

Network Working Group  
Request for Comments: 2364  
Category: Standards Track

G. Gross  
Lucent Technologies  
M. Kaycee  
Paradyne  
A. Lin  
Shasta Networks  
A. Malis  
Ascend Communications  
J. Stephens  
Cayman Systems  
July 1998

## PPP Over AAL5

### Status of this Memo

This document specifies an Internet standards track protocol for the Internet community, and requests discussion and suggestions for improvements. Please refer to the current edition of the "Internet Official Protocol Standards" (STD 1) for the standardization state and status of this protocol. Distribution of this memo is unlimited.

### Copyright Notice

Copyright (C) The Internet Society (1998). All Rights Reserved.

### Abstract

The Point-to-Point Protocol (PPP) [1] provides a standard method for transporting multi-protocol datagrams over point-to-point links.

This document describes the use of ATM Adaptation Layer 5 (AAL5) for framing PPP encapsulated packets.

### Applicability

This specification is intended for those implementations which desire to use the facilities which are defined for PPP, such as the Link Control Protocol, Network-layer Control Protocols, authentication, and compression. These capabilities require a point-to-point relationship between the peers, and are not designed for the multi-point relationships which are available in ATM and other multi-access environments.

## 1. Introduction

ATM AAL5 protocol is designed to provide virtual connections between end stations attached to the same network. These connections offer a packet delivery service that includes error detection, but does not do error correction.

Most existing implementations of PPP use ISO 3309 HDLC as a basis for their framing [3].

When an ATM network is configured with point-to-point connections, PPP can use AAL5 as a framing mechanism.

## 2. Conventions

The keywords MUST, MUST NOT, REQUIRED, SHALL, SHALL NOT, SHOULD, SHOULD NOT, RECOMMENDED, MAY, and OPTIONAL, when they appear in this document, are to be interpreted as described in [10].

## 3. AAL5 Layer Service Interface

The PPP layer treats the underlying ATM AAL5 layer service as a bit-synchronous point-to-point link. In this context, the PPP link corresponds to an ATM AAL5 virtual connection. The virtual connection MUST be full-duplex, point to point, and it MAY be either dedicated (i.e. permanent, set up by provisioning) or switched (set up on demand). In addition, the PPP/AAL5 service interface boundary MUST meet the following requirements:

Interface Format - The PPP/AAL5 layer boundary presents an octet service interface to the AAL5 layer. There is no provision for sub-octets to be supplied or accepted.

Transmission Rate - The PPP layer does not impose any restrictions regarding transmission rate or the underlying ATM layer traffic descriptor parameters.

Control Signals - The AAL5 layer MUST provide control signals to the PPP layer which indicate when the virtual connection link has become connected or disconnected. These provide the "Up" and

"Down" events to the LCP state machine [1] within the PPP layer.

#### 4. Multi-Protocol Encapsulation

This specification uses the principles, terminology, and frame structure described in "Multiprotocol Encapsulation over ATM Adaptation Layer 5" [4].

The purpose of this specification is not to document what is already standardized in [4], but to specify how the mechanisms described in [4] are to be used to map PPP onto an AAL5-based ATM network. Section 1 within [4] defines the two mechanisms for identifying the Protocol Data Unit (PDU) payload field's protocol type: virtual circuit based multiplexing, and Logical Link Control (LLC) encapsulation. In the former technique, the payload's protocol type is implicitly agreed to by the end points for each virtual circuit using provisioning or control plane procedures. When using the LLC encapsulation technique, the payload's protocol type is explicitly identified on a per PDU basis by an in-band LLC header, followed by the payload data.

When transporting a PPP payload over AAL5, an implementation:

1. MUST support virtual circuit multiplexed PPP payloads as described in section 5 below by mutual configuration or negotiation of both end points. This technique is referred to as "VC-multiplexed PPP".
2. MUST support LLC encapsulated PPP payloads on PVCs as described in section 6 below by mutual configuration or negotiation of both end points. This technique is referred to as "LLC encapsulated PPP".
3. For SVC set up, an implementation MUST negotiate using the Q.2931 [9] Annex C procedure, encoding the Broadband Lower Layer Interface (B-LLI) information element to signal either VC-multiplexed PPP or LLC encapsulated PPP. The details of this control plane procedure are described in section 7.

If an implementation is connecting through a Frame Relay/ATM FRF.8 [7] service inter-working unit to an RFC 1973 [6] end point, then it MUST use LLC encapsulated PPP payloads. Frame Relay/ATM FRF.8 inter-working units are exempted from the requirement to support VC-multiplexed PPP. This exemption allows the FR/ATM IWU to remain compliant with FRF.8 when the PPP over AAL5 end point is inter-operating with an RFC 1973 end point.

5. Virtual Circuit Multiplexed PPP Over AAL5

The AAL5 PDU format is shown in figure 1:

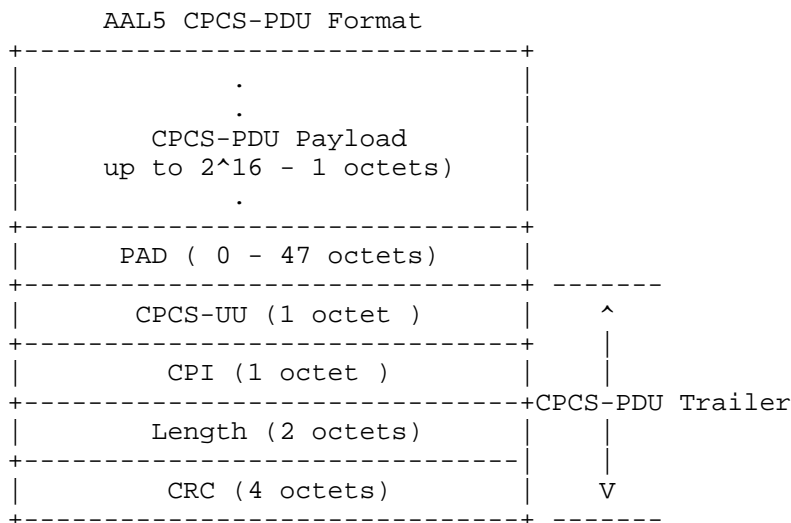


Figure 1

The Common Part Convergence Sub-layer (CPCS)-PDU Payload field contains user information up to 2<sup>16</sup> - 1 octets.

The PAD field pads the CPCS-PDU to fit exactly into the ATM cells such that the last 48 octet cell payload created by the SAR sublayer will have the CPCS-PDU Trailer right justified in the cell.

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

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

The Length field indicates the length, in octets, of the Payload field. The maximum value for the Length field is 65535 octets. A Length field coded as 0x00 is used for the abort function.

The CRC field protects the entire CPCS-PDU except the CRC field itself.

A VC-multiplexed PPP frame SHALL constitute the CPCS-PDU payload and is defined as:

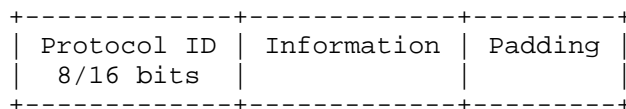


Figure 2

Each of these fields are specifically defined in [1].

#### 6. LLC Encapsulated PPP Over AAL5

LLC encapsulated PPP over AAL5 is the alternative technique to VC-multiplexed PPP over AAL5.

The AAL5 CPCS-PDU payload field is encoded as shown in figure 3. The pertinent fields in that diagram are:

1. LLC header: 2 bytes encoded to specify a source SAP and destination SAP of routed OSI PDU (values 0xFE 0xFE), followed by an Un-numbered Information (UI) frame type (value 0x03).
2. Network Layer Protocol Identifier (NLPID) representing PPP, (value 0xCF).
3. the PPP protocol identifier field, which can be either 1 or 2 octets long. See reference [1].
4. followed by the PPP information field as per Figure 2.

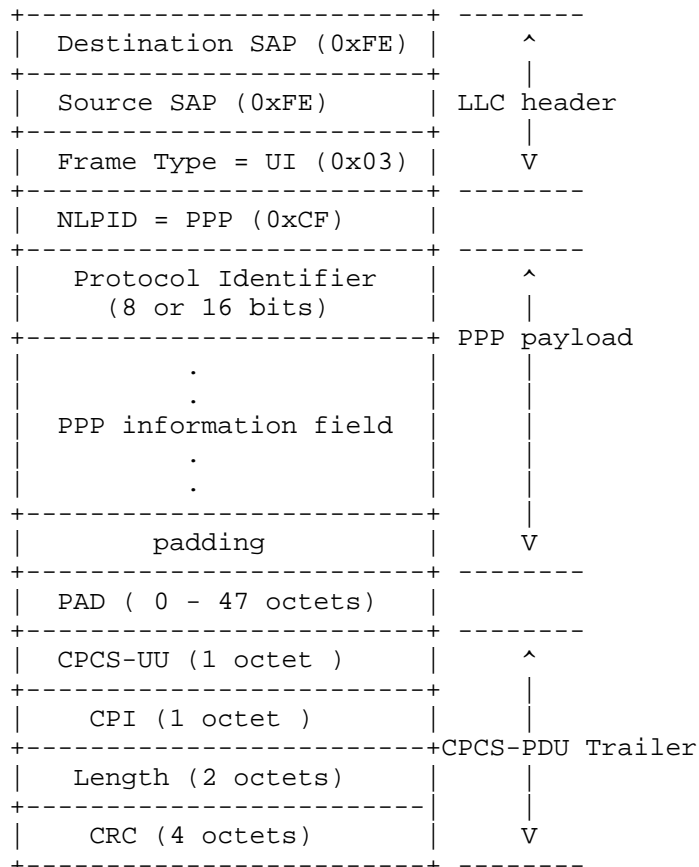


Figure 3

The end points MAY be bi-laterally provisioned to send other LLC-encapsulated protocols besides PPP across the same virtual connection. However, they MUST NOT send packets belonging to any protocol that has an active NCP within the PPP session. Implementations SHOULD do packet scheduling that minimizes the performance impact on the quality of service commitments associated with both the LLC-encapsulated PPP and non-PPP protocol flows.

#### 7. Out-Of-Band Control Plane Signaling

When originating a switched virtual circuit AAL5 connection, the caller MUST request in the SETUP message either VC-multiplexed PPP, LLC-encapsulated PPP, or else both VC-multiplexed and LLC-encapsulated PPP. When a caller is offering both techniques, the two

B-LLI IEs are encoded within a Broadband Repeat Indicator IE in the order of their preference. The called implementation MUST be able to accept an incoming call that offers LLC-encapsulated PPP in the caller's request. The called implementation MUST reject a call set up request that only offers an encapsulation that it does not support. Implementations originating a call offering both protocol encapsulation techniques MUST be able to negotiate the use of LLC-encapsulated PPP.

When originating a virtual circuit multiplexed call that is to carry a PPP payload, the ITU Q.2931 [9] B-LLI element user information layer 3 protocol field is encoded to select ISO/IEC TR 9577 [5] in octet 7. The extension octets specify an IPI value of PPP (0xCF). By definition, the first bytes of the AAL5 frame's payload field will always contain a PPP header followed by a packet.

When originating an LLC encapsulated call that is to carry a PPP payload, the ITU Q.2931 B-LLI element user information layer 2 protocol field is encoded to select LAN Logical Link Control (ISO/IEC8802-2) in octet 6. See RFC 1755 [8] appendix A for an example. By definition, the first bytes of the AAL5 frame's payload field will contain an LLC header, followed by a NLPID and the PPP payload.

#### 8. Detection And Recovery From Unsolicited PPP Encapsulation Transitions

When the virtual connection loses state, the PPP encapsulation technique may uni-laterally and unexpectedly change across such transitions. Detection and recovery procedures are defined for the following state transitions:

VC-multiplexed PPP changing to LLC encapsulated PPP

LLC encapsulated PPP changing to VC-multiplexed PPP

When LLC-encapsulated PPP is being used, the initial 6 octets of the LCP packets contain the sequence: fe-fe-03-cf-c0-21. This sequence constitutes the first 6 octets of the AAL5 frame. In the case of VC-multiplexed PPP, initial LCP packets contain the sequence c0-21. This sequence constitutes the first 2 octets of an AAL5 frame. When a LCP Configure-Request packet is received and recognized, the PPP link enters Link Establishment phase.

Once PPP has entered the Network-layer Protocol phase, and successfully negotiated a particular NCP for a PPP Protocol, if a frame arrives using an alternate but equivalent data encapsulation as defined in [4], then the PPP Link MUST:

For a SVC, immediately clear the call with the cause value 111, "protocol error, unspecified".

For a PVC: tear down the active NCPs, SHOULD generate an error message, enter the Termination state, and silently drop all received packets.

These policies prevent "black-holes" that occur when the peer loses state. An implementation which requires PPP link configuration, and other PPP negotiated features (such as authentication), MAY enter Termination state when configuration fails.

#### 9. LCP Configuration Options

The Magic Number LCP configuration option is RECOMMENDED, and the Protocol Field Compression (PFC) option is NOT RECOMMENDED. An implementation MUST NOT request any of the following options, and MUST reject a request for such an option:

Field Check Sequence (FCS) Alternatives,

Address-and-Control-Field-Compression (ACFC),

Asynchronous-Control-Character-Map (ACCM)

The Maximum-Receive-Unit (MRU) option MUST NOT be negotiated to a larger size than the maximum CPCS-SDU size specified in the associated direction for the virtual connection's traffic contract.

When viewed peer to peer, a PPP link may be bridged over multiple physical layer sections. For each such AAL5 section, the LCP framing options MUST be actively negotiated by the bridging convertors independently of the LCP framing options in use by other physical layer sections.

#### Implementation Note:

When an ATM AAL5 PVC is in the "Stopped" state, it is RECOMMENDED that the implementation wait for Configure-Requests. See the implementation option in reference [1] section 4.2, the "Stopped State" sub-section.

#### 10. Security Considerations

Generally, ATM networks are virtual circuit based, and security is implicit in the public data networking service provider's administration of Permanent Virtual Circuits (PVCs) between the network boundaries. The probability of a security breach caused by mis-routed ATM cells is considered to be negligible.



When a public ATM network supports Switched Virtual Circuits, the protocol model becomes analogous to traditional voice band modem dial up over the Public Telephone Switched Network (PTSN). The same PAP/CHAP authentication protocols that are already widely in use for Internet dial up access are leveraged. As a consequence, PPP over AAL5 security is at parity with those practices already established by the existing Internet infrastructure.

Those applications that require stronger security are encouraged to use authentication headers, or encrypted payloads, and/or ATM-layer security services.

When using LLC-encapsulated PPP over a virtual connection, an end point can not assume that the PPP session authentication and related security mechanisms also secure the other LLC encapsulated flows on that same virtual connection.

## 11. Acknowledgments

This design is based on work performed in ADSL Forum's Packet Mode Working Group. It is inspired by "PPP in Frame Relay", RFC 1973, by William Simpson. Special thanks to Phil Rakity of Flowpoint, Tim Kwok of Microsoft, and David Allan of Nortel for their constructive review and commentary.

## 12. References

- [1] Simpson, W., Editor, "The Point-to-Point Protocol (PPP)", STD 51, RFC 1661, July 1994.
- [2] The ATM Forum, "Frame based User-to-Network Interface (FUNI) Specification v2", af-saa-0088.000, May 1997.
- [3] Simpson, W., Editor, "PPP in HDLC-like Framing", STD 51, RFC 1662, July 1994.
- [4] Heinanen, J., "Multiprotocol Interconnect over AAL5", RFC 1483, July 1993.
- [5] ISO/IEC DTR 9577.2, "Information technology - Telecommunications and Information exchange between systems - Protocol Identification in the network layer", 1995-08-16.
- [6] Simpson, W., "PPP in Frame Relay", RFC 1973, June 1996.
- [7] The Frame Relay Forum, "Frame Relay/ATM PVC Service Inter-working Implementation Agreement", FRF.8, April 1995.

- [8] Perez, M., Liaw, F., Mankin, A., Hoffman, E., Grossman, D., and A. Malis, "ATM Signaling Support for IP over ATM", RFC 1755, February 1995.
- [9] International Telecommunication Union, "Broadband Integrated Service Digital Network (B-ISDN) Digital Subscriber Signaling System No.2 (DSS2) User Network Interface Layer 3 Specification for Basic Call/Connection Control", ITU-T Recommendation Q.2931, (International Telecommunication Union: Geneva, 2/95)
- [10] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

#### Chair's Address

The working group can be contacted via the current chair:

Karl Fox  
Ascend Communications  
3518 Riverside Drive, Suite 101  
Columbus, Ohio 43221

EEmail: karl@ascend.com

#### Authors' Addresses

Questions about this memo can also be directed to:

George Gross  
Lucent Technologies, Inc  
184 Liberty Corner Road  
Warren, NJ 07059

Phone: +1.908.580.4589  
EEmail: gmgross@lucent.com

Manu Kaycee  
Paradyne Corporation  
21 Bear Meadow Road  
Londonderry, NH 03053-2168

Phone: +1.603.434.6088  
EEmail: mjk@nj.paradyne.com

Arthur Lin  
Shasta Networks Inc.  
249 Humboldt Court  
Sunnyvale, CA 94089-1300

Phone: +1.408.747.5051  
EMail: alin@shastanets.com

Andrew Malis  
Ascend Communications, Inc.  
1 Robbins Road  
Westford, MA 01886

Phone: +1.978.952.7414  
EMail: malis@ascend.com

John Stephens  
Cayman Systems, Inc.  
100 Maple Street  
Stoneham, MA 02180

Phone: +1.617.279.1101  
EMail: john@cayman.com

## Full Copyright Statement

Copyright (C) The Internet Society (1998). All Rights Reserved.

This document and translations of it may be copied and furnished to others, and derivative works that comment on or otherwise explain it or assist in its implementation may be prepared, copied, published and distributed, in whole or in part, without restriction of any kind, provided that the above copyright notice and this paragraph are included on all such copies and derivative works. However, this document itself may not be modified in any way, such as by removing the copyright notice or references to the Internet Society or other Internet organizations, except as needed for the purpose of developing Internet standards in which case the procedures for copyrights defined in the Internet Standards process must be followed, or as required to translate it into languages other than English.

The limited permissions granted above are perpetual and will not be revoked by the Internet Society or its successors or assigns.

This document and the information contained herein is provided on an "AS IS" basis and THE INTERNET SOCIETY AND THE INTERNET ENGINEERING TASK FORCE DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY THAT THE USE OF THE INFORMATION HEREIN WILL NOT INFRINGE ANY RIGHTS OR ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.