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AERONAUTICAL TELECOMMUNICATION NETWORK PANEL (ATNP)
WORKING GROUPS 1 and 2

Guidance Concerning End System Connectivity to Multiple Ground-Based Subnetworks

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SUMMARY

The ICAO ATNP Internet Communications Service SARPs describes transport and network layer functionality required in Aeronautical Telecommunication Network (ATN) end systems and intermediate systems. Little guidance material is currently available pertaining to the support of ATN systems over various ground-based subnetworks such as ISO/IEC 8802-2 LAN-based networks, Fiber Distributed Data Interface (FDDI), Frame Relay/Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM), or the Internet Protocol Suite (IPS). This paper provides guidance in support of the ISO/IEC 8473-1 Connectionless Network Layer Protocol (CLNP) over these various subnetworks.

1.0 BACKGROUND

The current International Civil Aviation Organization (ICAO) Aeronautical Telecommunication Network Panel (ATNP) Internet Communications Service Standards and Recommended Practices (SARPs) [1] describes end system (ES) and intermediate system (IS) transport and network layer functionality. In the future, Aeronautical Telecommunication Network (ATN) systems may be supported over a variety of subnetworks such as:

1. Local Area Network (LAN) International Standards Organization (ISO)/ International Electrotechnical Commission (IEC) 8802-2 [2],

2. Fiber Distributed Data Interface (FDDI),

3. Frame Relay/ISDN,

4. Wide Area Network (X.25), (see ATN Manual)

5. Internet Protocol Suite (IPS)-based network, and

6. Asynchronous Transfer Mode (ATM).

This paper provides guidance in support of the ISO/IEC 8473-1/2/3/4 Connectionless Network Layer Protocol (CLNP) [3,4,5,6] over these various subnetworks.

2.0 DISCUSSION

As shown in Figure 1, ATN ESs or ISs may be supported over a variety of subnetworks.

The ATNP Internetwork SARPs [1] specifies requirements for the Subnetwork Dependent Convergence Function (SNDCF) in Chapter 7 and requires that Subnetwork (SN)-Service (SNS) primitives or equivalent mechanisms be provided.

The SNS-Userdata contains the ISO 8473-1 [3] or ISO/IEC 9542 [7] Network Protocol Data Unit (NPDU) that have to be conveyed between adjacent network entities.

Additional information concerning these parameters are provided in the ATNP Internet Communications Service SARPs [1].

2.1 Mapping CLNP over An ISO/IEC 8802 [2] Subnetwork

This mapping is provided in the ATNP Internetwork Communications Service SARPs [1]. The subnetwork service is provided as specified in Clause ISO/IEC 8473-2 *Information Technology—Protocol for Providing the Connectionless-Mode Network Service Part 2: Provision of the Underlying Service by an ISO/IEC 8802 Subnetwork* [4]. In this case, the generation of an SN-UNITDATA request by CLNP results in a

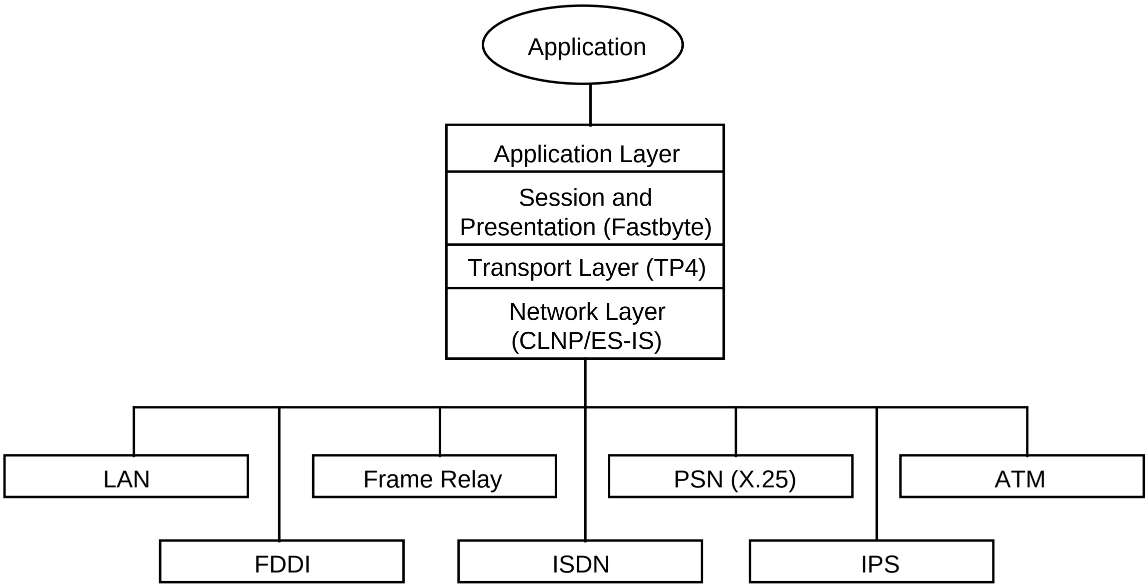


Figure 1. Expanded Subnetwork

Data Link Layer (DL)-UNITDATA request (as described in ISO/IEC 8802-2 [2]) being generated by the SNDCF.

2.2 Mapping CLNP over An FDDI Network

FDDI provides a high bandwidth LAN consisting of a physical layer and Media Access Control (MAC) sublayer as defined in ISO 9314-2 [8]. Encapsulation of CLNP in FDDI frames can be performed in a manner similar to the Internet Protocol (IP) encapsulation over FDDI (see Internet Engineering Task Force [IETF] Request for Comments [RFC] 1188 [9]). As per RFC 1188 [9], CLNP can be encapsulated via the Institute of Electrical and Electronics Engineers (IEEE) 802.2 Logical Link Control (LLC) [10] service as shown in Figure 2.

The Destination Service Access Point (DSAP) and Source Service Access Point (SSAP) should be set to the hexadecimal value [0xFE] to indicate that the Information field contains an OSI network layer Protocol Data Unit (PDU).

In this case, the mapping to the SNS parameters should be the following:

- SN-Source-Address: This address should be set to the assigned value FE to indicate that the information field contains an OSI network layer PDU.

- SN-Destination Address: This address should be set to the assigned value [0xFE] to indicate that the information field contains an OSI network layer PDU.

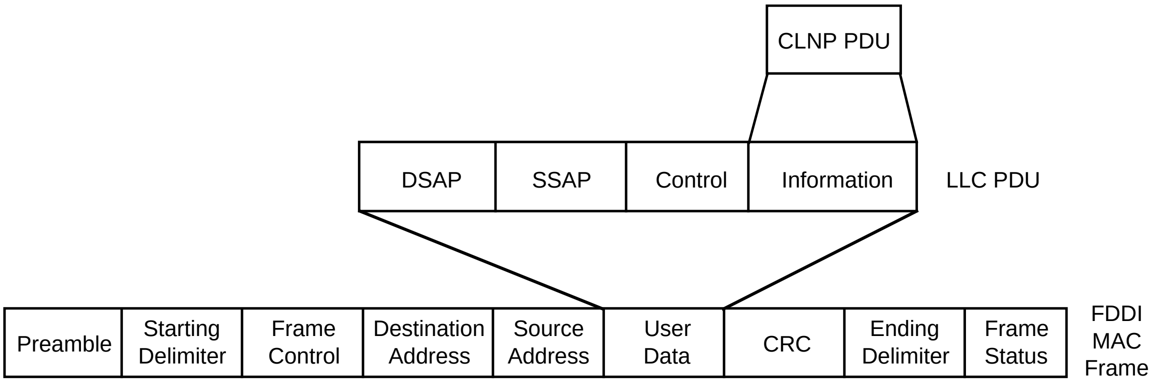


Figure 2. Mapping of CLNP into FDDI MAC Frames

- SN-Priority: If supported, this field should contain the mapped LLC priority based on the received SN-priority.

- SN-Quality-of-Service: If supported, this field should contain the mapped LLC quality-of-service based on the received SN-quality-of-service.

  SNS-User Data: This field should contain the ISO network layer PDU.

IEEE 802.2 [10] LLC Type 1 communication should be used exclusively. All frames should be transmitted in standard IEEE 802.2 [10] LLC Type 1 Unnumbered Information format, with the DSAP and the SSAP fields of the 802.2 header set to the assigned Service Access Point value for ISO-IP (0xFE).

The IEEE 802.2 [10] LLC subnetwork may then map the LLC PDU to the FDDI Frame as shown in Figure 2.

2.3 Mapping CLNP over Frame Relay ISDN Network

While encapsulation of CLNP in Frame Relay networks can be accommodated in a manner similar to IP encapsulation over Frame Relay as outlined in IETF RFC 1490 [11]. The Frame Relay access protocol is based on High-level Data Link Control (MDLC/Q.921) [12,13,14,15], and the link access protocol was developed for signaling over the D channel of narrowband Integrated Services Digital Network (ISDN) (International Telephone and Telephone Consultative Committee (CCITT) Recommenda-tion Q.922 [16]). As discussed in IETF RFC 1490 [11], the Frame Relay network provides a number of virtual circuits that form the basis for connections between stations attached to the same Frame Relay network. The resulting set of interconnected devices form a private Frame Relay group which may be either fully interconnected with a complete “mesh” of virtual circuits or only partially interconnected. In either case, each virtual circuit is uniquely identified at each Frame Relay interface by a Data Link Connection Identifier (DLCI). In most circumstances, DLCIs have strictly local significance at each Frame Relay interface.

All protocols encapsulate their packets within a CCITT Q.922 Annex A frame [16,17] or ATNSI T1.618 [17]. Additionally, the frames contain information necessary to identify the protocol carried within the PDU, thus allowing the receiver to properly process the incoming packet. The frame format is shown in Figure 3.

The Q.922 address is 2 octets and contains a 10-bit DLCI. In some networks Q.922 addresses may optionally be increased to 3 or 4 octets.

The control field is the Q.922 control field.

The Pad field is used to align the remainder of the frame to a 2-octet boundary. There may be zero or one Pad octet within the Pad field and, if present, must have a value of zero.

The Network Level Protocol ID (NLPID) field is administered by ISO and CCITT. It contains values for many different protocols including IP, CLNP, and IEEE Subnetwork Access Protocol (SNAP) [10]. This field tells the receiver what encapsulation or what protocol follows. Values for this field are defined in ISO/IEC Technical Report (TR) 9577 [18]. Some commonly used NLPIDs are defined below:

[0x00] Null Network Layer or Inactive Set

[0x80] SNAP

[0x81] ISO CLNP

[0x82] ISO ES-to-IS Protocol

Flag (7E hex)
Q.922 Address
Control
Optional Pad
NLPID
Data
Frame Check Sequence
Flag (7E hex)

Figure 3. Frame Format

[0x83]   ISO IS-to-IS

[0xCC]   Internet IP

[0x8] ISDN

In the case of ISO protocols, the NLPID is considered to be the first octet of the protocol data. The single octet serves both as the demultiplexing value and as part of the protocol data. ISO/IEC 8473-1 [3] has a NLPID value of [0x81]. For CLNP, PDUs, the frame would consist of the following fields as shown in Figure 4.

In this case, the mapping to the SNS parameters should be the following:

- SN-Source-Address: No source address field is provided in the frame relay header.

- SN-Destination Address: This address should be set to the destination Q.922 [16] address.

- SN-Priority: No priority field is provided in the Frame Relay header.

- SN-Quality-of-Service: This field should contain the mapped Frame Relay quality-of-service. (Note that forward or backward explicit congestion notification may be indicated in the frame relay header.)

  SNS-User Data: This field should contain the ISO network layer PDU.

2.4 Mapping CLNP over An ISO 8208 Network

This information is provided in the ATNP Internet Communications Service SARPs [1]. The subnetwork service is provided using ISO/IEC 8473-3 [5,19].

Management of X.25 connections is discussed in detail in ISO/IEC 8473-3 [5].

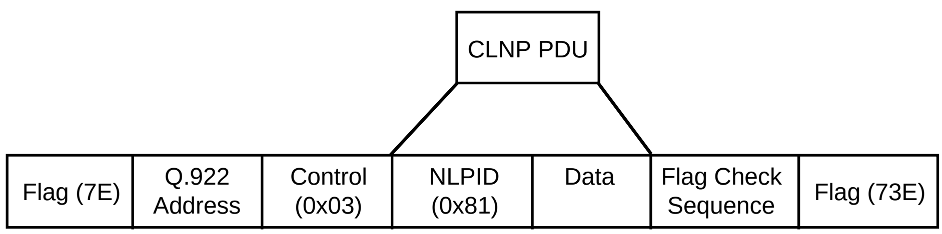


Figure 4. Frame Format for Transfer of CLNP PDUs

2.5 Mapping CLNP over IP

Recent IETF RFCs have been developed to allow the encapsulation of CLNP PDUs over IP. However, for OSI applications that may need to communicate via an IP internet, current commercial off-the-shelf (COTS) routers will encapsulate the ISO subnetwork PDUs (for example, X.25 PDUs) into IP datagrams, and decapsulate the datagrams and forward to the peer OSI application.

If there is a need for direct encapsulation of CLNP PDUs over IP, then IETF RFCs 1701 [20] 1702 [21], and 1070 [22] define an Generic Routing Encapsulation (GRE) protocol to allow a number of different protocols to be encapsulated over IP. As defined in these RFCs, the packet to be encapsulated and routed is called a payload packet. The payload is first encapsulated in a GRE packet. The resulting GRE packet can then be encapsulated in some other protocol (such as IP) and then forwarded. This outer protocol is called the delivery protocol.

The Delivery Header for IP will consist of the fields shown in Figure 5.

Within the GRE Header, the Protocol Type field contains the protocol type of the payload packet. Example protocol types are listed below as shown in Table 3.

In this case, the mapping to the SNS parameters should be the following:

- SN-Source-Address: This field should contain a source IP address.

- SN-Destination Address: This field should contain a destination IP address.

- SN-Priority: If supported, the priority can be indicated in IP datagrams via the precedence bits in the Type of Service field. This field should indicate the IP priority.

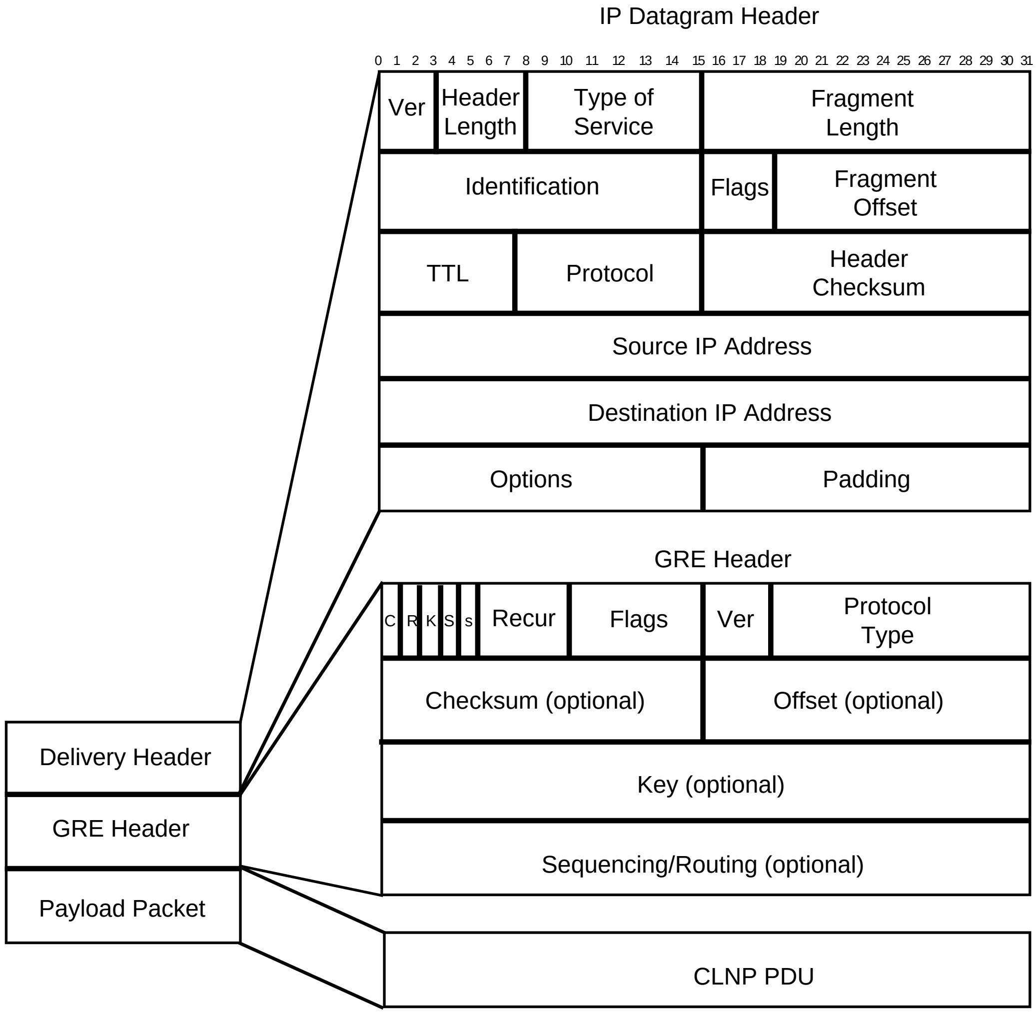
- SN-Quality-of-Service: If supported, this field should contain the Type of Service value.

- SNS-User Data: This field should contain the ISO network layer PDU.

The other method using RFC 1070 [22] permits ISO Systems using ES-IS to change their topological relationship to the IP format.

2.6 Mapping CLNP over Asynchronous Transfer Mode (ATM)

While encapsulation of CLNP over ATM networks has not been standardized, it could be accommodated in a similar manner that IP is encapsulated over ATM (IETF RFC 1483) [23].



Legend:

C	=	Checksum Present (1)
R	=	Routing Present (1)
K	=	Key Present (2)
S	=	Sequence Number Present (1)
s	=	Strict Source Route (1)
Recur	=	Recursion Control (3)
Ver	=	Version Number (3)

Figure 5. Delivery Header for IP

Table 3. Example Protocol Type Values

Protocol Family	Protocol Type Value (Hex)
Reserved	0000
OSI network layer	00FE
IP	0800
Frame Relay	0808
Raw Frame Relay	6559
IP Autonomous Systems	876C
Secure Data	876D
Reserved	FFFF

As described in RFC 1483 *Multiprotocol Encapsulation over ATM Adaptation Layer 5 (AAL5)* [23], ATM-based networks are of increasing interest for both local and wide area applications. There are two different methods for carrying connectionless network interconnect traffic, routed and bridged PDUs, over an ATM network. The first method allows multiplexing of multiple protocols over a single ATM virtual circuit (called “LLC encapsulation”). The protocol of a carried PDU is identified by prefixing the PDU by an IEEE 802.2 [10] LLC header. The second method performs higher-layer protocol multiplexing implicitly by ATM Virtual Circuits (VCs) (called “VC-based Multiplexing”).

No matter which multiplexing method is selected, routed and bridged PDUs are encapsulated within the Payload field of AAL5 Common Part Convergence Sublayer (CPCS)-PDU. The format of the AAL5 CPCS-PDU is shown in Figure 6.

The Payload field contains user information up to 2^16–1 octets.

The Padding (PAD) field pads the CPCS-PDU to fit exactly into the ATM cells such that the last 48-octet cell payload created by the new Segmentation and Reassembly sublayer will have the CPCS-PDU Trailer right justified in the cell.

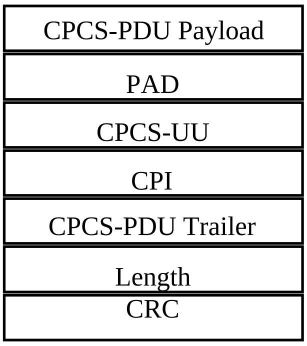


Figure 6. AAL5 CPCS-PDU Format

The CPCS-User-to-User (UU) field is used to transparently transfer CPCS-UU information. The field has no function under the multiprotocol ATM encapsulation described in this memo and can be set to any value.

The Common Part Indicator (CPI) field aligns the CPCS-PDU trailer to 64 bits. Possible additional functions are for further study in CCITT. When only the 64 bit alignment function is used, this field shall be codes as 0x00.

The Length field indicates the length, in octets, of the Payload field. The maximum value for the Length field is 65,535 octets. A Length field coded as 0x00 is used for the abort function.

The Cyclical Redundancy Check (CRC) field protects the entire CPCS-PDU except the CRC field itself.

RFC 1483 [23] describes the use of LLC encapsulation for CLNP PDUs which is described below. For additional information concerning VC-based multiplexing, the reader is referred to the RFC.

2.6.1 LLC Encapsulation

In LLC Encapsulation the protocol of the routed PDU is identified by prefixing the PDU by an IEEE 802.2 LLC header, which may be followed by an IEEE 802.2 SubNetwork Attachment Point (SNAP) header. In LLC Type 1 operation, the LLC header consists of three 1-octet fields as shown in Figure 7.

The LLC header value 0xFE-FE-03 identifies that a routed ISO PDU follows. The Control field value 0x03 specifies Unnumbered Information Command PDU. For routed ISO PDUs, the format of the AAL5 CPCS-PDU Payload field shall thus be as follows as shown in Figure 8.

DSAP
SSAP
Control

Figure 7. LLC Header Format

DSAP (0xFE)
SSAP (oxFE)
Control (0x03)
CLNP PDU

Figure 8. AAL5 CPCS-PDU Payload Field Format for Routed ISO PDUs

The routed ISO protocol is identified by a 1 octet NLPID field that is part of Protocol Data.

In this case, the mapping to the SNS parameters should be the following:

SN-Source-Address: This field should contain the value [0xFE].

SN-Destination Address: This field should contain the value [0xFE].

SN-Priority: This field does not map to AAL-5 fields.

SN-Quality-of-Service: This field does not map to AAL-5 fields.

SNS-User Data: This field should contain the ISO network layer PDU.

2.7 Naming and Addressing

Naming and addressing requirements will be presented at the next Working Group meeting based on acceptance of the recommendations in this working paper.

2.8 Recommendation

Implement the standards necessary to allow ATN end systems to communicate over various types of subnetworks, as presented in this working paper.

It is recommended that the following information be added to the second paragraph of Section 5.7.1, Version 5, Internet SARPs. “The intent of the SNDCF provisions is to support subnetwork services using a variety of connection-oriented and connection-less subnetworks. Support should be provided for the most common types of subnetworks as listed in Section 1.” In addition, the following forth note should be added as Note 4, “Detailed technical information about end system connectivity of multiple ground based subnetwork types can be found in Section 8.4 of the “Guidance Material.”

It is also recommended that the material in Section 2.0 of this working paper be added to Section 8.4 of the Guidance Material to other Subnetworks.

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LIST OF REFERENCES

1. ICAO CNS/ATM-1 Package SARPs and Guidance Material, Part V Internet Communications Service.

2. International Standard, Information Processing Systems—Local Area Networks—Logical Link Control, ISO/IEC 8802-2: 1989 (E), IEEE Std. 802.2-1989, 1989-12-31.

3. ISO/IEC 8473-1: 1994 Information Technology—Protocol for Providing the Connectionless-Mode Network Service—Part 1: Protocol Specification.

4. ISO/IEC 8473-2: 1994 Information Technology—Protocol for Providing the Connectionless-Mode Network Service—Part 2: Provision of the Underlying Service by An ISO/IEC 8802 Subnetwork.

5. ISO/IEC 8473-3: 1994 Information Technology—Protocol for Providing the Connectionless-Mode Network Service—Part 3: Provision of the Underlying Service by an X.25 Subnetwork.

6. ISO/IEC 8473-4, 1994: Information Technology—Protocol for Providing the Connectionless-Mode Network Service—Part 4: Provision of the Underlying Service by a Subnetwork That Provides the OSI Data Link Service.

7. ISO/IEC 9542: 1988 Information Processing Systems—Telecommunications and Information Exchange between Systems—ES to IS Routing Exchange Protocol for Use in Conjunction with the Protocol For Providing the Connectionless-Mode Network Service (ISO 8473).

8. ISO/IEC 9314-2, 1989: Information Processing Systems-Fibre Distributed Data Interface (FDDI)—Part 2: Token Ring Media Access Control (MAC).

9. IETF RFC 1188: A Proposed Standard for the Transmission of IP Datagrams over FDDI Networks, Network Working Group, D. Katz, Merit/NFSNET, October 1990.

10. IEEE 802.2, 1985, "IEEE Standards for Local Area Networks: Logical Link Control," IEEE, New York, NY.

11. IETF RFC 1490: Multiprotocol Interconnect over Frame Relay, Network Working Group, T. Bradley, Wellfleet Communications Inc., A. Malis, Ascom Timeplex, Inc. July 1993

12. International Organization for Standardization, ISO Standard 3309-1979, "Data Communication—High-Level Data Link Control Procedures—Frame Structure," 1979.

13. International Organization For Standardization, ISO Standard 4335-1979, “Data Communication—High-Level Data Link Control Procedures—Elements of Procedures,” 1979.

14. International Organization For Standardization, ISO Standard 4335-1979/ Addendum 1, “Data Communication—High-Level Data Link Control Procedures—Elements of Procedures—Addendum 1,” 1979.

15. International Telecommunication Union (ITU-T) Q.921 LAP D: 1995.

16. International Telephone and Telephone Consultative Committee, “ISDN Data Link Layer Specification for Frame Mode Bearer Services,” CCITT Recommendation Q.922, 19 April 1991.

17. American National Standard for Telecommunications—Integrated Services Digital Network—Core Aspects of Frame Protocol for Use with Frame Relay Bearer Service, ANSI T1.618-1991, 18 June 1991.

18. Information Technology—Telecommunications and Information Exchange between Systems—Protocol Identification in the Network Layer, ISO/IEC TR 9577: 1990 (E) 1990-10-15.

19. International Telecommunication Union, CCITT Recommendation X.25, “Interface between Data Terminal Equipment (DTE) and Data Circuit Terminating Equipment (DCE) for Terminals Operating in the Packet Mode on Public Data Networks,” CCITT Red Book, Volume VIII, Fascicle VIII.3, Rec. X.25., October 1984.

20. IETF RFC 1701: S. Hanks, Netsmiths, Ltd.; T. Li, D. Farinacci, and P. Traina, CISCO Systems; Generic Routing Encapsulation (GRE), Network Working Group, October 1994.

21. IETF RFC 1702: S. Hanks, Netsmiths, Ltd.; T. Li, D. Farinacci, and P. Traina, CISCO Systems; Generic Routing Encapsulation over IPv4 Networks, Network Working Group, October 1994.

22. IETF RFC 1070: Use of the Internet as a Subnetwork for Experimentation with the OSI Network Layer, R. Hapens, February 1989.

23. IETF RFC 1483: Multiprotocol Encapsulation over ATM Adaptation Layer 5, J. Heinanen, July 1993.

GLOSSARY

AAL5	ATM Adaptation Layer 5
ATM	Asynchonous Transfer Mode
ATN	Aeronautical Telecommunication Network
ATNP	Aeronautical Telecommunication Network Panel
C	Checksum Present
CCITT	International Telephone and Telephone Consultative Committee
CLNP	Connectionless Network Layer Protocol
CPCS	Common Part Convergence Sublayer
CPI	Common Part Indicator
CRC	Cyclical Redundancy Check
DL	Data Link Layer
DLCI	Data Link Connection Identifier
DSAP	Destination Service Access Point
DTE	Data Terminal Equipment
ES	End System
FDDI	Fiber Distributed Data Interface
GRE	Generic Routing Encapsulation
ICAO	International Civil Aviation Organization
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IP	Internet Protocol
IPS	Internet Protocol Suite
IS	Intermediate System
ISDN	Integrated Services Digital Network
ISO	International Standards Organization
K	Key Present
LAN	Local Area Network
LLC	Logical Link Control
MAC	Media Access Control
NLPID	Network Level Protocol ID

OSI	Open Systems Interconnection
PAD	Padding
PDU	Protocol Data Unit
R	Routing Present
Recur	Recursion Control
RFC	Request for Comments
S	Sequence Number Present
SARP	Standards and Recommended Practices
SN	Subnetwork
SNA	System Network Architecture
SNAP	Subnetwork Access Protocol
SNAP	SubNetwork Attachment Point
SNDCF	Subnetwork Dependent Convergence Function
SNS	SN Service
SSAP	Source Service Access Point
TP4	[Transport Layer 4?]
TR	Technical Report
UU	User-to-User
VC	Virtual Circuit
Ver	Version Number