   **Update to Include Route Object (IRO) specification in Path Computation
                   Element communication Protocol (PCEP)
                      draft-ietf-pce-iro-update-05**

Abstract

   During discussions of a document to provide a standard representation
   and encoding of Domain-Sequence within the Path Computation Element
   (PCE) communication Protocol (PCEP) for communications between a Path
   Computation Client (PCC) and a PCE, or between two PCEs, it was
   determined that there was a need for clarification with respect to
   the ordered nature of the Include Route Object (IRO).

   An informal survey was conducted to determine the state of current
   and planned implementation with respect to IRO ordering and handling
   of Loose bit (L bit).

   This document updates RFC 5440 regarding the IRO specification, based
   on the survey conclusion and recommendation.

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1. Introduction

   The Path Computation Element Communication Protocol (PCEP) provides
   mechanisms for Path Computation Elements (PCEs) to perform path
   computations in response to Path Computation Clients (PCCs) requests.

[RFC5440] defines the Include Route Object (IRO) to specify network
elements to be traversed in the computed path. The specification did
not mention if IRO is an ordered or un-ordered list of sub-objects.
It mentioned that the Loose bit (L bit) has no meaning within an IRO.

[RFC5441] suggested the use of IRO to indicate the sequence of
domains to be traversed during inter-domain path computation.

In order to discover the current state of affairs amongst
implementations a survey of the existing and planned implementations
was conducted. This survey [I-D.dhody-pce-iro-survey] was informal
and conducted via email. Responses were collected and anonymized by
the PCE working group chair.

During discussion of [I-D.ietf-pce-pcep-domain-sequence] it was
proposed to have a new IRO type with ordered nature, as well as
handling of Loose bit (L bit); however, with the update to [RFC5440]
described in this document, no new IRO type is needed.

This document updates the IRO specifications in section 7.12 of
[RFC5440] as per the conclusion and action points presented in
[I-D.dhody-pce-iro-survey].

1.1. 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].

2. Update in IRO specification

Section 7.12 of [RFC5440] describes IRO as an optional object used to
specify a set of network elements to be traversed in the computed
path. It also states that the Loose bit (L bit) in sub-object has no
meaning within an IRO. It did not mention if IRO is an ordered or
un-ordered list of sub-objects.

A survey of the existing and planned implementations was conducted in
order to discover the current state of affairs amongst
implementations. [I-D.dhody-pce-iro-survey] describe the
questionnaire, results and presents some conclusions and proposed
action items.

The survey suggest that most implementations construct or interpret
IRO in an ordered fashion and consider it to be an ordered list.
More than half of implementation under survey consider the IRO sub-
objects as strict hops, others consider loose or support both. The
results shown in this survey seems to suggest that most

implementations would be fine with updating [RFC5440] to specify IRO
as an ordered list as well as to enable support for Loose bit (L bit)
such that both strict and loose hops could be supported in the IRO.

2.1. Update to RFC 5440

Section 7.12 of [RFC5440] regarding the IRO specification is updated
to remove the last line in the section 7.12 of [RFC5440], that states

   - "The L bit of such sub-object has no meaning within an IRO."

Further, the Section 7.12 of [RFC5440] is updated to add following
two statements -

- The content of IRO is an ordered list of sub-objects representing a
series of abstract nodes. An abstract node could just be a simple
abstract node comprising one node or a group of nodes for example an
AS (comprising of multiple hops within the AS) (refer section 4.3.2
of [RFC3209]).

- The L Bit of IRO sub-object is set based on the loose or strict
property of the sub-object, which is set if the sub-object represents
a loose hop. If the bit is not set, the sub-object represents a
strict hop. The interpretation of Loose bit (L bit) is as per
section 4.3.3.1 of [RFC3209].

3. Other Considerations

Based on the survey [I-D.dhody-pce-iro-survey], it should be noted
that most implementation already support the update in the IRO
specification as per this document. The other implementation are
expected to make an update to the IRO procedures based on this
document.

During the survey it was also noted that minority of the
implementations, interpreted the IRO sub-objects as loose, when these
implementation interwork with an implementation conforming to this
document, the following impact might be seen -

o If a non-conforming (to this document) PCC sends an IRO, to a
   conforming (to this document) PCE, then the PCE may unexpectedly
   fail to find a path (since the PCC may think of IRO sub-objects as
   loose hops, but the PCE interprets them as strict hops).

o If a conforming PCC sends an IRO containing strict hops to a non-
   conforming PCE, then the PCE may erroneously return a path that
   does not comply with the requested strict hops (since PCE
   interprets them all as loose hops). The PCC may check the

returned path and find the issue or it may end up using incorrect
path.

Thus it is RECOMMENDED that network operators ensure that all PCEP
speakers in their network conform to this document with updated IRO
specification if they intend to use IRO.

4. Security Considerations

This update in IRO specification does not introduce any new security
considerations, apart from those mentioned in [RFC5440].
Clarification in the supported IRO ordering or Loose bit handling
will not have any negative security impact.

It is worth noting that PCEP operates over TCP. An analysis of the
security issues for routing protocols that use TCP (including PCEP)
is provided in [RFC6952], while [I-D.ietf-pce-pceps] discusses an
experimental approach to provide secure transport for PCEP.

5. IANA Considerations

This document makes no requests to IANA for action.

6. Acknowledgments

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