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The User cases for Using PCE as the Central Controller(PCECC) of LSPs
draft-zhao-pce-central-controller-user-cases-00

Abstract

In certain deployment networks deployment scenarios, service providers would like to keep all the existing MPLS functionalities in both MPLS and GMPLS network while removing the complexity of existing signaling protocols such as LDP and RSVP-TE. In this document, we propose to use the PCE as a central controller so that LSP can be calculated/signaled/initiated/downloaded through a centralized PCE server to each network devices along the LSP path while leveraging the existing PCE technologies as much as possible.

This draft describes the user cases for using the PCE as the central controller where LSPs are calculated/setup/initiated/downloaded through extending the existing PCE architectures and extending the PCEP.

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1. Introduction

In certain network deployment scenarios, service providers would like to have the ability to dynamically adapt to a wide range of customer's requests for the sake of flexible network service delivery, SDN has provides additional flexibility in how the network is operated comparing the traditional network.

The existing networking ecosystem has become awfully complex and highly demanding in terms of robustness, performance, scalability, flexibility, agility, etc. By migrating to the SDN enabled network from the existing network, service providers and network operators must have a solution which they can evolve easily from the existing network into the SDN enabled network while keeping the network services remain scalable, guarantee robustness and availability etc.

Taking the smooth transition between traditional network and the new SDN enabled network into account, especially from a cost impact assessment perspective, using the existing PCE components from the current network to function as the central controller of the SDN network is one choice, which not only achieves the goal of having a centralized controller to provide the functionalities needed for the central controller, but also leverages the existing PCE network components.

The Path Computation Element communication Protocol (PCEP) provides mechanisms for Path Computation Elements (PCEs) to perform route computations in response to Path Computation Clients (PCCs) requests. PCEP Extensions for PCE-initiated LSP Setup in a Stateful PCE Model draft [I-D. draft-ietf-pce- stateful-pce] describes a set of extensions to PCEP to enable active control of MPLS-TE and GMPLS tunnels.

[I-D. draft-crabbe-pce-pce-initiated-lsp] describes the setup and teardown of PCE-initiated LSPs under the active stateful PCE model, without the need for local configuration on the PCC, thus allowing for a dynamic MPLS network that is centrally controlled and deployed.

[I-D.draft-ali-pce-remote-initiated-gmpls-lsp-01] complements [I-D. draft-crabbe-pce-pce-initiated-lsp] by addressing the requirements for remote-initiated GMPLS LSPs.

SR technology leverages the source routing and tunneling paradigms. A source node can choose a path without relying on hop-by-hop signaling protocols such as LDP or RSVP-TE. Each path is specified as a set of "segments" advertised by link-state routing protocols (IS-IS or OSPF). [I-D.filsfils-rtgwg-segment-routing] provides an introduction to SR technology. The corresponding IS-IS and OSPF

extensions are specified in [I-D.previdi-isis-segment-routing-extensions] and [I-D.psenak-ospf-segment-routing-extensions], respectively.

A Segment Routed path (SR path) can be derived from an IGP Shortest Path Tree (SPT). Segment Routed Traffic Engineering paths (SR-TE paths) may not follow IGP SPT. Such paths may be chosen by a suitable network planning tool and provisioned on the source node of the SR-TE path.

It is possible to use a stateful PCE for computing one or more SR-TE paths taking into account various constraints and objective functions. Once a path is chosen, the stateful PCE can instantiate an SR-TE path on a PCC using PCEP extensions specified in [I-D.crabbe-pce-pce-initiated-lsp] using the SR specific PCEP extensions described in [I-D.draft-sivabalan-pce-segment-routing].

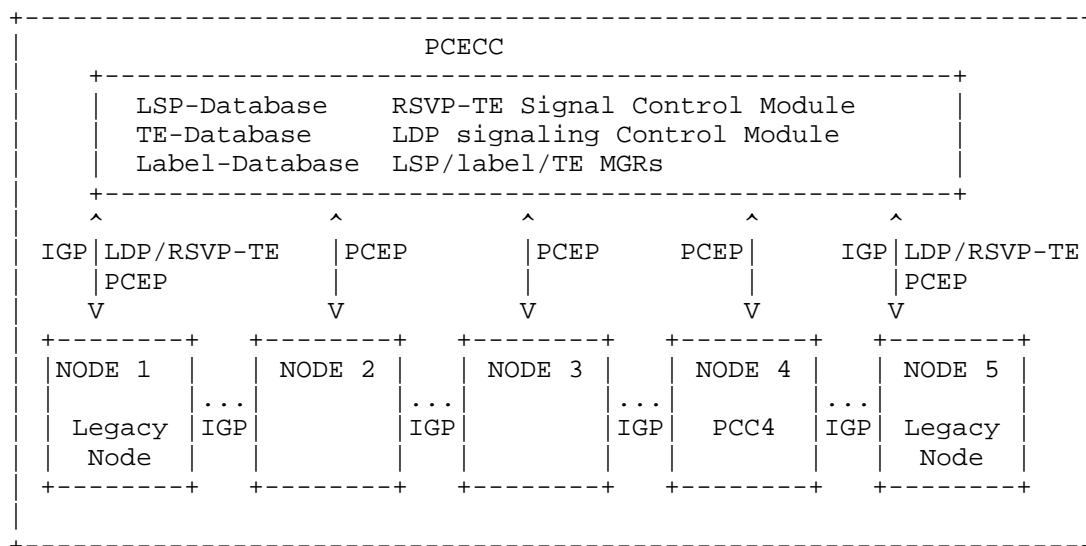
By using the solutions provided from above drafts, LSP in both MPLS and GMPLS network can be setup/delete/maintained/synchronized through a centrally controlled dynamic MPLS network. Since in these solutions, the LSP is need to be signaled through the head end LER to the tail end LER, there are either RSVP-TE signaling protocol need to be deployed in the MPLS/GMPLS network, or extend TGP protocol with node/adjacency segment identifiers signaling capability to be deployed.

The PCECC solution proposed in this document allow for a dynamic MPLS network that is eventually controlled and deployed without the deployment of RSVP-TE protocol or extended IGP protocol with node/adjacency segment identifiers signaling capability while providing all the key MPLS functionalities needed by the service providers. In the case that one LSP path consists legacy network nodes and the new network nodes which are centrally controlled, the PCECC solution provides a smooth transition step for users.

1.1.1. Using the PCE as the Central Controller (PCECC) Approach

With PCECC, it not only removes the existing MPLS signaling totally from the control plane without losing any existing MPLS functionalities, but also PCECC achieves this goal through utilizing the existing PCEP without introducing a new protocol into the network.

The following diagram illustrates the PCECC architecture.



Through the draft, we call the combination of the functionality for global label range signaling and the functionality of LSP setup/download/cleanup using the combination of global labels and local labels as PCECC functionality.

1.2. MPLS Label Resource Reservation through PCECCP

Current MPLS label has local meaning. That is, MPLS label allocated locally and signaled through the LDP/RSVP-TE/BGP etc dynamic signaling protocol.

As the SDN(Service-Driven Network) technology develops, MPLS global label has been proposed again for new solutions. [I-D.li-mppls-global-label-usecases] proposes possible usecases of MPLS global label. MPLS global label can be used for identification of the location, the service and the network in different application scenarios. From these usecases we can see that no matter SDN or traditional application scenarios, the new solutions based on MPLS global label can gain advantage over the existing solutions to facilitate service provisions.

To ease the label allocation and signaling mechanism, also with the new applications such as concentrated LSP controller is introduced, PCE can be conveniently used as a central controller and MPLS global label range negotiator.

The later section of this draft describes the user cases for PCE

server and PCE clients to have the global label range negotiation and local label range negotiation functionality.

1.3. Using PCECCP to Distribute the LSP Forwarding Entry from PCECC server to each PCECC clients

To empower networking with centralized controllable modules, there are many choices for downloading the forwarding entries to the data plane, one way is the use of the OpenFlow protocol, which helps devices populate their forwarding tables according to a set of instructions to the data plane. There are other candidate protocols to convey specific configuration information towards devices also. Since the PCEP protocol is already deployed in some of the service network, to leverage the PCEP to populated the MPLS forwarding table is a possible good choice.

2. Terminology

The following terminology is used in this document.

IGP: Interior Gateway Protocol. Either of the two routing protocols, Open Shortest Path First (OSPF) or Intermediate System to Intermediate System (IS-IS).

PCC: Path Computation Client: any client application requesting a path computation to be performed by a Path Computation Element.

PCE: Path Computation Element. An entity (component, application, or network node) that is capable of computing a network path or route based on a network graph and applying computational constraints.

TE: Traffic Engineering.

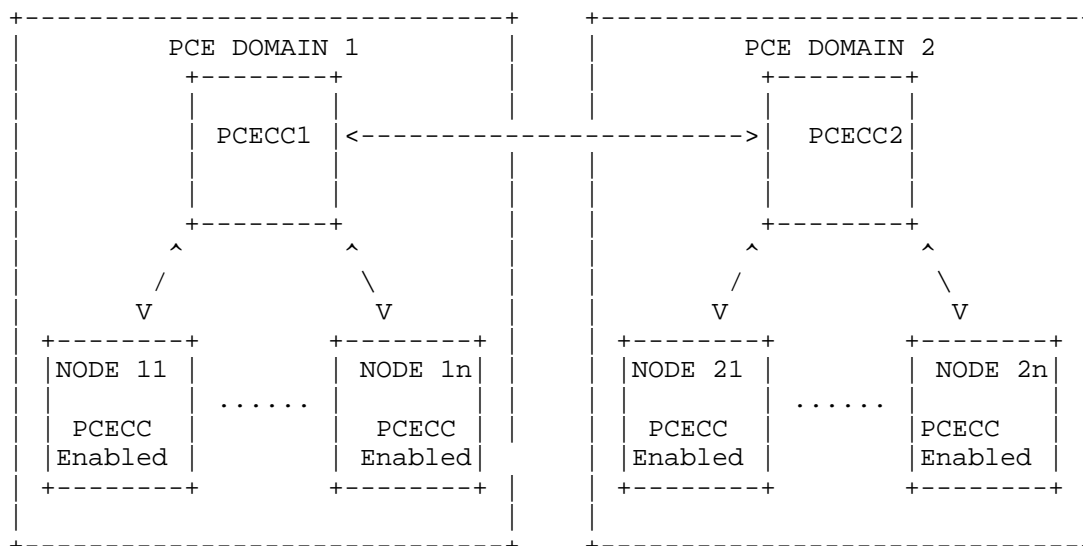
3. PCEP Requirements

Following key requirements associated PCECC should be considered when designing the PCECC based solution:

1. Path Computation Element (PCE) clients supporting this draft MUST have the capability to advertise its PCECC capability to the PCECC.
2. Path Computation Element (PCE) supporting this draft MUST have the capability to negotiate a global label range for a group of clients.

3. Path Computation Client (PCC) MUST be able ask for global label range assigned in path request message .
 4. PCE are not required to support label reserve service. Therefore, it MUST be possible for a PCE to reject a Path Computation Request message with a reason code that indicates no support for label reserve service.
 5. PCEP SHOULD provide a means to return global label range and LSP label assignments of the computed path in the reply message.
 6. PCEP SHOULD provide a means to download the MPLS forwarding entry to the PCECC's clients.
4. User Cases for PCECC's Label Resource Reservations

Example 1 to 3 are based on network configurations illustrated using the following figure:



Example 1: global Label Range Reservation

- o Node11 sends a label request message to PCECC1 with global label reservation range 100 to 1000.
- o PCECC1 sends a reply message with global label reservation range 100 to 1000 confirmed to node1, ..., node1n

- o PCECC1 sends a indication message with global label reservation range 100 to 1000 confirmed to PCECC2.
- o PCECC2 sends indication messages with global label reservation range 100 to 1000 confirmed to Node21,..., node2n

5. User Cases for PCECC for LSP Setup in the New PCECC Enabled Network

Example 2: Tunnel Head End Initiated LSP Setup Using Global Label Range Reserved

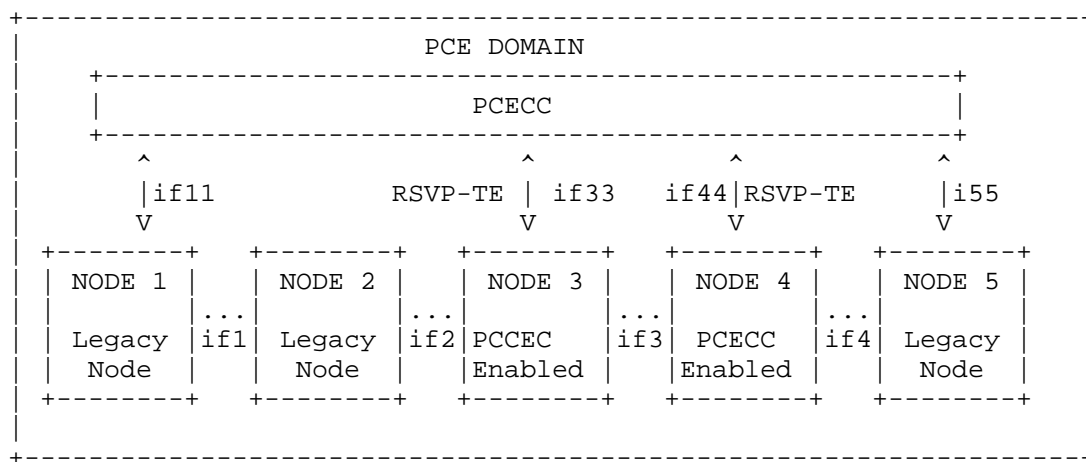
- o Node1 sends a path request message for LSP setup from Node11 to Node2n.
- o PCE1 sends a indication message LSP setup with [Label(to2n), Node2n] to Node12, ..., Node1n.
- o PCE1 sends a indication message LSP setup with [Label(to2n), Node2n] to PCE2;
- o PCE2 sends a indication message LSP setup with [Label(to2n), Node2n] to Node22, ..., Node2n.

Example 3: LSP Delete Using global Label Range Reserved

- o Node1 sends a path request message for LSP cleanup from Node11 to Node2n.
- o PCE1 sends a indication message LSP cleanup with [Label(to2n), Node2n] to Node12, ..., Node1n.
- o PCE1 sends a indication message LSP cleanup with [Label(to2n), Node2n] to PCE2;
- o PCE2 sends a indication message LSP cleanup with [Label(to2n), Node2n] to Node22, ..., Node2n.

6. User Cases for PCECC for LSP Setup in the Network Migration

Example 4 is based on network configurations illustrated using the following figure:



Example 4: PCECC Initiated LSP Setup In the Network Migration

In this example, there five nodes for the LSP from head end (node1) to the tail end (node5). Where the node3 and node4 with the PCECC capability, and other nodes are legacy nodes.

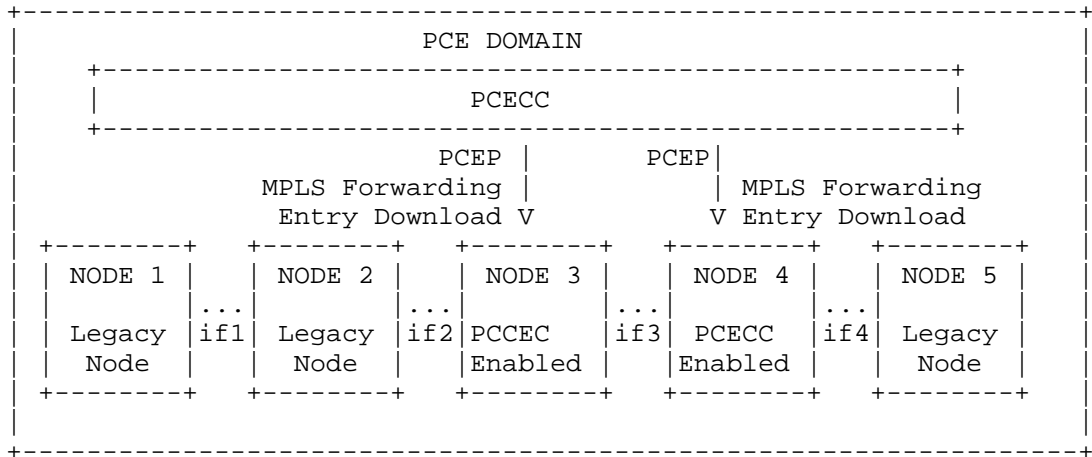
- o Node1 sends a path request message for LSP setup to Node5.
- o PCE sends a reply message for LSP setup with path (node1, i1), (node2, i2), (node-PCECC, if33), (node-PCECC, if55), Nnode5.
- o PCE sends an indication message for LSP segment setup with [Label(toN5), Node5] for node3 to node4.
- o Node1, Node2, Node-PCECC, Node-PCECC, Node 5 will setup the LSP to Node5 normally using the local label as normal. After the LSP is setup, then the PCECC will program the node 3 and node 4 to replace the LSP segment from node3-node-pcecc-node5 to node3-node4-node5.

7. Using Extended PCEP to download LSP info for Each Network Device

The existing PCEP is used to communicate between the PCE server and PCE's client PCC for exchanging the path request and reply information regarding to the LSP info. With minor extensions, we can use the PCEP to download the complete LSP forwarding entries for each node in the network.

In the example 4, the LSP segment between node3 and node4 for destination node5 is setup from PCECC and downloaded into node3 and

node4 directly from PCECC through the extended PCEP.



8. The Considerations for PCECC Procedure and PCEP extensions

The PCECC's procedures and PCEP extensions will be defined in a separate document.

9. Acknowledgments

We would like to thank Robert Tao, Changjing Yan, Tieying Huang for their useful comments and suggestions.

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