                         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.

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].

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-

5. Virtual Circuit Multiplexed PPP Over AAL5

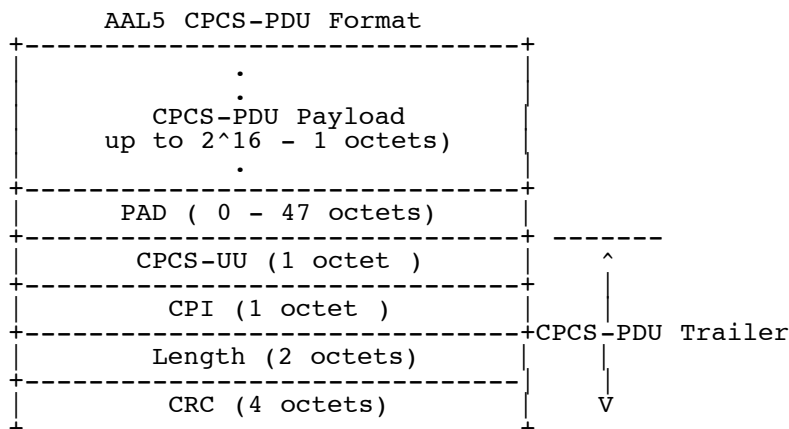   The AAL5 PDU format is shown in figure 1:

```
                       AAL5 CPCS-PDU Format
            +------------------------------+
            |                .             |
            |                .             |
            |         CPCS-PDU Payload     |
            |        up to 2^16 - 1 octets)|
            |                .             |
            +------------------------------+
            |       PAD ( 0 - 47 octets)   |
            +------------------------------+ -------
            |         CPCS-UU (1 octet )   |    ^
            +------------------------------+    |
            |         CPI (1 octet )       |    |
            +------------------------------+CPCS-PDU Trailer
            |       Length (2 octets)      |    |
            +------------------------------+    |
            |         CRC (4 octets)       |    V
            +------------------------------+ -------
                          Figure 1
```

    The Common Part Convergence Sub-layer (CPCS)-PDU Payload field
    contains user information up to 2^16 - 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:

```
            +-------------+-------------+---------+
            | Protocol ID | Information | Padding |
            |   8/16 bits |             |         |
            +-------------+-------------+---------+
                          Figure 2
```
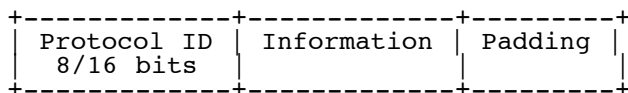
    Each of these fields are specifically defined in [1].

6. LLC Encapsulated PPP Over AAL5

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.

```
            +--------------------------+ --------
            |  Destination SAP (0xFE)  |     ^
            +--------------------------+     |
            |   Source SAP (0xFE)      | LLC header
            +--------------------------+     |
            |  Frame Type = UI (0x03)  |     V
            +--------------------------+ --------
            |  NLPID = PPP (0xCF)      |
            +--------------------------+ --------
            |   Protocol Identifier    |     ^
            |     (8 or 16 bits)       |     |
            +--------------------------+ PPP payload
            |            .             |     |
            |            .             |     |
            |  PPP information field   |     |
            |            .             |     |
            |            .             |     |
            +--------------------------+     |
            |         padding          |     V
            +--------------------------+ --------
            |  PAD ( 0 - 47 octets)    |
            +--------------------------+ --------
            |  CPCS-UU (1 octet )      |     ^
            +--------------------------+     |
            |    CPI (1 octet )        |     |
            +--------------------------+CPCS-PDU Trailer
            |   Length (2 octets)      |     |
            +--------------------------+     |
            |    CRC (4 octets)        |     V
            +--------------------------+ --------
```
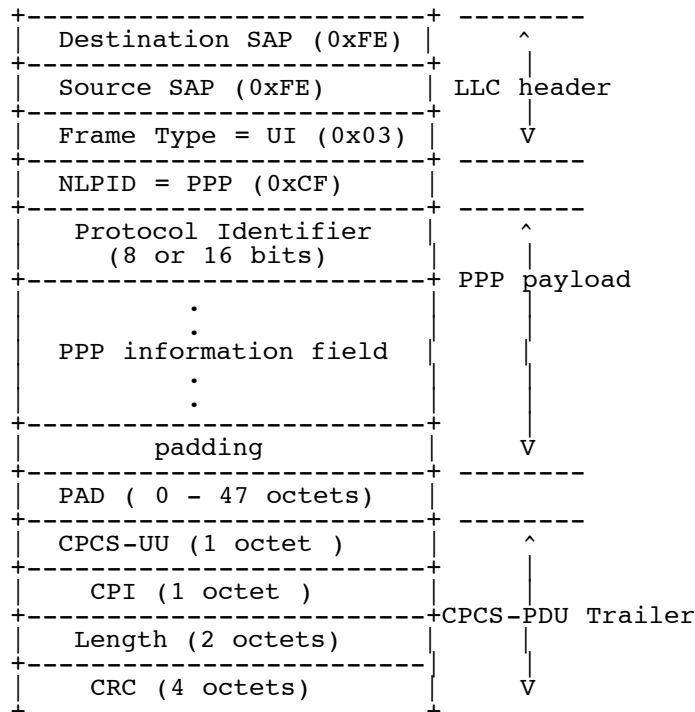
                        Figure 3

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

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 inital 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.

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