM PNNI signaling protocols.

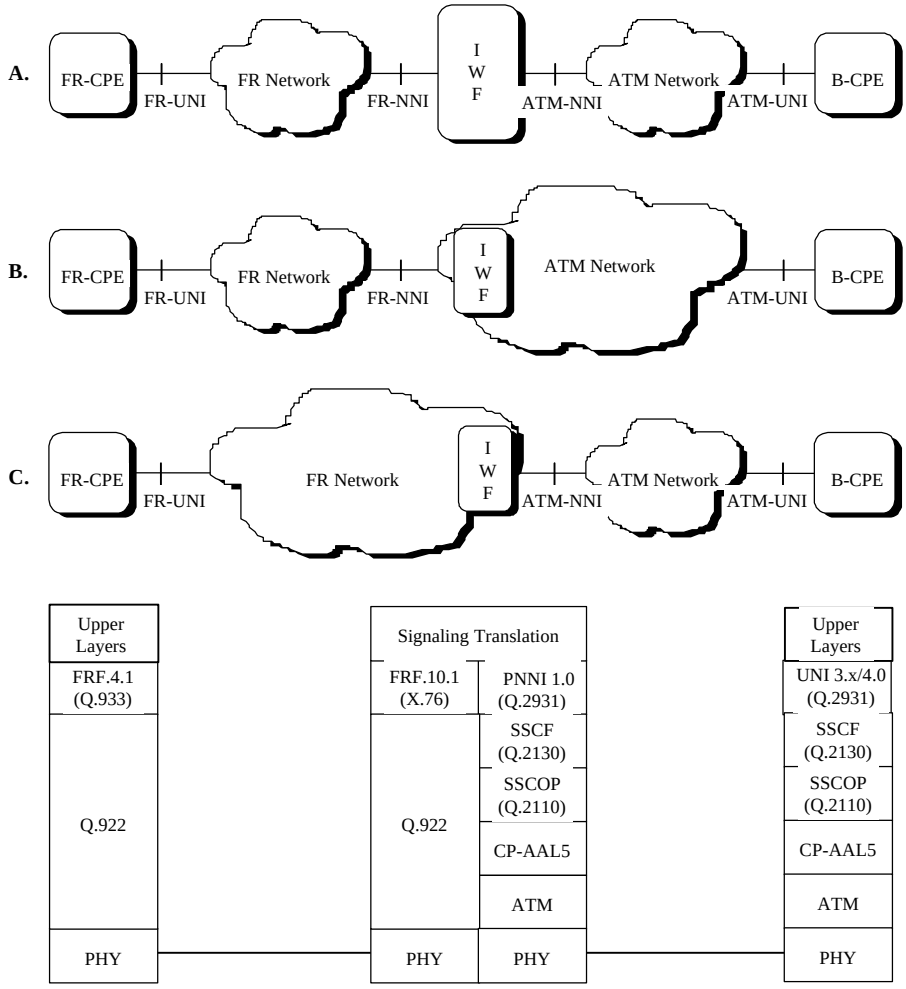

Figure 1. Service Interworking Between Frame Relay and ATM SVC Signaling at the NNI

Note that the PNNI recommendation includes more features than the FRF.10.1 implementation agreement. The Frame Relay/ATM IWF is required to support the following PNNI features:

1. Routing procedures (the ATM NNI side of the IWF participates in PNNI routing).
2. Signaling messages and procedures for ATM point-to-point call and connection control.
3. Signaling messages and procedures used with the global call reference.
4. Procedures for non-associated signaling.
5. Signaling of Switched Virtual Channel Connections (SVCCs).
6. Procedures for point-to-point Soft Permanent Virtual Channel Connections (SPVCCs).

The Frame Relay/ATM IWF is not required to support the following PNNI features:

1. Signaling messages for the support of 64 kbit/s based ISDN circuit mode services.
2. Signaling messages for point-to-multipoint call and connection control.
3. Procedures for associated signaling.
4. Signaling of Switched Virtual Path Connections (SVPCs).
5. ATM QoS features which are not supported by FRF.10.1 include CBR signaling and ATM specific QoS parameters. Handling of ABR signaling is implementation dependent.
6. Procedures for point-to-point Soft Permanent Virtual Path Connections (SPVPCs).
7. Procedures for point-to-multipoint SPVCCs.

The following subsections of section 4.0 define the general signaling translations for the Frame Relay/ATM IWF. Section 5.0 *Frame Relay/ATM SVC Signaling Message Translation* defines the more detailed translations at the message and information element level and refers back to section 4.0 as appropriate.

4.1 DLCI and VPI/VCI Fields

As defined in FRF.10.1, for Frame Relay SVC NNI signaling, both of the networks assign exclusive DLCI values in the SETUP message. By bilateral agreement, one network begins DLCI assignment from the minimum DLCI value; the other begins DLCI assignment from the maximum DLCI value. Therefore, the Frame Relay NNI end of the IWF must be configurable to begin DLCI assignment from the minimum or maximum value. FRF.10.1 (X.76) defines the procedures and actions to be taken upon call collision (when both networks signal the same DLCI value).

As defined in PNNI, for ATM SVC NNI signaling, in order to avoid call collision, the side of the interface which has the higher node identifier allocates the VPI/VCI values. Either the SETUP message sent by the higher node ID, or the first response sent by the higher node ID to a SETUP message received from the lower node ID, contains the exclusive ATM Connection Identifier Information Element (VPI/VCI) values. (The lower node ID's SETUP message may contain (1) no ATM Connection Identifier, or (2) an ATM Connection Identifier coded as "exclusive VPI/any VCI".) In accordance with PNNI, the ATM NNI end of the IWF shall signal its node identifier to the ATM network.

In accordance with FRF.8.1 section 4.5, a one-to-one mapping between the Frame Relay DLCI and the ATM Connection Identifier VPI/VCI shall be used. The IWF shall be responsible for maintaining the association between the DLCI and VPI/VCI for each "in-progress" or "active" SVC.

4.2 Addresses

Translation between the FRF.10.1 and the PNNI addresses, as presented in this section, is organized into two categories: (1) calling/called/connected party address translations and (2) calling/called/connected party subaddress translations.

4.2.1 Calling/Called/Connected Party Addresses

Table 1 identifies the number plans supported by FRF.10.1 and PNNI for calling, called, and connected party addresses. This table also indicates which number plans the IWF is required to translate (mandatory), which are optional, and which are outside the scope of this implementation agreement (blank). See specific subsections of section 5.0 for procedures to follow when the IWF receives an address which it is not required to translate.

Regarding number types, FRF.10.1 (X.76) only allows "international" number types for E.164 and X.121 and "alternate" number types for NSAP. The ATM UNI 4.0[9] recommendation section 3.2 limits native E.164 addresses to the "international" number type and ATM Endsystem Addresses (AESAs) to the "unknown" number type. (Note that, although an ATM AESA is required to be coded as an "unknown" number type, section 3.1.1.3 of ATM UNI 4.0[9] indicates ternational format of these numbers will be used.") The IWF shall only translate "international" number types for the native E.164 and X.121 number plans. The IWF shall translate "unknown" number types for the ATM AESA number plans to FR NSAP "alternate" number types; and, in the reverse direction, FR NSAP "alternate" number types shall be translated

Table 1. Calling/Called/Connected Party Address Translation

	ATM Native E.164	ATM AESA DCC	ATM AESA ICD	ATM AESA E.164 (zero-valued DSP)	ATM AESA E.164 (non-zero DSP)	ATM AESA X.121 (zero-valued DSP)	ATM AESA X.121 (non-zero DSP)
FR Native E.164	Optional (Note)			Mandatory			
FR Native X.121						Optional	
FR NSAP DCC		Mandatory					
FR NSAP ICD			Mandatory				
FR NSAP E.164 (zero-valued DSP)				Mandatory			
FR NSAP E.164 (non-zero DSP)					Mandatory		
FR NSAP X.121 (zero-valued DSP)						Mandatory	
FR NSAP X.121 (non-zero DSP)							Mandatory

Note: The ATM Forum Addressing Reference Guide does not support signaling of native E.164 addresses in PNNI.

4.2.1.1 Direct Translations

The native E.164 number plan is not supported by ATM PNNI 1.0 switches which conform to the ATM Forum Addressing Reference Guide [4]. The IWF may optionally translate the native E.164 number plan in the FR-to-ATM direction but the SVC is not guaranteed to be routed properly over PNNI networks that comply with the ATM Forum Addressing Reference Guide. It is recommended that FR native E.164 addresses be translated to ATM E.164 AESAs as specified in section 4.2.1.2.

The NSAP number plan is supported by FRF.10.1; the AESA number plan is supported by PNNI. The IWF shall support the following translations in both the FR-to-ATM and the ATM-to-FR directions:

- FR NSAP DCC and ATM AESA DCC
- FR NSAP ICD and ATM AESA ICD
- FR NSAP E.164 and ATM AESA E.164
- FR NSAP X.121 and ATM AESA X.121

4.2.1.2 FR Native E.164 / ATM AESA E.164 (zero-valued DSP) Translation

The IWF shall support translation between the E.164 AESA (with a "zero-valued" or "null-valued" Domain Specific Part (DSP)) and the Frame Relay native E.164 address coding. In the FR-to-ATM direction, the native E.164 ASCII format is translated to the AESA Initial Domain Part (IDP) Binary Coded Decimal (BCD) format; and the AESA DSP is set to zeros. In the opposite direction, if the AESA DSP is zeros, the AESA IDP BCD format is translated to the native E.164 address format.

4.2.1.3 FR Native X.121 / ATM AESA X.121 (zero-valued DSP) Translation

The IWF may optionally support translation between the X.121 AESA (with a "zero-valued" or "null-valued" DSP) and the Frame Relay native X.121 address coding. In the FR-to-ATM direction, the native X.121 ASCII format is translated to the AESA IDP BCD format; and the AESA DSP is set to zeros. In the opposite direction, if the AESA DSP is zeros, the AESA IDP BCD format is translated to the native X.121 address format.

4.2.2 Calling/Called/Connected Party Subaddresses

As illustrated in Figure 2, case A, the situation may arise where the IWF is attached to a Public ATM network which supports only native E.164 addressing. In this case, according to ATM UNI 4.0 Annex 1[9], the CPE device may send two subaddresses in the SETUP message: an AESA subaddress (to identify the "called party" in a downstream Private ATM network) and an NSAP subaddress. For this implementation agreement, the AESA subaddress shall be discarded by the IWF, since FRF.10.1 only allows a single called subaddress to be signaled in the SETUP message. The retained NSAP subaddress is translated as defined below.

In Figure 2, case B, the IWF is attached to an ATM network that supports AESAs. In this case, only a single NSAP called subaddress is present in the received SETUP message. Translation of the AESA called party address is defined in section 4.2.1. Translation of the NSAP subaddress is defined below.

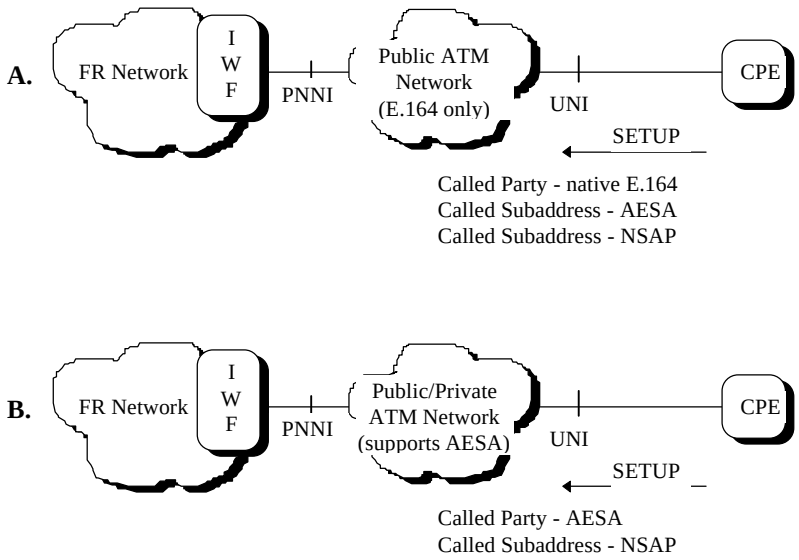

Figure 2. Subaddress Translation Configurations

Table 2 identifies the number plans supported by FRF.10.1 and PNNI for calling, called, and connected subaddresses. This table also indicates which number plans the IWF is required to translate (mandatory) and which are outside the scope of this implementation agreement (blank). See specific subsections of section 5.0 for procedures to follow when the IWF receives a subaddress which it is not required to translate.

Table 2. Calling/Called/Connected Party Subaddress Translation

	ATM NSAP	ATM AESA	ATM User-Specified
FR NSAP	Mandatory		
FR User-Specified			Mandatory

4.2.2.1 FR NSAP / ATM NSAP Translation

The NSAP number plan is supported by both FRF.10.1 (X.76) and ATM PNNI. The IWF shall translate the NSAP number plan in both the FR-to-ATM and the ATM-to-FR directions.

4.2.2.1 FR User-Specified / ATM User-Specified Translation

The User-Specified number plan is supported by both FRF.10.1 (X.76) and ATM PNNI. The IWF shall translate the User-Specified number plan in both the FR-to-ATM and the ATM-to-FR directions.

4.2.2.2 ATM AESA

Translation of the ATM AESA number plan is currently outside the scope of this implementation agreement. See specific subsections of section 5.0 for procedures to follow when the IWF receives this address plan, which it is not required to translate.

4.3 Traffic Parameter Negotiation and Translation

Both FRF.10.1 and PNNI allow for negotiation of traffic parameters during call establishment.

In the Frame Relay SETUP message, the Link Layer Core Parameters IE contains a Minimum Acceptable Throughput for each of the incoming and outgoing directions. This identifies the minimum throughput that each network node (and CPE device) must support in order for the call to proceed. In the Frame Relay CONNECT message, the Link Layer Core Parameters IE indicates the final negotiated values for a successfully established call.

Similarly, in ATM PNNI, the SETUP message contains either a Minimum Acceptable ATM Traffic Descriptor IE or an Alternative ATM Traffic Descriptor IE. These identify the minimum or alternative traffic parameters that each network node (and CPE device) must support in order for the call to proceed. In the ATM CONNECT message, the ATM Traffic Descriptor IE indicates the final negotiated values for a successfully established call.

Translation between the Frame Relay and ATM traffic parameters must be performed at the IWF. In the Frame Relay to ATM direction, the Link Layer Core Parameters IE shall be translated into an ATM Traffic Descriptor IE and, if the Frame Relay Minimum Acceptable Throughput is present in the SETUP message, it may optionally be translated into a Minimum Acceptable ATM Traffic Descriptor IE.

In the ATM to Frame Relay direction, the ATM Traffic Descriptor IE shall be translated into a Link Layer Core Parameters IE and, if present in the SETUP message, the Minimum Acceptable ATM Traffic Descriptor IE may optionally be translated to determine the Frame Relay Minimum

Acceptable Throughput. If the Alternative ATM Traffic Descriptor IE is present in the SETUP message, it shall be ignored.

More detailed discussion of SETUP and CONNECT message translations can be found in section 5 of this document. Translations between the FRF.10.1 and PNNI traffic parameters are defined in Annex A of this document.

As the default procedure, when translating a SETUP message from the Frame Relay to ATM direction, the IWF shall select non-real-time VBR transfer capability for the ATM Broadband Bearer Capability IE. Alternatively, the IWF may utilize the FR Priority and Service Class Parameters IE to select either the real-time VBR, non-real-time VBR, or the UBR ATM service category. Mapping between the FR Priority and Service Class Parameters IE and the ATM service categories is further defined in sections 5.1.1.6 and 5.3.1.13.

4.4 Frame Relay Switched PVCs and ATM Soft PVCs

There are three configurations in which FR/ATM SVC Service Interworking for Switched/Soft PVCs is viable:

A. FR PVC-to-FR PVC across a PNNI interface.

B. FR PVC-to-ATM PVC across a PNNI interface.

C. FR PVC-to-ATM PVC across an FR NNI interface.

These are illustrated in Figure 3. (ATM PVC-to-ATM PVC across an FR NNI interface is unlikely since ATM QoS functionality would be lost.) Note that SPVC origination could be performed by either the FR-CPE or the ATM B-CPE endpoint.

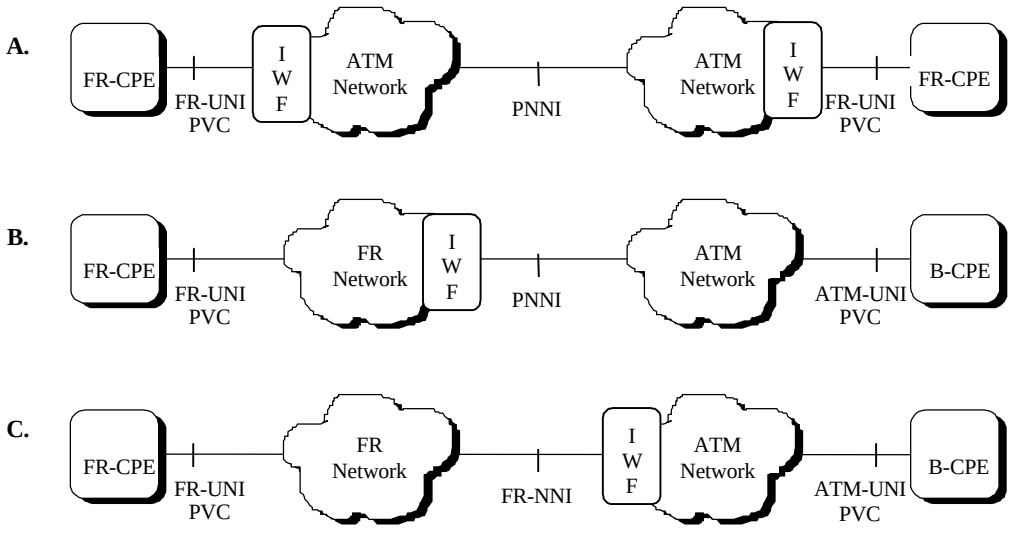

Figure 3. FR/ATM SPVC Interworking Configurations

Extensions to the base SPVC interworking configurations pictured above are also possible. For example, cases A and C could be combined to create the configuration presented in Figure 4.

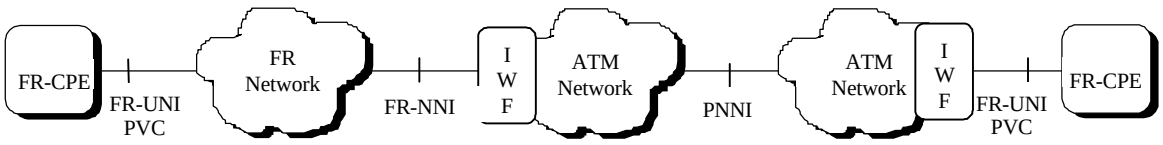

Figure 4. FR/ATM SPVC Interworking Configuration Extension Example

The following paragraph concerns transport of the PNNI 1.0 Broadband Low Layer Information (B-LLI) IE to indicate multiprotocol encapsulation information. This paragraph is not required by this implementation agreement and is provided for information only, due to Section 9.1 of PNNI 1.0 prohibiting the inclusion of the Broadband Low Layer Information (B-LLI) IE for SPVC signaling messages. It should be noted that the ATM Forum plans to amend the PNNI specification in the future to allow signaling of the B-LLI IE for SPVCs, but it is not allowed in the current PNNI 1.0 specification. It should also be noted that some PNNI 1.0 implementations do allow transport of the B-LLI IE for SPVCs and will support the following paragraph. Finally, also note that for case A of Figure 3, PNNI is not required to transport a B-LLI IE containing the multiprotocol encapsulation information, since each interworking unit can be configured with this information as part PVC endpoint configuration.

> If one SPVC endpoint is FR and the other endpoint is ATM and the SPVC originating endpoint is configured for multiprotocol data encapsulation *translation*, either the Low Layer Compatibility (LLC) IE must be issued in the SETUP at the FR NNI (to indicate RFC 2427 encapsulation), or the Broadband Low Layer Information (B-LLI) IE must be issued in the SETUP at the ATM PNNI (to indicate RFC 1483 encapsulation). If, instead, the originating endpoint is configured for *transparent* carriage of data frames, neither the LLC IE or the B-LLI IE shall be included in the SETUP message. See section 4.8 for further discussion of multiprotocol encapsulation interworking.

Enhancements to the FR SPVC MIB are required to support FR origination of an SPVC towards an ATM VPI/VCI destination; these enhancements include destination VPI/VCI identification and multiprotocol translation mode. Likewise, enhancements to the ATM SPVC MIB are required to support ATM origination of an SPVC towards a FR DLCI destination; these enhancements include destination DLCI identification and multiprotocol translation mode. These MIB enhancements are outside the scope of this implementation agreement.

Section 3.6.6 of FRF.10.1 and Annex C section 9.4 of PNNI 1.0 address the procedures for connecting Frame Relay Switched PVCs and ATM Soft PVCs, respectively. Each procedure defines an information element (IE) that signals the called endpoint connection identifier:

- the FRF.10.1 Called Party SPVC IE signals the DLCI (or VPI/VCI for interworking); and
- the PNNI 1.0 Called Party Soft PVPC/PVCC IE signals the VPI/VCI only.

This information element is carried between networks from the SPVC calling endpoint to the called endpoint in the SETUP message, and from the called endpoint to the calling endpoint in the CONNECT message.

The Frame Relay/ATM SVC IWF shall be required to translate between these information elements to support SPVCs.

Annex C of this document defines optional extensions to support the ATM Forum PNNI SPVC Addendum [19].

4.4.1 FRF.10.1 -to- PNNI 1.0 Translation Requirements

When translating the Called Party SPVC IE from FRF.10.1 to PNNI 1.0 and the Frame Relay SPVC Selection Type indicates "specific" or "assigned DLCI", the VCI value shall be set equal to the DLCI value and the VPI value shall be fixed at zero. Therefore, the FRF.10.1 Called Party SPVC DLCI value (for interworking of SPVCs) shall have a maximum length of 16 bits. The Selection Type field contained in the FRF.10.1 Called Party SPVC IE shall be directly mapped to the Selection Type field contained in the PNNI 1.0 Called Party Soft PVPC/PVCC IE as indicated in Table 3. The Frame Relay Specific SPVC Correlator type shall not be supported by the IWF and a SETUP message containing this selection shall be cleared with cause #127 *"interworking, unspecified"*.

Table 3. FRF.10.1 –to- PNNI 1.0 SPVC Selection Type Translations

Frame Relay Called Party SPVC Selection Type	ATM Called Party Soft PVPC/PVCC Selection Type
Any DLCI	Any Value
Specific DLCI	Required Value
Assigned DLCI	Assigned Value
Specific SPVC Correlator	*Selection Type Not Available*

When translating the Calling Party SPVC IE from FRF.10.1 to PNNI 1.0, the VCI value shall be set equal to the DLCI value and the VPI value shall be fixed at zero. Therefore, the FRF.10.1 Calling Party SPVC DLCI value (for interworking of SPVCs) shall have a maximum length of 16 bits.

When translating from PNNI 1.0 to FRF.10.1, the FRF.10.1 Called Party SPVC IE fields shall be obtained from the corresponding fields of the PNNI 1.0 Called Party Soft PVPC/PVCC IE (since the FRF.10.1 Called Party SPVC IE supports signaling of the VPI/VCI). In addition, in the SETUP message, the FRF.10.1 Calling Party SPVC IE fields shall be obtained from the corresponding fields of the PNNI 1.0 Calling Party Soft PVPC/PVCC IE.

4.5 PNNI Routing

The ATM PNNI recommendation requires that the ATM NNI side of the IWF support the PNNI routing protocol.

Figure 5, Example A depicts the configuration addressed by this implementation agreement. The ATM Network, as well as the ATM NNI side of the IWF, shall support PNNI routing signaling. The Frame Relay Network is not required to support PNNI routing signaling.

The IWF is included in a peer group with one or more nodes from the attached ATM Network. The IWF participates in the exchange of "PNNI Topology State Elements" (PTSEs) in order to establish the topology database for its peer group.

When an SVC call is forwarded from an ATM network into the IWF, the Designated Transit List (DTL) IE defines the route and includes the IWF node as its last entry. When the IWF forwards an SVC call into an ATM network, the Designated Transit List (DTL) IE includes the IWF as its first entry.

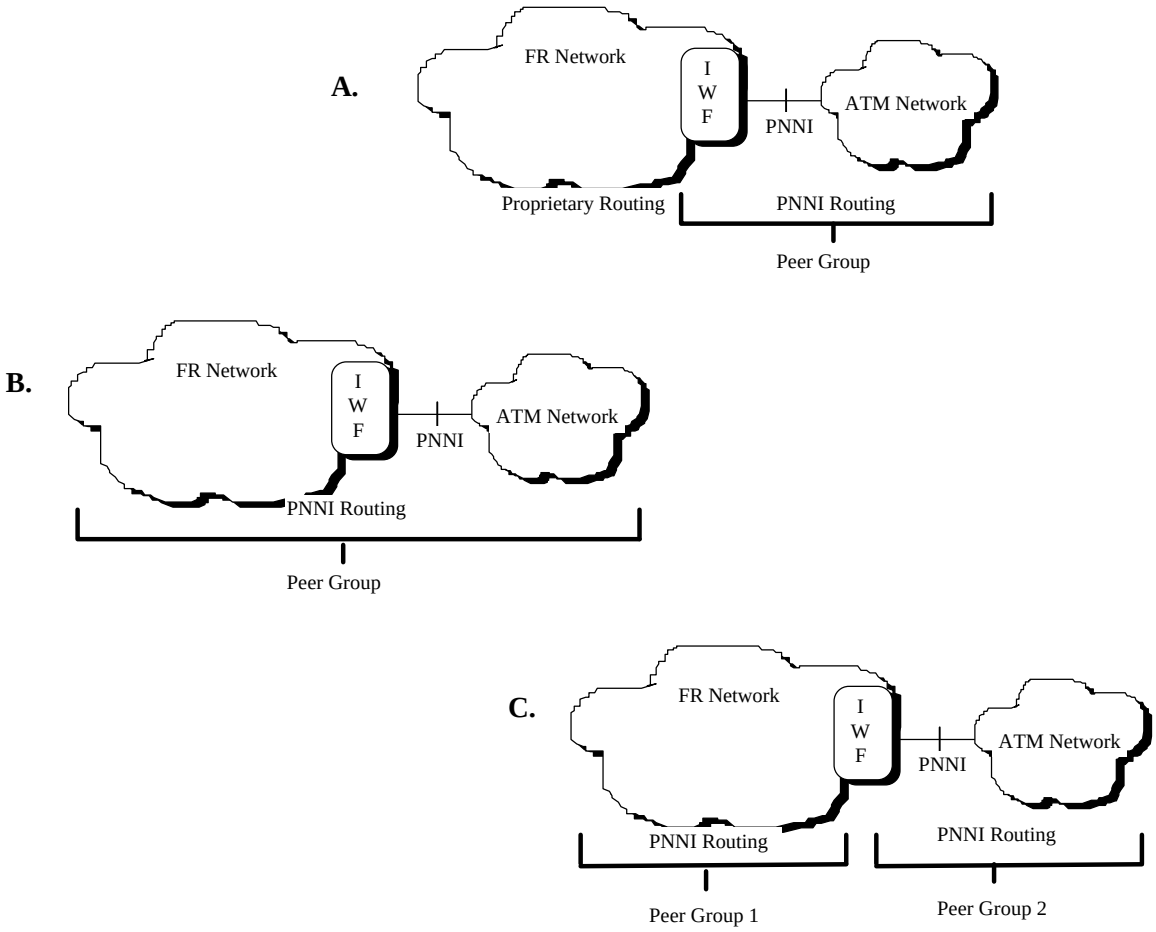

Figure 5. PNNI Routing Interworking Configurations

Examples B and C in Figure 5 again depict the configuration addressed by this implementation agreement. In these examples, however, the Frame Relay Network supports PNNI routing signaling. These implementations are for further study.

4.6 Cause Values

The IWF shall transport cause value, location, and diagnostic information transparently (i.e., *unchanged*) between the ATM and FR protocols for ITU-T standardized cause values. Both the ATM and FR protocols base cause values on ITU-T recommendation Q.850[15]. ATM Q.2610[16] lists additional cause values that are not in Q.850 and therefore have no FR equivalent but are still ITU-T standardized and are unique. It is preferred that these values be passed on transparently to the FR network (or user) to aid in troubleshooting. These additional Q.2610 ATM cause values are #35, #36, #37, #45, and #93.

Certain ATM cause values are encoded using the coding standard "11, standard defined for the network (either public or private) present on the network side of the interface". These ATM-network-specific cause values are not ITU-T standardized and include the PNNI cause values #34 and #53 and the ATM UNI 4.0 [9] cause value #23. The IWF shall map any ATM cause values with coding standard "11" to the Q.850 cause #127 "interworking, unspecified".

4.7 Call States and Timers

There are no issues to be addressed by this implementation agreement regarding correlation of the states and timers of the Frame Relay-NNI and ATM-NNI. The FRF.10.1 and ATM PNNI call control timers operate independently within each of the two layer 3 protocols.

4.8 Multiprotocol Encapsulation Interworking

For FR/ATM SVC service interworking, the interworking function (IWF) must determine whether to transport data frames ***transparently*** across the IWF, or whether data frames must be ***translated*** across the IWF between the FR (RFC 2427[11]) and ATM (RFC 1483[12]) multiprotocol encapsulation methods.

Normally, the FR Low Layer Compatibility (LLC) IE and the ATM Broadband Low Layer Information (B-LLI) IE are passed transparently in the SETUP message from the call originating entity to the addressed entity. However, the IWF shall use the information in these IEs to determine whether multiprotocol encapsulation translation is necessary.

To indicate RFC 2427 multiprotocol encapsulation, the LLC IE is coded as follows:

8	7	6	5	4	3	2	1	Octet
Low Layer Compatibility								
0	1	1	1	1	1	0	0	1
information element identifier								
Length of LLC contents								
0	0	0	0	0	0	1	1	2
	Coding std		Information transfer capability					
1	0	0	0	1	0	0	0	3
ext	CCITT		Unrestricted digital information					
	Transfer mode		Reserved					
1	0	1	0	0	0	0	0	4
ext	Frame mode							
	Layer 3 ID		User information layer 3 protocol					
1	1	1	0	1	0	1	1	7
ext			ISO/IEC TR 9577					

Figure 6. FR Low Layer Compatibility (LLC) IE for RFC 2427 Multiprotocol Encapsulation

As defined in Appendix D of the ATM UNI 3.1[13] specification, indication of ATM protocol encapsulation using LAN Logical Link Control (RFC 1483) is by coding the B-LLI IE as follows:

8	7	6	5	4	3	2	1	Octet
Broadband Low Layer Information								
0	1	0	1	1	1	1	1	1
information element identifier								
	Coding std		IE instruction field					
1	0	0	0	0	0	0	0	2
ext	ITU-T specified		Not significant					
Length of B-LLI contents								
0	0	0	0	0	0	0	0	3
0	0	0	0	0	0	0	1	4
	Layer 2 ID		User information layer 2 protocol					
1	1	0	0	1	1	0	0	6
ext			LAN logical link control (ISO 8802/2)					

Figure 7. ATM Broadband Low Layer Information (B-LLI) IE for RFC 1483 Multiprotocol Encapsulation

Upon receipt of an FR SETUP message with an LLC IE coded for “multiprotocol encapsulation” (as shown in Figure 6), the IWF shall replace the contents of this information element and send an ATM SETUP with the B-LLI IE coded for “multiprotocol encapsulation” (as shown in Figure 7) towards the ATM endpoint.

Likewise, upon receipt of an ATM SETUP message with a B-LLI IE coded for “multiprotocol encapsulation” (as shown in Figure 7), the IWF shall replace the contents of this information element and send an FR SETUP with the LLC IE coded for “multiprotocol encapsulation” (as shown in Figure 6) towards the FR endpoint.

When “multiprotocol encapsulation” is not indicated in the LLC or B-LLI IEs, conversion between the LLC and B-LLI IEs is as depicted in Figure 8. Note that the conversion requires modification of the length octet(s) and deletion/insertion of the ATM IE instruction octet. The “content” octets shall be copied unchanged between the FR LLC IE and the ATM B-LLI IE.

[The basic format of the two IEs is identical; however, the ATM B-LLI allows additional octets for layer 2 HDLC negotiation and for layer 3 selection of a specific TR 9577 protocol identifier. Also, the Q.933 LLC IE allows for layer 2 "address inclusion" codepoints; the B-LLI IE sets the "address inclusion" (or "Q.933 use") field to zeros. It is left to the endpoint device to determine whether it can support the additional B-LLI octets or codepoint differences. For example, an FRF.4/Q.933-based endpoint device would ignore an LLC IE that contained additional TR 9577 protocol identifier octets based on IE length or invalid content and would optionally send a STATUS message with cause #43 "access information discarded".]

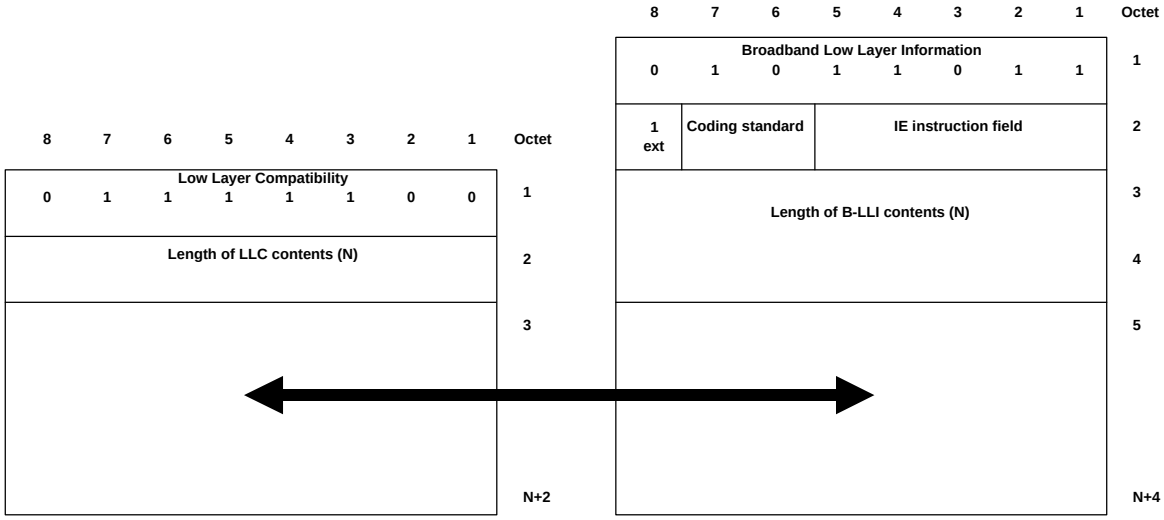

Figure 8. FR LLC/ ATM B-LLI IE Conversion When Multiprotocol Encapsulation Is Not Indicated

Note that both FR and ATM SVC signaling support negotiation of the LLC/B-LLI IE in the CONNECT message either by negotiating HDLC parameters for a single B-LLI IE or by selecting one LLC/B-LLI IE from up to 3 LLC/B-LLI IEs received in the SETUP message. The IWF must support this LLC/B-LLI negotiation as specified in the following paragraphs.

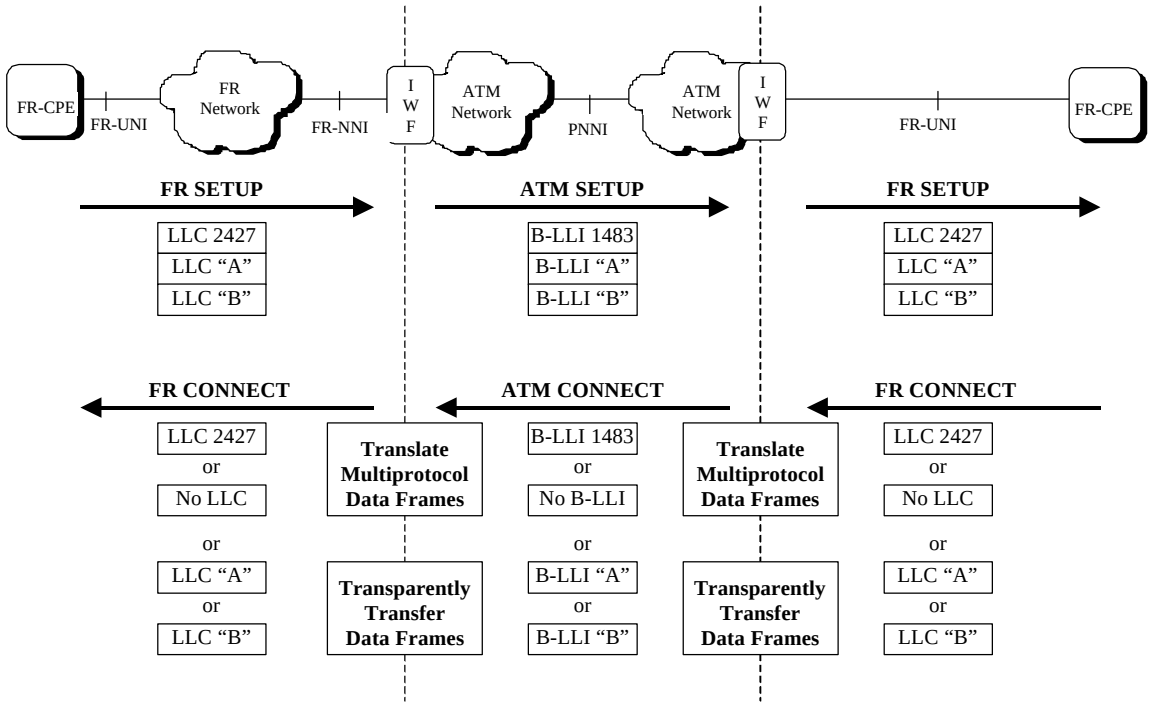

Figure 9. FR LLC /ATM B-LLI Negotiation Interworking (with Multiprotocol Encapsulation Preferred)

Figure 9 depicts the case in which one or more LLC/B-LLI IEs are signaled in the SETUP message. The IEs are always in preferential order and, for this case, the preferred selection is "multiprotocol encapsulation". (Note that the IWF translates each LLC/B-LLI IE in the SETUP and CONNECT messages as previously discussed.) Based on the LLC/B-LLI selected by the destination CPE in the CONNECT message, the IWF must determine whether data frames must undergo multiprotocol encapsulation *translation* or must be carried *transparently*. As shown in the figure, the IWF must perform multiprotocol encapsulation *translation* of the data frames if:

- the CPE explicitly signals an LLC/B-LLI IE encoded for multiprotocol encapsulation in the CONNECT message, or
- the CPE implicitly selects LLC/B-LLI IE by omitting the LLC/B-LLI IE in the CONNECT message

Encapsulation translations shall be as defined in FRF.8.1. Otherwise, the IWF shall transfer the data frames *transparently*.

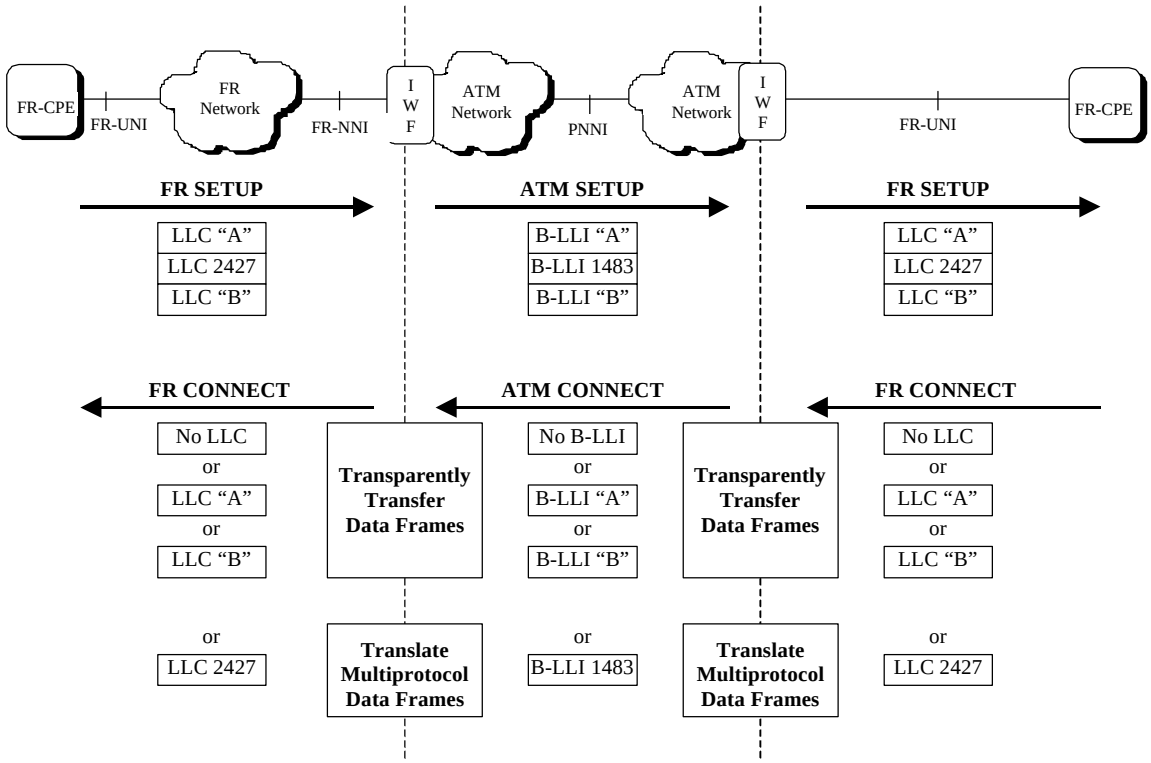

Figure 10. FR LLC /ATM B-LLI Negotiation Interworking (with Multiprotocol Encapsulation Not Preferred)

Figure 10 depicts the case in which one or more LLC/B-LLI IEs are signaled in the SETUP message but, for this case, the preferred selection is not "multiprotocol encapsulation". As shown in the figure, the IWF must perform multiprotocol encapsulation *translation* of the data frames if:

- the CPE explicitly signals an LLC/B-LLI IE encoded for multiprotocol encapsulation in the CONNECT message

Encapsulation translations shall be as defined in FRF.8.1. Otherwise, the IWF shall transfer the data frames *transparently*.

When there are no LLC/B-LLI IEs signaled in the SETUP message, the IWF shall transfer the data frames *transparently*.

5.0 Frame Relay/ATM SVC Signaling Message Translation

This section defines the signaling message translations to be performed between the FRF.10.1 and ATM PNNI signaling protocols. It contains four subsections which cover call establishment and call clearing from both the Frame Relay network and the ATM network perspectives:

- Frame Relay Initiated Call Establishment
- Frame Relay Initiated Call Clearing
- ATM Initiated Call Establishment
- ATM Initiated Call Clearing

A message flow figure is provided within each of the following subsections. Each of these figures depicts message flow between the Frame Relay network and the ATM network.

Message translation summary tables are also provided within each of the following subsections. In each of these tables, the signaling information elements for a message are listed for the FRF.10.1 (left-most columns) and the ATM PNNI (right-most columns) protocols. The center column (labeled "Translation Description") defines the direction of message flow (Frame Relay -> ATM, or Frame Relay <- ATM) and a short summary of how the information elements are to be translated. A more detailed explanation of the translations can be found in the accompanying text.

The signaling translations are defined above the layer 3 signaling protocols. The layer 3 FRF.10.1 and ATM PNNI protocols still provide call state, message, and information element validation processing. The service interworking requirements provided in this section are in addition to layer 3 processing.

It is assumed that the layer 3 signaling protocols handle the mechanics of translating FRF.10.1 messages to PNNI messages by:

1. Inserting the message type instruction octet (containing the flag and action indicator fields) and the 2-octet message length for each PNNI message; and
2. Inserting the IE instruction octet and the 2-octet IE length for each PNNI information element.

In the reverse translation, from PNNI to FRF.10.1:

1. A single message type octet is generated (with no message length octets) for each FRF.10.1 message; and
2. A single IE length octet is generated (and no IE instruction octet) for each FRF.10.1 information element.

Only messages of "global" (or "end-to-end") significance require translation across the IWF. These include:

- CONNECT
- RELEASE
- The cause information contained in RELEASE COMPLETE (as the first clearing message)
- SETUP

While ALERTING, NOTIFY, and PROGRESS have global significance within an ATM network, they are not supported by FRF.10.1 and cannot be transferred by the IWF into the Frame Relay network.

Messages of “local” significance do not require translation. These include:

- CALL PROCEEDING
- RELEASE COMPLETE (as a response to the RELEASE message)
- STATUS
- STATUS ENQUIRY
- RESTART
- RESTART ACKNOWLEDGE

5.1 Frame Relay Initiated Call Establishment

Figure 11 illustrates the call establishment message flow from the FR-CPE to the ATM B-CPE.

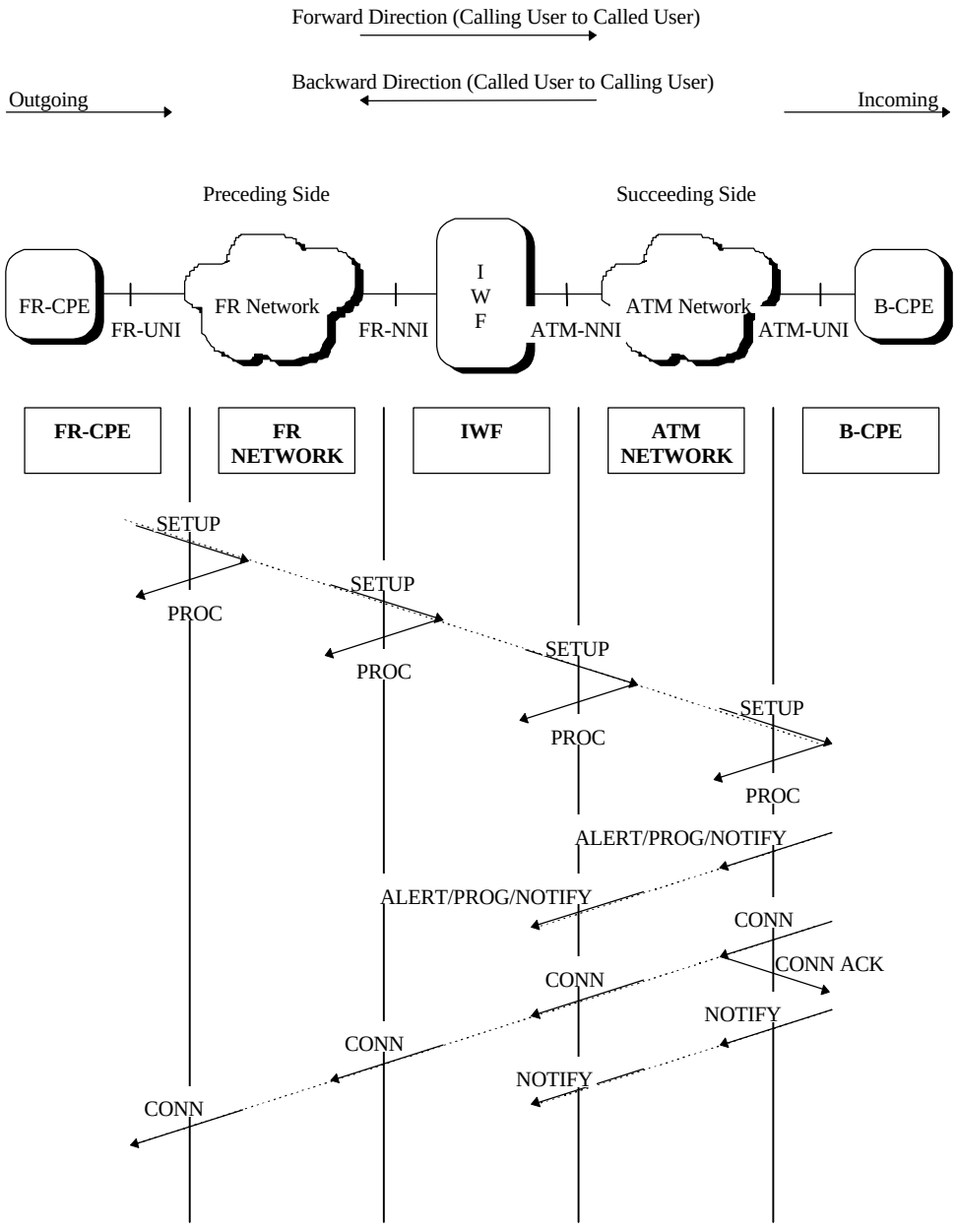

Figure 11. Frame Relay Initiated Call Establishment Message Flow

5.1.1 Setup Message Translation (Frame Relay -> ATM at IWF)

Upon receipt of a Frame Relay SETUP message, the IWF shall ignore the FRF.10.1 information elements listed as “No ATM Equivalent - Ignore” in Table 4, since they have no ATM NNI equivalent. However, in the case of the FRF.10.1 CUG Interlock Code, if the CUG indication (octet 3) does not indicate “closed user group with outgoing access selection and indication”, the call shall be cleared with cause #29 “facility rejected”.

In the ATM SETUP message to be sent, the IWF shall not use the ATM PNNI information elements listed as “Not Used” in Table 4.

In the ATM SETUP message to be sent, the ATM NNI Connection Identifier information element shall be created if the IWF is configured with a higher node identifier than its peer node on the PNNI interface.

The following ATM NNI information elements will be included in the SETUP message, as described in the subparagraphs of this section 5.1.1:

- Broadband Bearer Capability
- Designated Transit List
- Quality of Service Parameter
- AAL Parameters
- ATM Traffic Descriptor
- Minimum Acceptable ATM Traffic Descriptor
- Broadband Repeat Indicator
- Broadband Low Layer Information
- Calling Party Number
- Calling Party Subaddress
- Called Party Number
- Called Party Subaddress
- Calling Party SPVCC
- Called Party SPVCC
- Transit Network Selection (not translatable)

Table 4. SETUP Translation Summary for Frame Relay Initiated Call Establishment

FRF.10.1 SETUP Info Element	FR -> ATM Translation Summary	PNNI SETUP Info Element
DLCI	Save at IWF	
	Higher Node ID Sets at IWF	Connection Identifier
	Mandatory - IWF Provided	Broadband Bearer Capability
	Mandatory - IWF Provided	Designated Transit List
	Mandatory - IWF Provided	QoS Parameter
LL Core Parameters	Translate	AAL Parameters
LL Core Parameters	Translate - Mandatory	ATM Traffic Descriptor
Priority and Service Class Parameters	Translate-Mandatory	ATM Traffic Descriptor
LL Core Parameters	Translate	Min Accept ATM Traffic Descriptor
	IWF Provided For Multiple B-LLI IEs	Broadband Repeat Indicator
Low Layer Compatibility	Translate	Broadband Low Layer Info
Calling Party Number	Translate	Calling Party Number
Calling Party Subaddress	Translate	Calling Party Subaddress
Called Party Number	Translate - Mandatory	Called Party Number
Called Party Subaddress	Translate	Called Party Subaddress
Calling Party SPVC	Translate	Calling Party SPVCC
Called Party SPVC	Translate	Called Party SPVCC
Transit Network Selection	Not Translatable - Clear Call	Transit Network Selection
Bearer Capability	No ATM Equivalent - Ignore	
User-User	No ATM Equivalent - Ignore	
Transit Network Identification	No ATM Equivalent - Ignore	
CUG Interlock Code	No ATM Equivalent - Ignore	
Call Identification	No ATM Equivalent - Ignore	
	Not Used	Broadband High Layer Info
	Not Used	Endpoint Reference
	Implementation Dependent	ABR Additional Parameters
	Implementation Dependent	ABR Setup Parameters
	Not Used	Alternate ATM Traffic Descriptor
	Not Used	Connection Scope Selection
	Not Used	End-to-End Transit Delay
	Not Used	Extended QoS
	Not Used	Generic Identifier Transport
	Not Used	Notification Indicator

5.1.1.1 ATM Connection Identifier IE

If the IWF has a higher ATM node identification value that its PNNI peer node, this IE is mandatory and must be provided by the IWF in the outgoing SETUP message. See section 4.1.

5.1.1.2 ATM Broadband Bearer Capability IE

This mandatory IE must be provided by the IWF in the outgoing SETUP message. It is to be coded as follows:

- Bearer Class *BCOB-C*
- Susceptibility to Clipping *Not Susceptible To Clipping*
- User Plane Connection Configuration *Point-to-Point*

Refer to section 5.1.1.6 for tranlation of the FR Priority and Service Class Parameters IE to obtain the ATM service category. If the derived ATM service category is non-real-time VBR or UBR (with the Best Effort Indicator signaled in the ATM Traffic Descriptor IE), octet 5a, ATM Transfer Capability, may be omitted since the Bearer Class is BCOB-C. For indicating real-time VBR, the ATM Transfer Capability shall be included in octet 5a.

Handling of ABR signaling is implementation dependent.

5.1.1.3 ATM Designated Transit List IE

This mandatory IE must be provided by the IWF in the outgoing SETUP message. See section 4.5.

5.1.1.4 ATM Quality of Service Parameter IE

This mandatory IE must be provided by the IWF in the outgoing SETUP message. The QoS Class Forward and QoS Class Backward values shall be set to QoS Class 0, "unspecified".

5.1.1.5 ATM AAL Parameters IE

In the outgoing SETUP message's ATM AAL Parameters IE, the IWF shall indicate AAL Type 5 in accordance with FRF.8.1. The Forward and Backward Maximum CPCS-SDU sizes shall be set to the values provided in the Frame Relay Link Layer Core Parameters IE Outgoing and Incoming Maximum FMIF Size fields, respectively.

The SSCS Type shall be set to NULL in accordance with FRF.8.1.

5.1.1.6 ATM Traffic Descriptor IE

This mandatory IE must be provided by the IWF in the outgoing SETUP message. The ATM Traffic Descriptor IE shall be generated using the Frame Relay Link Layer Core Parameters IE as defined in Annex A and section 4.3 of this document.

The algorithms in Annex A for determining ATM traffic conformance parameters require an estimate of frame size. The frame size parameter shall be configurable at the IWF.

The other fields of the ATM Traffic Descriptor IE shall be coded as follows:

- Forward Frame Discard — *Frame Discard Allowed*
- Backward Frame Discard — *Frame Discard Allowed*
- Tagging Forward — *Tagging Requested*
- Tagging Backward — *Tagging Requested*

By default the ATM Traffic Descriptor IE should be formatted for VBR.3 conformance and the Best Effort Indicator should not be indicated since the default ATM service category is non-real-time VBR.

If the IWF supports translation of the FR Priority and Service Class Parameters IE, it is suggested that the mapping from the FR Priority and Service Class Parameters IE to the ATM Service Categories be configurable at the IWF. A suggested mapping is shown in Table 5. For example, if X.146 Service Class 0 is received, the IWF should format the ATM Traffic Descriptor IE as UBR.2 and the Best Effort Indicator should be indicated.

Table 5. Suggested Mapping of X.146 Service Class to ATM Service Category

FR X.146 Service Class	ATM Service Category
0	UBR
1	Reserved for ABR
2	VBRnrt
3	VBRrt

Translation of the Transfer and Discard Priorities in the FR Priority and Service Class Parameters IE is outside the scope of this implementation agreement.

5.1.1.7 ATM Minimum Acceptable Traffic Descriptor IE

This IE may be provided by the IWF if the Frame Relay Link Layer Core Parameters IE includes the Minimum Acceptable Throughput. The Minimum Acceptable ATM Traffic Descriptor IE is generated as in section 5.1.1.6 except that the Minimum Acceptable Throughput and not the Throughput from the Frame Relay Link Layer Core Parameters IE is used. See Annex A and section 4.3 of this document.

5.1.1.8 ATM Broadband Repeat Indicator IE and Broadband Low Layer Information IE

FRF.10.1 provides for specification of the user information layer 2 and layer 3 protocols in up to three Frame Relay Low Layer Compatibility IEs. If one or more Low Layer Compatibility IEs are present in the received SETUP message, each shall be translated into an ATM Broadband Low Layer Information IE as defined in section 4.8. If multiple FR Low Layer Compatibility IEs are present in the SETUP message, the IWF shall precede the ATM Broadband Low Layer Information IEs with an ATM Broadband Repeat Indicator IE.

5.1.1.9 ATM Calling Party Number IE

Translation of the Calling Party Number IE from Frame Relay to ATM is defined in section 4.2.1. Translation of the number plan of the Frame Relay Calling Party Number may not be supported by the IWF. Since this IE isn't mandatory, an unsupported address simply won't be forwarded by the IWF.

5.1.1.10 ATM Calling Party Subaddress IE

Translation of the Calling Party Subaddress IE from Frame Relay to ATM is defined in section 4.2.2.

5.1.1.11 ATM Called Party Number IE

Translation of the Called Party Number IE from Frame Relay to ATM is defined in section 4.2.1. Translation of the number plan of the Frame Relay Called Party Number may not be supported by

the IWF. Since this is a mandatory IE, an unsupported address received in a SETUP message is to be rejected with cause #100 *"invalid information element contents"*.

5.1.1.12 ATM Called Party Subaddress IE

Translation of the Called Party Subaddress IE from Frame Relay to ATM is defined in section 4.2.2.

5.1.1.13 ATM Calling Party SPVCC IE

This IE must be provided by the IWF if the Frame Relay Calling Party SPVC IE is received in the Frame Relay SETUP message. See section 4.4.

5.1.1.14 ATM Called Party SPVCC IE

This IE must be provided by the IWF if the Frame Relay Called Party SPVC IE is received in the Frame Relay SETUP message. See section 4.4.

5.1.1.15 ATM Transit Network Selection IE

This IE cannot be translated from the first Frame Relay Transit Network Selection (TNS) IE if present in the received SETUP message. The codepoints used by FRF.10.1 (X.76) and PNNI are as follows:

Table 6. Transit Network Selection Type and Plan Codepoints

	Network ID Type	Network ID Plan
FRF.10.1	International	Carrier ID Code (E.164 Country Code), or X.121 Data Network ID Code
PNNI	National	Carrier ID Code

Note that the "network ID type" codepoints don't match. If a Frame Relay Transit Network Selection IE is received, then the call shall be cleared by the IWF with cause #100 *"invalid information element contents"*.

5.1.2 Call Proceeding Message Handling (Frame Relay <- ATM at IWF)

As listed in Table 7, upon receipt of a Frame Relay SETUP message at the IWF, the IWF responds with a CALL PROCEEDING message.

After sending an ATM SETUP message, the IWF should receive a CALL PROCEEDING message from the ATM network. If the IWF is attached to an ATM node with a higher node identifier, the VPI/VCI value for the SVC is received in the Connection Identifier IE. If an Endpoint Reference IE is received in the ATM CALL PROCEEDING message, the call shall be cleared since multipoint functionality is not supported by the IWF.

Note that CALL PROCEEDING is of "local" significance and shall be issued by the IWF only upon receipt of a SETUP message.

Table 7. CALL PROCEEDING Handling Summary for Frame Relay Initiated Call Establishment

FRF.10.1 CALL PROC Info Element	FR <- ATM Handling Summary	PNNI CALL PROC Info Element
DLCI	Mandatory - Duplicate of SETUP DLCI	
	Lower Node ID Saves at IWF	Connection Identifier
	No FR Equivalent - Clear Call	Endpoint Reference

5.1.2.1 Frame Relay Data Link Connection Identifier IE

The Frame Relay DLCI value must be provided in the outgoing CALL PROCEEDING message. It shall be identical to that received in the Frame Relay SETUP message. See section 4.1.

5.1.3 Alerting Message Handling (Frame Relay <- ATM at IWF)

The ALERTING message is not supported by FRF.10.1. If received from the ATM network, this message shall not be forwarded by the IWF to the Frame Relay network.

5.1.4 Progress Message Handling (Frame Relay <- ATM at IWF)

The PROGRESS message is not supported by FRF.10.1. If received from the ATM network, this message shall not be forwarded by the IWF to the Frame Relay network.

5.1.5 Notify Message Handling (Frame Relay <- ATM at IWF)

The NOTIFY message is not supported by FRF.10.1. If received from the ATM network, this message shall not be forwarded by the IWF to the Frame Relay network.

5.1.6 Connect Message Translation (Frame Relay <- ATM at IWF)

Upon receipt of an ATM CONNECT message, the IWF shall ignore the ATM PNNI information elements listed as “No FR Equivalent - Ignore” in Table 8, since they have no FRF.10.1 equivalent.

Handling of ABR signaling is implementation dependent. If an Endpoint Reference IE is received in the CONNECT message, the call shall be cleared with cause #99 *“information element/parameter non-existent or not implemented”* since multipoint functionality is not supported by the IWF.

In the Frame Relay CONNECT message to be sent, the IWF shall not use the FRF.10.1 information elements listed as “Not Used

The following FRF.10.1 information elements will be included in the CONNECT message by translating the ATM NNI information elements, as described in the following subparagraphs:

- Connected Number
- Connected Subaddress
- Link Layer Core Parameters
- Called Party SPVCC
- Low Layer Compatibility

Table 8. CONNECT Translation Summary for Frame Relay Initiated Call Establishment

FRF.10.1 CONNECT Info Element	FR <- ATM Translation Summary	PNNI CONNECT Info Element
Connected Number	Translate	Connected Number
Connected Subaddress	Translate	Connected Subaddress
Link Layer Core Parameters	Mandatory - Translate	ATM Traffic Descriptor
Link Layer Core Parameters	Mandatory - Translate	AAL Parameters
Called Party SPVC	Translate	Called Party SPVCC
Low Layer Compatibility	Translate	Broadband Low Layer Info
User-User	Not Used	
Transit Network Identification	Not Used	
	No FR Equivalent - Ignore	Generic Identifier Transport
	No FR Equivalent - Ignore	Notification Indicator
	Implementation Dependent	ABR Additional Parameters
	Implementation Dependent	ABR Setup Parameters
	No FR Equivalent - Clear Call	End-to-End Transit Delay
	No FR Equivalent - Clear Call	Extended QoS Parameters
	No FR Equivalent - Clear Call	Endpoint Reference

5.1.6.1 Frame Relay Connected Number IE

Translation of the Connected Number IE from ATM to Frame Relay is defined in section 4.2.1. Translation of the number plan of the ATM Connected Number may not be supported by the IWF. Since this IE isn't mandatory, an unsupported address simply won't be forwarded by the IWF.

5.1.6.2 Frame Relay Connected Subaddress IE

Translation of the Connected Subaddress IE from ATM to Frame Relay is defined in section 4.2.2. The ATM Endsystem Address (AESA) coding of the ATM Connected Subaddress is not supported since there is no direct FRF.10.1 equivalent. Since this IE isn't mandatory, an AESA address simply won't be forwarded by the IWF.

5.1.6.3 Frame Relay Link Layer Core Parameters IE

This mandatory IE shall be generated by the IWF for the outgoing CONNECT message. If the ATM AAL Parameters IE is received in the ATM CONNECT message, the Frame Relay Link Layer Core Parameters IE Outgoing and Incoming FMIF Size fields shall be set to the Forward and Backward Maximum CPCS-SDU Sizes, respectively. If the ATM Traffic Descriptor IE is received in the ATM CONNECT message, the Frame Relay CIR, Bc, and Be values shall be calculated according to the algorithms defined in Annex A. See section 4.3.

If the AAL Parameters IE does not indicate AAL Type 5, the call shall be rejected with cause #100 *"invalid information element contents"*.

If the AAL Parameters IE is not present in the ATM CONNECT message, the IWF shall set the Frame Relay Link Layer Core Parameters IE Outgoing and Incoming FMIF Size fields to the values previously sent in the FR SETUP message.

If the ATM Traffic Descriptor IE is not present in the ATM CONNECT message, the IWF shall set the Frame Relay Link Layer Core Parameters IE CIR, Bc, and Be fields to the values previously sent in the FR SETUP message.

5.1.6.4 Frame Relay Called Party SPVC IE

This IE shall be translated by the IWF if the ATM Called Party SPVCC IE is received in the ATM CONNECT message. See section 4.4.

5.1.6.5 Frame Relay Low Layer Compatibility IE

This IE shall be translated by the IWF if the ATM Broadband Low Layer Information IE is received in the ATM CONNECT message. See section 4.8.

5.2 Frame Relay Initiated Call Clearing

Figure 12 illustrates the call clearing message flow from the Frame Relay network to the ATM network. Tables 9 and 10 summarize the translation of these messages at the IWF. Translation of cause values shall be as defined in section 4.6.

As specified in FRF.10.1, the Frame Relay network initiates call clearing with REL COMP in call state N0 and with RELEASE in all other call states. These two scenarios are reflected in Figure 12. The IWF may also initiate call clearing towards the Frame Relay network and towards the ATM network.

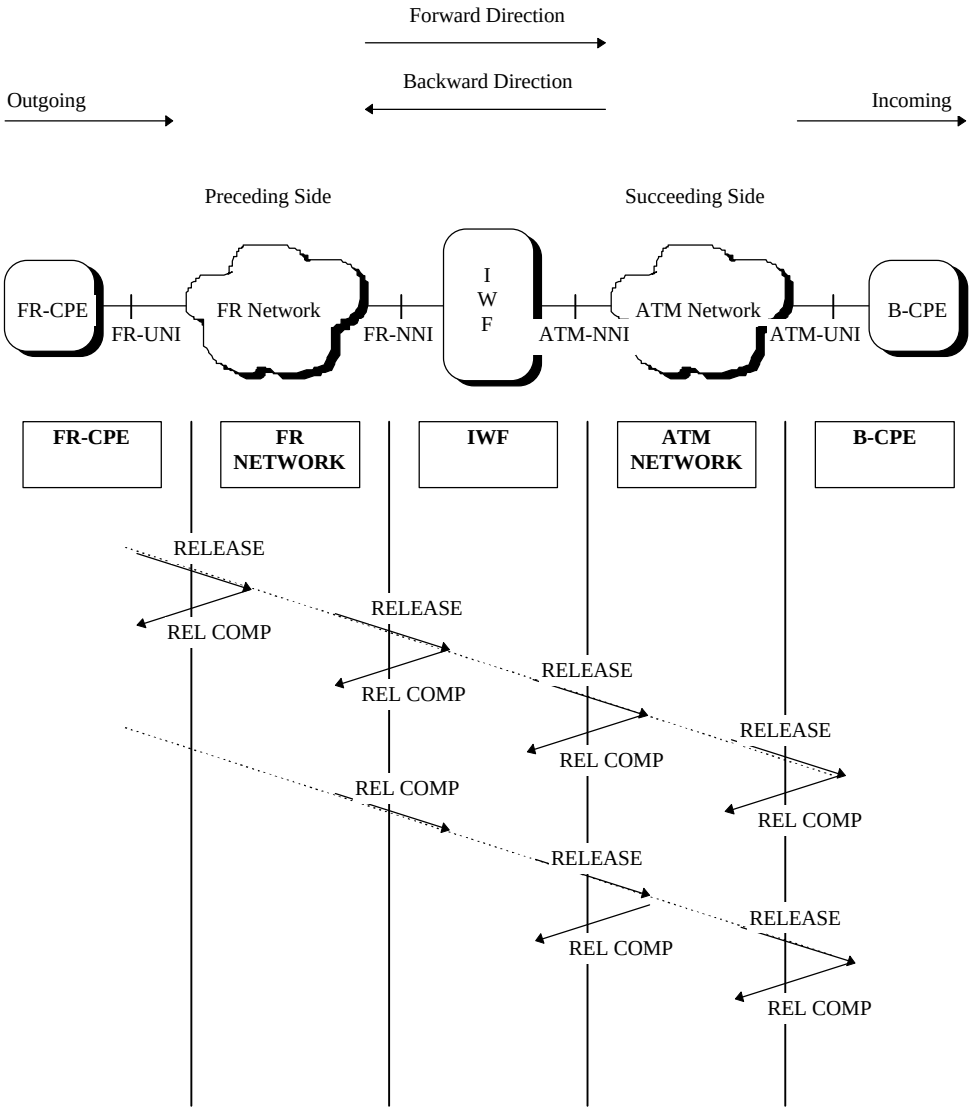

Figure 12. Frame Relay Initiated Call Clearing Message Flow

Table 9. RELEASE Translation Summary for Frame Relay Initiated Call Clearing

FRF.10.1 RELEASE Info Element	FR -> ATM Translation Summary	PNNI RELEASE Info Element
Cause (2 instances possible)	Translate	Cause (2 instances possible)
	IWF Provided	Crankback
Clearing Network Identification	No ATM Equivalent - Ignore	
Transit Network Identification	No ATM Equivalent - Ignore	
	Not Used	Notification Indicator
	Not Used	Generic Identifier Transport

Table 10. RELEASE COMPLETE Translation Summary for Frame Relay Initiated Call Clearing

FRF.10.1 REL COMP Info Element	FR -> ATM Translation Summary	PNNI RELEASE Info Element
Cause (2 instances possible)	Translate	Cause (2 instances possible)
	IWF Provided	Crankback
Clearing Network Identification	No ATM Equivalent - Ignore	
Transit Network Identification	No ATM Equivalent - Ignore	
	Not Used	Notification Indicator
	Not Used	Generic Identifier Transport

5.3 ATM Initiated Call Establishment

Figure 13 illustrates the call establishment message flow from the ATM network to the Frame Relay network.

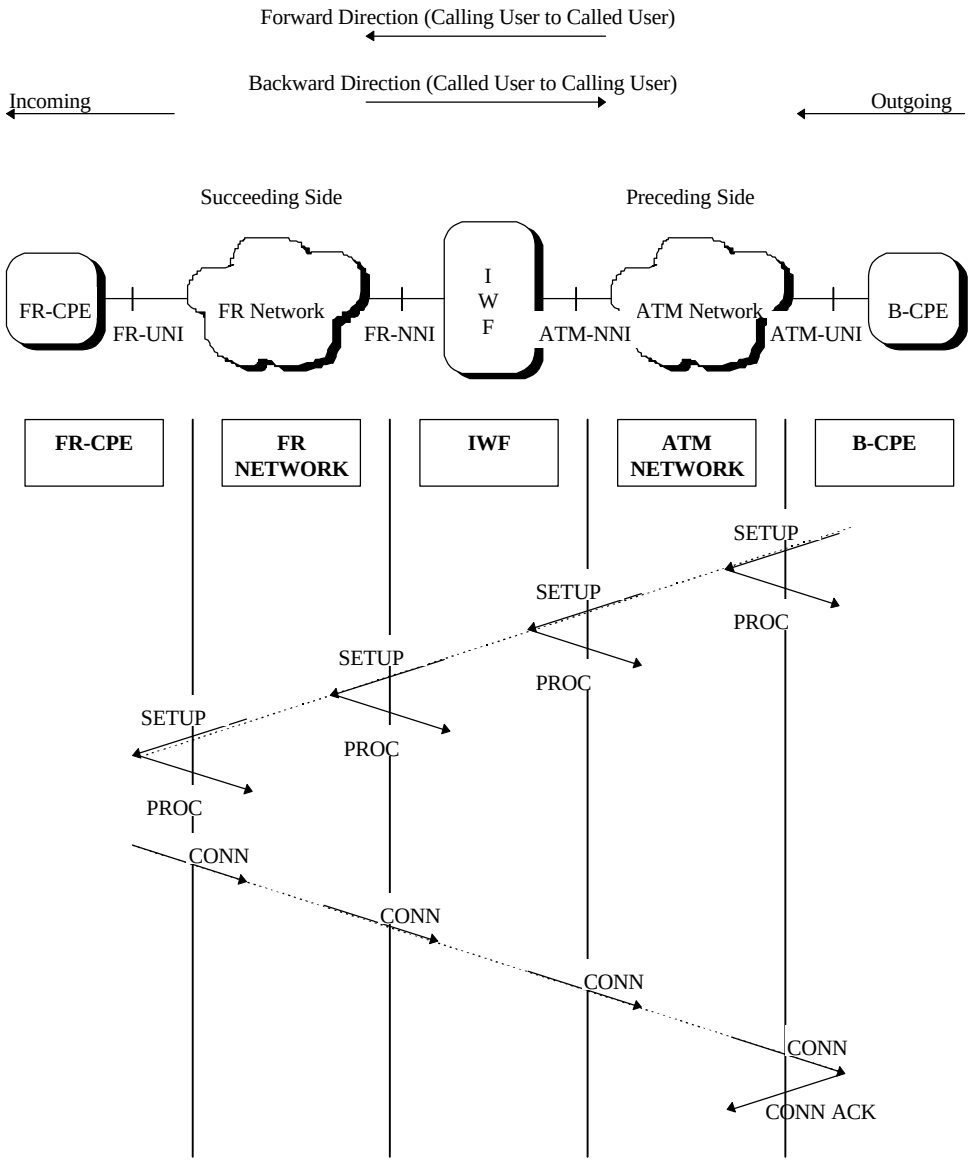

Figure 13. ATM Initiated Call Establishment Message Flow

5.3.1 Setup Message Translation (Frame Relay <- ATM at IWF)

Upon receipt of an ATM SETUP message, the IWF shall ignore the PNNI information elements listed as "No FR Equivalent - Ignore" in Table 11, since they have no Frame Relay NNI equivalent.

If the Broadband Bearer Capability IE user plane field is not set to "point-to-point", the call shall be rejected with cause #100 *"invalid information element contents"*, because FRF.10.1 does not support point-to-multipoint connections.

The Frame Relay network is not capable of supporting the CBR or ABR service categories. Rules for decoding ATM service categories from the PNNI Broadband Bearer Capability IE are defined in section 2.0 "Basic Point-to-Point Call" (paragraph 4.5.7/Q.2931 Broadband bearer capability). If the PNNI SETUP message Broadband Bearer Capability IE indicates either CBR or ABR, the call shall be rejected with cause #99 *"information element not implemented"*:

Handling of ABR signaling is implementation dependent. Since FRF.10.1 does not support point-to-multipoint connections, receipt of an ATM Endpoint Reference IE in the SETUP message shall result in the call shall be rejected with cause #99 *"information element/parameter non-existent or not implemented"*.

In the Frame Relay SETUP message to be sent, the IWF shall not use the FRF.10.1 information elements listed as "Not Used" in Table 11.

In the Frame Relay SETUP message to be sent, the Data Link Connection Identifier information element shall be created by the IWF as defined in section 4.1.

The following FRF.10.1 information elements will be included in the SETUP message, as described in the subparagraphs of this section 5.3.1:

- Bearer Capability
- Link Layer Core Parameters
- Low Layer Compatibility
- Calling Party Number
- Calling Party Subaddress
- Called Party Number
- Called Party Subaddress
- Calling Party SPVC
- Called Party SPVC
- Transit Network Selection (not translatable)
- Call Identification
- Priority and Service Class Parameters

Table 11. SETUP Translation Summary for ATM Initiated Call Establishment

FRF.10.1 SETUP Info Element	FR <- ATM Translation Summary	PNNI SETUP Info Element
DLCI	Mandatory - Set at IWF	
	Lower Node ID Saves at IWF	Connection Identifier
Bearer Capability	Mandatory - IWF Provided	
LL Core Parameters	Translate - Mandatory	AAL Parameters
LL Core Parameters	Translate - Mandatory	ATM Traffic Descriptor
LL Core Parameters	Translate	Min Accept ATM Traffic Descriptor
Low Layer Compatibility	Translate	Broadband Low Layer Info
Calling Party Number	Translate - Mandatory	Calling Party Number
Calling Party Subaddress	Translate	Calling Party Subaddress
Called Party Number	Translate - Mandatory	Called Party Number
Called Party Subaddress	Translate	Called Party Subaddress
Calling Party SPVC	Translate	Calling Party SPVCC
Called Party SPVC	Translate	Called Party SPVCC
Transit Network Selection	Not Translatable - Clear Call	Transit Network Selection
Call Identification	Create - Mandatory	
Priority and Service Class Parameters	Translate	ATM Traffic Descriptor
User-User	Not Used	
Transit Network Identification	Not Used	
CUG Interlock Code	Not Used	
	No FR Equivalent - Validate	Broadband Bearer Capability
	No FR Equivalent - Ignore	QoS Parameter
	No FR Equivalent - Ignore	Alternate ATM Traffic Descriptor
	No FR Equivalent - Ignore	Broadband High Layer Info
	No FR Equivalent - Ignore	Broadband Repeat Indicator
	No FR Equivalent - Ignore	Connection Scope Selection
	No FR Equivalent - Ignore	Designated Transit List
	No FR Equivalent - Ignore	Generic Identifier Transport
	No FR Equivalent - Ignore	Notification Indicator
	Implementation Dependent	ABR Additional Parameters
	Implementation Dependent	ABR Setup Parameters
	No FR Equivalent - Clear Call	End-to-End Transit Delay
	No FR Equivalent - Clear Call	Extended QoS
	No FR Equivalent - Clear Call	Endpoint Reference

5.3.1.1 Frame Relay Data Link Connection Identifier IE

This mandatory IE must be provided by the IWF in the outgoing SETUP message. See section 4.1.

5.3.1.2 Frame Relay Bearer Capability IE

This mandatory IE must be provided by the IWF in the outgoing SETUP message. It shall be coded as follows as defined by FRF.10.1:

- Coding Standard — *CCITT*
- Information Transfer Capability — *Unrestricted Digital Information*
- Transfer Mode — *Frame Mode*
- User Information Layer 2 Protocol — *Core Aspects of Frame Mode (Annex A/Q.922)*

5.3.1.3 Frame Relay Link Layer Core Parameters

This mandatory IE must be provided by the IWF in the outgoing SETUP message.

If the ATM AAL Parameters IE is received in the ATM SETUP message, it shall be used to generate the Frame Relay Link Layer Core Parameters IE for the outgoing Frame Relay SETUP message. The Frame Relay Link Layer Core Parameters IE Outgoing and Incoming FMIF Size fields shall be set to the Forward and Backward Maximum CPCS-SDU Sizes, respectively. If the ATM AAL Parameters IE is not received, IWF default values shall be used.

If the AAL Parameters IE does not indicate AAL Type 5, the call shall be rejected with cause #100 *"invalid information element contents"*.

The Frame Relay traffic conformance parameters (CIR, Bc, and Be) shall be generated using the ATM Traffic Descriptor IE. If present, the Minimum Acceptable ATM Traffic Descriptor IE may be used to generate the Frame Relay minimum acceptable CIR. See section 4.3 and Annex A of this document.

The algorithms in Annex A for determining the Frame Relay traffic conformance parameters require an estimate of frame size. The frame size parameter shall be configurable at the IWF.

5.3.1.4 Frame Relay Low Layer Compatibility IE

ATM NNI provides for specification of the user information layer 2 and layer 3 protocols in the ATM Broadband Low Layer Information (B-LLI) IE. Up to 3 B-LLI IEs may be present in the ATM SETUP message. If one or more IEs are present in the received ATM SETUP message, each B-LLI IE shall be translated into a Frame Relay Low Layer Compatibility IE as defined in section 4.8.

5.3.1.5 Frame Relay Calling Party Number IE

This mandatory IE must be provided by the IWF in the outgoing SETUP message. If the ATM Calling Party Number IE is not included in the received SETUP message, the IWF shall generate a FR Calling Party Number IE with the Presentation Indicator set to "number not av
Screening Indicator set to "network provided".

Translation of the Calling Party Number IE from ATM to Frame Relay is defined in section 4.2.1.

Translation of the number plan of the ATM Calling Party Number may not be supported by the IWF. Since this is a mandatory IE, an unsupported address received in a SETUP message is to be rejected with cause #100 *"invalid information element contents"*.

5.3.1.6 Frame Relay Calling Party Subaddress IE

Translation of the Calling Party Subaddress IE from ATM to Frame Relay is defined in section 4.2.2. The ATM Endsystem Address (AESA) coding of the ATM Calling Party Subaddress is not supported since there is no direct FRF.10.1 equivalent. Since this IE isn't mandatory, an AESA
arded by the IWF.

5.3.1.7 Frame Relay Called Party Number IE

This mandatory IE must be provided by the IWF in the outgoing SETUP message.

Translation of the Called Party Number IE from ATM to Frame Relay is defined in section 4.2.1.

Translation of the number plan of the ATM Called Party Number may not be supported by the IWF. Since this is a mandatory IE, when an unsupported address is received in a SETUP message, it shall be rejected with cause #100 *"invalid information element contents"*.

5.3.1.8 Frame Relay Called Party Subaddress IE

Translation of the Called Party Subaddress IE from ATM to Frame Relay is defined in section 4.2.2. The ATM Endsystem Address (AESA) coding of the ATM Called Party Subaddress is not supported since there is no direct FRF.10.1 equivalent. Since this IE isn't mandatory, an AESA address simply won't be forwarded by the IWF.

5.3.1.9 Frame Relay Calling Party SPVC IE

This IE is provided by the IWF if the ATM Calling Party SPVCC IE is received in the ATM SETUP message. See section 4.4.

5.3.1.10 Frame Relay Called Party SPVC IE

This IE shall be provided by the IWF if the ATM Called Party SPVCC IE is received in the ATM SETUP message. See section 4.4.

5.3.1.11 Frame Relay Transit Network Selection IE

This IE cannot be translated from the ATM Transit Network Selection IE if present in the received SETUP message. The codepoints used by FRF.10.1 (X.76) and PNNI are as defined in Table 6 of section 5.1.1.15.

Note that the "network ID type" codepoints don't match. If the ATM Transit Network Selection IE is received, then the call shall be cleared by the IWF with cause #100 *"invalid information element contents"*.

5.3.1.12 Frame Relay Call Identification IE

The Call Identification shall be created by the IWF. It is a unique identifier created by the originating network and passed unchanged by intermediate and the terminating network(s).

5.3.1.13 Frame Relay Priority and Service Class Parameters IE

If the IWF supports translation of the FR Priority and Service Class Parameters IE, it is suggested that the mapping from the FR Priority and Service Class Parameters IE to the ATM Service Categories be configurable at the IWF. A suggested mapping is shown in Table 5 in section 5.1.1.6. For example, if the Best Effort Indicator is received in the ATM Traffic Descriptor IE (indicating a UBR ATM service category), the IWF should indicate X.146 Service Class 0 in the FR Priority and Service Class Parameters IE.

By default, the FR Priority and Service Class Parameters IE should indicate X.146 Service Class 1 since the default ATM service category is non-real-time VBR.

Translation of the Transfer and Discard Priorities in the FR Priority and Service Class Parameters IE is outside the scope of this implementation agreement.

5.3.2 Call Proceeding Message Handling (Frame Relay -> ATM at IWF)

As listed in Table 12, upon receipt of an ATM SETUP message, the IWF responds with a CALL PROCEEDING message. After sending a Frame Relay SETUP message, the IWF receives a CALL PROCEEDING message.

In the ATM CALL PROCEEDING message to be sent, the VPI/VCI value in the Connection Identifier IE shall be generated by the IWF if it is attached to an ATM node with a lower node identifier. If the IWF is attached to an ATM node with a higher node identifier, it shall echo the VPI/VCI value previously received in the ATM SETUP message.

Since FRF.10.1 does not support point-to-multipoint connections, the ATM Endpoint Reference IE shall not be used.

Note that CALL PROCEEDING is of "local" significance and is issued by the IWF only upon receipt of a SETUP message.

Table 12. CALL PROCEEDING Handling Summary for ATM Initiated Call Establishment

FRF.10.1	FR -> ATM	PNNI
CALL PROC Info Element	**Handling Summary**	**CALL PROC Info Element**
DLCI	Duplicate of SETUP DLCI	
	Mandatory - Higher Node ID Sets at IWF; or Lower Node ID Reuses SETUP Connection ID	Connection Identifier
	Not Used	Endpoint Reference

5.3.2.1 ATM Connection Identifier IE

The VPI/VCI value must be provided in the outgoing CALL PROCEEDING message. See section 4.1.

5.3.3 Connect Message Translation (Frame Relay -> ATM at IWF)

Upon receipt of a Frame Relay CONNECT message, the IWF shall ignore the FR.NNI information elements listed as “No ATM Equivalent - Ignore” in Table 13, since they have no PNNI equivalent.

In the ATM CONNECT message to be sent, the IWF shall not use the PNNI information elements listed as “Not Used” in Table 13.

The following FRF.10.1 information element will be included in the CONNECT message by translating the FRF.10.1 information elements, as described in the following subparagraphs:

- Connected Number
- Connected Subaddress
- ATM Traffic Descriptor
- AAL Parameters
- Called Party SPVCC
- Broadband Low Layer Information

Table 13. CONNECT Translation Summary for ATM Initiated Call Establishment

FRF.10.1 CONNECT Info Element	FR -> ATM Translation Summary	PNNI CONNECT Info Element
Connected Number	Translate	Connected Number
Connected Subaddress	Translate	Connected Subaddress
Link Layer Core Parameters	Translate	ATM Traffic Descriptor
Link Layer Core Parameters	Translate	AAL Parameters
Called Party SPVC	Translate	Called Party SPVCC
Low Layer Compatibilty	Translate	Broadband Low Layer Info
User-User	No ATM Equivalent - Ignore	
Transit Network Identification	No ATM Equivalent - Ignore	
	Implementation Dependent	ABR Additional Parameters
	Implementation Dependent	ABR Setup Parameters
	Not Used	End-to-End Transit Delay
	Not Used	Extended QoS Parameters
	Not Used	Generic Identifier Transport
	Not Used	Notification Indicator
	Not Used	Endpoint Reference

5.3.3.1 ATM Connected Number IE

Translation of the Connected Number IE from Frame Relay to ATM is defined in section 4.2.1. Translation of the X.121 coding of the Frame Relay Connected Number may not be supported by the IWF. Since this IE isn’t mandatory, an unsupported address simply won’t be forwarded by the IWF.

5.3.3.2 ATM Connected Subaddress IE

Translation of the Connected Subaddress IE from Frame Relay to ATM is defined in section 4.2.2.

5.3.3.3 ATM Traffic Descriptor IE

The ATM Traffic Descriptor IE shall be generated using the Frame Relay Link Layer Core Parameters IE as defined in Annex A and section 4.3 of this document.

The algorithms in Annex A for determining ATM traffic conformance parameters require an estimate of frame size. The frame size parameter shall be configurable at the IWF.

The other fields of the ATM Traffic Descriptor IE shall be coded as follows:

- Forward Frame Discard — *Frame Discard Allowed*
- Backward Frame Discard — *Frame Discard Allowed*
- Tagging Forward — *Tagging Requested*
- Tagging Backward — *Tagging Requested*

5.3.3.4 ATM AAL Parameters

In the outgoing CONNECT message's ATM AAL Parameters IE, the IWF shall indicate AAL Type 5 in accordance with FRF.8.1. The Forward and Backward Maximum CPCS-SDU sizes shall be set to the values provided in the Frame Relay Link Layer Core Parameters IE Outgoing and Incoming Maximum FMIF Size fields, respectively.

5.3.3.5 ATM Called Party SPVCC IE

This IE shall be provided by the IWF if the Frame Relay Called Party SPVC IE is received in the Frame Relay CONNECT message. See section 4.4.

5.3.3.6 ATM Broadband Low Layer Information IE

This IE shall be translated by the IWF if the Frame Relay Low Layer Compatibility IE is received in the Frame Relay CONNECT message. See section 4.8.

5.4 ATM Initiated Call Clearing

Figure 14 illustrates the call clearing message flow from the ATM network to the Frame Relay network. Tables 14 and 15 summarize the translation of these messages at the IWF. Translation of cause values shall be as defined in section 4.6.

As specified in PNNI, the ATM network initiates call clearing with REL COMP in call state U0/N0, and with RELEASE in all other call states. These two scenarios are reflected in Figure 14. The IWF may also initiate call clearing towards the Frame Relay network and towards the ATM network.

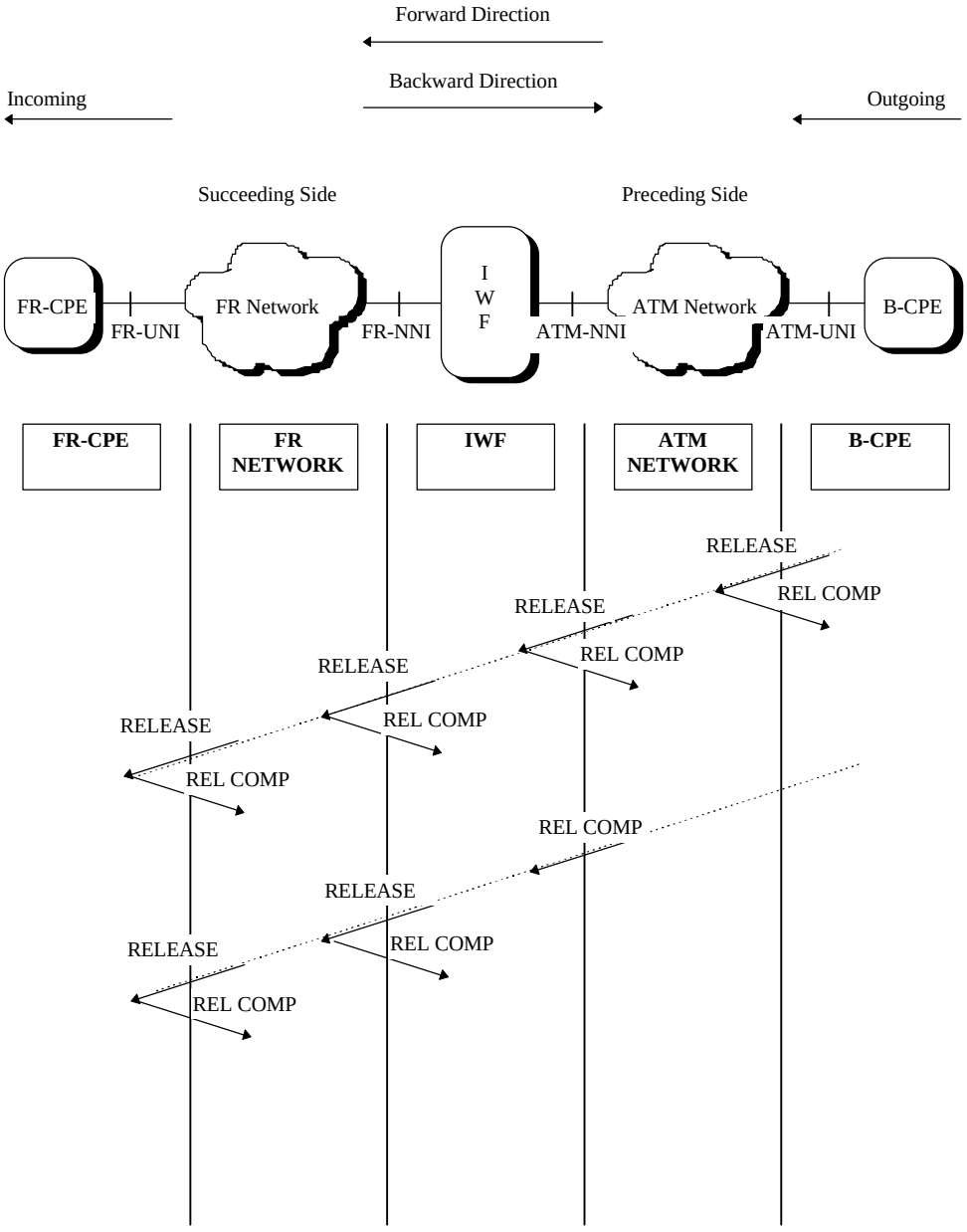

Figure 14. ATM Initiated Call Clearing Message Flow

Table 14. RELEASE Translation Summary for ATM Initiated Call Clearing

FRF.10.1 RELEASE Info Element	FR <- ATM Translation Summary	PNNI RELEASE Info Element
Cause (2 instances possible)	Translate	Cause (2 instances possible)
Clearing Network Identification	Not Used	
Transit Network Identification	Not Used	
	No FR Equivalent - Ignore	Crankback
	No FR Equivalent - Ignore	Notification Indicator
	No FR Equivalent - Ignore	Generic Identifier Transport

Table 15. RELEASE COMPLETE Translation Summary for ATM Initiated Call Clearing

FRF.10.1 RELEASE Info Element	FR <- ATM Translation Summary	PNNI REL COMP Info Element
Cause (2 instances possible)	Translate	Cause (2 instances possible)
Clearing Network Identification	Not Used	
Transit Network Identification	Not Used	
	No FR Equivalent - Ignore	Crankback
	No FR Equivalent - Ignore	Notification Indicator
	No FR Equivalent - Ignore	Generic Identifier Transport

Annex A - Conversion of Traffic Parameters

The Frame Relay traffic conformance parameters can be used to determine approximately equivalent ATM traffic conformance parameters, as described in this annex. Approximately equivalent Frame Relay traffic conformance parameters can be determined from ATM traffic conformance parameters, as described in this appendix.

A.1 Conversion from Frame Relay to ATM Traffic Parameters

Conversion from FR to ATM VBR.3 traffic conformance parameters is performed as follows:

PCR_{0+1} = (CIR + EIR) * IOHR

SCR_0 = CIR * IOHR

MBS_0 = Bc * IOHR

Mode 1 DE-to-CLP Mapping Mode as defined in FRF.8.1.

where:

- PCR and SCR units are [cells/second],
- MBS units are [cells],
- CIR, and EIR units are [bytes/second],
- Bc and Be units are [bytes],
- EIR = Be * CIR / Bc,
- FRHS is the Frame Relay Header Size (2 or 4 bytes),
- FROH is the Frame Relay HDLC Overhead (4 bytes of CRC and Flags),
- AALHS is the AAL5 trailer size (8 bytes)
- N_Avg is the average number of user information [bytes/frame],

and

- IOHR is the Interworking Overhead Ratio [cells/byte]= ((N_Avg + AALHS)/48)/N_Avg,

A.2 Conversion from ATM to FR Traffic Parameters

Determination of the FR traffic conformance parameters (CIR, Bc, and Be) from the ATM traffic conformance parameters is dependent on the combination of parameters received in the ATM Traffic Descriptor. Table A-1 defines the allowable combinations of ATM traffic parameters for each direction (forward and backward) and the associated mapping algorithm to determine the FR traffic parameters.

Table A-1 ATM to FR Traffic Parameters Mapping Algorithms

Allowable Combinations of ATM Traffic Parameters	**Mapping Algorithm**	**CLP-to-DE Mapping Mode (see reference [3])**
PCR_{0+1} SCR_0 MBS_0 Tagging/No Tagging	CIR = SCR_0 * IOHR, EIR = (PCR_{0+1} - SCR_0)* IOHR, Bc = MBS_0 * IOHR	Mode 1
PCR_{0+1} Best Effort	CIR = 0, EIR = PCR_{0+1} * IOHR, Bc = 0 B_e = EIR * Tc	Mode 1
PCR_{0+1}	CIR = PCR_{0+1} * IOHR, EIR = 0, B_c = CIR * Tc	Mode 2 with DE=0
PCR_{0+1} SCR_{0+1} MBS_{0+1}	CIR = SCR_{0+1} * IOHR, EIR = 0, Bc = MBS_{0+1} * IOHR	Mode 2 with DE=0
PCR_0 PCR_{0+1} Tagging/No Tagging	CIR = PCR_0 * IOHR, EIR = (PCR_{0+1} - PCR_0)* IOHR, Bc = CIR * Tc Be = EIR * Tc	Mode 1

where:

- PCR and SCR units are [cells/second],
- MBS units are [cells],
- CIR and EIR units are [bytes/second],
- Bc and Be units are [bytes],
- Tc is a configurable time constant [seconds] = Bc/CIR,

- FRHS is the Frame Relay Header Size (2 or 4 bytes),
- FROH is the Frame Relay HDLC Overhead (4 bytes of CRC and Flags),
- N_Avg is the average number of user information [bytes/frame],
- IOH is the Interworking Overhead [bytes/frame] = N_Avg + FRHS + FROH,

and

- IOHR is the Interworking Overhead Ratio [bytes/cell] = IOH * 48 / N_Avg,

Notes

- *All transformations leading to non-integer values should be rounded up.*
- *In performing the mapping from ATM to FR traffic parameters, attention is given to the two major FR functions that utilize the FR traffic parameters: (1) trunk bandwidth allocation, and (2) rate enforcement. The above transformations lead to a bandwidth allocation corresponding to either the PCR or the SCR depending on the Traffic Descriptor type. The above transformations also lead to the enforcement of a committed burst size equivalent to MBS cells if an MBS value is specified or 1 cell otherwise. All values are adjusted by the IOHR which represents an estimate of the actual number of frame relay bytes corresponding to any 1 ATM cell. It is based on the rationale that n ATM cells will be mapped into a single frame and that involves the additional overhead comprised of the FRHS and FROH bytes.*

Annex B - Generic Application Transport (GAT)

This document is an optional annex to the Network-to-Network FR/ATM SVC Service Interworking Implementation Agreement. It contains the description and specification for the Generic Application Transport (GAT) feature.

B.1 General Description

Generic Application Transport (GAT) is an optional FRF.10.1 facility which supports the following functions:

a) It allows Frame Relay networks to transport organization-specific information in an interoperable manner. This is achieved by using the FRF.10.1 GAT IE which can be directly mapped to the PNNI GAT IE [17] with the "Application Type" field coded as "organization-specific".

b) It provides a mechanism for FR/ATM interworking by allowing Frame Relay networks to tunnel FRF.10.1 information elements through PNNI networks. For example, some of the capabilities available in Frame Relay that are missing in PNNI are:
   - Call Identification
   - Transit Network Identification
   - Clearing Network Identification
   - Link Layer Core Parameters
   - Priority and Service Class

   The information necessary to support these features need not be processed or understood by intermediate PNNI nodes, but rather only at interworking units. Hence, the approach of defining new PNNI information elements to support each of these non-PNNI features (as currently taken by ITU-T Q.2933 [18]) is undesirable. Instead, the GAT mechanism is used to "tunnel" FRF.10.1 information elements transparently between FR/ATM Inter-Working Units (IWUs) across PNNI networks.

   This is achieved by using the Application Type value of "Frame Relay Forum FRF.10.1" in the PNNI GAT IE.

B.2 Additions to FR/ATM SVC Signalling Translations

This section defines the additional signalling translations to be performed between the Frame Relay FRF.10.1 and ATM PNNI protocols, in order to support the GAT feature.

Only messages of global significance require translation across the IWF. These include:

- SETUP
- CONNECT
- RELEASE
- RELEASE COMPLETE (as first clearing message)

B.2.1 FR to ATM Translation

When a FR GAT IE is received and the Interworking Unit does not recognize the Application Type, the following actions shall be taken:

a) If the received message is a RELEASE COMPLETE and it is not the first clearing message, no action shall be taken on the IE.

b) Otherwise, the IE shall be forwarded unchanged.

If the Application Type is "FR Forum FRF.10.1" or "organization-specific", the Interworking Unit shall perform the information element encoding and procedures for one of the following:

- Tunnelling of the FRF.10.1 information elements through a Network using the PNNI GAT IE, with the Application Type set to "FR Forum FRF.10.1", or
- Mapping of FRF.10.1 GAT IE to PNNI GAT IE for the transport of organization-specific information, using the Application Type "Organization-specific".

The information element encoding and procedures are described in the sub-sections below.

B.2.1.1 Tunnelling of FRF.10.1 Information Elements

Two types of FRF.10.1 information elements may be transported transparently using the PNNI GAT IE. These are described in the sub-sections below.

B.2.1.1.1 FR Information Elements With No ATM Equivalent

Table B-1 lists the FRF.10.1 IEs which may be encapsulated in the PNNI GAT IE to be sent in the corresponding PNNI Message. These IEs are currently being discarded since they have no ATM equivalents.

FRF.10.1 Information Elements	PNNI Messages
Call Identification	SETUP
Transit Network Identification	SETUP, CONNECT, RELEASE, RELEASE COMPLETE (first clearing)
Clearing Network Identification	RELEASE, RELEASE COMPLETE (first clearing)

Table B-1 FRF.10.1 IEs Without ATM Equivalent

The IWF should code the PNNI GAT IE as shown in Figure B-1 and Table B-2.

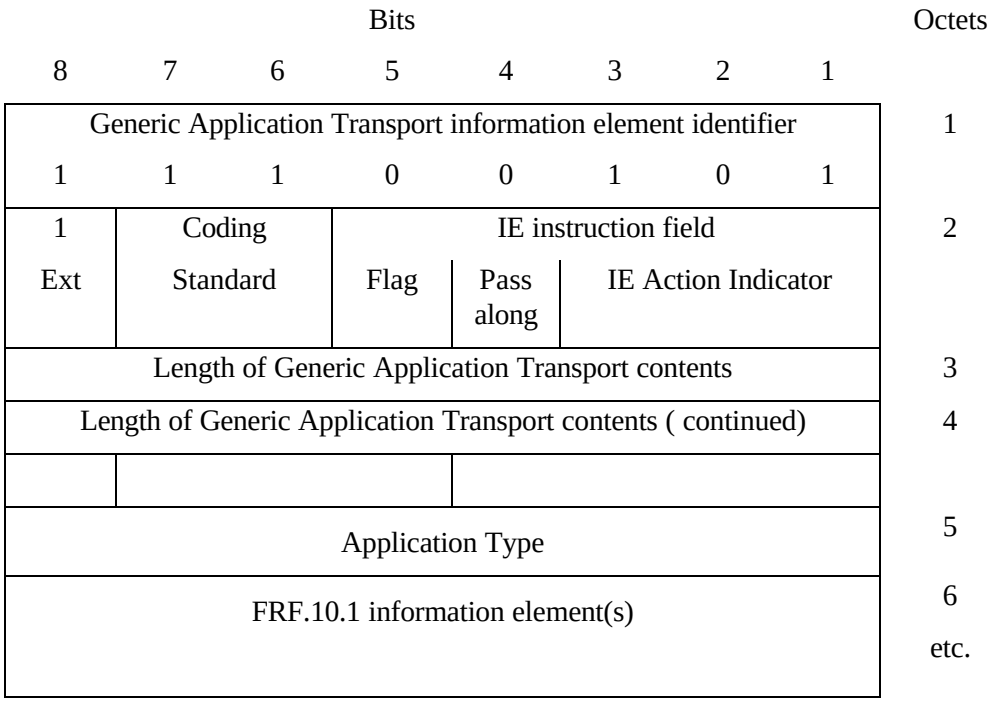

Figure B-1 PNNI GAT IE Encoding for Application Type FRF.10.1

Coding Standard (Octet 2)

Bits								Meaning
8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
	1	1						ATM Forum specific

Flag (Octet 2)

Bits								Meaning
8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
			1					Follow explicit instructions

Pass along (Octet 2)

Bits								Meaning
8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
				1				Pass along request

IE Action Indicator (Octet 2)

Bits								Meaning
8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
					0	0	1	Discard IE and proceed

Application Type (Octet 5)

Bits								Meaning
8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
0	0	0	0	0	1	0	0	Frame Relay Forum FRF.10.1

FRF.10.1 Information Elements (Octet 6 etc.)

One or more information elements as specified in FRF.10.1

Table B-2 PNNI GAT IE Encoding for Application Type FRF.10.1

B.2.1.1.2 FR Information Elements Without Direct Mapping

Table B-3 specifies the FR information elements which cannot be directly mapped to corresponding PNNI IEs. These IEs must be translated using specific mathematical calculations or various approximations. An example is the Link Layer Core Parameters information element.

It is highly recommended that these IEs be tunnelled over PNNI using the PNNI GAT IE (in addition to the translation to ATM IEs), so that the original values may be retrieved if the destination is a Frame Relay endpoint. The PNNI GAT IE should be coded as described in 0.

FRF.10.1 Information Elements	**PNNI Messages**
Link Layer Core Parameters	SETUP, CONNECT
Priority and Service Class Parameters	SETUP

Table B-3 FRF.10.1 IEs Which Cannot Be Directly Mapped

B.2.1.2 Translation of FRF.10.1 GAT IE With Organization Specific Information

This section describes the mapping of the FRF.10.1 GAT IE with application type coded as organization-specific. The IWF should code the PNNI GAT IE as shown in Figure B-2 and Table B-4.

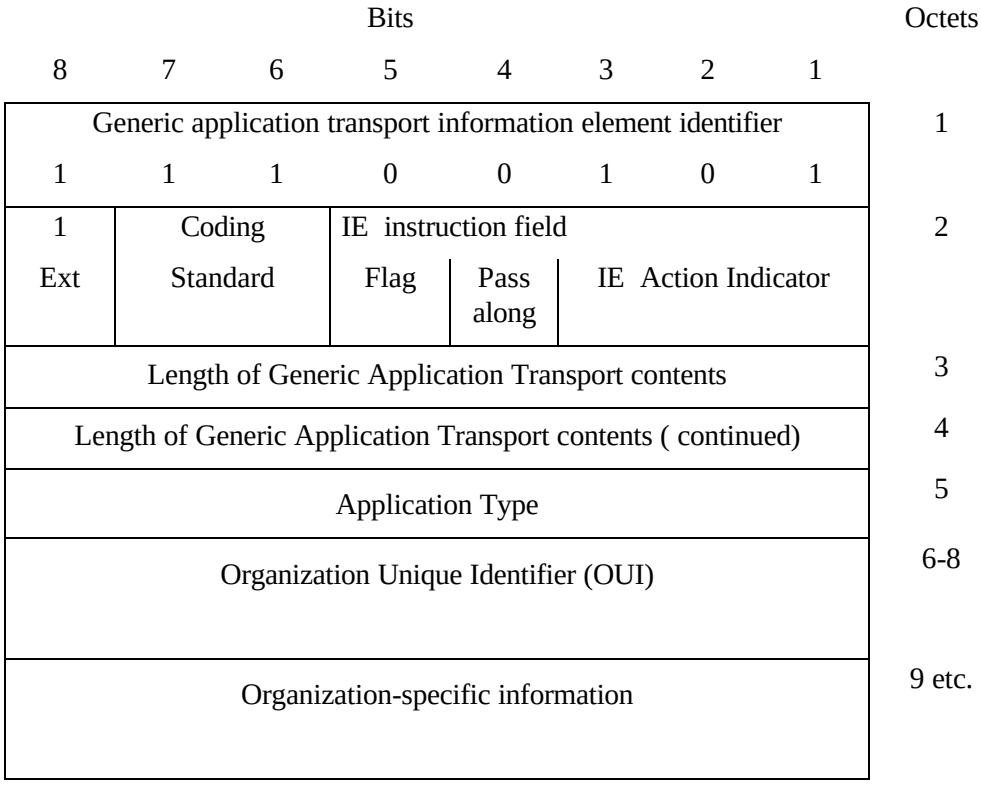

Figure B-2 PNNI GAT IE Encoding for Application Type Organization Specific

Coding Standard (Octet 2)

As described in Table B-2.

Flag (Octet 2)

As described in Table B-2.

Pass along (Octet 2)

As described in Table B-2.

IE Action Indicator (Octet 2)

As described in Table B-2.

Application Type (Octet 5)

Bits	
8 7 6 5 4 3 2 1	**Meaning**

0 0 0 0 0 0 0 1 organization-specific **Organization Unique Identifier (Octets 6-8)** These octets uniquely identify an organization. The value is assigned by IEEE. The most significant octet of the OUI appears in octet 6 and the least significant octet appears in octet 8. **Organization-specific information (Octets 9 etc.)** The format of this field is defined by the organization identified by the OUI in octets 6-8.

Table B-4 PNNI GAT IE Encoding for Application Type Organization Specific

The FR OUI and Organization-specific information fields should be copied unchanged to the corresponding fields in the PNNI GAT IE.

The application type field should be coded as "organization-specific".

B.2.2 ATM to FR Translation Requirements

When a PNNI GAT IE is received and the Interworking Unit does not recognize the Application Type, the following actions shall be taken:

a) If the received message is a RELEASE COMPLETE and it is not the first clearing message, no action shall be taken on the IE.

b) Otherwise, the IE shall be forwarded unchanged.

If the Application Type is "organization-specific" or "FR Forum FRF.10.1, the translations to be performed are described in the sub-sections below.

B.2.2.1 Translation of PNNI GAT IE with FRF.10.1 Information Elements

When a PNNI GAT IE with the application type coded as "Frame Relay Forum FRF.10.1" is received, the IWF shall extract each of the FRF.10.1 information elements encapsulated in the PNNI GAT IE application-specific information field. These information elements should be processed according to the normal FRF.10.1 procedures, as if they were received from a Frame Relay NNI link in a FRF.10.1 message.

If any of the Frame Relay IEs (e.g. Link Layer Core Parameters) specified in the ITU-T Recommendation Q.2933 [18] is present in both the PNNI GAT IE and the received PNNI message, then the Q.2933 IE shall be treated as if it has not been received.

B.2.2.2 Translation of PNNI GAT IE with Organization-Specific Information

When a PNNI GAT IE with the application type coded as organization-specific is received, the IWF should translate it to one or two FRF.10.1 GAT information element(s) according to the following procedures:

a) If the length of the PNNI GAT contents (specified in octets 3 and 4) is less than255, then the contents field, starting at octet 5, shall be copied unchanged into the FRF.10.1 GAT IE, starting at octet 4. The "Start" and "End" bits in octet 3 of the FRF.10.1 GAT IE shall both be set to 1 to denote this is a standalone instance, as shown in Figure B-3.

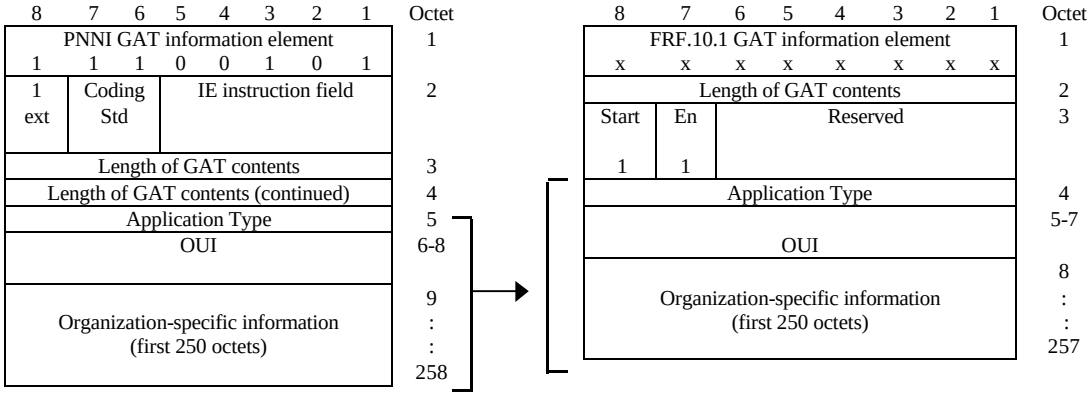

Figure B-3 Translation of PNNI GAT IE to Standalone FRF.10.1 GAT IE

b) If the length of the PNNI GAT contents is equal to or greater than 255, then the following actions shall be taken (as depicted in Figure B-4)

i) The first 254 octets (Application type, OUI and first 250 octets of organization-specific information) of the PNNI GAT IE contents fieldshall be copied unchanged into the first FRF.10.1 GAT IE, starting at octet 4. The "Start" bit in octet 3 shall be coded to 1 and the "End" bit coded to 0 to denote there is another segment to follow.

ii) The remaining octets from the PNNI GAT IE Organization-specific information field (up to a maximum of 254 octets) shall be copied unchanged into the Organization-specific information field of the second FRF.10.1 GAT IE. . The "Start" bit shall be coded to 0 and the "End" bit coded to 1 to denote this is the last segment.

iii) It is mandatory that the GAT instance containing the second segment (with "End" bit coded to 1) be placed immediately after the GAT instance containing the first segment (with Application Type, OUI and "Start" bit coded to 1), in the message to be sent.

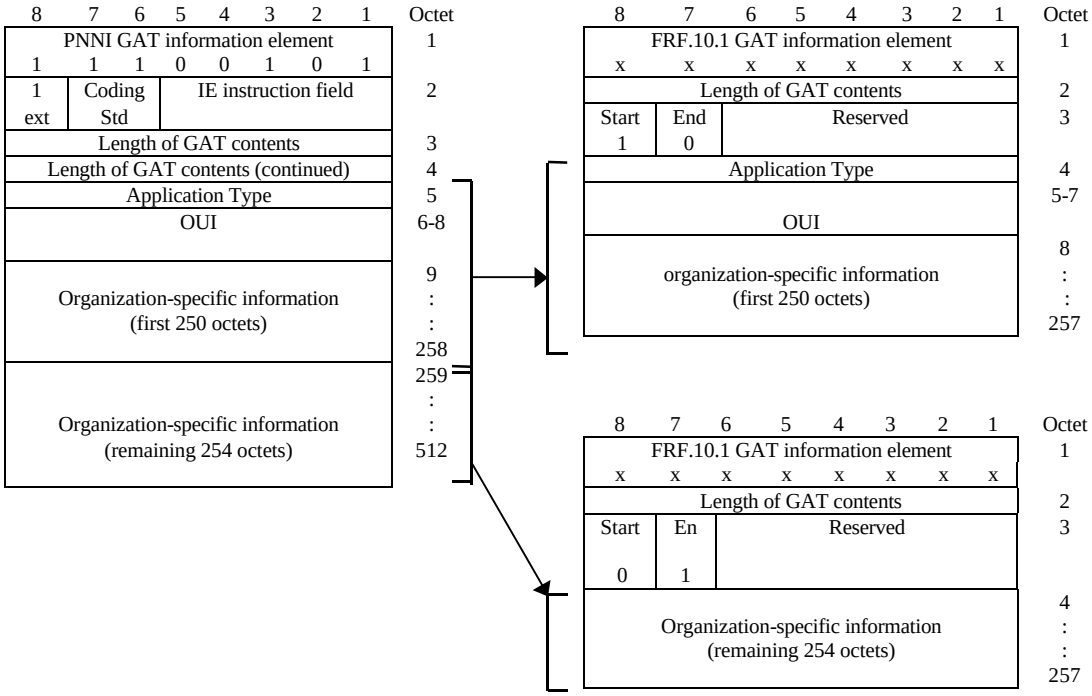

Figure B-4 Segmentation of PNNI GAT IE to Two FRF.10.1 GAT IEs

These procedures will be repeated if there are more than one instance of the PNNI GAT IE in the received message. It is mandatory that all instances of the GAT IE are contiguous.

Annex C – ATM Forum PNNI SPVC Addendum Requirements

This annex is an optional extension to this implementation agreement. It contains the description and specification for additional SPVC information element translation requirements.

C.1 General Description

In the ATM Forum PNNI SPVC Addendum [19], the PNNI 1.0 Calling and Called Soft PVPC/PVCC information elements have been enhanced to signal the DLCI for a Frame Relay endpoint.

This new functionality facilitates the interworking between FR and ATM SVC by providing the following added features:

1. There is a one-to-one direct mapping of the DLCI fields between the two protocols.
2. The FR DLCI value would not be encoded as the ATM VCI in the PNNI SPVC IEs. This will allow the detection of mis-configuration of endpoint types at the destination, which would not be possible using the existing mapping.
3. The restriction for signalling a 16-bit DLCI value is no longer applicable.
4. The PNNI SPVC Addendum procedures has built-in mechanisms to accommodate other endpoint types in the future, without having to upgrade immediate nodes which support this PNNI SPVC Addendum. This will facilitate interworking FR endpoints with endpoint types other than Cell relay, when SPVCs are routed over PNNI networks.

C.2 Additions to FR/ATM SVC Signalling Translations

This section defines the additional signalling translations to be performed between the Frame Relay and ATM protocols. FR NNI signalling elements are based on FRF.10.1 [1]. ATM SVC NNI signalling elements are based on the PNNI SPVC Addendum.

C.2.1 FR to ATM Translation Requirements

This section specifies the translation requirements in the FR to ATM direction.

C.2.1.1 Called Party SPVC IE Translation

When translating the FRF.10.1 Called Party SPVC IE to the PNNI SPVC Addendum Called Party Soft PVPC/PVCC IE the following actions shall be taken:

1. If the FRF.10.1 Called endpoint selection type indicates “Specific DLCI” or “Assigned DLCI”, the PNNI DLCI fields shall be obtained from the corresponding fields of the FRF.10.1 Called Party SPVC IE. The PNNI Selection type field shall be coded as “Requir “Assigned value” respectively. If no DLCI or a VPI/VCI is included in the FRF.10.1 Called Party SPVC IE, then the call shall be cleared by sending a RELEASE COMPLETE message with cause #100 “Invalid information element contents”.
2. If the FRF.10.1 Called endpoint selection type indicates “ATM endpoint” and the FRF.10.1 ATM called endpoint selection type field indicates “Required value” or “Assigned value”, then the FRF.10.1 ATM called endpoint selection type field shall be mapped directly to the

Selection type field contained in the PNNI Called party Soft PVCP/PVCC IE. The PNNI VPCI and/or VPCI/VCI fields shall be obtained from the VPI and/or VPI/VCI fields of the FRF.10.1 called party SPVC IE. If no VPI/VCI or a DLCI is specified in the FRF.10.1 Called Party SPVC IE, the call shall be cleared by sending a RELEASE COMPLETE message with cause #100 "Invalid information element contents".

3. If the FRF.10.1 Called endpoint selection type indicates "Specific SPVC Correlator" the call shall be cleared with cause #127 "interworking, unspecified".

C.2.1.2 Calling Party SPVC IE Translation

When translating the FRF.10.1 Calling Party SPVC IE to the PNNI SPVC Addendum Calling Party Soft PVPC/PVCC IE, the PNNI Calling Party Soft PVPC/PVCC IE DLCI or VPCI/VCI fields shall be obtained from the corresponding fields of the FRF.10.1 Calling Party SPVC IE.

C.2.2 ATM to FR Translation

This section specifies the translation requirements in the ATM to FR direction.

C.2.2.1 Called Party SPVC IE Translation

When translating the PNNI SPVC Addendum Called Party Soft PVPC/PVCC IE to the FRF.10.1 Called Party SPVC IE and the PNNI Selection type indicates "Required value" or "Assigned value", the following actions shall be taken:

1. If the DLCI octet group is included in the PNNI Called Party Soft PVPC/PVCC IE, this is mapped directly to the corresponding fields of the FRF.10.1 Called Party SPVC IE and the FRF.10.1 "Called endpoint selection type" shall be coded as "Specific DLCI" or "Assigned

2. If the VPCI and/or VPCI/VCI octet groups are included in the PNNI Called Party Soft PVPC/PVCC IE, these fields are mapped directly to the VPI and/or VPI/VCI fields of the FRF.10.1 Called Party SPVC IE. The FRF.10.1 "Called endpoint selection type" shall be coded as "ATM endpoint" and the FRF.10.1 "ATM called endpoint selection type" shall be coded as "Required value" or "Assigned value" respectively.
3. If neither the DLCI nor the VPCI/VCI is included in the PNNI Called Party Soft PVPC/PVCC IE, then the call shall be cleared by sending a RELEASE COMPLETE message with cause #100 "Invalid information element contents".

C.2.2.2 Calling Party SPVC IE Translation

When translating the PNNI SPVC Addendum Calling Party Soft PVPC/PVCC IE to the FRF.10.1 Calling Party SPVC IE, the FRF.10.1 Calling Party SPVC IE DLCI or VPI/VCI fields shall be obtained from the corresponding fields of the PNNI Calling Party Soft PVPC/PVCC IE.