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PCEP Extension for Distribution of Link-State and TE information for Optical Networks

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Abstract

In order to compute and provide optimal paths, Path Computation Elements (PCEs) require an accurate and timely Traffic Engineering Database (TED). Traditionally this Link State and TE information has been obtained from a link state routing protocol (supporting traffic engineering extensions).

This document extends the Path Communication Element Communication Protocol (PCEP) with Link-State and TE information for optical networks.

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Table of Contents

1. Introduction.....	3
2. Applicability.....	4
3. Requirements for PCEP extension.....	5
4. PCEP-LS extension for Optical Networks.....	6
4.1. Node Attributes TLV.....	6
4.2. Link Attributes TLV.....	7
5. Security Considerations.....	8
6. IANA Considerations.....	8
6.1. PCEP-LS Sub-TLV Type Indicators.....	8
7. References.....	9
7.1. Normative References.....	9
7.2. Informative References.....	10
Appendix A. Contributor Addresses.....	12

Author's Addresses.....[12](#)

[1. Introduction](#)

In Multiprotocol Label Switching (MPLS) and Generalized MPLS (GMPLS), a Traffic Engineering Database (TED) is used in computing paths for connection oriented packet services and for circuits. The TED contains all relevant information that a Path Computation Element (PCE) needs to perform its computations. It is important that the TED should be complete and accurate anytime so that the PCE can perform path computations.

In MPLS and GMPLS networks, Interior Gateway routing Protocols (IGPs) have been used to create and maintain a copy of the TED at each node. One of the benefits of the PCE architecture [[RFC4655](#)] is the use of computationally more sophisticated path computation algorithms and the realization that these may need enhanced processing power not necessarily available at each node participating in an IGP.

[Section 4.3 of \[RFC4655\]](#) describes the potential load of the TED on a network node and proposes an architecture where the TED is maintained by the PCE rather than the network nodes. However it does not describe how a PCE would obtain the information needed to populate its TED. PCE may construct its TED by participating in the IGP ([[RFC3630](#)] and [[RFC5305](#)] for MPLS-TE; [[RFC4203](#)] and [[RFC5307](#)] for GMPLS). An alternative is offered by [[BGP-LS](#)].

[RFC7399] touches upon this issue: "It has also been proposed that the PCE Communication Protocol (PCEP) [[RFC5440](#)] could be extended to serve as an information collection protocol to supply information from network devices to a PCE. The logic is that the network devices may already speak PCEP and so the protocol could easily be used to report details about the resources and state in the network, including the LSP state discussed in Sections [14](#) and [15](#)."

[Stateful-PCE] describes a set of extensions to PCEP to provide stateful control. A stateful PCE has access to not only the information carried by the network's Interior Gateway Protocol (IGP), but also the set of active paths and their reserved resources for its computations. PCC can delegate the rights to modify the LSP parameters to an Active Stateful PCE. This requires PCE to quickly be updated on any changes in the Topology and TEDB, so that PCE can meet the need for updating LSPs effectively and in a timely manner. The fastest way for a PCE to be updated on TED changes is via a direct interface with each network node and with incremental update from each network node.

[PCE-initiated] describes the setup, maintenance and teardown of PCE-initiated LSPs under the stateful PCE model, without the need for local configuration on the PCC, thus allowing for a dynamic network that is centrally controlled and deployed. This model requires timely topology and TED update at the PCE.

[PCEP-LS-Arch] proposes alternative architecture approaches for learning and maintaining the Link State (and TE) information directly on a PCE from network nodes as an alternative to IGPs and BGP transport and investigate the impact from the PCE, routing protocol, and network node perspectives.

[RFC6805] describes a Hierarchical PCE (H-PCE) architecture which can be used for computing end-to-end paths for inter-domain MPLS Traffic Engineering (TE) and GMPLS Label Switched Paths (LSPs). Within the Hierarchical PCE (H-PCE) architecture [[RFC6805](#)], the Parent PCE (P-PCE) is used to compute a multi-domain path based on the domain connectivity information. A Child PCE (C-PCE) may be responsible for a single domain or multiple domains, it is used to compute the intra-domain path based on its domain topology information.

[Stateful H-PCE] presents general considerations for stateful PCE(s) in hierarchical PCE architecture. In particular, the behavior changes and additions to the existing stateful PCE mechanisms (including PCE-initiated LSP setup and active PCE usage) in the context of networks using the H-PCE architecture.

[PCEP-LS] describes a mechanism by which Link State and TE information can be collected from packet networks and shared with PCE with the PCEP itself. This is achieved using a new PCEP message format.

This draft describes an optical extension of [[PCEP-LS](#)] and explains how encodings suggested by [[PCEP-LS](#)] can be used in the optical network contexts.

2. Applicability

There are three main applicability of this alternative proposed by this draft:

- Case 1: Where there is IGP running in optical network but there is a need for a faster link-state and TE resource collection at the PCE directly from an optical node (PCC) via a PCC-PCE interface.
 - o A PCE may receive an incremental update (as opposed to the entire TE information of the node/link).

Note: A PCE may receive full information from IGP using existing mechanism. In some cases, the convergence of full link-state and TE resource information of the entire network may not be appropriate for certain applications. Incremental update capability will enhance the accuracy of the TE information at a given time.

- Case 2: Where there is no IGP running in the optical network and there is a need for link-state and TE resource collections at the PCE directly from an optical node (PCC) via a PCC-PCE interface.
- Case 3: Where there is a need for transporting abstract optical link-state and TE information from child PCE and to a parent PCE in H-PCE [[RFC6805](#)] and [Stateful H-PCE] as well as for Physical Network Controller (PNC) to Multi-Domain Service Coordinator (MDSC) in Abstraction and Control of TE Networks (ACTN) [[ACTN-Frame](#)].

Note: The applicability for Case 3 may arise as a consequence of Case 1 and Case 2. When TE information changes occur in the optical network, this may also affect abstracted TE information and thus needs to be updated to Parent PCE/MSDC from each child PCE/PNC.

3. Requirements for PCEP extension

The key requirements associated with link-state (and TE) distribution are identified for PCEP and listed in Section 4 of [[PCEP-LS](#)]. These new functions required in PCEP to support distribution of link-state (and TE) information are described in Section 5 of [[PCEP-LS](#)]. Details of PCEP messages and related Objects/TLVs are specified in Sections [8](#) and [9](#) of [[PCEP-LS](#)]. The key

requirements and new functions specified in [[PCEP-LS](#)] are equally applicable to optical networks.

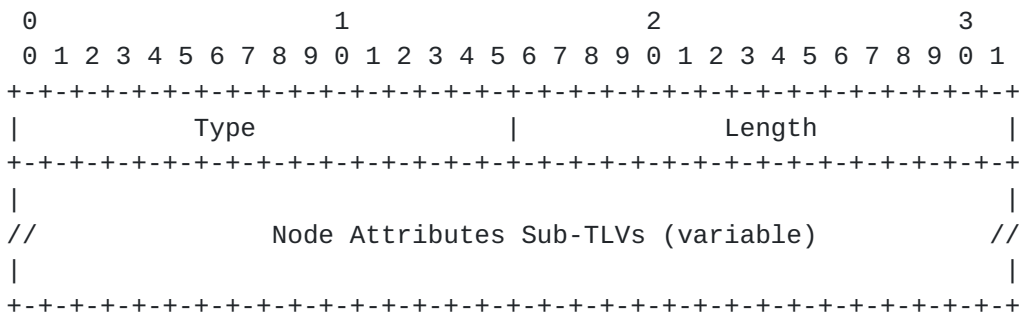
[Section 4](#) in this draft will specify additional PCEP-LS extension for Optical Networks.

4. PCEP-LS extension for Optical Networks

This section provides additional PCEP-LS extension necessary to support optical networks. All Objects/TLVs defined in [[PCEP-LS](#)] are applicable to optical networks.

4.1. Node Attributes TLV

Node-Attributed TLV is defined in Section 9.2.10.1 in [[PCEP-LS](#)] as follows. This TLV is applicable for LS Node Object-Type as defined in [[PCEP-LS](#)].



The following 'Node Attribute' sub-TLVs are valid for optical networks:

Sub-TLV	Description	TLV/Sub-TLV	Length	Reference
TBD	Connectivity Matrix	5/14	variable	[RFC7579]
TBD	Resource Block Information	6/1	variable	[RFC7688]
TBD	Resource Block Accessibility	6/2	variable	[RFC7688]
TBD	Resource Block Wavelength Const	6/3	variable	[RFC7688]
TBD	Resource Block	6/4	variable	[RFC7688]

		Pool State					
	TBD	Resource Block	6/5	variable	RFC7688		
		Shared Access					
		Wavelength Avail.					
+-----+-----+-----+-----+-----+-----+-----+-----+							

[4.2. Link Attributes TLV](#)

Link-Attributes TLV is defined in Section 9.2.10.2 in [[PCEP-LS](#)] as follows. This TLV is applicable for LS Link Object-Type as defined in [[PCEP-LS](#)].

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																				Length											
+-----+-----+-----+-----+-----+-----+-----+-----+																																									
//										Link Attributes Sub-TLVs (variable)										//																					
+-----+-----+-----+-----+-----+-----+-----+-----+																																									

The following 'Link Attribute' sub-TLVs are valid for optical networks:

Sub-TLV	Description	TLV/Sub-TLV	Length	Reference
TBD	ISCD	15	Variable	[RFC4203]
TBD	OTN-TDM SCSI	15/1,2	Variable	[RFC4203]
TBD	WSON-LSC SCSI	15/1,2	Variable	[RFC4203]
TBD	Flexi-grid SCSI	15/1	Variable	[Flex0SPF]
TBD	Port Label	34	Variable	[RFC7579]
	Restriction			[RFC7580]
				[Flex0SPF]

5. Security Considerations

This document extends PCEP for LS (and TE) distribution including a set of TLVs. Procedures and protocol extensions defined in this document do not effect the overall PCEP security model. See [RFC5440], [I-D.ietf-pce-pceps]. The PCE implementation SHOULD provide mechanisms to prevent strains created by network flaps and amount of LS (and TE) information. Thus it is suggested that any mechanism used for securing the transmission of other PCEP message be applied here as well. As a general precaution, it is RECOMMENDED that these PCEP extensions only be activated on authenticated and encrypted sessions belonging to the same administrative authority.

6. IANA Considerations

This document requests IANA actions to allocate code points for the protocol elements defined in this document.

6.1. PCEP-LS Sub-TLV Type Indicators

This document specifies a set of PCEP-LS Sub-TLVs. IANA is requested to create an "PCEP-LS Sub-TLV Types" sub-registry in the "PCEP TLV Type Indicators" for the sub-TLVs carried in the PCEP-LS TLV (Node Attributes TLV and Link Attributes TLV).

Sub-TLV	Description	Ref Sub-TLV	Reference
TBD	Connectivity Matrix	5/14	[RFC7579] [RFC7580]
TBD	Resource Block Information	6/1	[RFC7688]
TBD	Resource Block Accessibility	6/2	[RFC7688]
TBD	Resource Block Wavelength Const	6/3	[RFC7688]
TBD	Resource Block Pool State	6/4	[RFC7688]
TBD	Resource Block Shared Access	6/5	[RFC7688]
TBD	Wavelength Avail.		
TBD	ISCD	15	[RFC4203]
TBD	OTN-TDM SCSI	15/1,2	[RFC4203] [RFC7138]
TBD	WSN-LSC SCSI	15/1,2	[RFC4203] [RFC7688]
TBD	Flexi-grid SCSI	15/1	[Flex0SPF]
TBD	Port Label Restriction	34	[RFC7579] [RFC7580] [Flex0SPF]

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