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Layer Two Tunneling Protocol version 3 - Setup of Time-Division
Multiplexing (TDM) Pseudowires

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Abstract

This document defines extensions to the Layer Two Tunneling Protocol version 3 (L2TPv3) for support of structure-agnostic and structure-aware (CESoPSN style) Time-Division Multiplexing (TDM) pseudowires. Support of structure-aware (TDMoIP style) pseudowires over L2TPv3 is left for further study.

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Conventions used in this document

In this document we refer to control plane as the packets that contain control information (via Attribute-Value pairs (AVP)) and the mechanism that handles these packets.

In this document we refer to the data plane as the packets that contain transported user data.

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC-2119](#) [[RFC2119](#)].

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[1.](#) Introduction

This document defines extensions to the Layer Two Tunneling Protocol Version 3(L2TPv3) for support of structure-agnostic [[RFC4553](#)] and structure-aware (CESoPSN style, see [[RFC5086](#)]) Time-Division Multiplexing (TDM) pseudowires. Structure-agnostic encapsulation of TDM bit-streams over L2TPv3 is described in [[RFC4553](#)], Figure 2b, and Circuit Emulation Service over packet-Switched Networks (CESoPSN) structure-aware encapsulation - in [[RFC5086](#)], Figures 1c (TDM data packets) and 4a (CE application signaling packets). However, the order of the CESoPSN Control Word (CW) and RTP header (if it is used) MUST match between the TDM data and CE signaling packets.

Setup of structure-aware TDM pseudowires using encapsulations described in [[RFC5087](#)] has been left for further study.

Setup and maintenance of TDM PWs in MPLS networks using LDP is described in [[RFC5287](#)].

[2.](#) L2TPv3 Extension

The L2TPv3 Control Connection is responsible for 3 main operations:

1. Establishment and validation of a pseudowire (PW) session.
2. Ending (tearing down) of a pseudowire session.
3. Transferring of End Point status.

Tearing down of session for a TDM pseudowire performed as described in [[RFC3931](#)].

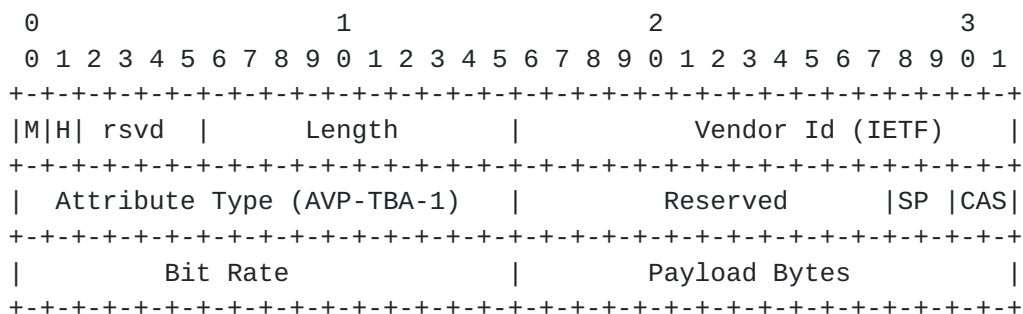
[[RFC5086](#)] and [[RFC4553](#)] describe how to transfer the Attachment Circuit (AC) status via the data plane. Therefore the Set-Link-Info (SLI) message described in [[RFC3931](#)] SHOULD NOT be used for conveying this status for the PWs in question.

[RFC3931] specifies that the Circuit Status Attribute-Value Pair (AVP) MUST be present in the ICRQ/ICRP messages. It also specifies that the N bit in this AVP should be set during the PW setup even if the specific AC does not provide any way to convey the "new AC" indication. Accordingly, the Circuit Status AVP for the PWs in question, when used in the ICRQ/ICRP messages, MUST always have both N and A bits set.

The next sections describe the extensions to L2TPv3 for establishment and validation of TDM pseudowire sessions.

There are two new AVPs for the Session Management messages. One AVP describes the TDM pseudowire attributes. The second AVP describes the RTP attributes for this TDM pseudowire.

2.1 TDM PW Attribute-Value Pair (AVP)(ICRQ, OCRQ)



This AVP MAY be hidden (the H bit MAY be 0 or 1). The M bit for this AVP SHOULD be set to 0. The Length (before hiding) of this AVP is 12.

The Bit Rate field contains the value that represents the bit rate of the local AC in the units of 64 Kbit/s encoded as an unsigned 16-bit integer. Its usage for all types of TDM PWs employs the following semantics:

- 1) Only the following values MUST be specified for structure-agnostic emulation (see [RFC4553]):
 - a) Structure-agnostic E1 emulation - 32
 - b) Structure-agnostic T1 emulation:
 - i) MUST be set to 24 for the basic mode
 - ii) MUST be set to 25 for the "Octet-aligned T1" mode
 - c) Structure-agnostic E3 emulation - 535
 - d) Structure-agnostic T3 emulation - 699
- 2) For CESoPSN PWs this parameter MUST be set to the number of DS0 channels in the corresponding attachment circuit.

Note: For structure-agnostic T1 emulation, the values 24 and 25 do

not reflect the exact bit rate, and are used for convenience only.

Note: The semantics of the Bit Rate field defined above are consistent with those of the Bit Rate Interface Attribute as defined in [[RFC5287](#)].

The Payload Bytes field contains the value representing the number of the TDM Payload bytes in the PW packet and is used with the following semantics:

- 1) For structure-agnostic emulation any value of the payload bytes can be specified.
- 2) For CESoPSN PWs:
 - a) The specified value MUST be an integer multiple of the number of DS0 channels in the corresponding attachment circuit.
 - b) In addition to that, for trunk-specific NxDS0 with CAS, the number of the trunk frames per multiframe fragment (value resulting from the Payload Bytes divided by the number of DS0 channels) MUST be an integer divisor of the number of frames per corresponding trunk multiframe.

The Reserved bits MUST be set to 0 on transmission and MUST be ignored on reception.

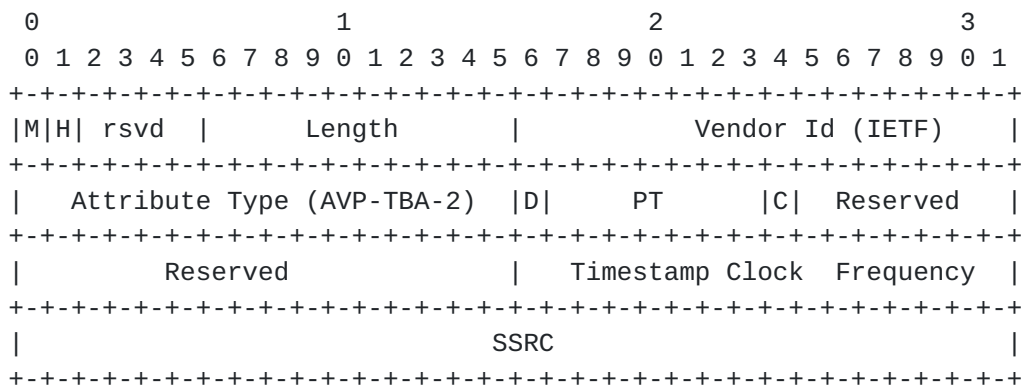
The SP bits define support for the CESoPSN application signaling packets (see [[RFC5086](#)]) and MUST be used as following:

- 1) Set to '01' for the CESoPSN PWs carrying TDM data packets and expecting CE application signaling packets in a separate PW
- 2) Set to '10' for a PW carrying CE application signaling packets with the data packets in a separate PW
- 3) Set to '11' for e CESoPSN PW carrying both TDM data and signaling packets
- 4) Set to '00' for SAToP PWs and for CESoPSN PWs not using separate signaling packets.

The CAS bits define the trunk type for trunk-specific CESoPSN services with CAS. These bits:

- 1) For trunk-specific CESoPSN with CAS these bits MUST be set to:
 - a) '01' in the case of an E1 trunk
 - b) '10' in the case of a T1/ESF trunk
 - c) '11' in the case of a T1/SF trunk.
- 2) MUST be set to '00' for all the other TDM pseudowire types.

2.2 RTP Attribute-Value Pair AVP (ICRQ, OCRQ, ICRP, OCRP)



Presence of this AVP indicates that the RTP header is used in the TDM pseudowire encapsulation. Use or non-use of the RTP header MUST match for the two directions of a TDM PW. This AVP MAY be hidden (the H bit MAY be 0 or 1). The M bit for this AVP SHOULD be set to 0. The Length (before hiding) of this AVP is 16.

The D bit indicates the timestamping mode (absolute or differential) in the RTP header. These modes are described in, e.g., in [\[RFC4553\]](#), [Section 4.3.2](#). If the D bit is set to 1 then the Differential timestamping mode is used, otherwise the Absolute timestamping mode is used. Timestamping modes can be used independently for the two directions of a TDM PW.

The C bit indicates the ordering of the RTP header and the control word as following:

- o If the C bit is set to 1 the RTP header appears after the control word in the data channel of the TDM pseudowire. This mode is described as SAToP/CESoPSN encapsulation over IPv4/IPv6 PSN with L2TPv3 demultiplexing in [\[RFC4553\]](#) and [\[RFC5086\]](#) respectively.
- o If the C bit is set to 0 the RTP header appears before the control word. This mode described as the old mode of the SAToP/CESoPSN encapsulation over L2TPv3 in [\[RFC4553\]](#), [Appendix A](#), and [\[RFC5086\]](#), Annex C, respectively.

PT is the payload type expected in the RTP header. A value of zero indicates that the receiver shall not check payload type to detect malformed packets.

Timestamp Clock Frequency is the clock frequency used for the time stamping in units of 8 KHz.

SSRC indicates the expected value of SSRC ID in the RTP header. A zero in this field means that SSRC ID will not be used for detecting

misconnections. Since L2TP provides an alternative security mechanism using cookies, if the cookie length is larger than zero the SSRC SHOULD be zero.

2.3 Changes in the Control Connection AVPs

Control Connections that support TDM PWs MUST add the appropriate PW Type value(s) to the list in the Pseudowire Capabilities List AVP. The valid values are listed in the next section.

2.4 Changes in the Session Connection AVPs

PW Type AVP should be set to one of the following values:

1. Structure-agnostic emulation [[RFC4553](#)] of:
 - a. E1 circuits - TBA-SAToP-E1 by IANA
 - b. T1 circuits - TBA-SAToP-T1 by IANA
 - c. E3 circuits - TBA-SAToP-E3 by IANA
 - d. T3 circuits - TBA-SAToP-T3 by IANA
2. Structure-aware emulation [[RFC5086](#)] of:
 - a. CESoPSN basic mode - TBA-CESoPSN-Basic by IANA
 - b. Trunk-specific CESoPSN service with CAS - TBA-CESoPSN-CAS by IANA

TDM pseudowires use their own control word. Therefore the L2-Specific Sublayer AVP MUST either be omitted or set to zero.

TDM pseudowires use their own sequencing. Therefore the Data Sequencing AVP MUST either be omitted or set to zero.

Note: The Control Word (CW) used in the SAToP and CESoPSN encapsulations over L2TPv3 effectively represents a dedicated L2-Specific Sub-layer.

3. Creation of the TDM Pseudowire Session

When LCCE wants to open a Session for TDM PW it MUST include the TDM PW AVP (in any case) and the RTP AVP (if and only if the RTP header is used) in the ICRQ or OCRQ message. The LCCE peer must validate the TDM PW AVP and make sure it can meet the requirements derived from the RTP AVP (if it exists). If the peer agrees with the TDM AVP it will send an appropriate ICRP or OCRP message with the matching RTP AVP (if needed). The Initiator need to validate that it can supply the requirements derived from the received RTP AVP.

The two peers MUST agree on the values in the TDM PW AVP:

1. Bit Rate values MUST be equal on both sides. If they are different, the connection will be rejected with return code RC-TBD-1 and error code EC-TBD-1.
2. In the case of trunk-specific CESoPSN with CAS, the trunk type (as encoded in the CAS bits of the TDM AVP) MUST be the same for the two sides. Otherwise the connection will be rejected with return code RC-TBD-1 and error code EC-TBD-2.
3. If one side does not support the payload bytes value proposed by the other one, the connection will be rejected with return code RC-TBD-1 and error code EC-TBD-3.
4. If one side cannot send RTP header as requested by the other side, the connection will be rejected with return code RC-TBD-1 and error code EC-TBD-4.
5. If one side can send RTP header but not with the requested timestamp clock frequency, the connection will be rejected with return code RC-TBD-1 and error code EC-TBD-5.

If CE signaling for a CESoPSN basic PW is transported in a separate PW instance, then the two PW instances:

1. MUST use the same PW type
2. MUST use the same values in all the fields of the TDM AVP excluding the SP field which must be set to '01' for the TDM data PW and to '10' for the PW carrying CE application signaling
3. MUST both use or not use RTP header (and accordingly, include or not include the RTP AVP).

4. IANA Considerations

This draft requires assignment of the following values by IANA:

New L2TPv3 Pseudowire Types:

0x0011 (TBA-SAToP-E1)	- Structure-agnostic E1 circuit
0x0012 (TBA-SAToP-T1)	- Structure-agnostic T1 (DS1) circuit
0x0013 (TBA-SAToP-E3)	- Structure-agnostic E3 circuit
0x0014 (TBA-SAToP-T3)	- Structure-agnostic T3 (DS3) circuit
0x0015 (TBA-CESoPSN-Basic)	- CESoPSN basic mode
0x0017 (TBA-CESoPSN-CAS)	- CESoPSN TDM with CAS

Note that the values listed are suggested to match with the values defined in [[RFC4446](#)] for the MPLS Pseudowire Types.

New attribute value pair IDs:

1. AVP-TBD-1 - TDM Pseudowire AVP
2. AVP-TBD-2 - RTP AVP

New return codes for the CDN message:

1. RC-TBD-1 - return code to indicate connection refused because of TDM PW parameters. The error code indicates the problem.

TDM PW Specific error codes, to be used with the RC-TDB-1 return code For the CDN message:

This is a new registry for IANA to maintain within the Result Code AVP (Attribute Type 1) Values. Additional values may be assigned by Expert Review [[RFC5226](#)].

0. 0 - Reserved
1. EC-TBD-1 - Bit Rate values disagree.
2. EC-TBD-2 - Different trunk types in the case of trunk-specific CESoPSN with CAS
3. EC-TBD-3 - Requested payload size too big or too small.
4. EC-TBD-4 - RTP header cannot be generated.
5. EC-TBD-5 - Requested timestamp clock frequency cannot be generated

5. Congestion Control

The congestion considerations from [[RFC4553](#)] and [[RFC5086](#)] apply respectively to the structure-agnostic and CESoPSN modes of this specification.

6. Security Considerations

This document specifies only the L2TPv3-based control plane for setup of TDM PWs. Within this scope, there are no additional security considerations on top of those discussed in [[RFC3931](#)].

Common data plane security considerations for the TDM PWs have been discussed in some detail in both [[RFC4553](#)] and [[RFC5086](#)]. On top of these, the L2TPv3-based data plane provides additional security mechanisms based on usage of cookies.

7. Acknowledgements

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Normative references

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