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The Pseudowire (PW) & Virtual Circuit Connectivity Verification (VCCV) Implementation Survey Results
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Abstract

Most Pseudowire Emulation Edge-to-Edge (PWE3) encapsulations mandate the use of the Control Word (CW) in order to better emulate the services for which the encapsulations have been defined. However, some encapulations treat the Control Word as optional. As a result, implementations of the CW, for encapsulations for which it is optional, vary by equipment manufacturer, equipment model and service provider network. Similarly, Virtual Circuit Connectivity Verification (VCCV) supports three Control Channel (CC) types and multiple Connectivity Verification (CV) Types. This flexibility has led to reports of interoperability issues within deployed networks and associated drafts to attempt to remedy the situation. This survey of the PW/VCCV user community was conducted to determine implementation trends. The survey and results is presented herein.

Status of this Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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This Internet-Draft will expire on October 19, 2012.

Table of Contents

1. Introduction

The IETF has defined many encapsulations of various layer 1 and layer 2 service-specific PDUs and circuit data. Within these encapsulations, there are often several modes of encapsulation which have differing requirements in order to fully emulate the service. As such, the use of the PWE3 Control Word is mandated in many of the encapsulations, but not all. This can present interoperability issues related to A) Control Word use and B) VCCV Control Channel negotiation in mixed implementation environments.

The encapsulations and modes for which the Control Word is currently optional are:

- Ethernet Tagged Mode
- Ethernet Raw Mode
- PPP
- HDLC
- Frame Relay Port Mode
- ATM (N:1 Cell Mode)

[RFC5085] defines three Control Channel types for MPLS PW's: Type 1, using the Pseudowire Control Word, Type 2, using the Router Alert Label, and Type 3, using TTL Expiration (e.g. MPLS PW Label with TTL == 1). While Type 2 (RA Label) is indicated as being "the preferred mode of VCCV operation when the Control Word is not present," RFC 5085 does not indicate a mandatory Control Channel to ensure interoperable implementations. The closest it comes to mandating a control channel is the requirement to support Type 1 (Control Word) whenever the control word is present. As such, the three options yield seven implementation permutations (assuming you have to support at least one Control Channel type to provide VCCV). Due to these permuations, interoperability challenges have been identified by several VCCV users.

In order to assess the best approach to address the observed interoperability issues, the PWE3 working group decided to solicit feedback from the PW and VCCV user community regarding implementation. This document presents the survey and the information returned by the user community who participated.

1.1. PW/VCCV Survey Overview

Per the direction of the PWE3 Working Group chairs, a survey was created to sample the nature of implementations of Pseudowires, with specific emphasis on Control Word usage, and VCCV, with emphasis on Control Channel and Control Type usage. The survey consisted of a series of questions based on direction of the WG chairs and the survey opened to the public on November 4, 2010. The URL for the survey (now closed) was http://www.surveymonkey.com/pwe3/. The survey ran from November 4, 2010 until February 25, 2011.

1.2. PW/VCCV Survey Form

The PW/VCCV Implementation Survey requested the following information about user implementations:

- Responding Organziation. No provisions were made for anonymity. All responses required a valid email address in order to validate the survey response.

- Of the various encapsulations (and options therein) known at the time, including the WG draft for Fiber Channel), which were implemented b the respondent. These included:

- Ethernet Tagged Mode - RFC 4448
- Ethernet Raw Mode - RFC 4448
- SAToP - RFC 4553
- PPP - RFC 4618
- HDLC - RFC 4618
- Frame Relay (Port Mode) - RFC 4619
- Frame Relay (1:1 Mode) - RFC 4619
- ATM (N:1 Mode) - RFC 4717
- ATM (1:1 Mode) - RFC 4717
- ATM (AAL5 SDU Mode) - RFC 4717
- ATM (AAL5 PDU Mode) - RFC 4717
- CEP - RFC 4842

- o CESoPSN - RFC 5086
- o TDMoIP - RFC 5087
- o Fiber Channel (Port Mode) - draft-ietf-pwe3-fc-encap

- Approximately how many Pseudowires of each type were deployed. Respondents could list a number, or for the sake of privacy, could just respond "In-Use" instead.

- For each encapsulation listed above, the respondent could indicated which Control Channel was in use. The options listed were:

- o Control Word (Type 1)
- o Router Alert Label (Type 2)
- o TTL Expiry (Type 3)

- For each encapsulation listed above, the respondent could indicate which Connectivity Verification types were in use. The options were:

- o ICMP Ping
- o LSP Ping

- For each encapsulation type for which the use of the Control Word is optional, the respondents could indicated the encaps for which Control Word was supported by the equipment used and whether it was in use in the network. The encaps listed were:

- o Ethernet (Tagged Mode)
- o Ethernet (Raw Mode)
- o PPP
- o HDLC
- o Frame Relay (Port Mode)
- o ATM (N:1 Cell Mode)

- Finally, a freeform entry was provided for the respondent to provide feedback regarding PW and VCCV deployments, VCCV interoperability challenges, the survey or any network/vendor details they wished to share.

1.3. PW/VCCV Survey Highlights

There were 17 valid responses to the survey. The responding companies are listed below in Section 2.1.

2. Survey Results

2.1. Respondents

The following companies participated in the PW/VCCV Implementation Survey. The data provided has been aggregated. No specific company’s reponse will be detailed herein.

- Time Warner Cable
- Bright House Networks
- Tinet
- AboveNet
- Telecom New Zealand
- Cox Communications
- MTN South Africa
- Wipro Technologies
- Verizon
- AMS-IX
- Superonline
- Deutsche Telekom AG
- Internet Solution
- Easynet Global Services
- Telstra Corporation
- OJSC MegaFon
- France Telecom Orange

2.2. Pseudowire Encapsulations Implemented

The following question was asked: "In your network in general, across all products, please indicate which Pseudowire encapsulations your company has implemented." Of all responses, the following list shows the percentage of responses for each encapsulation:

- Ethernet Tagged Mode - RFC 4448 = 76.5%
- Ethernet Raw Mode - RFC 4448 = 82.4%
- SAToP - RFC 4553 = 11.8%
- PPP - RFC 4618 = 11.8%
- HDLC - RFC 4618 = 5.9%
- Frame Relay (Port Mode) - RFC 4619 = 17.6%
- Frame Relay (1:1 Mode) - RFC 4619 = 41.2%
- ATM (N:1 Mode) - RFC 4717 = 5.9%
- ATM (1:1 Mode) - RFC 4717 = 17.6%
- ATM (AAL5 SDU Mode) - RFC 4717 = 5.9%
- ATM (AAL5 PDU Mode) - RFC 4717 = 0.0%
- CEP - RFC 4842 = 0.0%
- CESoPSN - RFC 5086 = 11.8%
- TDMoIP - RFC 5087 = 11.8%
- Fiber Channel (Port Mode) - draft-ietf-pwe3-fc-encap = 5.9%

2.3. Number of Pseudowires Deployed

The following question was asked: "Approximately how many Pseudowires are deployed of each encapsulation type. Note, this should be the number of pseudowires in service, carrying traffic, or pre-positioned to do so." The following list shows the number of psudowires in use for each encapsulation:

- Ethernet Tagged Mode = 93,861

- Ethernet Raw Mode = 94,231
- SAToP - RFC 4553 = 20,050
- PPP - RFC 4618 = 500
- HDLC - RFC 4618 = 0
- Frame Relay (Port Mode) - RFC 4619 = 5,002
- Frame Relay (1:1 Mode) - RFC 4619 = 50,959
- ATM (N:1 Mode) - RFC 4717 = 50,000
- ATM (1:1 Mode) - RFC 4717 = 70,103
- ATM (AAL5 SDU Mode) - RFC 4717 = 0
- ATM (AAL5 PDU Mode) - RFC 4717 = 0
- CEP - RFC 4842 = 0
- CESoPSN - RFC 5086 = 21,600
- TDMoIP - RFC 5087 = 20,000
- Fiber Channel (Port Mode) - draft-ietf-pwe3-fc-encap = 0

In the above responses, on several occasions the response was in the form of "> XXXXX" where the response indicated a number greater than the one provided. Where applicable, the number itself was used in the sums above. For example, ">20K" and "20K+" yielded 20K.

Additionally, the following encaps were listed as "In-Use" with no quantity provided:

- Ethernet Raw Mode: 2 Responses
- ATM (AAL5 SDU Mode): 1 Response
- TDMoIP: 1 Response

2.4. VCCV Control Channel In Use

The following instructions were given: "Please indicate which VCCV Control Channel is used for each encapsulation type. Understanding that users may have different networks with varying implementations, for your network in general, please select all which apply." The

numbers below indicate the number of responses. The responses were:

- Ethernet Tagged Mode - RFC 4448
  - Control Word (Type 1) = 7
  - Router Alert Label (Type 2) = 3
  - TTL Expiry (Type 3) = 3
- Ethernet Raw Mode - RFC 4448
  - Control Word (Type 1) = 8
  - Router Alert Label (Type 2) = 4
  - TTL Expiry (Type 3) = 4
- SAToP - RFC 4553
  - Control Word (Type 1) = 1
  - Router Alert Label (Type 2) = 0
  - TTL Expiry (Type 3) = 0
- PPP - RFC 4618
  - Control Word (Type 1) = 0
  - Router Alert Label (Type 2) = 0
  - TTL Expiry (Type 3) = 0
- HDLC - RFC 4618
  - Control Word (Type 1) = 0
  - Router Alert Label (Type 2) = 0
  - TTL Expiry (Type 3) = 0
- Frame Relay (Port Mode) - RFC 4619
  - Control Word (Type 1) = 1
  - Router Alert Label (Type 2) = 0

    * TTL Expiry (Type 3) = 0

- Frame Relay (1:1 Mode) - RFC 4619
    * Control Word (Type 1) = 3
    * Router Alert Label (Type 2) = 0
    * TTL Expiry (Type 3) = 2
- ATM (N:1 Mode) - RFC 4717
    * Control Word (Type 1) = 1
    * Router Alert Label (Type 2) = 0
    * TTL Expiry (Type 3) = 0
- ATM (1:1 Mode) - RFC 4717
    * Control Word (Type 1) = 1
    * Router Alert Label (Type 2) = 0
    * TTL Expiry (Type 3) = 1
- ATM (AAL5 SDU Mode) - RFC 4717
    * Control Word (Type 1) = 0
    * Router Alert Label (Type 2) = 1
    * TTL Expiry (Type 3) = 0
- ATM (AAL5 PDU Mode) - RFC 4717
    * Control Word (Type 1) = 0
    * Router Alert Label (Type 2) = 0
    * TTL Expiry (Type 3) = 0
- CEP - RFC 4842
    * Control Word (Type 1) = 0
    * Router Alert Label (Type 2) = 0

    * TTL Expiry (Type 3) = 0

- CESoPSN - RFC 5086
    * Control Word (Type 1) = 0
    * Router Alert Label (Type 2) = 0
    * TTL Expiry (Type 3) = 1
- TDMoIP - RFC 5087
    * Control Word (Type 1) = 0
    * Router Alert Label (Type 2) = 0
    * TTL Expiry (Type 3) = 0
- Fiber Channel (Port Mode) - draft-ietf-pwe3-fc-encap
    * Control Word (Type 1) = 0
    * Router Alert Label (Type 2) = 0
    * TTL Expiry (Type 3) = 0

2.5. VCCV Connectivity Verification Types In Use

The following instructions were given: "Please indicate which VCCV Connectivity Verification types are used in your networks for each encapsulation type." Note that BFD was not one of the choices. The responses were as follows:

- Ethernet Tagged Mode - RFC 4448
    * ICMP Ping = 5
    * LSP Ping = 11
- Ethernet Raw Mode - RFC 4448
    * ICMP Ping = 6
    * LSP Ping = 11
- SAToP - RFC 4553

    * ICMP Ping = 0

    * LSP Ping = 2

- PPP - RFC 4618
    * ICMP Ping = 0

    * LSP Ping = 0

- HDLC - RFC 4618
    * ICMP Ping = 0

    * LSP Ping = 0

- Frame Relay (Port Mode) - RFC 4619
    * ICMP Ping = 0

    * LSP Ping = 1

- Frame Relay (1:1 Mode) - RFC 4619
    * ICMP Ping = 2

    * LSP Ping = 5

- ATM (N:1 Mode) - RFC 4717
    * ICMP Ping = 0

    * LSP Ping = 1

- ATM (1:1 Mode) - RFC 4717
    * ICMP Ping = 0

    * LSP Ping = 3

- ATM (AAL5 SDU Mode) - RFC 4717
    * ICMP Ping = 0

    * LSP Ping = 1

- ATM (AAL5 PDU Mode) - RFC 4717
  - ICMP Ping = 0
  - LSP Ping = 0
- CEP - RFC 4842
  - ICMP Ping = 0
  - LSP Ping = 0
- CESoPSN - RFC 5086
  - ICMP Ping = 0
  - LSP Ping = 1
- TDMoIP - RFC 5087
  - ICMP Ping = 0
  - LSP Ping = 1
- Fiber Channel (Port Mode) - draft-ietf-pwe3-fc-encap
  - ICMP Ping = 0
  - LSP Ping = 0

2.6. Control Word Support for Encaps for which CW is Optional

The following instructions were given: "Please indicate your network's support of and use of the Control Word for encapsulations for which the Control Word is optional." The responses were:

- Ethernet (Tagged Mode)
  - Supported by Network/Equipment = 13
  - Used in Network = 6
- Ethernet (Raw Mode)
  - Supported by Network/Equipment = 14
  - Used in Network = 7

- PPP
  - Supported by Network/Equipment = 5
  - Used in Network = 0
- HDLC
  - Supported by Network/Equipment = 4
  - Used in Network = 0
- Frame Relay (Port Mode)
  - Supported by Network/Equipment = 3
  - Used in Network = 1
- ATM (N:1 Cell Mode)
  - Supported by Network/Equipment = 5
  - Used in Network = 1

2.7. Open Ended Question

Space was provided for user feedback. The following instructions were given: "Please use this space to provide any feedback regarding PW and VCCV deployments, VCCV interoperability challenges, this survey or any network/vendor details you wish to share." Below are the responses, made anonymous.

1. BFD VCCV Control Channel is not indicated in the survey (may be required for PW redundancy purpose)

2. Using CV is not required at the moment

3. COMPANY has deployed several MPLS network elements, from multiple vendors. COMPANY is seeking a uniform implementation of VCCV Control Channel (CC) capabilities across its various vendor platforms. This will provide COMPANY with significant advantages in reduced operational overheads when handling cross-domain faults. Having a uniform VCCV feature implementation in COMPANY multi-vendor network leads to: o Reduced operational cost and complexity o Reduced OSS development to coordinate incompatible VCCV implementations. o Increased end-end service availability when handing faults. In addition, currently some of COMPANY deployed VCCV traffic flows (on some vendor platforms) are not

guaranteed to follow those of the customer's application traffic (a key operational requirement). As a result, the response from the circuit ping cannot faithfully reflect the status of the circuit. This leads to ambiguity regarding the operational status of our networks. An in-band method is highly preferred, with COMPANY having a clear preference for VCCV Circuit Ping using PWE Control Word. This preference is being pursued with each of COMPANY vendors.

4. PW VCCV is very useful tool for finding faults in each PW channel. Without this we can not find fault on a PW channel. PW VCCV using BFD is another better option. Introperbility challences are with Ethernet OAM mechanism.

5. We are using L2PVPN AToM like-to-like models - ATMoMPLS - EoMPLS ATMoMPLS : This service offered for transporting ATM cells over IP/MPLS core with Edge ATM CE devices including BPX, Ericsson Media Gateway etc. This is purely a Port mode with cell-packing configuration on it to have best performance. QoS marking is done for getting LLQ treatment in the core for these MPLS encapsulated ATM packets. EoMPLS: This service offered for transporting 2G/3G traffic from network such as Node-B to RNC's over IP/MPLS backbone core network. QoS marking is done for getting guaranteed bandwidth treatment in the core for these MPLS encapsulated ATM packets. In addition to basic L2VPN service configuration, these traffic are routed via MPLS TE tunnels with dedicated path and bandwidth defined to avoid bandwidth related congestion.

6. EQUIPMENT MANUFACTURER does not provide options to configure VCCV control-channel and its sub options for LDP based L2Circuits. How can we achieve end-to-end management and fault detection of PW without VCCV in such cases?

7. I'm very interested in this work as we continue to experience interop challenges particularly with newer vendors to the space who are only implementing VCCV via control word. Vendors who have tailed their MPLS OAM set specifically to the cell backhaul space and mandatory CW have been known to fall into this space. That's all I've got.

3. Security Considerations

As this document is a report of the PW/VCCV User Implementation Survey results, no security considerations are introduced.

4. IANA Considerations

This document has no actions for IANA.

5. Acknowledgements

We would like to thank the chairs of the PWE3 Working Group for their guidance and review of the Survey questions. We would also like to sincerely thank those listed in Section 2.1. who took the time and effort to participate.

6. Appendix

The detailed reponses are included in this appendix. The respondent contact info has been removed.

6.1. Respondent 1

2. In your network in general, across all products, please indicate which Pseudowire encapsulations your company has implemented.

Ethernet Tagged Mode - RFC 4448

3. Approximately how many Pseudowires are deployed of each encapsulation type. Note, this should be the number of pseudowires in service, carrying traffic, or pre-positioned to do so. ***Note, please indicate "In-Use" for any PW Encap Types which you are using but cannot provide a number.

Ethernet Tagged Mode - RFC 4448 - 423

4. Please indicate which VCCV Control Channel is used for each encapsulation type. Understanding that users may have different networks with varying implementations, for your network in general, please select all which apply.

Ethernet Tagged Mode - RFC 4448: Control Word (Type 1)

5. Please indicate which VCCV Connectivity Verification types are used in your networks for each encapsulation type.

Ethernet Tagged Mode - RFC 4448: LSP Ping

6. Please indicate your network’s support of and use of the Control Word for encapsulations for which the Control Word is optional.

Supported by Network/Equipment: Ethernet (Tagged Mode), Ethernet (Raw Mode)

Used in Network: Ethernet (Tagged Mode), Ethernet (Raw Mode)

7. Please use this space to provide any feedback regarding PW and VCCV deployments, VCCV interoperability challenges, this survey or any network/vendor details you wish to share.

No Response

6.2. Respondent 2

2. In your network in general, across all products, please indicate which Pseudowire encapsulations your company has implemented.

Ethernet Tagged Mode - RFC 4448

Ethernet Raw Mode - RFC 4448

SAToP - RFC 4553

CESoPSN - RFC 5086

3. Approximately how many Pseudowires are deployed of each encapsulation type. Note, this should be the number of pseudowires in service, carrying traffic, or pre-positioned to do so. ***Note, please indicate "In-Use" for any PW Encap Types which you are using but cannot provide a number.

Ethernet Tagged Mode - RFC 4448 - 5000

Ethernet Raw Mode - RFC 4448 - 1000

SAToP - RFC 4553 - 50

CESoPSN - RFC 5086 - 1600

4. Please indicate which VCCV Control Channel is used for each encapsulation type. Understanding that users may have different networks with varying implementations, for your network in general, please select all which apply.

Ethernet Tagged Mode - RFC 4448: Control Word (Type 1), Router Alert Label (Type 2), TTL Expiry (Type 3)

Ethernet Raw Mode - RFC 4448: Control Word (Type 1), Router Alert Label (Type 2), TTL Expiry (Type 3)

CESoPSN - RFC 5086: TTL Expiry (Type 3)

5. Please indicate which VCCV Connectivity Verification types are used in your networks for each encapsulation type.

Ethernet Tagged Mode - RFC 4448: ICMP Ping, LSP Ping

Ethernet Raw Mode - RFC 4448: ICMP Ping, LSP Ping

SAToP - RFC 4553: LSP Ping

CESoPSN - RFC 5086: LSP Ping

6. Please indicate your network’s support of and use of the Control Word for encapsulations for which the Control Word is optional.

Supported by Network/Equipment: Ethernet (Tagged Mode), Ethernet (Raw Mode)

Used in Network: No Response

7. Please use this space to provide any feedback regarding PW and VCCV deployments, VCCV interoperability challenges, this survey or any network/vendor details you wish to share.

I’m very interested in this work as we continue to experience interop challenges particularly with newer vendors to the space who are only implementing VCCV via control word. Vendors who have tailed their MPLS OAM set specifically to the cell backhaul space and mandatory CW have been known to fall into this space. That’s all I’ve got.

6.3. Respondent 3

2. In your network in general, across all products, please indicate which Pseudowire encapsulations your company has implemented.

Ethernet Tagged Mode - RFC 4448

Ethernet Raw Mode - RFC 4448

Frame Relay (Port Mode) - RFC 4619

Frame Relay (1:1 Mode) - RFC 4619

3. Approximately how many Pseudowires are deployed of each encapsulation type. Note, this should be the number of pseudowires in service, carrying traffic, or pre-positioned to do so. ***Note, please indicate "In-Use" for any PW Encap Types which you are using

but cannot provide a number.

Ethernet Tagged Mode - RFC 4448 - 800

Ethernet Raw Mode - RFC 4448 - 50

Frame Relay (Port Mode) - RFC 4619 - 2

Frame Relay (1:1 Mode) - RFC 4619 - 2

4. Please indicate which VCCV Control Channel is used for each encapsulation type. Understanding that users may have different networks with varying implementations, for your network in general, please select all which apply.

No Response

5. Please indicate which VCCV Connectivity Verification types are used in your networks for each encapsulation type.

No Response

6. Please indicate your network’s support of and use of the Control Word for encapsulations for which the Control Word is optional.

Supported by Network/Equipment: Ethernet (Tagged Mode), Ethernet (Raw Mode)

Used in Network: No Response

7. Please use this space to provide any feedback regarding PW and VCCV deployments, VCCV interoperability challenges, this survey or any network/vendor details you wish to share.

No Response

6.4. Respondent 4

2. In your network in general, across all products, please indicate which Pseudowire encapsulations your company has implemented.

Ethernet Tagged Mode - RFC 4448

Ethernet Raw Mode - RFC 4448

3. Approximately how many Pseudowires are deployed of each encapsulation type. Note, this should be the number of pseudowires in service, carrying traffic, or pre-positioned to do so. ***Note,

please indicate "In-Use" for any PW Encap Types which you are using but cannot provide a number.

Ethernet Tagged Mode - RFC 4448 - 1000

Ethernet Raw Mode - RFC 4448 - 200

4. Please indicate which VCCV Control Channel is used for each encapsulation type. Understanding that users may have different networks with varying implementations, for your network in general, please select all which apply.

No Response

5. Please indicate which VCCV Connectivity Verification types are used in your networks for each encapsulation type.

Ethernet Tagged Mode - RFC 4448: LSP Ping

Ethernet Raw Mode - RFC 4448: LSP Ping

6. Please indicate your network’s support of and use of the Control Word for encapsulations for which the Control Word is optional.

Supported by Network/Equipment: Ethernet (Tagged Mode), Ethernet (Raw Mode)

Used in Network: No Response

7. Please use this space to provide any feedback regarding PW and VCCV deployments, VCCV interoperability challenges, this survey or any network/vendor details you wish to share.

EQUIPMENT MANUFACTURER does not provide options to configure VCCV control-channel and its sub options for LDP based L2Circuits. How can we achieve end-to-end management and fault detection of PW without VCCV in such cases?

6.5. Respondent 5

2. In your network in general, across all products, please indicate which Pseudowire encapsulations your company has implemented.

Ethernet Tagged Mode - RFC 4448

Ethernet Raw Mode - RFC 4448

PPP - RFC 4618

Frame Relay (Port Mode) - RFC 4619

Frame Relay (1:1 Mode) - RFC 4619

Fiber Channel (Port Mode) - draft-ietf-pwe3-fc-encap

3. Approximately how many Pseudowires are deployed of each encapsulation type. Note, this should be the number of pseudowires in service, carrying traffic, or pre-positioned to do so. ***Note, please indicate "In-Use" for any PW Encap Types which you are using but cannot provide a number.

Ethernet Tagged Mode - RFC 4448 - 4000

4. Please indicate which VCCV Control Channel is used for each encapsulation type. Understanding that users may have different networks with varying implementations, for your network in general, please select all which apply.

Ethernet Tagged Mode - RFC 4448: Control Word (Type 1), Router Alert Label (Type 2)

Ethernet Raw Mode - RFC 4448: Control Word (Type 1), Router Alert Label (Type 2)

5. Please indicate which VCCV Connectivity Verification types are used in your networks for each encapsulation type.

Ethernet Tagged Mode - RFC 4448: LSP Ping

6. Please indicate your network’s support of and use of the Control Word for encapsulations for which the Control Word is optional.

Supported by Network/Equipment: Ethernet (Tagged Mode), Ethernet (Raw Mode)

Used in Network: Ethernet (Tagged Mode), Ethernet (Raw Mode)

7. Please use this space to provide any feedback regarding PW and VCCV deployments, VCCV interoperability challenges, this survey or any network/vendor details you wish to share.

No Response

6.6. Respondent 6

2. In your network in general, across all products, please indicate which Pseudowire encapsulations your company has implemented.

Ethernet Tagged Mode - RFC 4448

Ethernet Raw Mode - RFC 4448

3. Approximately how many Pseudowires are deployed of each encapsulation type. Note, this should be the number of pseudowires in service, carrying traffic, or pre-positioned to do so. ***Note, please indicate "In-Use" for any PW Encap Types which you are using but cannot provide a number.

Ethernet Tagged Mode - RFC 4448 - 1000+

Ethernet Raw Mode - RFC 4448 - 500

4. Please indicate which VCCV Control Channel is used for each encapsulation type. Understanding that users may have different networks with varying implementations, for your network in general, please select all which apply.

Ethernet Tagged Mode - RFC 4448: Control Word (Type 1)

Ethernet Raw Mode - RFC 4448: Control Word (Type 1)

5. Please indicate which VCCV Connectivity Verification types are used in your networks for each encapsulation type.

Ethernet Tagged Mode - RFC 4448: ICMP Ping, LSP Ping

Ethernet Raw Mode - RFC 4448: ICMP Ping, LSP Ping

6. Please indicate your network’s support of and use of the Control Word for encapsulations for which the Control Word is optional.

Supported by Network/Equipment: Ethernet (Tagged Mode), Ethernet (Raw Mode)

Used in Network: Ethernet (Tagged Mode), Ethernet (Raw Mode)

7. Please use this space to provide any feedback regarding PW and VCCV deployments, VCCV interoperability challenges, this survey or any network/vendor details you wish to share.

No Response

6.7. Respondent 7

2. In your network in general, across all products, please indicate which Pseudowire encapsulations your company has implemented.

Ethernet Raw Mode - RFC 4448

ATM (1:1 Mode) - RFC 4717

3. Approximately how many Pseudowires are deployed of each encapsulation type. Note, this should be the number of pseudowires in service, carrying traffic, or pre-positioned to do so. ***Note, please indicate "In-Use" for any PW Encap Types which you are using but cannot provide a number.

Ethernet Raw Mode - RFC 4448 - 20

ATM (1:1 Mode) - RFC 4717 - 100

4. Please indicate which VCCV Control Channel is used for each encapsulation type. Understanding that users may have different networks with varying implementations, for your network in general, please select all which apply.

No Response

5. Please indicate which VCCV Connectivity Verification types are used in your networks for each encapsulation type.

Ethernet Raw Mode - RFC 4448: LSP Ping

ATM (1:1 Mode) - RFC 4717: LSP Ping

6. Please indicate your network’s support of and use of the Control Word for encapsulations for which the Control Word is optional.

Supported by Network/Equipment: Ethernet (Tagged Mode), Ethernet (Raw Mode), PPP, HDLC, Frame Relay (Port Mode), ATM (N:1 Cell Mode)

Used in Network: No Response

7. Please use this space to provide any feedback regarding PW and VCCV deployments, VCCV interoperability challenges, this survey or any network/vendor details you wish to share.

We are using L2PVPN AToM like-to-like models - ATMoMPLS - EoMPLS ATMoMPLS : This service offered for transporting ATM cells over IP/ MPLS core with Edge ATM CE devices including BPX, Ericsson Media Gateway etc. This is purely a Port mode with cell-packing configuration on it to have best performance. QoS marking is done for getting LLQ treatment in the core for these MPLS encapsulated ATM packets. EoMPLS: This service offered for transporting 2G/3G traffic from network such as Node-B to RNC’s over IP/MPLS backbone core

network. QoS marking is done for getting guaranteed bandwidth treatment in the core for these MPLS encapsulated ATM packets. In addition to basic L2VPN service configuration, these traffic are routed via MPLS TE tunnels with dedicated path and bandwidth defined to avoid bandwidth related congestion.

6.8. Respondent 8

2. In your network in general, across all products, please indicate which Pseudowire encapsulations your company has implemented.

Ethernet Raw Mode - RFC 4448

ATM (AAL5 SDU Mode) - RFC 4717

TDMoIP - RFC 5087

3. Approximately how many Pseudowires are deployed of each encapsulation type. Note, this should be the number of pseudowires in service, carrying traffic, or pre-positioned to do so. ***Note, please indicate "In-Use" for any PW Encap Types which you are using but cannot provide a number.

Ethernet Raw Mode - RFC 4448 - In-Use

ATM (AAL5 SDU Mode) - RFC 4717 - In-Use

TDMoIP - RFC 5087 - In-Use

4. Please indicate which VCCV Control Channel is used for each encapsulation type. Understanding that users may have different networks with varying implementations, for your network in general, please select all which apply.

Ethernet Raw Mode - RFC 4448: Control Word (Type 1)

ATM (AAL5 SDU Mode) - RFC 4717: Router Alert Label (Type 2)

5. Please indicate which VCCV Connectivity Verification types are used in your networks for each encapsulation type.

Ethernet Raw Mode - RFC 4448: LSP Ping

ATM (AAL5 SDU Mode) - RFC 4717: LSP Ping

TDMoIP - RFC 5087: LSP Ping

6. Please indicate your network’s support of and use of the Control

Word for encapsulations for which the Control Word is optional.

Supported by Network/Equipment: Ethernet (Raw Mode), ATM (N:1 Cell Mode)

Used in Network: Ethernet (Raw Mode), ATM (N:1 Cell Mode)

7. Please use this space to provide any feedback regarding PW and VCCV deployments, VCCV interoperability challenges, this survey or any network/vendor details you wish to share.

PW VCCV is very useful tool for finding faults in each PW channel. Without this we can not find fault on a PW channel. PW VCCV using BFD is another better option. Intropерbility challences are with Ethernet OAM mechanism.

6.9. Respondent 9

2. In your network in general, across all products, please indicate which Pseudowire encapsulations your company has implemented.

Ethernet Tagged Mode - RFC 4448

Frame Relay (1:1 Mode) - RFC 4619

3. Approximately how many Pseudowires are deployed of each encapsulation type. Note, this should be the number of pseudowires in service, carrying traffic, or pre-positioned to do so. ***Note, please indicate "In-Use" for any PW Encap Types which you are using but cannot provide a number.

Ethernet Tagged Mode - RFC 4448 - 19385

Frame Relay (1:1 Mode) - RFC 4619 - 15757

4. Please indicate which VCCV Control Channel is used for each encapsulation type. Understanding that users may have different networks with varying implementations, for your network in general, please select all which apply.

Frame Relay (1:1 Mode) - RFC 4619: Control Word (Type 1)

5. Please indicate which VCCV Connectivity Verification types are used in your networks for each encapsulation type.

Frame Relay (1:1 Mode) - RFC 4619: LSP Ping

6. Please indicate your network’s support of and use of the Control

Word for encapsulations for which the Control Word is optional.

Supported by Network/Equipment: Ethernet (Tagged Mode), Ethernet (Raw Mode), PPP, HDLC, Frame Relay (Port Mode), ATM (N:1 Cell Mode)

Used in Network: No Response

7. Please use this space to provide any feedback regarding PW and VCCV deployments, VCCV interoperability challenges, this survey or any network/vendor details you wish to share.

No Response

6.10. Respondent 10

2. In your network in general, across all products, please indicate which Pseudowire encapsulations your company has implemented.

Ethernet Raw Mode - RFC 4448

3. Approximately how many Pseudowires are deployed of each encapsulation type. Note, this should be the number of pseudowires in service, carrying traffic, or pre-positioned to do so. ***Note, please indicate "In-Use" for any PW Encap Types which you are using but cannot provide a number.

Ethernet Raw Mode - RFC 4448 - 325

4. Please indicate which VCCV Control Channel is used for each encapsulation type. Understanding that users may have different networks with varying implementations, for your network in general, please select all which apply.

Ethernet Raw Mode - RFC 4448: Control Word (Type 1)

5. Please indicate which VCCV Connectivity Verification types are used in your networks for each encapsulation type.

Ethernet Raw Mode - RFC 4448: ICMP Ping, LSP Ping

6. Please indicate your network’s support of and use of the Control Word for encapsulations for which the Control Word is optional.

Supported by Network/Equipment: No Response

Used in Network: No Response

7. Please use this space to provide any feedback regarding PW and

VCCV deployments, VCCV interoperability challenges, this survey or any network/vendor details you wish to share.

No Response

6.11. Respondent 11

2. In your network in general, across all products, please indicate which Pseudowire encapsulations your company has implemented.

Ethernet Tagged Mode - RFC 4448

Ethernet Raw Mode - RFC 4448

PPP - RFC 4618 HDLC - RFC 4618

Frame Relay (1:1 Mode) - RFC 4619

3. Approximately how many Pseudowires are deployed of each encapsulation type. Note, this should be the number of pseudowires in service, carrying traffic, or pre-positioned to do so. ***Note, please indicate "In-Use" for any PW Encap Types which you are using but cannot provide a number.

Ethernet Tagged Mode - RFC 4448 - 2000

Ethernet Raw Mode - RFC 4448 - 100

PPP - RFC 4618 - 500

Frame Relay (1:1 Mode) - RFC 4619 - 200

4. Please indicate which VCCV Control Channel is used for each encapsulation type. Understanding that users may have different networks with varying implementations, for your network in general, please select all which apply.

No Response

5. Please indicate which VCCV Connectivity Verification types are used in your networks for each encapsulation type.

Ethernet Tagged Mode - RFC 4448: ICMP Ping, LSP Ping

Ethernet Raw Mode - RFC 4448: ICMP Ping, LSP Ping

Frame Relay (1:1 Mode) - RFC 4619: ICMP Ping, LSP Ping

6. Please indicate your network’s support of and use of the Control Word for encapsulations for which the Control Word is optional.

Supported by Network/Equipment: Ethernet (Tagged Mode), Ethernet (Raw Mode), PPP, HDLC

Used in Network: Ethernet (Tagged Mode)

7. Please use this space to provide any feedback regarding PW and VCCV deployments, VCCV interoperability challenges, this survey or any network/vendor details you wish to share.

No Response

6.12. Respondent 12

2. In your network in general, across all products, please indicate which Pseudowire encapsulations your company has implemented.

Ethernet Raw Mode - RFC 4448

3. Approximately how many Pseudowires are deployed of each encapsulation type. Note, this should be the number of pseudowires in service, carrying traffic, or pre-positioned to do so. ***Note, please indicate "In-Use" for any PW Encap Types which you are using but cannot provide a number.

Ethernet Raw Mode - RFC 4448 - 50000

4. Please indicate which VCCV Control Channel is used for each encapsulation type. Understanding that users may have different networks with varying implementations, for your network in general, please select all which apply.

Ethernet Raw Mode - RFC 4448: Control Word (Type 1), Router Alert Label (Type 2), TTL Expiry (Type 3)

5. Please indicate which VCCV Connectivity Verification types are used in your networks for each encapsulation type.

No Response

6. Please indicate your network’s support of and use of the Control Word for encapsulations for which the Control Word is optional.

Supported by Network/Equipment: Ethernet (Tagged Mode), Ethernet (Raw Mode)

Used in Network: Ethernet (Tagged Mode), Ethernet (Raw Mode)

7. Please use this space to provide any feedback regarding PW and VCCV deployments, VCCV interoperability challenges, this survey or any network/vendor details you wish to share.

No Response

6.13. Respondent 13

2. In your network in general, across all products, please indicate which Pseudowire encapsulations your company has implemented.

Ethernet Tagged Mode - RFC 4448

Ethernet Raw Mode - RFC 4448

Frame Relay (1:1 Mode) - RFC 4619

3. Approximately how many Pseudowires are deployed of each encapsulation type. Note, this should be the number of pseudowires in service, carrying traffic, or pre-positioned to do so. ***Note, please indicate "In-Use" for any PW Encap Types which you are using but cannot provide a number.

Ethernet Tagged Mode - RFC 4448 - 3

Ethernet Raw Mode - RFC 4448 - 10-20

ATM (1:1 Mode) - RFC 4717 - 3

4. Please indicate which VCCV Control Channel is used for each encapsulation type. Understanding that users may have different networks with varying implementations, for your network in general, please select all which apply.

Ethernet Tagged Mode - RFC 4448: Control Word (Type 1), TTL Expiry (Type 3)

Ethernet Raw Mode - RFC 4448: Control Word (Type 1), TTL Expiry (Type 3)

Frame Relay (1:1 Mode) - RFC 4619: Control Word (Type 1), TTL Expiry (Type 3)

5. Please indicate which VCCV Connectivity Verification types are used in your networks for each encapsulation type.

Ethernet Tagged Mode - RFC 4448: ICMP Ping, LSP Ping

Ethernet Raw Mode - RFC 4448: ICMP Ping, LSP Ping

Frame Relay (1:1 Mode) - RFC 4619: ICMP Ping, LSP Ping

6. Please indicate your network's support of and use of the Control Word for encapsulations for which the Control Word is optional.

Supported by Network/Equipment: Ethernet (Tagged Mode), Ethernet (Raw Mode), PPP, HDLC, Frame Relay (Port Mode), ATM (N:1 Cell Mode)

Used in Network: Ethernet (Tagged Mode), Ethernet (Raw Mode), Frame Relay (Port Mode)

7. Please use this space to provide any feedback regarding PW and VCCV deployments, VCCV interoperability challenges, this survey or any network/vendor details you wish to share.

No Response

6.14. Respondent 14

2. In your network in general, across all products, please indicate which Pseudowire encapsulations your company has implemented.

Ethernet Tagged Mode - RFC 4448

Ethernet Raw Mode - RFC 4448

3. Approximately how many Pseudowires are deployed of each encapsulation type. Note, this should be the number of pseudowires in service, carrying traffic, or pre-positioned to do so. ***Note, please indicate "In-Use" for any PW Encap Types which you are using but cannot provide a number.

Ethernet Tagged Mode - RFC 4448 - 150

Ethernet Raw Mode - RFC 4448 - 100

4. Please indicate which VCCV Control Channel is used for each encapsulation type. Understanding that users may have different networks with varying implementations, for your network in general, please select all which apply.

Ethernet Tagged Mode - RFC 4448: Control Word (Type 1), Router Alert Label (Type 2)

Ethernet Raw Mode - RFC 4448: Control Word (Type 1), Router Alert Label (Type 2)

5. Please indicate which VCCV Connectivity Verification types are used in your networks for each encapsulation type.

Ethernet Tagged Mode - RFC 4448: LSP Ping

Ethernet Raw Mode - RFC 4448: LSP Ping

6. Please indicate your network's support of and use of the Control Word for encapsulations for which the Control Word is optional.

Supported by Network/Equipment: Ethernet (Tagged Mode), Ethernet (Raw Mode), PPP, HDLC, Frame Relay (Port Mode)

Used in Network: Ethernet (Tagged Mode), Ethernet (Raw Mode)

7. Please use this space to provide any feedback regarding PW and VCCV deployments, VCCV interoperability challenges, this survey or any network/vendor details you wish to share.

No Response

6.15. Respondent 15

2. In your network in general, across all products, please indicate which Pseudowire encapsulations your company has implemented.

Ethernet Tagged Mode - RFC 4448

Ethernet Raw Mode - RFC 4448

Frame Relay (1:1 Mode) - RFC 4619

ATM (1:1 Mode) - RFC 4717

3. Approximately how many Pseudowires are deployed of each encapsulation type. Note, this should be the number of pseudowires in service, carrying traffic, or pre-positioned to do so. ***Note, please indicate "In-Use" for any PW Encap Types which you are using but cannot provide a number.

Ethernet Tagged Mode - RFC 4448 - 20,000

Ethernet Raw Mode - RFC 4448 - 1000

Frame Relay (1:1 Mode) - RFC 4619 - 30,000

ATM (1:1 Mode) - RFC 4717 - 20,000

4. Please indicate which VCCV Control Channel is used for each encapsulation type. Understanding that users may have different networks with varying implementations, for your network in general, please select all which apply.

Ethernet Tagged Mode - RFC 4448: TTL Expiry (Type 3)

Ethernet Raw Mode - RFC 4448: TTL Expiry (Type 3)

Frame Relay (1:1 Mode) - RFC 4619: TTL Expiry (Type 3)

ATM (1:1 Mode) - RFC 4717: TTL Expiry (Type 3)

5. Please indicate which VCCV Connectivity Verification types are used in your networks for each encapsulation type.

Ethernet Tagged Mode - RFC 4448: LSP Ping

Ethernet Raw Mode - RFC 4448: LSP Ping

Frame Relay (1:1 Mode) - RFC 4619: LSP Ping

ATM (1:1 Mode) - RFC 4717: LSP Ping

6. Please indicate your network’s support of and use of the Control Word for encapsulations for which the Control Word is optional.

Supported by Network/Equipment: No Response

Used in Network: No Response

7. Please use this space to provide any feedback regarding PW and VCCV deployments, VCCV interoperability challenges, this survey or any network/vendor details you wish to share.

COMPANY has deployed several MPLS network elements, from multiple vendors. COMPANY is seeking a uniform implementation of VCCV Control Channel (CC) capabilities across its various vendor platforms. This will provide COMPANY with significant advantages in reduced operational overheads when handling cross-domain faults. Having a uniform VCCV feature implementation in COMPANY multi-vendor network leads to: o Reduced operational cost and complexity o Reduced OSS development to coordinate incompatible VCCV implementations. o Increased end-end service availability when handing faults. In addition, currently some of COMPANY deployed VCCV traffic flows (on some vendor platforms) are not guaranteed to follow those of the

customer’s application traffic (a key operational requirement). As a result, the response from the circuit ping cannot faithfully reflect the status of the circuit. This leads to ambiguity regarding the operational status of our networks. An in-band method is highly preferred, with COMPANY having a clear preference for VCCV Circuit Ping using PWE Control Word. This preference is being pursued with each of COMPANY vendors.

6.16. Respondent 16

2. In your network in general, across all products, please indicate which Pseudowire encapsulations your company has implemented.

Ethernet Tagged Mode - RFC 4448

Ethernet Raw Mode - RFC 4448

3. Approximately how many Pseudowires are deployed of each encapsulation type. Note, this should be the number of pseudowires in service, carrying traffic, or pre-positioned to do so. ***Note, please indicate "In-Use" for any PW Encap Types which you are using but cannot provide a number.

Ethernet Tagged Mode - RFC 4448 - 100

Ethernet Raw Mode - RFC 4448 - 100

4. Please indicate which VCCV Control Channel is used for each encapsulation type. Understanding that users may have different networks with varying implementations, for your network in general, please select all which apply.

No Response

5. Please indicate which VCCV Connectivity Verification types are used in your networks for each encapsulation type.

Ethernet Tagged Mode - RFC 4448: ICMP Ping, LSP Ping

Ethernet Raw Mode - RFC 4448: ICMP Ping, LSP Ping

6. Please indicate your network’s support of and use of the Control Word for encapsulations for which the Control Word is optional.

Supported by Network/Equipment: Ethernet (Tagged Mode), Ethernet (Raw Mode)

Used in Network: No Resposne

7. Please use this space to provide any feedback regarding PW and VCCV deployments, VCCV interoperability challenges, this survey or any network/vendor details you wish to share.

Using CV is not required at the moment

6.17. Respondent 17

2. In your network in general, across all products, please indicate which Pseudowire encapsulations your company has implemented.

Ethernet Tagged Mode - RFC 4448

SAToP - RFC 4553

Frame Relay (Port Mode) - RFC 4619

Frame Relay (1:1 Mode) - RFC 4619

ATM (N:1 Mode) - RFC 4717

ATM (1:1 Mode) - RFC 4717

CESoPSN - RFC 5086

TDMoIP - RFC 5087

3. Approximately how many Pseudowires are deployed of each encapsulation type. Note, this should be the number of pseudowires in service, carrying traffic, or pre-positioned to do so. ***Note, please indicate "In-Use" for any PW Encap Types which you are using but cannot provide a number.

Ethernet Tagged Mode - RFC 4448 - >40k

Ethernet Raw Mode - RFC 4448 - In-Use

SAToP - RFC 4553 - >20k

Frame Relay (Port Mode) - RFC 4619 - >5k

Frame Relay (1:1 Mode) - RFC 4619 - >5k

ATM (N:1 Mode) - RFC 4717 - >50k

ATM (1:1 Mode) - RFC 4717 - >50k

CESoPSN - RFC 5086 - >20k

TDMoIP - RFC 5087 - >20k

4. Please indicate which VCCV Control Channel is used for each encapsulation type. Understanding that users may have different networks with varying implementations, for your network in general, please select all which apply.

Ethernet Tagged Mode - RFC 4448: Control Word (Type 1)

SAToP - RFC 4553: Control Word (Type 1)

Frame Relay (Port Mode) - RFC 4619: Control Word (Type 1)

Frame Relay (1:1 Mode) - RFC 4619: Control Word (Type 1)

ATM (N:1 Mode) - RFC 4717: Control Word (Type 1)

ATM (1:1 Mode) - RFC 4717: Control Word (Type 1)

5. Please indicate which VCCV Connectivity Verification types are used in your networks for each encapsulation type.

Ethernet Tagged Mode - RFC 4448: LSP Ping

SAToP - RFC 4553: LSP Ping

Frame Relay (Port Mode) - RFC 4619: LSP Ping

Frame Relay (1:1 Mode) - RFC 4619: LSP Ping

ATM (N:1 Mode) - RFC 4717: LSP Ping

ATM (1:1 Mode) - RFC 4717: LSP Ping

6. Please indicate your network’s support of and use of the Control Word for encapsulations for which the Control Word is optional.

Supported by Network/Equipment: ATM (N:1 Cell Mode)

Used in Network: No Response

7. Please use this space to provide any feedback regarding PW and VCCV deployments, VCCV interoperability challenges, this survey or any network/vendor details you wish to share.

BFD VCCV Control Channel is not indicated in the survey (may be required for PW redundancy purpose)

7. Informative References

[RFC5085] Nadeau, T., Ed. and C. Pignataro, Ed., "Pseudowire Virtual Circuit Connectivity Verification (VCCV): A Control Channel for Pseudowires", December 2007.

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