          LDP 'Typed Wildcard' Forwarding Equivalence Class (FEC) for
                 PWid and Generalized PWid FEC Elements

Abstract

   The "Typed Wildcard Forwarding Equivalence Class (FEC) Element"
   defines an extension to the Label Distribution Protocol (LDP) that
   can be used when requesting, withdrawing, or releasing all label
   bindings for a given FEC Element type is desired. However, a Typed
   Wildcard FEC Element must be individually defined for each FEC
   Element type. This specification defines the Typed Wildcard FEC
   Elements for the Pseudowire Identifier (PWid) (0x80) and Generalized
   PWid (0x81) FEC Element types.

Status of This Memo

   This is an Internet Standards Track document.

   This document is a product of the Internet Engineering Task Force
   (IETF). It represents the consensus of the IETF community. It has
   received public review and has been approved for publication by
   the Internet Engineering Steering Group (IESG). Further
   information on Internet Standards is available in Section 2 of
   RFC 5741.

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   errata, and how to provide feedback on it may be obtained at
   http://www.rfc-editor.org/info/rfc6667.

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1. Introduction

   An extension to the Label Distribution Protocol (LDP) [RFC5036]
   defines the general notion of a "Typed Wildcard Forwarding
   Equivalence Class (FEC) Element" [RFC5918]. This can be used when
   requesting, releasing, or withdrawing all label bindings for a given
   type of FEC Element is desired. However, a Typed Wildcard FEC
   Element must be individually defined for each type of FEC Element.

   [RFC4447] defines the "PWid FEC Element" and "Generalized PWid FEC
   Element", but does not specify the Typed Wildcard format for these
   elements. This document specifies the format of the Typed Wildcard
   FEC Element for the "PWid FEC Element" and "Generalized PWid FEC
   Element". The procedures for Typed Wildcard processing for PWid and
   Generalized PWid FEC Elements are the same as described in [RFC5918]
   for any Typed Wildcard FEC Element type.

   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].

2. Typed Wildcard for PW FEC Elements

   The format of the Typed Wildcard FEC Element for PWid and Generalized
   PWid is specified as:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Typed Wcard=0x5| Type=PW FEC   |    Len = 2    |R|   PW type   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    . . .      |
+-+-+-+-+-+-+-+-+
```
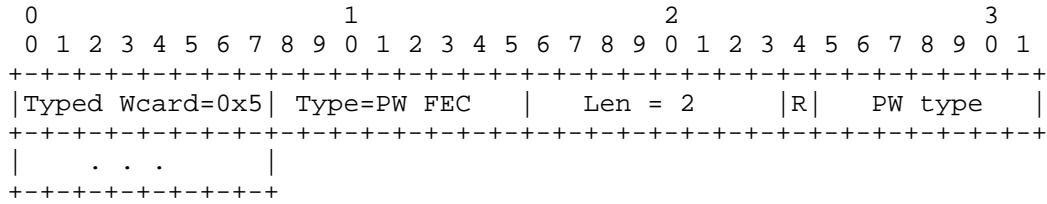
                  Figure 1: Format of Typed Wildcard FEC Element for
                            PW FEC Element Types

   Where:

      Typed Wcard (one octet): Typed Wildcard FEC Element type (0x05)
           as specified in [RFC5918].

      [FEC Element] Type (one octet): PW FEC Element type:

         PWid: (type 0x80 [RFC4447])
         Generalized PWid: (type 0x81 [RFC4447])

      Len [FEC Type Info] (one octet): Two. (There is additional
           FEC info to scope the Typed Wildcard.)

      R bit (Reserved bit): MUST be set to ZERO on transmit and ignored
           on receipt.

      PW type (15-bits): PW type as specified in [RFC4447]. This field
           is used to scope the wildcard FEC operation to limit all PWs
           of a given type. This MUST be set to "Wildcard" type
           (0x7FFF), as defined in [IANA-PWE3], when referring PWs of
           all types (see Section 4 for its usage).

   [RFC4447] defines the "PW Grouping ID TLV" that can be used for
   wildcard withdrawal or status messages related to Generalized PWid
   FECs. When the Typed Wildcard FEC for Generalized PWid FEC element
   is in use, the "PW Grouping ID TLV" MUST NOT be present in the same
   message. If present, the receiving Label Switching Router (LSR) MUST
   ignore this TLV silently and process the rest of the message.

3. Applicability Statement

   The Typed Wildcard FEC Elements defined in this document for the PWid
   and Generalized PWid FEC Elements provide a finer degree of
   granularity when compared to the wildcard FEC mechanics defined in
   [RFC5036].

   The PWid FEC Element as defined in [RFC4447] contains a Group ID
   field. This field is defined as an arbitrary 32-bit value that
   represents a group of PWs and is used to create groups in the PW
   space, including potentially a single group of all PWs for a given
   FEC Element type. This grouping enables an LSR to send "wildcard"
   label withdrawals and/or status notification messages corresponding
   to a PW group upon physical port failures. Similarly, [RFC4447]
   defines the "PW Grouping ID TLV" used in the same fashion for the
   Generalized PWid FEC Element.

   The PWid Typed Wildcard FEC Elements defined in this document help us
   achieve similar functionality as the "Group ID" field or "PW Grouping
   ID TLV" for label withdrawal and status notification messages.
   Additionally, the Typed Wildcard procedures [RFC5918] provide a more
   generalized and comprehensive solution by allowing:

   1. Typed Wildcard Label Request messages

   2. Label TLVs in label messages to further constrain the wildcard to
      all FECs of the specified FEC type [and its specific filter] that
      are also bound to the specified label.

   This document allows use of the Typed Wildcard PW FEC Element in any
   LDP message that specifies a FEC TLV as a mandatory or optional
   parameter of the message. In addition to LDP label messages, this
   also applies to notification messages (containing PW Status) and
   Address Withdraw (for MAC address withdrawal [RFC4762]) messages in
   the context of LDP PW signaling. When a Typed Wildcard PW FEC
   Element is used in an Address Withdraw message for Virtual Private
   LAN Service (VPLS) Media Access Control (MAC) address withdrawal, the
   MAC List TLV MUST contain an empty list.

4. Operation

   The use of Typed Wildcard FEC Elements for PW can be useful under
   several scenarios. This section describes some use cases to
   illustrate their application. The following use cases consider two
   LSR nodes, A and B, with an LDP session between them to exchange
   Layer 2 Virtual Private Network (L2VPN) PW bindings.

4.1. PW Consistency Check

   A user may request a control-plane consistency check at LSR A for the
   Generalized PWid FEC bindings that it learned from LSR B over the LDP
   session. To perform this consistency check, LSR A marks all its
   learned Generalized PWid FEC bindings from LSR B as stale, and then
   sends a Label Request message towards LSR B for the Typed Wildcard
   FEC Element for Generalized PWid FEC Element type with the PW type
   set to "Wildcard" (0x7FFF). Upon receipt of such a request, LSR B
   replays its database related to the Generalized PWid FEC Element
   using one or more Label Mapping messages. As a PW binding is
   received at LSR A, the associated binding state is marked as
   refreshed (not stale). When replay completes for the Generalized
   PWid FEC type, LSR B marks the end of its replay by sending an
   End-of-LIB notification [RFC5919] corresponding to the Generalized
   PWid FEC Element type. Upon receipt of this notification at LSR A,
   any remaining stale PW binding of the Generalized PWid FEC type
   learned from the peer LSR B is cleaned up and removed from the
   database. This completes the consistency check with LSR B at LSR A
   for Generalized PWid FEC type.

4.2. PW Graceful Shutdown

   It may be desirable to perform shutdown/removal of existing PW
   bindings advertised towards a peer in a graceful manner -- i.e., all
   advertised PW bindings are to be removed from a peer without session
   flap. For example, to request a graceful delete of the PWid FEC and
   Generalized PWid FEC bindings at LSR A learned from LSR B, LSR A
   would send a Label Withdraw message towards LSR B with Typed Wildcard
   FEC Elements pertaining to the PWid FEC Element (with PW type set to
   0x7FFF) and Generalized PWid FEC Element (with PW type set to
   0x7FFF). Upon receipt of such a message, LSR B would delete all PWid
   and Generalized PWid bindings learned from LSR A. Afterwards, LSR B
   would send Label Release messages corresponding to received Label
   Withdraw messages with the Typed FEC Element.

4.3. Wildcard PW Status

   The Typed Wildcard FEC Elements for PW FECs can be very useful to
   convey PW status amongst LSRs. The Provider Edge (PE) devices can
   send the "PW Status TLV" in an LDP Notification message to indicate
   PW status (i.e., a Pseudowire Status Code denoting, for example, a
   particular fault) to their remote peers [RFC4447]. In case of a
   global failure affecting all PWs, an LSR typically sends one PW
   Status LDP Notification message per PW. This per-PW-Status message
   has scalability implications in a large-scale network with a large
   number of PWs.

Using Typed Wildcard FEC Element for a given type of PW FEC Element,
the LSR will need to send only one PW Status Notification message
with the Typed Wildcard PW FEC specified to notify about the common
status applicable to all PWs as scoped by the PW Typed Wildcard FEC.

4.4. Typed Wildcard MAC Withdrawal in VPLS

   [RFC4762] defines a pseudowire-based solution to implement Virtual
   Private LAN Service (VPLS). Section 6.2 of RFC 4762 describes MAC
   Withdrawal procedures and extensions in a VPLS environment. These
   procedures use the LDP Address Withdraw message containing the FEC
   TLV (with the PW FEC element corresponding to the VPLS instance) and
   MAC List TLV (to specify addresses to be withdrawn). The procedures
   described in RFC 4762 also allow MAC address withdrawal wildcarding
   for a given VPLS instance.

   Using RFC 4762 procedures, a PE LSR can withdraw all MAC addresses
   for a given VPLS instance by sending an Address Withdraw message with
   a VPLS instance corresponding to the PW FEC element in a FEC TLV, and
   a MAC List TLV with an empty list of addresses. If there is more
   than one VPLS instance on a given PE LSR node, separate Address
   Withdraw messages need to be sent by the PE LSR if it wishes to
   withdraw MAC addresses for all or a subset of VPLS instances upon
   some global failure or configuration. Per-PW (VPLS instance) MAC
   Withdraw message may have some scalability implications in a large-
   scale network.

   As stated in Section 3, this document allows use of the Typed
   Wildcard PW FEC in Address Withdraw messages corresponding to VPLS
   MAC Withdrawal. The use of PW Typed Wildcard FEC enhances the scope
   of MAC withdrawal beyond just a single VPLS instance and allows a PE
   node to wildcard withdraw all MAC addresses for:

      o all VPLS instances; or
      o all VPLS instances corresponding to a given PW type.

5. Security Considerations

   No new security considerations beyond those that apply to
   specifications [RFC5036], [RFC4447], [RFC4762], [RFC5918], and
   [RFC5920] apply to the use of the PW Typed Wildcard FEC Element types
   described in this document.

6. Acknowledgments

   The authors would like to thank Eric Rosen, Reshad Rahman, Siva
   Sivabalan, and Zafar Ali for their review and valuable comments. We
   also acknowledge Daniel Cohn for suggesting use of the Typed Wildcard
   PW FEC for VPLS MAC withdrawal.

   This document was prepared using 2-Word-v2.0 template.dot.

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Authors' Addresses

    Kamran Raza
    Cisco Systems, Inc.
    2000 Innovation Drive
    Ottawa ON K2K-3E8
    Canada
    EMail: skraza@cisco.com

    Sami Boutros
    Cisco Systems, Inc.
    3750 Cisco Way
    San Jose, CA 95134
    USA
    EMail: sboutros@cisco.com

    Carlos Pignataro
    Cisco Systems, Inc.
    7200 Kit Creek Road
    Research Triangle Park, NC 27709-4987
    USA
    EMail: cpignata@cisco.com