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                  Reliable Transport For PIM Register States
                    draft-anish-reliable-pim-registers-02

Abstract

   This document introduces a hard-state, reliable transport for the
   existing PIM-SM registers states. This eliminates the needs for
   periodic NULL-registers and register-stop in response to each data-
   register or NULL-registers.

   This specification uses the existing PIM reliability mechanisms
   defined by PIM Over Reliable Transport [RFC6559]. This is simply a
   means to transmit reliable PIM messages and does not require the
   support for Join/Prune messages over PORT as defined in [RFC6559].

Requirements Language

   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 RFC2119 [RFC2119].

Status of This Memo

This Internet-Draft will expire on September 20, 2018.

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1. Introduction

   Protocol Independent Multicast-Sparse Mode Register mechanism serves
   the following purposes.

   a, With a register, First-Hop-Router (FHR) informs the RP (that way
       the network) that a particular multicast stream is active

   b, A register helps avoid initial packet loss. (Initial packet loss
       could happen in an anycast-RP deployment even when packet
       registers are used.)

   c, Through its periodic refreshes register keeps RP informed about
       the aliveness of this multicast stream.

   As it is defined in [RFC4601] , register mechanisms face limitations,
   when the number of multicast streams on the network is high,
   especially when one RP is expected to serve a large number of
   streams. These problems are mainly due to these factors.

   a, PIM register needs control-plane and data-plane intervention to
       handle it.

   b, Due to the nature of PIM register, First-Hop-Router and RP now
       needs to maintain states and timers for each register state
       entry.

   c, PIM register's requirements for periodic refresh and expiry, is
       quite aggressive and makes them vulnerable when the PIM speaker
       could not find cycles to meet these needs

   To take for instance a major multicast application the IPTV. With
   the streaming servers connected to FHR. A restarting, FHR would
   result in a burst of register messages at line rate. The RP may get

overloaded with packet registers. Which will continue untill RP is
able to create states and do a register-stop. In the meantime many
flows may go unserviced due to drops. In addition to affecting
multicast streams it may lead to starvation for other processing done
by the controlplane application. With Anycast RP, this becomes even
more tricky due to the control-plane's job to forward the registers
to the rp-set.

In general: PIM registers have limitation in connections across WAN.
It has no flow-control mechanisms, making PIM not compatible with
IETF transport/congestion control expectations. It is challenging to
deployed it over WAN or other bandwidth limited networks. High
amount of state: periodic retransmission creates undesirable
processing load. Especially with larger mesh-groups (re-send same
(S,G) N-times, periodically).

2. Reliable Register Overview

Reliable PIM register extends PIM PORT [RFC6559] to have PIM register
states to be sent over a reliable transport.

This document introduces 'targeted' hellos between any two PIM peers.
This helps in capability negotiation and discovery between two PIM
speakers (FHR and RP in the context of this document). Once this
discovery happens, First-Hop-Router would setup a reliable transport
connection based on the negotiated parameters.

Over this reliable connection, First-Hop-Router would start sending
to RP the source and group addresses of the multicast streams active
with it. When any of this stream stops, First-Hop-Router would sent
an update to RP about the streams that have stopped. This way once a
reliable connection is setup, First-Hop-Router would update RP with
its existing active multicast streams. Subsequently it would sent
incremental updates about the change to RP.

For a multicast application that may demand initial packets or for
bursty sources existing data-registers may be used. For them the RP
would now respond with a 'reliable'-register-stop, which could
persist until the First-Hop-Router withdraws the register-state.

3. Targeted Hellos

PIM hellos defined in PIM-SM [RFC4601] confines them to link level.
This document extends these hellos to support 'targeted' hellos.

Targeted hellos are identical to existing hellos messages except that
they would have an unicast address as its destination address. It

would traverse multiple hops using the unicast routing to reach the
targeted hello neighbor.

3.1. New Hello Optional TLV's

Option Type: Targeted hello

```
     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
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |     Type = H1 (for alloc)     |          Length = 4           |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |F|R|                  Reserved                       |  Exp   |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
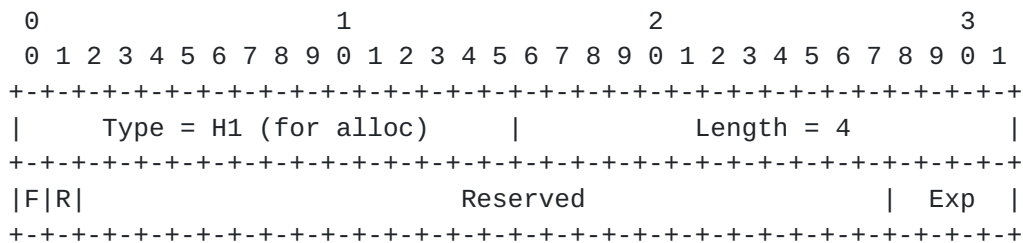
Figure 1: PIM Hello Optional TLV

Assigned Hello Type values can be found in IANA PIM registry.

Type: This is subject to IANA allocation. Its stated as H1 for
reference

Length: Length in bytes for the value part of the Type/Length/Value
encoding fixed as 4.

F: To be set by a router that wants to be a First-Hop-Router.

R: To be set by a RP that is capable taking the role of an RP as per
the current states.

Reserved: Set to zero on transmission and ignored on receipt.

Exp: For experimental use [RFC3692]. One expected use of these bits
would be to signal experimental capabilities. For example, if a
router supports an experimental feature, it may set a bit to indicate
this. The default behavior, unless a router supports a particular
experiment, is to keep these bits reset and ignore the bits on
receipt.

3.2. Differences from Link-Level hellos

The Major differences that Link-Level-Hellos have over Interface
hellos are,

1. Destination address would be an unicast address unlike ALL-PIM-
    ROUTER destination address for link-level hellos

2. TTL value would be the system default TTL

3. Targeted Hellos SHOULD carry Targeted Hello Optional TLV (Defined
    in this document.)

4. Holdtime SHOULD NOT be set as 0xffff by a targeted hello sender,
    and such hellos should be discarded up on receive.

3.3. Address in Hello message

When sending targeted hellos, the sender SHOULD send with its primary
reachable address (may be its loopback address) as the source address
for the hellos. The other addresses that are relevant SHOULD be
added in the secondary address list.

3.4. Timer Values

The timers relevant to this specification are in relation to PIM
hello. The recommended timer values are

1: PIM Targeted Hello default refresh time : 60s (2 * Default Link-
    level hello time)

2: PIM Targeted Hello default hold time : 210s (3.5 times targeted
    hello default refresh time)

3.5. Targeted Neighbor

A Targeted PIM neighbor is a neighbor-ship established by virtue of
exchanging targeted hello messages.

A First-Hop-Router (The initiator) that learns the RP's address would
start sending hellos to the known RP address (could be anycast-
address).

The RP (The Responder) when it receives this hello, would add sender
as a targeted neighbor and would respond to this targeted neighbor
from it primary address. The responder SHOULD also include its any-
cast address (If available) in the secondary address list. The
First-Hop-Router when receiving this hello would form a targeted
neighbor with the anycast address.

The RP upon hold-time-out for the neighbor would remove this neighbor
and its associated states.

The initiator or responder upon having a need to terminate a targeted
neighbor MAY send hello with hold-time as 0.

4. Reliable Connection setup

A reliable connection has to be setup between the First-Hop-Router
and RP for reliable registers to happen. Targeted hellos works as
the medium for discovery and capability-negotiation between the two
peers.

4.1. Active FHR

Once First-Hop-Router and RP discovery each other, First-Hop-Router
takes the active role. First-Hop-Router would listen for RP to
connect once it forms targeted neighbor-ship with RP. The RP would
be expected to use its primary address, which it would have used as
the source address in its PIM hellos.

4.2. Connection setup between two RP's

In a network if there happens to be two RP's which are First-Hop-
Router's too, then the mechanism could result in two connections
getting established. It's desirable to have just one connection
instead of two. First-Hop-Router could detect this condition the
when it receives hello with targeted hello header identifying that
the RP want to be First-Hop-Router too.

In this condition the connection setup could used the procedures
stated in PIM over reliable transport [RFC6559]

4.3. Hello Generation ID and reconnect

If RP or First-Hop-Router gets into a situation needing for
capability-renegotiation or reconnect, it would change the hello
generation ID (gen-ID) to notify it peer to reset all the states and
re-init this peering. The trigger for this could be configuration
change or local operating parameter change, restart, etc. . .

4.4. Handling Connection or reachability loss

Connection loss or reachability loss could happen for one or more of
the following reasons

1: PORT Keep-alive time out

2: Targeted neighbor loss

3: Reliable Connection close

Upon detecting one of these conditions, the connection with the peer
SHOULD be closed immediately and the states created by the peer

SHOULD be cleared after a grace-period, long enough for the peer to re-establish connection and re-sync the states.

This interval for re-sync would involve the initial time needed for re-establishing the connection, followed by transmission and reception of the states from FHR to RP over the reliable connection.

The ideal interval for this re-sync period could not be predicted, hence the this should be a configurable parameter with default value as 300s.

5. Anycast RP's

PIM uses Anycast-RP [RFC4610] as a mechanism for RP redundancy. This section describes how anycast-RP would work with this specification.

5.1. Targeted Hellos and Neighbors

An RP that serves an anycast RP address, would know the primary addresses of other RP's serving the anycast address. These anycast-RP's would form a full mesh of targeted hello-neighbor-ships. In its targeted hello options tlv, the R bit MUST be set. The secondary address list in the PIM hello message SHOULD include the anycast-addresses that the sender is servicing.

5.2. Anycast-RP connection setup

A full mesh of connection is needed among the anycast-RP's of the same anycast address. Once targeted neighbor-ship is established, it would use the PIM PORT [RFC6559] procedures to setup reliable connection among them.

5.3. Anycast-RP state sync

An anycast-RP that gets the register state from a peer who's address is in the RP-set of address for the given group would update the register state and would retain the state. If the peer address is not in the RP-set address for the RP-group range, then the RP would replicate the state to all the other RP's in the RP-set. This procedure and forwarding rules are similar to the existing forwarding rules in Anycast-rp [RFC4610] register specification.

An RP should identify register state as a combinations of (source, group, 'PORT connection'). Where 'PORT connection' is the reliable connection with the PORT peer which had reported this s,g. Following considerations are made for a register-state identity.

A. Reconnect: Connection between RP and First-Hop-Router could get
    re-established for various reasons. The register-states would
    get retransmitted over the new connection. Then it should be
    possible for RP to identify and timeout register-states on the
    old connection and retain the right set of states.

B. DR-change: When DR in the First-Hop-LAN changes, a new First-Hop-
    Router would be retransmitting the same set of SG's that are
    already known and the old DR would be withdrawing the states
    advertised by it.

C. FHR primary address change: In this case too connection would get
    re-established and state handling would be similar to case A.

D. Multi-homed sources (but not on same LAN): In this case different
    First-Hop-Routers could be sending the same register-states.
    Then RP should be capable of identifying register-state along
    with the peer.

5.4. Anycast-RP change

In the event of nearest anycast-RP changing over to a different
router, First-Hop-Router would detect that when it starts receiving
PIM hellos with a different primary address for the same anycast
address. This can also happen if the primary address of present
anycast-RP has changed.

Upon detecting this scenario, the First-Hop-Router would establish
connection and transmit its states to the new peer. Subsequently
older connection would get terminated due to neighbor timeout.

5.5. Anycast-RP with MSDP

MSDP [RFC3618] is an alternative mechanism for 'active multicast
stream state' synchronization between RP's. When MSDP is used, PIM's
anycast synchronization need not be used. An anycast-RP network
could use MSDP instead of PIM procedures for state synchronization
among anycast-RP's. This document does not state any change in MSDP
specification and usage

In such deployments, PIM will not have RP-set configured. As RP-set
address is not available PIM procedures for Anycast-RP
synchronization does not apply.

MSDP being a soft-state oriented protocol, it depends on frequent
state refreshes over the reliable TCP transport. The support for
mesh-groups in MSDP could be advantageous in some case.

6. **PIM-registers and Interoperation with legacy PIM nodes**

   It may not be possible for PIM node to migrate altogether onto a
   PORT-registers in one go. Also there could be a few nodes in the
   network, which may not support PORT register states. This section
   states how both could interoperate.

6.1. **Initial packet-loss avoidance with PORT**

   If its found that a few streams in the multicast network has to have
   initial packets to be delivered to the receiver, the existing PIM
   register mechanism could be used for them. For these streams a PORT
   register-stop message would be sent by the RP to First-Hop-Router.

6.2. **First-Hop-Router does not support PORT**

   If the First-Hop-Router is not capable of doing PORT-register, then
   it would not establish targeted hello neighbor-ship with the RP.
   Hence reliable connection also would not be established. To handle
   such scenarios RP should accept PIM register messages and should
   respond to them with register-stop messages.

6.3. **RP does not support PORT**

   If the RP is not capable of doing PORT-register, then it would not
   respond to the targeted hellos from the RP. Hence reliable
   connection also would not be established. In this case First-Hop-
   Router could sent existing packet registers to RP.

6.4. **Data-Register free operations**

   If initial packet loss is acceptable in a multicast network, then
   Data-Registers could be avoided altogether in such networks. In such
   network PORT-Register-state specified in this document alone would be
   supported.

7. **PORT message**

   This document defines new PORT register state message and PORT
   register-stop messages, to the existing messages in PORT
   specification.

7.1. **PORT register message TLV**

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Type = P1 (for alloc)     |        Message Length         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                           Reserved                   | Exp.   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|B|N|A|                    Reserved-1                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         src addr-1                           z
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
z                         grp addr-1                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
z                         2, 3,  . . .                         z
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|B|N|A|                    Reserved-n                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         src addr-n                           z
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
z                         grp addr-n                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 2: PORT Register State Message

Type: This is subject to IANA allocation. It would be next
unallocated value, which is referred untill allocation as P1.

Length: Length in bytes for the value part of the Type/Length/Value

B: As specified in [RFC4601] (set as 0 on send and ignore when
received)

N: As specified in [RFC4601] (set as 1 on send and ignore when
received.)

A: This flag signifies if the SG is to be Added or Deleted. When
cleared, it indicates that the First-Hop-Router is withdrawing the SG
.

src addr-x : This is the encoded source address of an ipv4/ipv6
stream

grp addr-x : This is the encoded group address of an ipv4/ipv6 stream

Reserved: Set to zero on transmission and ignored on receipt. These
reserved bits are for properties that apply to the entire message.

   Reserved-n: Set to zero on transmission and ignored on receipt.
   These reserved bits are for properties that apply to any particular
   sg.

   Exp: : For experimental use.

7.2. Sending and receiving PORT register messages

   The First-Hop-Router upon learning a new stream would send a register
   state add message to the corresponding RP. If the reliable
   connection got setup later, then once the connection becomes
   established it would send the entire list of streams active with it.

   When KAT timer for a multicast stream expires, it would send an
   update to RP to remove that stream from its list.

   An RP would maintain a database of multicast streams (src, grp)
   active along with the peer from which it had learned it. If the
   receiver RP is an anycast RP, it SHOULD re-transmit this register
   state message to each of the other anycast RP. An RP SHOULD not re-
   transmit a register state message it received from an another
   anycast-RP.

7.3. PORT register-stop message TLV

```
    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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     Type = P2(for alloc)      |         Message Length        |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                           Reserved                 | Exp.  |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                          Reserved-1                           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                           src addr-1                         z
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   z                           grp addr-1                          |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   z                           2, 3, . . .                        z
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                          Reserved-n                           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                           src addr-n                         z
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   z                           grp addr-n                          |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
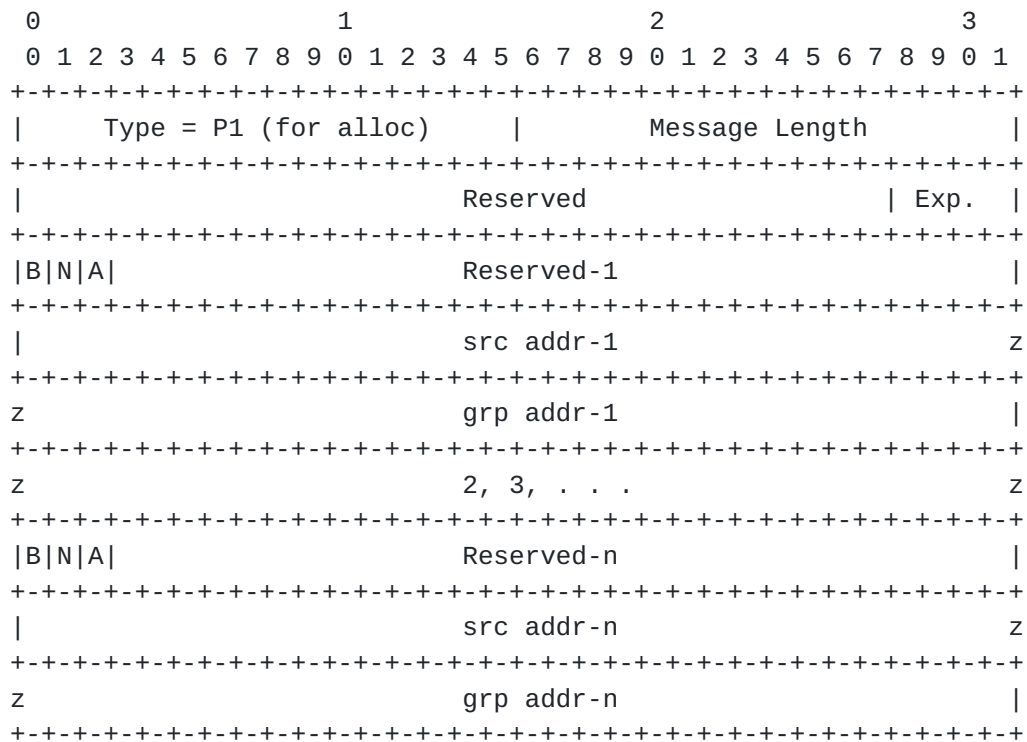
                   Figure 3: PORT Register Stop Message

Type: This is subject to IANA allocation. It would be next
unallocated value, which is referred untill allocation as P2.

Length: Length in bytes for the value part of the Type/Length/Value

src addr-x : This is the encoded source address of an ipv4/ipv6
stream

grp addr-x : This is the encoded group address of an ipv4/ipv6 stream

Reserved: Set to zero on transmission and ignored on receipt. These
reserved bits are for properties that apply to the entire message.

Reserved-n: Set to zero on transmission and ignored on receipt.
These reserved bits are for properties that apply to any particular
sg.

Exp: : For experimental use.

7.4. Sending and receiving PORT register stop messages

PORT register-stop messages are send only as a response to receiving
packet registers from a PIM peer, with which a reliable connection
has been established. If reliable connection is not available, the
RP should consider the peer as a legacy node and should respond to
this PIM register-stop message as defined in PIM-SM [RFC4601]

The First-Hop-Router up on receiving PORT-Register-Stop message
should treat that as an indication from RP that it does not require
the packets over the PIM tunnel and should stop sending register
messages.

7.5. PORT Keep-Alive Message

The PORT Keep-alive messages as specified in PIM over Reliable
Transport [RFC6559] would be used to check the liveliness of the peer
and the reliable session

8. Management Considerations

PORT-register is capable of configuration free operations. But its
recommended to have it as configuration controlled.

Implementation should provide knobs needed to stop supporting data-
registers on a router.

9. IANA Considerations

   This specification introduces new TLV in PIM hello and in PIM PORT
   messages. Hence the tlv ids for these needs IANA allocation

9.1. PIM Hello Options TLV

   The following Hello TLV types needs IANA allocation. Place holder
   are kept to differentiate the different types.

Value	Length	Name	Reference
H1 (next-available)	4 (Fixed)	Targeted-Hello-Options	This document

         Table 1: Place holder values for PIM Hello TLV type until IANA
                               allocation

9.2. PIM PORT Message Type

   The following PIM PORT message TLV types needs IANA allocation.
   Place holder are kept to differentiate the different types.

Value	Name	Reference
P1 (Next available)	PORT Register-state	This document
P2 (Next available)	PORT Register-stop	This document

          Table 2: Place holder values for PIM PORT TLV type for IANA
                               allocation

10. Security Considerations

10.1. PIM Register Threats

   PIM register is considered as security vulnerability for PIM
   networks. [RFC4609] The concern arises mainly due to the existing
   PIM register protocol design where in any remote node could start
   sending line-rate multicast traffic as PIM registers due to
   malfunction, mis-configuration or from a malicious remote node.

10.2. Targeted Hello Threats

This document introduces targeted hellos. This could be a seen as a new security threat. Targeted hellos are part of other IETF protocol implementations, which are widely deployed. In future introduction of a mechanism similar to those stated in RFC 7349 [RFC7349] could be used in PIM.

10.3. TCP or SCTP security threats

The security perception for this is stated in [RFC6559].

11. References

11.1. Normative References

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