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**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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7. References

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