Frame Relay Multiprotocol Encapsulation Implementation Agreement

FRF. 3.2

Frame Relay Forum Technical Committee
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Revision History

Version	Change	Date
FRF.3	Base document for multiprotocol encapsulation	1993
FRF.3.1	1. Addition of SNA-High Performance Routing (HPR) - Network Layer Packet (NLP) codepoints 2. Addition of codepoint for “no layer 2 protocol” 3. Updated references	June 22, 1995
FRF.3.2	1. Updated formatting to reflect recent FRF IAs 2. Updated references 3. Added Annex A for FRF-owned codepoint space and SVC signaling	TDB

1 INTRODUCTION

1.1 Purpose

This document is a protocol encapsulation over Frame Relay implementation agreement. The agreements herein were reached in the Frame Relay Forum, and are based on the relevant Frame Relay standards referred in Section 1.3. They address the optional parts of these standards, and document agreements reached among vendors/suppliers of Frame Relay network products and services regarding the options to be implemented.

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

1.2 Definitions

- Must, Shall, or Mandatory - the item is an absolute requirement of this 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.

1.3 Relevant Standards

The following is a list of standards on which this protocol encapsulation over Frame Relay implementation agreement is based:

1. ITU-T Recommendation Q.933, Integrated Services Digital Network (ISDN) Digital Subscriber Signalling System No. 1 (DSS 1) – Signalling Specifications For Frame Mode Switched And Permanent Virtual Connection Control And Status Monitoring, October 1995.
2. ITU-T Recommendation X.36, Interface Between Data Terminal Equipment (DTE) And Data Circuit-Terminating Equipment (DCE) For Public Data Networks Providing Frame Relay Data Transmission Service By Dedicated Circuit, April 1995
3. ITU-T Recommendation I.555, Frame Relaying Bearer Service Interworking, September 1997
4. Brown, C., Malis, A., RFC 2427, Multiprotocol Interconnect over Frame Relay, September 1998
5. ISO/IEC TR 9577 - Information processing systems - Telecommunications and information exchange between systems - Protocol identification in the network layer, most recent version (periodically updated)
6. FRF.4.1, User-Network Interface (UNI) SVC Implementation Agreement, Date TBD
7. FRF.10.1, Network-to-Network (NNI) SVC Implementation Agreement, Date TBD
8. FRF.11, Voice over Frame Relay Implementation Agreement, May 1997

9. FRF.12, Frame Relay Fragmentation Implementation Agreement, December 1997

2 IMPLEMENTATION AGREEMENT

2.1 General

Terminal equipment which supports an encapsulation method must know which Frame Relay virtual connection will carry a given method. Encapsulation procedures must only be used over a Permanent Virtual Connection (PVC) that has been explicitly configured or Switched Virtual Connection (SVC) that are established indicating encapsulation during call setup in the low layer compatibility information element.

This agreement contains procedures for encapsulating protocol traffic within Frame Relay CCITT Q.922 Annex A frames. The encapsulation procedures are based on X.36 Annex D [2], I.555 [3], and RFC 2427 [4][1]. The implementation agreement describes the procedures for usage of multiprotocol encapsulation and single-protocol X.25 encapsulation.

2.2 Multiprotocol Encapsulation

Multiprotocol encapsulation provides a flexible method for carrying multiple protocols on a given Frame Relay connection. These methods are useful when there is a need to multiplex/demultiplex across a single Frame Relay connection. They are described in X.36 Annex D [2], I.555 [3], and RFC 2427 [4][1].

If a protocol can be encapsulated using more than one multiprotocol header format, the first format from the list below, which provides a code point for the protocol, shall be used.

1. Direct Network Layer Protocol Identifiers (NLPID) - protocols for which an NLPID value is defined in ISO TR 9577: e.g., IP, CLNP (ISO 8473),

2. SNAP encapsulation - using SNAP NLPID followed by SNAP: LAN bridging, connectionless protocols which have a SNAP value (e.g., DECNET, IPX, AppleTalk etc.).

3. NLPID followed by four octets indicating layer 2 and layer 3 identifications: connection oriented protocols (e.g., ISO 8208, SNA, etc.) and other protocols which are not supported by the other two methods.

2.2.1 Formats and code point log for user defined protocols

This section contains the code point log and frame formats for user defined protocols which are not defined in the above references. This will enhance interoperability.

Some protocols that do not have a specific NLPID can use NLPID 0x08 (which indicates ITU-T Q.933 [1]). The four octets following the NLPID field identify both the layer 2 and layer 3 protocols being used. The code points for most protocols are currently defined in ITU-T Q.933 low layer compatibility information element (see section 4.5.21 of ITU-T Q.933 octets 6 and 7 codings).

[1] X.36 Annex D and RFC 2427 are functionally identical.

2.2.1.1 Code point log for user specified protocols

Octets 6a and 7a in the low layer compatibility information element are used for identification of user specified protocols that have no code value assigned in octet 6 or 7.

2.2.1.1.1 Codepoint log for octet 6a (layer 2)

The following codepoints are for user defined layer 2 protocols; others may be added in the future.

Code point	Description
0x81	No layer 2 protocol

Table 2-1
Codepoint log for octet 6a (layer 2)

2.2.1.1.2 Codepoint log for octet 7a (layer 3)

The following codepoints are for user defined layer 3 protocols; others may be added in the future.

Code point	Description
0x81	SNA - Subarea (FID4) (Systems Network Architecture - Network Product Formats LY43 - 0081)
0x82	SNA - Peripheral (FID2) (Systems Network Architecture Formats GA27 - 3136)
0x83	SNA - APPN (FID2) (Systems Network Architecture Formats GA27 - 3136)
0x84	Network Basic Input Output System (NETBIOS) (Local Area Network Technical Reference SC30 - 3383)
0x85	SNA - HPR (Systems Network Architecture Formats GA27 - 3136)

Table 2-2
Codepoint log for octet 7a (layer 3)

2.2.1.2 Frame formats for user defined protocols

This section describes the frame formats for user defined protocols using the Q.933 NLPID.

2.2.1.2.1 SNA -- Subarea (FID4)

Q.922 (T1.618) Address	
Control 0x03	NLPID 0x08
L2 Protocol ID	
8802 / 2 0x4C	0x80 (Note 1)
L3 Protocol ID	
User Spec. 0x70	0x81
DSAP 0x04 (Note 2)	SSAP 0x04 (Note 2)
Control (Note 3)	
remainder of PDU	
.	
FCS	

Notes 1 - Included for padding only.

2 - For other values see Token-Ring Network Architecture Reference (IBM SC30-3374).

3 - Control field is two octets for I-format and S-format frames (see ISO 8802/2).

Figure 2-1
Format of frame with 8802.2 (layer 2 and SNA-Subarea - FID4)

2.2.1.2.2 SNA -- Peripheral (FID2)

Q.922 (T1.618) Address	
Control 0x03	NLPID 0x08
L2 Protocol ID	
8802 / 2 0x4C	0x80 (Note 1)
L3 Protocol ID	
User Spec. 0x70	0x82
DSAP 0x04 (Note 2)	SSAP 0x04 (Note 2)
Control (Note 3)	
remainder of PDU	
.	
FCS	

Notes 1 - Included for padding only.

2 - For other values see Token-Ring Network Architecture Reference (IBM SC30-3374).

3 - Control field is two octets for I-format and S-format frames (see ISO 8802/2).

Figure 2-2
Format of frame with 8802.2 (layer 2 and SNA Peripheral - FID2)

2.2.1.2.3 SNA -- APPN (FID2)

Q.922 (T1.618) Address	
Control 0x03	NLPID 0x08
L2 Protocol ID	
8802 / 2 0x4C	0x80 (Note 1)
L3 Protocol ID	
User Spec. 0x70	0x83
DSAP 0x04 (Note 2)	SSAP 0x04 (Note 2)
Control (Note 3)	
remainder of PDU .	
FCS	

Notes 1 - Included for padding only.

2 - For other values see Token-Ring Network Architecture Reference (IBM SC30-3374).

3 - Control field is two octets for I-format and S-format frames (see ISO 8802/2).

Figure 2-3
Format of frame with 8802.2 (layer 2 and SNA - APPN - (FID2))

2.2.1.2.4 NETBIOS

Q.922 (T1.618) Address	
Control 0x03	NLPID 0x08
L2 Protocol ID	
8802 / 2 0x4C	0x80 (Note 1)
L3 Protocol ID	
User Spec. 0x70	0x84
DSAP 0xF0 (Note 2)	SSAP 0xF0 (Note 2)
Control (Note 3)	
remainder of PDU .	
FCS	

Notes 1 - Included for padding only.

2 - For other values see Token-Ring Network Architecture Reference (IBM SC30-3374).

3 - Control field is two octets for I-format and S-format frames (see ISO 8802/2).

Figure 2-4
Format of frame with 8802.2 (layer 2 and NETBIOS)

2.2.1.2.5 High Performance Routing (HPR) Network Layer Packet (HPR) without Layer 2

Q.922 (T1.618) Address	
Control 0x03	NLPID 0x08
L2 Protocol ID	
User Spec. 0x50	0x81
L3 Protocol ID	
User Spec. 0x70	0x85
remainder of PDU .	
FCS	

Figure 2-5
Format of frame with no layer 2 and HPR NLP

2.2.1.2.6 High Performance Routing (HPR) Network Layer Packet (HPR)

Q.922 (T1.618) Address	
Control 0x03	NLPID 0x08
L2 Protocol ID	
8802 / 2 0x4C	0x80 (Note 1)
L3 Protocol ID	
User Spec. 0x70	0x85
DSAP 0x04 (Note 2)	SSAP 0x04 (Note 2)
Control (Note 3)	
remainder of PDU .	
FCS	

Notes 1 - Included for padding only.

2 - For other values see Token-Ring Network Architecture Reference (IBM SC30-3374).

3 - Control field is two octets for I-format and S-format frames (see ISO 8802/2).

Figure 2-6
Format of frame with 8802.2 (layer 2) and HPR NLP

2.3 Single-protocol X.25 Encapsulation

Single-protocol X.25 encapsulation provides a simple method to allow interconnection of X.25 devices via a Frame Relay connection. This method is useful for devices that do not need or wish to support multiprotocol encapsulation procedures, or wishes to use LAPB procedures end to end. The encapsulation procedure is described in section 5 of I.555 [3][2].

Note - Only X.25 single protocol usage is defined. Usage of other single protocol Frame Relay encapsulation is outside the scope of this implementation agreement.

[2] Note that I.555 Section 5 was formerly known as ANSI T1.617 Annex G.

ANNEX A USE OF THE INITIAL DATA OCTET FOR PROTOCOL IDENTIFICATION

ITU Recommendation X.36 Annex D, I.555, RFC 2427, and FRF.11 [8] have all codified uses for the initial data octet following the Frame Relay header for protocol identification uses. This Annex lists the currently allocated values for this octet and allocates a value to identify additional Frame Relay Forum protocols.

Use of this octet as listed in Table A-1 requires bilateral agreement between the DTEs connected by a FR VC that it may be used to carry the specified protocol or protocols. This agreement may be reached by PVC configuration or by use of the Lower Layer Compatibility (LLC) mechanism during SVC signaling [6, 7].

The currently allocated values for initial data octet protocol identification are:

Value	Use
0	Vendor Specific Use
1	I.555 Section 5[3]
2	See Table A-2
3	X.36 Annex D, RFC 2427[4], I.555 Section 5[5]
4-255	FRF.11

Table A-1
Initial Data Octet

When the initial data octet contains the value 2, Table A-2 defines the use of the second octet for further protocol identification:

Value	Use
178 (0xB2)	Frame Relay OAM
0-177, 179-255	Reserved for future allocation by the FRF

Table A-2
Second Data Octet

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[3] Note that I.555 Section 5 was formerly known as ANSI T1.617 Annex G.

[4] X.36 Annex D and RFC 2427 are functionally identical.

[5] Whether X.36 Annex D/RFC 2427 or I.555 Section 5 are in use must be determined by PVC configuration or SVC signaling.

Table A-3 shows the combination of capabilities that can coexist on a single Frame Relay connection, in a form to guide implementations of DLCI configuration for PVCs. In addition, to support SVC signaling, Table A-3 contains the bit encoding for the enumeration of Frame Relay capabilities in the Lower Layer Capability Information Element.

Valid Configuration	**End-to-End Fragmentation for single protocol encapsulation**[6]	**UI Frame Multiprotocol Encapsulation (MPE)**[7]	**Non-UI Frame MPE**	**Single Protocol X.25**[8]	**FRF.11 Voice over FR**	**UI-only MPE OAM**	**Non-UI OAM**	**SVC LLC IE Contents without OAM**	**SVC LLC IE Contents with OAM**
Full Multiprotocol Encapsulation		X	X			X		0x30	0x32
UI-only MPE and VoFR		X			X	X		0x24	0x26
X.25 data and Voice over FR	X			X	X		X	0x0C	0x0D
UI-Only MPE		X				X		0x20	0x22
X.25 only	X			X			X	0x08	0x09
VoFR only	X				X	X		0x04	0x06
Bit Positions for SVC LLC IE	0x40	0x20	0x10	0x08	0x04	0x02	0x01		

Table A-3
Valid Frame Relay Capabilities on a Single DLCI

The forthcoming Frame Relay Operations, Administration, and Maintenance (OAM) Implementation Agreement will define two types of OAM encapsulation, Multiprotocol Encapsulation and Non-UI Encapsulation. In Table A-3, these are referred to as "UI-only MPE OAM" and "Non-UI OAM" respectively.

There are twelve valid combinations of multiprotocol encapsulation over a Frame Relay connection (PVC or SVC). These twelve consist of each of the six rows in the table, without and with OAM encapsulation.

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[6] This is mutually exclusive with Multiprotocol Encapsulation.

[7] X.36 Annex D, RFC 2427

[8] I.555 Section 5, formerly known as ANSI T1.617 Annex G

Note that each row only allows one specific OAM encapsulation type. This restriction was deliberate to reduce the OAM options required to be implemented.

For PVCs, one of these twelve combinations may be configured on each end of the PVC (both ends must be configured identically).

For SVCs, one of these twelve combinations may be signaled between the SVC end points by using the LLC mechanism. The legal bit patterns for LLC IE signaling are contained in the final two columns in Table A-3, the first column without OAM and the second column with OAM, and are derived from the final row of the table.

Within each row in Table A-3, the octets following the DLCI can be parsed unambiguously to obtain the type of protocol contained within the information field of each Frame Relay frame.

In addition to the above, the bit 0x40 is used to indicate the use of End-to-End Fragmentation [9] when Multiprotocol Encapsulation is not in use. When Multiprotocol Encapsulation (as signaled by bit 0x20) is used, End-to-End Fragmentation is automatically included, and thus does not need to be explicitly signaled. However, it has not previously been possible to signal the use of End-to-End Fragmentation with single protocols, such as X.25 over Frame Relay. In this case, adding bit 0x40 to the appropriate configurations in Table A-3 indicates the use of End-to-End Fragmentation. When bit 0x40 is used, **every** frame on the SVC **must** include the End-to-End Fragmentation header, even if the frame size is less than the negotiated maximum. This is because without the use of Multiprotocol Encapsulation, the presence or absence of the fragmentation header may not be able to be discerned by inspecting each frame.

The use of the 0x40 is mutually exclusive with the use of the 0x20 bit. Thus, the valid configurations in Table A-3 that may utilize this End-to-End Fragmentation signaling are "X.25 data and Voice over FR" (which would use the octet value 0x4C or 0x4D), "X.25 only" (0x48 or 0x49) and "VoFR only" (0x44 or 0x46).

NOTE: VCs that utilize the VoFR sub-frame data payload for non-voice frames must use the Data Transfer Syntax Payload Format defined in Annex C of FRF.11, instead of the End-to-End Fragmentation defined in FRF.12 and signaled by 0x40. This restriction is discussed in detail in Section 8.1 of FRF.12.

This Implementation Agreement does not address configuration or signaling of other higher layer protocol information such as multilink, data compression, or encryption used within Unnumbered Information transfer. Their use in a frame is parsed using NLPIDs, as defined in X.36 Annex D/RFC 2427.