Ameritech

AM-TR-NIS-000091

American Frame Relay PVC Service Interface Specification

To:	N/A
Effective Date:	February 1992
Issue Date:	Issue 1, February 1992
Expires On:	N/A
Related Documents:	N/A
Canceled Documents:	N/A

Points of Contact:
N/A

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1. Purpose

This document describes the User Network Interface specifications for Ameritech's proposed Frame Relay Service.

2. Change and Reissue

This section will show future changes and modifications.

3. General

Ameritech's Frame Relay Service (FRS) is a connection oriented, "frame mode" data service based on permanent virtual circuits that will support data applications up to 1.544 Mbit/s.

FRS provides users with a high performance data transfer service. If combines the bandwidth efficiency of packet switching with end-to-end protocol transparency, increased speed and performance. The FR protocol is a multiplexing protocol designed to operate over transmission facilities that have low error rates, because there is no error correction performed in the FR nodes. Protocols in the customer premises equipment are responsible for retransmitting frames that may be lost or discarded by the network due to errors or congestion. FRS can multiplex/ demultiplex different user data streams within the same physical channel by virtue of data link layer addressing.

FRS is generally targeted toward bursty applications having varying delay and throughput requirements. Several categories of applications have been identified. Some of the applications are, LAN Interconnection, Block-Interactive Data Applications, File Transfer, Multiplexed Low/ Medium-Bit Rate data transfer.

The basic protocol as defined in both ANSI and CCITT Standards is supplemented with documentation from the Frame Relay Users Group. In addition, the Frame Relay Users Group has defined extensions to the basic protocol for management of the local interface.

The Frame Relay protocol uses only the first layer (Physical) and part of the second layer (Data Link) of the International Standards Organization / Open Systems Interconnection (ISO/OSI) model.

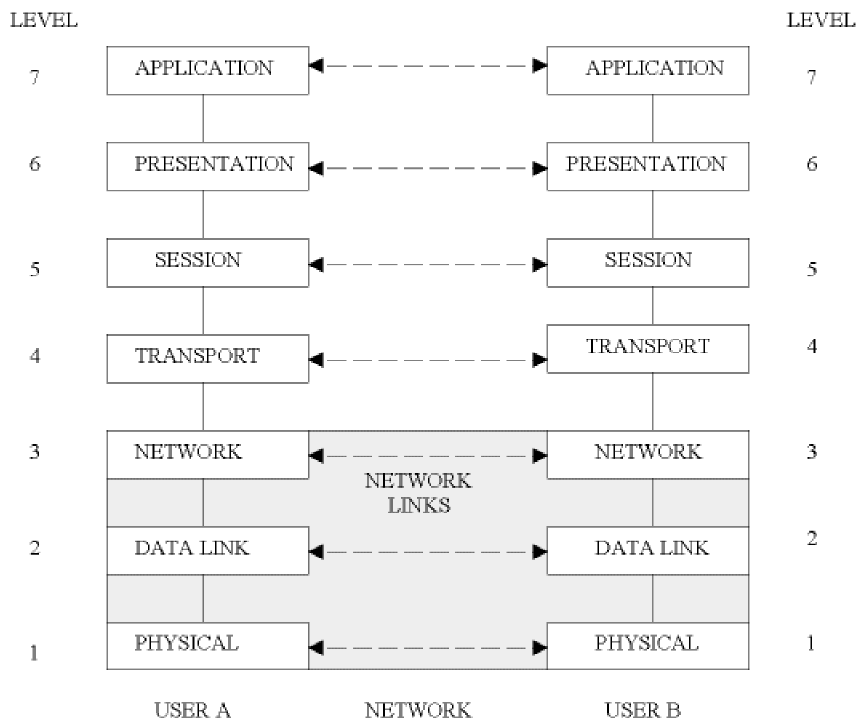
Differences / extensions between Ameritech's Frame Relay Service and that defined in the standards in noted in italics.

This service will be initially offered as an intralata service only.

4. Open Systems Interconnection (OSI) Stack

The International Standards Organization - Open Systems Interconnection (ISO-OSI) model is divided into seven functional layers as shown in Figure 1.

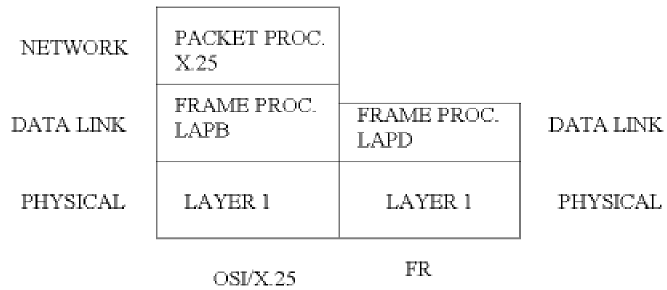
Figure 1. Representation of the ISO-OSI Model



A.25 networks use the three lowest levels of the ISO-OSI seven layer model. Layer 1, the physical layer provides physical and electrical connectivity between a user device and the network. Layer 2, the data link layer ensures data integrity across a physical link. Layer 3, the network layer provides end-to-end data integrity and ensures that the data reaches the correct destination.

In contrast to X.25, frame relay performs its switching function using only the physical layer and a portion of the link layer known as the “core aspects” of the data link layer (See Figure 2.

Figure 2. Frame Relay vs. X.25 Layer comparison



5. Frame Relay Features / Service Characteristics

- FRS provides for the order-processing transfer of frames from the network side of one user-network interface to the network side of the other user-network interface.
- It provides for real-time (no store and forward) bidirectional transfer of information. A single Permanent Virtual Circuit (PVC) provides a full-duplex channel.
- FRS transports the user data contents of a frame transparently; only the frame's address and FCS fields may be modified.
- It is a high throughput, low-delay data transfer service.
- FRS does not provide error-correction or frame sequencing; frames are unackowledged by the network. Error detection, and recovery from these error conditions need to be performed by the Customer Premise Equipment (CPE). Error conditions include lost, duplicated, misdelivered, and out-of-sequence frames.
- FRS detects transmission, format, and operational errors.
- FRS provides logical channel multiplexing by assigning multiple virtual circuits to a single interface.
- Virtual circuits are uniquely identified at an interface by the value of the Data Link Connection Identifier (DLCI), a parameter in the header of FRS Protocol Data Unit (PDU) See Protocol Structure in Section 7.2.1. DLCI values have local significance and may be reused at different interfaces. The frames are routed through the network on the basis of the DLCI. The DLCI and the other associated parameters are defined by means of administrative procedures.

- FRS access is provided via dedicated 56/64 kbps and 1.544 Mbps digital subscriber lines.
- FRS provides user throughput classes of 56, 64, 128, 384 kbps and 1.544 Mbps. Maximum subscriber throughput is limited by the rate of the supporting physical interface.
- Fundamental PVC management functions such as PVC status enquiry and indication, PVC Failure Recovery, PVC Failure Notification, and PVC Activation/ Reaction. These features are implemented by using the Local Management Interface (LMI).

6. Provisioning

The connections between originating device endpoints (routers, bridges, and other similar devices) are implemented as Permanent Virtual Circuits (PVCs), a type of preadministered connection. Each user data stream is called a data link connection (DLC). To identify the different DLCs within the same access channel, each DLC is assigned a data link connection identifier (DLCI) at subscription time.

During the data transfer phase, all frames belonging to a particular FR call carry the same DLCI in the link layer address field of each frame. Users are connected via PVCs rather than with dedicated physical circuits. Frames are routed through the network on the basis of the attached DLCI. This label may change as the frame travels through the network; therefore, the DLCI has local significance only. The DLCI is not an address uniquely identifying a destination, but instead serves to identify a logical connection between the user and the local network access node.

The FR PVC service provisioning process for new customers will consist of two steps:

1. Access Path Provisioning - Encompasses the installation of the digital transmission facility that provides the “physical” connectivity between the customer’s premises and end office supporting FRS PVC service.
2. PVC Provisioning - Entails the configuration of PVC routing tables (at end-office and at tandem offices) to provide the “logical” paths specified by the customer.

7. User Network Interface (UNI)

Frame Relay - User-Network Interface (FR-UNI) refers to the point where the CPE interfaces to the network supporting FRS. Access to the network supporting FRS is over dedicated 56/64 kbps and 1.544 Mbps digital subscriber lines.

The UNI is based on Frame Relay Protocols. These protocols have been established by the vendor community consensus around the use of CCITT and ANSII standards. See Section 8.1 for Primary References. Transfer of FRS PDUs is based on the Core Aspects of LAPD protocol. The core aspects of LAPD are:

- Frame delimiting, alignment, and transparency provided by the user of HDLC flags and zero-bit insertion.
- Virtual circuit multiplexing/demultiplexing using the address field of the frame.
- Inspection of the frame of ensure that it consists of an integer number of octets prior to zero-bit insertion or following zero-bit extraction.
- Inspection of the frame to ensure that it is not too long or too short.
- Detection of transmission, format, and operational errors.

7.1. Physical Layer Interface

Ameritech's Frame Relay Network will support the following interfaces:

1. DS1

Clock Rate: 1.544 Mbps

User Information Rate: 1.536 Mbps

Consecutive Zero: There should be no more than 15 consecutive zeros generated. Violation may cause erroneous data.

2. Clear Channel DS1

Clock Rate: 1.544 Mbps

User Information Rate: 1.536 Mbps

Consecutive Zero: B8ZS is used to overcome the rule limiting the user to no more than 15 consecutive zeros in the bit stream. ZBTSI is not supported in the Ameritech Network.

3. Clear Channel 65 Kbps and N x 64 Kbps

Data/Clock Rate: 64 Kbps and N x 64 Kpbs within Clear Channel 1.544 Mbps

4. N x 56 Kbps

Data Clock Rate: N x 56 Kbps within a 1.544 Mbps channel

5. 56 Kbps

Data/Clock Rate: 56 Kbps

See Primary References 6, 7 and 8 in Section 8.1.

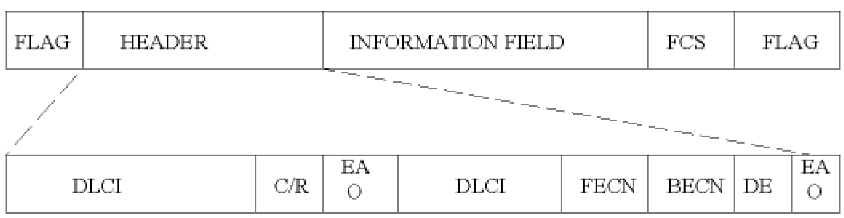
7.2. Data Link Layer Interface

This interface specification describes the data transfer protocol supported by Ameritech's FR network. The frame structure must conform with CCITT and ANSI standards.

7.2.1. Protocol Structure

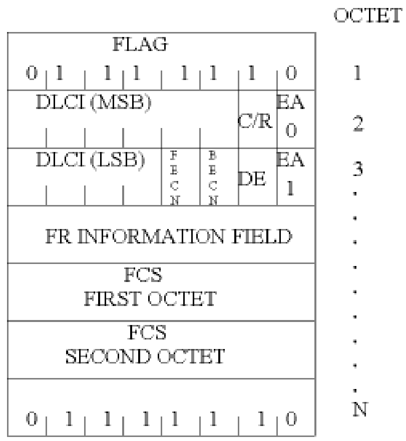
The Frame Relay Protocol carried over the data link layer must conform with LAPD. The FR format is shown in Figure 3. FRS Protocol Data Unit (PDU) consists of a beginning Flag Sequence, Header (which consists of the Address Field and Control Sequence), Frame Relay Information Field, Frame Check Sequence, Closing Flag Sequence.

Figure 3. Frame Relay Protocol Data Unit



FCS = Frame Check Sequence (Used for error detection)
DLCI - Data Link Connection Identifier (Logical channel address)
C/R - Command/Response (Application Specific; not modified by network)
EA = Address Extension bit (Allows indication of 3 or 4 byte header)
FECN - Forward Explicit Congestion Notification (Used for congestion management)
BECN = Backward Explicit Congestion Notification (Used for congestion management)
DE = Discard Eligibility Indicator (Used for congestion management)

Figure 4. Field Description in PDU



Following is a description of each field in the PDU as shown in Figure 4.

7.2.1.1. Flag Sequence

All frames start and end with the flag sequence consisting of one 0 bit followed by six contiguous 1 bits and one 0 bit. The flag preceding the address is defined as the opening flag. The flag following the FCS field is defined as the closing flag. The closing flag may also serve as the opening flag of the next frame; however, receivers must be able to accommodate reception of one or more consecutive flags.

7.2.1.2. Data Link Connection Identifier (DLCI)

The DLCI is used to identify the logical connection, multiplexed within the physical channel, with which a frame is associated. All frames carried within a particular physical channel and having the same DLCI value are associated with the same logical connection. The DLCI is an unstructured field. It consists of the six most significant bits of the first octet (comprising of the most significant bits (msb) of the DLCI), and the four most significant bits of the second octet (comprising of the least significant bits (lsb) of the DLCI); concatenated into a 10 bit field. The 10 bit DLCI thus represents values between 0 and 1023. See Table 1 below for valid DLCIs.

	RANGE	r	USAGE
	0		Reserved for Call Control Signaling (in-Channel)
	1 - 15		Reserved
	16 - 1007		Assignable to Frame Relay PVSs

1008 - 1022	Reserved
1023	Local Management Interface

7.2.1.3. Command/Response (C/R) Bit

the C/R indication bit is not used by the frame relay data link protocol and may be set to any value by the user device. The use of this field is application specific. The C/R bit is carried transparently by the frame relay network.

7.2.1.4. Address Extension (EA) Bit

The address field range is extended by reserving the first transmitted bit of the address field octets to indicate the final octet of the address of the address field. This field is used for addresses longer than two octets. The Extended Addressing (EA) bit in the header will be set to “1” to indicate that the FRS frame header consists of three or four octets.

NOTE: The Ameritech Frame Relay PVC Network will support two octet addressing. The EA bit in the first octet is set to 0 and the EA in the second octet is set to 1.

7.2.1.5. Forward Explicit Congestion Notification (BECN) Bit

The FECN bit may be set by a congested network to notify the user that congestion avoidance procedures should be initiated where applicable for traffic in the direction of the transmitted frame. This bit is set to “1” to indicate to the receiving user device that the frames it receives has encountered congested resources. This bit may be used with source controlled transmitted rate adjustment.

7.2.1.6. Backward Explicit Congestion Notification (BECN) Bit

This bit may be set at a congested network to notify the user that congestion avoidance procedures should be initiated where applicable for traffic in the opposite direction of the frame carrying the BECN indicator. This bit is set to “1” to indicate to the receiving user device that the frames it transmits may encounter congested resources. This bit may be used with source controlled transmitter.

7.2.1.7. Discard Eligibility (DE) Bit

The DE bit, is used, is set to “1” to indicate a request that a frame should be discarded in preference to other frames in a congestion situation. When frames must be discarded to ensure safe network operation and maintain the committed level of service within the network. Setting of this bit by the network or user is optional.

7.2.2. Invalid Frames

The network will discard invalid frames. The following are considered to be invalid frames:

- A frame not bounded by two flags
- A frame containing fewer than 5 octets between flags
- A frame containing more than 1600 octets between flags
- A frame that does not consist of an integral number of octets
- A frame containing a frame check sequence error
- A frame with an invalid DLCI (not subscribed to or configured by the network or out of range)
- A frame containing a Frame Abort

7.2.3. Local Management Interface (LMI)

Ameritech FR network supports an industry standard known as LMI for management of PVCs. The LMI defines the protocol and set of messages based on ANSI and CCITT message format and PVC management procedures. (See Section 8.1 - Primary Reference 5) These procedures incorporate much of the functionality that is in the LMI specification - common extensions.

LMI operates on the local interface between the user and the network. It is a synchronous polling scheme where the user polls the network to obtain status and configuration information concerning the PVCs available at this interface. LMI is partitioned into two categories, common and optional.

The common LMI features are:

- Notification of the addition, deletion and presence of a PVC.
- Notification of the availability of unavailability of a configures PVC.
- A “Keep Alive” sequence number interchange for verifying the integrity of the physical link between the network and the user.

Messages used for PVC status are:

1. STATUS - This message is sent to the user device by the network in response to a STATUS_ENQUIRY message.

2. STATUS_ENQUIRY - This message is used by the user device to request a STATUS message from the network.

The optional features are:

1. Support for a Global Addressing convention - This convention uses the DLCIs to identify a specific end device.

2. Multicast capability - has the ability to request that the network send a frame to all user devices which belong to a “multicast group”.

3. Asynchronous Status Updates - The STATUS ENQUIRY/STATUS exchange may occur infrequently. Extensions have been added to the LMI protocol to notify the user immediately of a change in the interface status.

4. Flow Control - XON/XOFF flow control mechanism is implemented specifically for routers and bridges for preventing congestion collapse in the FRS network.

NOTE: The Ameritech FR Network will not support the LMI - Optional Extensions in it’s Initial Implementation.

8. References

8.1. Primary References

1. ANSI T2.606 - Frame Relaying Bearer Service - *Architectural Framework and Service Description*, American National Standards Institute, Inc., 1990.

2. ANSI T1.617 – *DSS1 – Signaling Specification for Frame Relay Bearer Service*, American National Standards Institute, Inc., 1991.

3. ANSI T2.618 – DSS1 – Core Aspects of Frame Relay Protocol for Use with Frame Relay Bearer Service, American National Standards Institute, Inc., 1991.

4. CCITT Recommendation Q.921, Digital Subscriber Signaling System No. 1 (DSS1) Data Link Layer, Blue Book, ITU, Geneva, 1988.

5. Frame Relay Specification with Extensions, Cisco Systems, Digital Equipment Corporation, Northern Telecom, Inc., and StrataCom, Inc. September 18, 1990.

6. Telcordia (formerly Bellcore) TR-NPL-000054 - High Capacity Digital Service (1.544 Mbps) Interface Generic Requirements for End Users, Issue 1, April 1989.

7. Telcordia (formerly Bellcore) TR-NPL-000341 - Digital Data Special Access Service - Transmission Parameter Limits and Interface Combinations, Issue 1, March 1989.

8. Telcordia (formerly Bellcore) TR-NIS-000342 - High Capacity Digital Special Access Service Transmission Parameter Limits and Interface Combinations, Issue 1, February 1991.

8.2. Secondary References

1. ANSI T1S1/90-175 - Addendum to T1.606 - Frame Relaying Bearing Service - Architectural Framework and Service Description, American National Standards Institute, Inc., July 1990.

2. ANSI T1.602 - Telecommunications - ISDN - Data-Link Layer Signaling Specification for Application at the User-Network Interface, American National Standards Institute, Inc., 1989.

3. ANSI T1S1/90-214 - DSS1 - Core Aspects of Frame Protocol for Use with Frame Relay Bearer Service - Architectural Framework and Service Description, American National Standards Institute, Inc., July 1990.

4. ANSI T1S1/90-213 - DSS1 - Signaling Specification for Frame Relay Bearer Service, American National Standards Institute, Inc., July 1990.

5. CCITT Recommendation, I.122, Framework for Providing Additional Packet Mode Bearer Services, Blue Book, ITU, Geneva, 1988.

6. Draft CCITT Recommendation Q.922, ISDN Data Link Layer Specification for Extended ISDN Applications, ITU, Geneva, 1990.

7. CCITT Recommendation Q.933, ISDN Signaling Specification for Frame Mode Bearer Services, ITU, Geneva, 1991.

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