

Network Working Group  
Internet-Draft  
Intended status: Informational  
Expires: April 24, 2014

V. Lopez  
O. Gonzalez de Dios  
Telefonica I+D  
D. King  
Old Dog Consulting  
S. Previdi  
Cisco Systems, Inc.  
October 21, 2013

Traffic Engineering Database dissemination for Hierarchical PCE  
scenarios  
draft-lopez-pce-hpce-ted-00

## Abstract

The PCE architecture is well-defined and may be used to compute the optimal path for LSPs across domains in MPLS-TE and GMPLS networks. The Hierarchical Path Computation Element (H-PCE) [RFC6805] was developed to provide an optimal path when the sequence of domains is not known in advance. The procedure and mechanism for populating the Traffic Engineering Database (TED) with domain topology and link information used in H-PCE-based path computations is open to interpretation. This informational document describes how topology dissemination mechanisms may be used to provide TE information between Parent and Child PCEs (within the H-PCE context). In particular, it describes how BGP-LS might be used to provide inter-domain connectivity. This document is not intended to define new extensions, it demonstrates how existing procedures and mechanisms may be used.

## 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 April 24, 2014.

## Copyright Notice

Copyright (c) 2013 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. Parent PCE Domain Topology . . . . .	3
1.2. Parent PCE TED requirements . . . . .	3
2. H-PCE Domain Topology Dissemination and Construction Methods	4
3. H-PCE architecture using BGP-LS . . . . .	5
4. Including Inter-domain connectivity in BGP-LS . . . . .	8
4.1. Mapping from OSPF-TE . . . . .	8
4.2. Mapping from ISIS-TE . . . . .	8
5. BGP considerations . . . . .	8
6. Manageability Considerations . . . . .	8
7. Security Considerations . . . . .	8
8. Acknowledgements . . . . .	9
9. References . . . . .	9
9.1. Normative References . . . . .	9
9.2. Informative References . . . . .	9
Authors' Addresses . . . . .	10

## 1. Introduction

In scenarios with multiple domains in both MPLS-TE and GMPLS networks, the hierarchical Path Computation Element (H-PCE) Architecture, defined in [RFC6805], allows to obtain the optimum end-to-end path. The architecture exploits a hierarchical relation among domains.

[RFC6805] defines the architecture and requirements for the end-to-end path computation across domains. The solution draft for the H-PCE [I-D.draft-ietf-pce-hierarchy-extensions-00] is focused on the PCEP protocol extensions to support such H-PCE procedures, including negotiation of capabilities and errors. However, neither the architecture nor the solution draft specify which mechanism must to

be used to build and populate the parent PCE (pPCE) Traffic Engineering Database (TED).

The H-PCE architecture documents define the minimum content needed in the traffic engineering database required to compute paths. The information required by parent TEDB are identified in [RFC6805] and further elaborated in [I-D.draft-ietf-pce-inter-area-as-applicability-03]. For instance, [RFC6805] and [I-D.draft-ietf-pce-inter-area-as-applicability-03] suggest that BGP-LS could be used as a "northbound" TE advertisement. This means that a PCE does not need to listen IGP in its domain, but its TED is populated by messages received (for example) from a Route Reflector.

This document highlights the applicability of BGP-LS to the dissemination of domain topology within the H-PCE architecture. In particular, it describes how can BGP-LS be used to send the inter-domain connectivity. It also shows how can OSPF-TE and ISIS-TE updates be mapped into BGP-LS.

Note that this document is not intended to define new protocol extensions, it is an informational document and where required it highlights where existing mechanisms and protocols may be applied.

### 1.1. Parent PCE Domain Topology

The pPCE maintains a domain topology map of the child domains and their interconnectivity. This map does not include any visibility into the child domains. Where inter-domain connectivity is provided by TE links, the capabilities of those links may also be known to the pPCE. The pPCE maintains a TED for the parent domain, the nodes in the parent domain are abstractions of the cPCE domains (connected by real or virtual TE links), but the pPCE domain may also include real nodes and links.

The procedure and protocol mechanism for disseminating and construction of the pPCE TED may be provided using a number of mechanisms, including manually configuring the necessary information or automated using a separate instance of a routing protocol to advertise the domain interconnectivity. Since inter-domain TE links can be advertised by the IGPs operating in the child domains, this information could then be exported to the parent PCE either by the child PCEs or using north-bound export mechanisms.

### 1.2. Parent PCE TED requirements

The information that would be exchanged includes:

- o Identifier of advertising child PCE.
- o Identifier of PCE's domain.
- o Identifier of the link.
- o TE properties of the link (metrics, bandwidth).
- o Other properties of the link (technology-specific).
- o Identifier of link endpoints.
- o Identifier of adjacent domain.

## 2. H-PCE Domain Topology Dissemination and Construction Methods

A variety of methods exist to provide are different alternatives so the parent PCE can get the topological information from the child PCEs (cPCEs):

- o Statically configure all inter-domain link and topology information.
- o Membership of an IGP instance. The necessary topological information could be disseminated by joining the IGP instance of each child PCE domain. However, by doing so, it would break the domain confidentiality principles and is subject to scalability issues.
- o PCEP Notification Messages. Another solution is to send the interconnection information between domains using PCEP Notifications (see section 4.8.4 of [RFC6805]). One approach, followed in research work, is embedding in PCEP Notifications the Inter-AS OSPF-TE Link State Advertisements (LSA) to send the Inter-Domain Link information from child PCEs to the parent PCE and to send reachability information (list of end-points in each domain). However, it is argued that the utilization of PCEP to disseminate topology is beyond scope of the protocol.
- o Separate IGP instance. [RFC6805] points out that in models such as ASON it is possible to consider a separate instance of an IGP running within the parent domain where the participating protocol speakers are the nodes directly present in that domain and the PCEs (parent and child PCEs).
- o Use north-bound distribution of TE information. The North-Bound Distribution of Link-State and TE Information using BGP has been recently propose in the IEFT

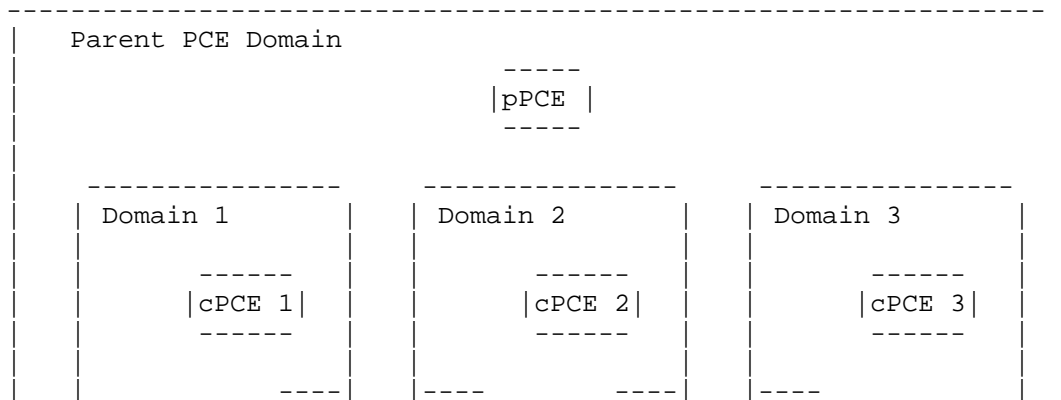
[I-D.draft-ietf-idr-ls-distribution-03]. This approach is known as BGP-LS and defines a mechanism by which links state and traffic engineering information can be collected from networks and exported to external elements using the BGP routing protocol. By using BGP-LS as northbound distribution mechanism, there would be a BGP speaker in each domains that sends the necessary information to a BGP speaker in the parent domain. This architecture is further elaborated in this document.

### 3. H-PCE architecture using BGP-LS

As mentioned in [I-D.draft-dugeon-pce-ted-reqs-01] PCE has to retrieve Traffic Engineering (TE) information to carry out its path computation. This is required not only for intra-domain information, which can be got using IGP (like OSPF-TE or ISIS-TE), but also for inter-domain information in the Hierarchical PCE (H-PCE) architecture.

Figure 1 shows an example of a H-PCE architecture. In this example, there is a parent PCE and three child PCEs, and they are organized in multiple domains. The parent PCE does not have information of the whole network, but is only aware of the connectivity among the domains and provides coordination to the child PCEs. Figure 2 shows which is the visibility that parent PCE has from the network according to the definition in [RFC6805].

Thanks to this topological information, when there is a request to a child PCE with the destination in another domain, this path request is sent to the parent PCE, which selects a set of candidate domain paths and sends requests to the child PCEs responsible for these domains. Then, the parent PCE selects the best solution and it is transmitted to the source PCE.



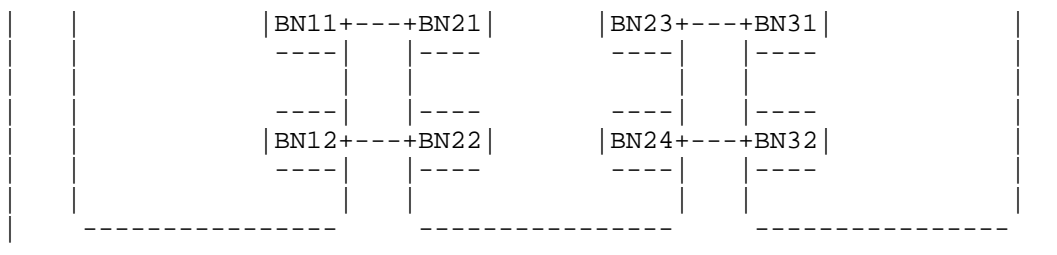


Figure 1: Example of Hierarchical PCE architecture

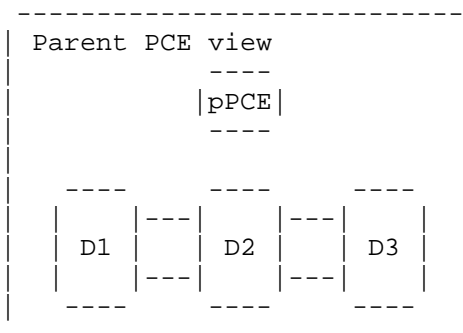
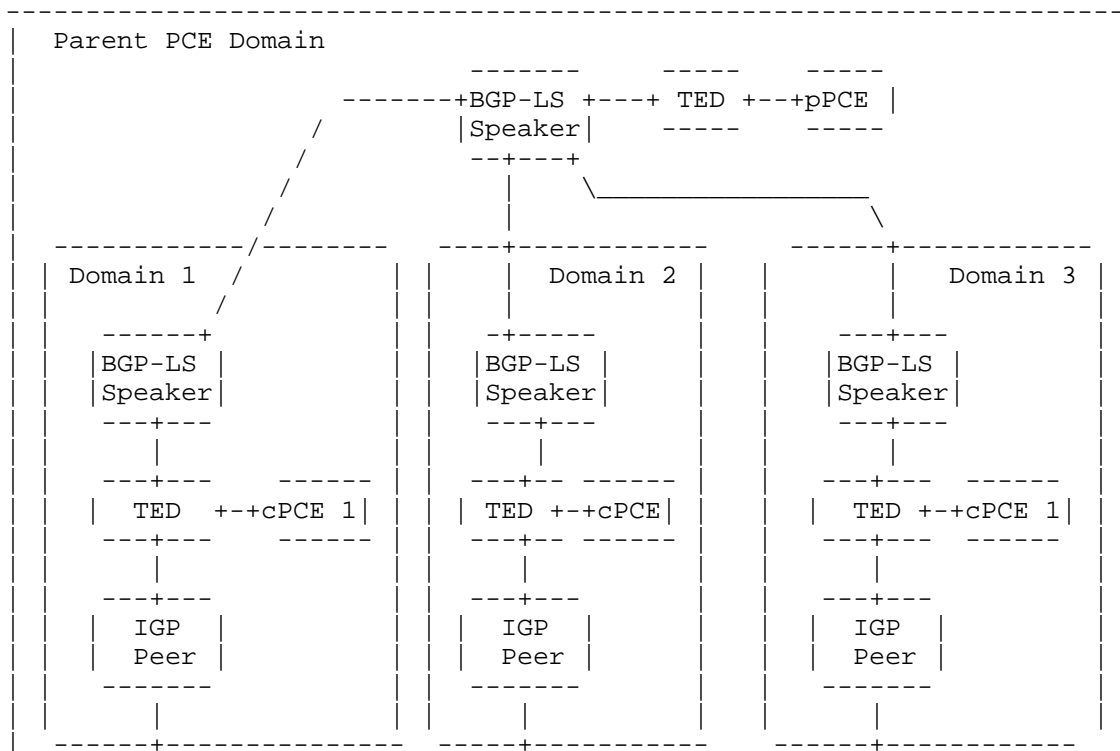


Figure 2: Parent PCE topology information

Thanks to the dissemination of inter-domain adjacency information from each cPCE to the pPCE, the pPCE can have a view of reachability between the domains. The H-PCE architecture with BGP-LS is shown in Figure 3. Each domain has a cPCE that is able to compute paths in the domain. This child PCE has access to a domain TED, which is built using IGP information. In each domain, a BGP speaker has access to such domain TED and acts as BGP-LS Route Reflector to provide network topology to the pPCE. Next to the pPCE, there is a BGP speaker that maintains a BGP session with each of the BGP speakers in the domains to receive the topology and build the parent TED. A policy can be applied to the BGP-LS speakers to decide which information is sent to its peer speaker. The minimum amount of information that needs to be exchanged is the inter-domain connectivity, including the details of the Traffic Engineering Inter-domain Links [RFC6805]. With this information, the parent PCE is able to have access to a domain topology map and its connectivity. Additionally, the BGP-LS speaker can be configured to send the

complete list of TE Links, including its details. In this case, the parent PCE has access to an extended database, with visibility of both intra-domain and inter-domain information and can compute the sequence of domains with better accuracy. Even, the pPCE could have enough information to compute the whole end-to-end path by itself.

BGP-LS [I-D.draft-ietf-idr-ls-distribution-03] extends the BGP Update messages to advertise link-state topology thanks to new BGP Network Layer Reachability Information (NLRI). The Link State information is sent in two BGP attributes, the MP\_REACH (defined in [RFC4670]) and a LINK\_STATE attribute (defined in [I-D.draft-ietf-idr-ls-distribution-03]). To describe the inter domain links, in the MP\_REACH attribute, a Link NLRI can be used with the local node descriptors the address of the source, and in the remote descriptors, the address of the destination of the link. The Link Descriptors field has a TLV (Link Local/Remote Identifiers), which carries the prefix of the Unnumbered or Numbered Interface. In case of the message informs about an intra-domain link, the standard traffic engineering information is included in the LINK\_STATE attribute.



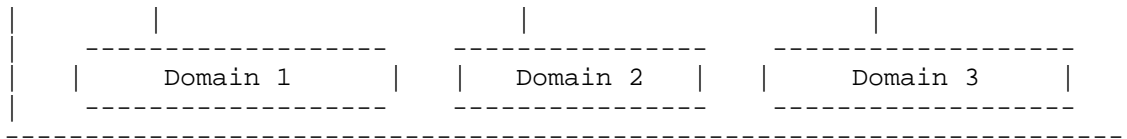


Figure 3: Example of Hierarchical PCE architecture with BGP-LS

#### 4. Including Inter-domain connectivity in BGP-LS

TBD

##### 4.1. Mapping from OSPF-TE

TBD

##### 4.2. Mapping from ISIS-TE

TBD

#### 5. BGP considerations

TBD

- o Supporting BGP-4
- o BGP Speakers
- o Graceful Restart
- o SRLGs
- o Multiprotocol extensions

#### 6. Manageability Considerations

TBD

#### 7. Security Considerations

TBD



## 8. Acknowledgements

Authors would like to thank Stefano Previdi for his comments.

## 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.
- [RFC4670] Nelson, D., "RADIUS Accounting Client MIB for IPv6", RFC 4670, August 2006.
- [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.

### 9.2. Informative References

- [I-D.draft-dugeon-pce-ted-reqs-01]  
Dugeon, O., Meuric, J., Douville, R., Casellas, R., and O. Gonzalez de Dios, "Path Computation Element (PCE) Traffic Engineering Database (TED) Requirements", March 2012.
- [I-D.draft-ietf-idr-ls-distribution-03]  
Gredler, H., Medved, J., Previdi, S., Farrel, A., and S. Ray, "North-Bound Distribution of Link-State and TE Information using BGP", May 2013.
- [I-D.draft-ietf-pce-hierarchy-extensions-00]  
Zhang, F., Zhao, Q., Gonzalez de Dios, O., Casellas, R., and D. King, "Extensions to Path Computation Element Communication Protocol (PCEP) for Hierarchical Path Computation Elements (PCE)", August 2013.
- [I-D.draft-ietf-pce-inter-area-as-applicability-03]  
King, D., Meuric, J., Dugeon, O., Zhao, Q., and O. Gonzalez de Dios, "Applicability of the Path Computation Element to Inter-Area and Inter-AS MPLS and GMPLS Traffic Engineering", March 2012.

Authors' Addresses

Victor Lopez  
Telefonica I+D  
Don Ramon de la Cruz 82-84  
Madrid 28045  
Spain

Phone: +34913128872  
Email: vlopez@tid.es

Oscar Gonzalez de Dios  
Telefonica I+D  
Don Ramon de la Cruz 82-84  
Madrid 28045  
Spain

Phone: +34913128832  
Email: ogondio@tid.es

Daniel King  
Old Dog Consulting  
UK

Email: daniel@olddog.co.uk

Stefano Previdi  
Cisco Systems, Inc.  
Via Del Serafico 200  
Rome 00144  
IT

Email: sprevidi@cisco.com