

PCE support for Maximizing Diversity
draft-dhody-pce-of-diverse-00

Abstract

The computation of one or a set of Traffic Engineering Label Switched Paths (TE LSPs) in MultiProtocol Label Switching (MPLS) and Generalized MPLS (GMPLS) networks is subject to a set of one or more specific optimization criteria, referred to as objective functions.

In the Path Computation Element (PCE) architecture, a Path Computation Client (PCC) may want a set of services that are required to be diverse (disjointed) from each other. In case when full diversity could not be achieved, it is helpful to maximize diversity as much as possible (or in other words minimize the common shared resources).

This document defines objective function code types for three new objective functions for this purpose to be applied to a set of synchronized path computation requests.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of [BCP 78](#) and [BCP 79](#).

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute working documents as Internet-Drafts. The list of current Internet-Drafts is at <http://datatracker.ietf.org/drafts/current/>.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

This Internet-Draft will expire on September 27, 2014.

Copyright Notice

Copyright (c) 2014 IETF Trust and the persons identified as the document authors. All rights reserved.

This document is subject to [BCP 78](#) and the IETF Trust's Legal Provisions Relating to IETF Documents (<http://trustee.ietf.org/license-info>) in effect on the date of publication of this document. Please review these documents carefully, as they describe your rights and restrictions with respect to this document. Code Components extracted from this document must include Simplified BSD License text as described in Section 4.e of the Trust Legal Provisions and are provided without warranty as described in the Simplified BSD License.

Table of Contents

1.	Introduction	2
1.1.	Requirements Language	3
2.	Terminology	3
3.	Extension to PCEP	3
4.	Other Considerations	4
4.1.	Relationship between SVEC Diversity Flags and OF	4
4.2.	Inter-Domain Considerations	5
4.3.	Domain Diversity	5
4.4.	Diversity v/s Optimality	5
5.	Security Considerations	5
6.	Manageability Considerations	6
6.1.	Control of Function and Policy	6
6.2.	Information and Data Models	6
6.3.	Liveness Detection and Monitoring	6
6.4.	Verify Correct Operations	6
6.5.	Requirements On Other Protocols	6
6.6.	Impact On Network Operations	6
7.	IANA Considerations	6
8.	Acknowledgments	6
9.	References	6
9.1.	Normative References	7
9.2.	Informative References	7
Appendix A.	Contributor Addresses	8

[1.](#) Introduction

[RFC5440] describes the specifications for the Path Computation Element Communication Protocol (PCEP). PCEP specifies the communication between a Path Computation Client (PCC) and a Path Computation Element (PCE), or between two PCEs based on the PCE architecture [[RFC4655](#)].

Further [[RFC5440](#)] describes dependent path computation requests in which case computations cannot be performed independently of each other used for diverse path computation. [[RFC5440](#)] and [[RFC6006](#)] describe the use of Synchronization VECTOR (SVEC) dependency flags (i.e., Node, Link, or Shared Risk Link Group (SRLG) diverse flags).

In some scenario it may be noted that full diversity cannot be achieved because of topology considerations, deployment considerations, transient network issues etc. In this case it would be helpful to maximize diversity as much as possible (or in other words minimize the common shared resources (Node, Link or SRLG) between a set of paths during path computation).

It is interesting to note that for non synchronized diverse path computation the X bit in XRO or EXRS [[RFC5521](#)] sub-objects can be used, where X bit set as 1 indicates that the resource specified SHOULD be excluded from the path computed by the PCE, but MAY be included subject to PCE policy and the absence of a viable path that meets the other constraints and excludes the resource.

This document defines objective function code types for three new objective functions for this purpose to be applied to a set of synchronized path computation requests.

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. Terminology

The terminology is as per [[RFC5440](#)].

3. Extension to PCEP

[RFC5541] describes and define Objective function (OF) used in PCEP protocol.

To minimize the common shared resources (Node, Link or SRLG) between a set of paths during path computation three new OF codes are proposed:

MSL

* Name: Minimize the number of shared (common) Links.

* Objective Function Code: TBD

- * Description: Find a set of paths such that it passes through the least number of shared (common) links.

MSN

- * Name: Minimize the number of shared (common) Nodes.
- * Objective Function Code: TBD
- * Description: Find a set of paths such that it passes through the least number of shared (common) nodes.

MSS

- * Name: Minimize the number of shared (common) SRLG.
- * Objective Function Code: TBD
- * Description: Find a set of paths such that it share least number of common SRLGs.

4. Other Considerations

4.1. Relationship between SVEC Diversity Flags and OF

[RFC5440] uses SVEC diversity flag for node, link or SRLG to describe the potential disjointness between the set of path computation requests used in PCEP protocol. [[I-D.dwpz-pce-domain-diverse](#)] further extends by adding domain-diverse 0-bit in SVEC object and a new OF Code for minimizing the number of shared transit domain.

This document defines three new OF codes to maximize diversity as much as possible, in other words, minimize the common shared resources (Node, Link or SRLG) between a set of paths.

It may be interesting to note that the diversity flags in the SVEC object and OF for diversity can be used together. Some example of usage are listed below -

- o SVEC object with node-diverse bit=1 - ensure full node-diversity.
- o SVEC object with node-diverse bit=1 and OF=MSS - full node diverse with as much as SRLG-diversity as possible.
- o SVEC object with domain-diverse bit=1; link diverse bit=1 and OF=MSS - full domain and node diverse path with as much as SRLG-diversity as possible.

- o SVEC object with node-diverse bit=1 and OF=MSN - ensure full node-diversity.

4.2. Inter-Domain Considerations

The mechanics for synchronous end to end path computations using Backward-Recursive PCE-Based Computation (BRPC) procedure [[RFC5441](#)] described in [[RFC6006](#)].

In H-PCE [[RFC6805](#)] architecture, the parent PCE is used to compute a multi-domain path based on the domain connectivity information. The parent PCE may be requested to provide a end to end path or only the sequence of domains. Child PCE should be able to request synchronized diverse end to end paths from its parent PCE.

The new objective function described in this document can be used to maximize diversity when full diverse paths cannot be found.

4.3. Domain Diversity

As per [[I-D.dwpz-pce-domain-diverse](#)].

4.4. Diversity v/s Optimality

In case of non-synchronized path computation, PCE may be requested to provide an optimal primary path first and then PCC requests for a backup path with exclusion. Note that this approach does not guarantee diversity comparing to disjoint path computations for primary and backup path in a synchronized manner.

A synchronized path computation with diversity flags and/or objective function is used to make sure that both the primary path and the backup path can be computed simultaneously with full diversity or optimized to be as diverse as possible. In the latter case we may sacrifice optimal path for diversity, thus there is a trade-off between the two.

An implementation may further choose to analyze the trade-off i.e. it may send multiple request to PCE asking to optimize based on diversity as well as say, cost and make an intelligent choice between them.

5. Security Considerations

TBD.

6. Manageability Considerations

6.1. Control of Function and Policy

TBD.

6.2. Information and Data Models

TBD.

6.3. Liveness Detection and Monitoring

TBD.

6.4. Verify Correct Operations

TBD.

6.5. Requirements On Other Protocols

TBD.

6.6. Impact On Network Operations

TBD.

7. IANA Considerations

As described in [Section 3](#), three new Objective Functions have been defined. IANA has made the following allocations from the PCEP "Objective Function" sub-registry:

Value	Description	Reference
(TBD)	MSL	[This I.D.]
(TBD)	MSN	[This I.D.]
(TBD)	MSS	[This I.D.]

8. Acknowledgments

We would like to thank Adrian Farrel for pointing out the need for this document.

9. References

9.1. Normative References

- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [BCP 14](#), [RFC 2119](#), March 1997.
- [RFC5440] Vasseur, JP. and JL. Le Roux, "Path Computation Element (PCE) Communication Protocol (PCEP)", [RFC 5440](#), March 2009.
- [RFC5541] Le Roux, JL., Vasseur, JP., and Y. Lee, "Encoding of Objective Functions in the Path Computation Element Communication Protocol (PCEP)", [RFC 5541](#), June 2009.

9.2. Informative References

- [RFC4655] Farrel, A., Vasseur, J., and J. Ash, "A Path Computation Element (PCE)-Based Architecture", [RFC 4655](#), August 2006.
- [RFC5441] Vasseur, JP., Zhang, R., Bitar, N., and JL. Le Roux, "A Backward-Recursive PCE-Based Computation (BRPC) Procedure to Compute Shortest Constrained Inter-Domain Traffic Engineering Label Switched Paths", [RFC 5441](#), April 2009.
- [RFC5521] Oki, E., Takeda, T., and A. Farrel, "Extensions to the Path Computation Element Communication Protocol (PCEP) for Route Exclusions", [RFC 5521](#), April 2009.
- [RFC6006] Zhao, Q., King, D., Verhaeghe, F., Takeda, T., Ali, Z., and J. Meuric, "Extensions to the Path Computation Element Communication Protocol (PCEP) for Point-to-Multipoint Traffic Engineering Label Switched Paths", [RFC 6006](#), September 2010.
- [RFC6805] King, D. and A. Farrel, "The Application of the Path Computation Element Architecture to the Determination of a Sequence of Domains in MPLS and GMPLS", [RFC 6805](#), November 2012.
- [I-D.dwpz-pce-domain-diverse]
Dhody, D., Wu, Q., Palle, U., and X. Zhang, "PCE support for Domain Diversity", [draft-dwpz-pce-domain-diverse-00](#) (work in progress), September 2013.

Appendix A. Contributor Addresses

Xian Zhang
Huawei Technologies
Bantian, Longgang District
Shenzhen 518129
P.R.China

EMail: zhang.xian@huawei.com

Udayasree Palle
Huawei Technologies
Leela Palace
Bangalore, Karnataka 560008
INDIA

EMail: udayasree.palle@huawei.com

Avantika
Huawei Technologies
Leela Palace
Bangalore, Karnataka 560008
INDIA

EMail: avantika.sushilkumar@huawei.com

Authors' Addresses

Dhruv Dhody
Huawei Technologies
Leela Palace
Bangalore, Karnataka 560008
INDIA

EMail: dhruv.ietf@gmail.com

Qin Wu
Huawei Technologies
101 Software Avenue, Yuhua District
Nanjing, Jiangsu 210012
China

EMail: bill.wu@huawei.com

