

SR: PCE Initiated LSPs

The SR: PCE Initiated LSPs feature provides support for PCE-initiated LSPs in stateful PCE model on segment routing networks.

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Prerequisites for SR: PCE Initiated LSPs

- The Dynamic PCC feature must be configured.
- Auto tunnels must be enabled on the PCC.

Restrictions for SR: PCE Initiated LSPs

- The SR: PCE Initiated LSPs feature supports only basic LSP generation and does not support TE attributes.

Information About SR: PCE Initiated LSPs

Overview of Path Computation Element Protocol

draft-ietf-pce-stateful-pce-21 describes Stateful Path Computation Element Protocol (PCEP) enables a router to report and optionally delegate Label Switched Paths (LSPs) which is established using either Resource Reservation Protocol (RSVP) protocol or Segment Routing Traffic Engineering (SR-TE) to a stateful Path Computation Element (PCE). An LSP delegated to a PCE can be updated by the PCE and a stateful PCE can compute and provide the path of an LSP to the Path Computation Client (PCC).

The **PCEP Extensions for PCE-initiated LSP Setup in a Stateful PCE Model (draft-ietf-pce-pce-initiated-lsp-11)** specifies a set of extensions to PCEP to enable stateful control of TE

LSPs across PCEP sessions in compliance with RFC4657. The **PCEP Extensions for PCE-initiated LSP Setup in a Stateful PCE Model** provides information about the following:

- Configuring LSPs on a PCC
- Delegating control of LSP to a PCE

SR: PCE Initiated LSPs

The SR: PCE Initiated LSPs feature allows a client to create, setup, control, and delete an LSP from PCE server, which controls creating and deleting LSP on PCC through an PCE initiate message. PCE initiated LSP is automatically delegated to the PCE server that initiated the LSP. A PCE client processes an LSP initiate message. By using the LSP initiate message, PCE client can create or delete LSP.

When a failover occurs on a route processor (RP), the failover results in the RP being disconnected from the network. To reestablish the connection, the PCE server has to resend LSP initiate message to reclaim PCE Initiated LSPs on a client, else PCE initiated LSPs created by the client are automatically deleted.

You must use the **pce** command for establishing a PCEP session with PCC. The **force auto-route** command is used to advertise an LSP within an area via the autoroute announce message and across areas via the autoroute destination message. The decision to use autoroute announce or autoroute destination is performed by a device depending on the destination IP address. Enabling the **force auto-route** command for an initiated LSP allows automatic routing of traffic through a TE tunnel instead of routing traffic via manually configuring static routes. The autoroute announce message installs routes announced by the destination router and downstream routers into the routing table of a headend device that can be reached through a tunnel.

The PCC configuration includes IP addresses for each PCE (both primary and standby or more). The precedence for each PCE can be explicitly specified. If the precedence for two PCEs is same, PCE with smaller IP address has a higher precedence.

Single and Redundant PCE Operations

The SR: PCE Initiated LSPs feature supports single and redundant PCE operations. In a single PCE operation, when a PCE fails, PCC waits until the state timeout expiry (60 seconds) to remove the LSP.

In a redundant PCE operation, if a Representational state transfer (REST) call is initiated to a standby PCE before the expiry of the timer, the initiated LSP is retained else, the LSP is removed.

Note The REST call must be initiated again to a standby PCE if the primary PCE fails, and the call must include the standby PCE IP address.

In a redundant PCE operation, PCC configurations include both primary and standby IP addresses for an LSP and the IP address with a lower precedence becomes the primary PCE. The IP addreseses are compared incase of equal priority.

How to Configure SR: PCE Initiated LSPs

Establishing a PCEP session with PCC

Perform this task to configure a PCEP session PCE server XR based XTC server.

```
configure terminal
pce
 address ipv4 192.0.2.1
end
```

The IP address 192.0.2.1 is the IP address of the transport controller.

Advertising an LSP in a Network

```
configure terminal
 mpls traffic-eng pcc peer 192.0.2.1 source 203.0.113.1 force-autoroute
 end
```

In the above code snippet, 192.0.2.1 is PCE IP address and 203.0.113.1 is PCC source address for establishing a PCEP session.

Specifying Precedence of a PCE for PCC

```
configure terminal
mpls traffic-eng pcc peer 192.0.2.1 source 203.0.113.1 force autoroute precedence 255
mpls traffic-eng pcc peer 192.0.2.2 source 203.0.113.1 force-autoroute precedence 100
end
```

In the above code snippet, 100 is a lower precedence than 255, which is the default precedence. Therefore, the device with IP address 192.0.2.2 becomes the primary PCE and the device with 192.0.2.1 becomes the standby PCE.

Triggering PCE server precedence re-evaluation

A change in a PCE server's precedence is not considered a PCE server failure. So, the change in precedence does not trigger a redelegation timeout or a re-evaluation of LSP delegation to the PCE server at a PCC.

Re-evaluation of LSP delegation to PCE servers after CLI reconfiguration is controlled by the TE reoptimisation timer. By default, the TE reoptimisation timer is set to 3600 seconds.

You can accelerate the re-evaluation of LSP delegation from a PCC to PCE servers after you have changed the precedence of PCE servers or added new PCE servers. To do so, manually trigger TE reoptimisation using the following command in privileged EXEC mode:

```
mpls traffic-eng reoptimize
```

Verifying LSP Configurations

SUMMARY STEPS

1. **show pce ipv4 peer detail**
2. **show pce lsp detail**
3. **show pce client peer**
4. **show mpls traffic-eng tunnel tunnel** *number*

DETAILED STEPS

Procedure

Step 1 **show pce ipv4 peer detail**

Use this command to verify PCEP session details on a PCE. In this example, the term instantiation indicates that PCE supports initiated LSP.

```
Device# show pce ipv4 peer detail


PCE's peer database:

--------------------

Peer address: 10.2.2.2----' PCC IP address

                State: Up

  Capabilities: Stateful, Segment-Routing, Update, Instantiation
```

Step 2 **show pce lsp detail**

Use this command to verify the initiated LSP on a PCE.

```
Device# show pce lsp detail


PCE's tunnel database:

----------------------

PCC 10.52.2.2 ----' PCC IP address


Tunnel Name: Test1--------' tunnel name set by REST Call
```

```
LSPs:

  LSP[0]:

   source 10.52.2.2, destination 10.57.7.7, tunnel ID 2000, LSP ID 1

   State: Admin up, Operation active

   Binding SID: 26

   PCEP information:

     plsp-id 526288, flags: D:1 S:0 R:0 A:1 O:2 C:1

   LSP Role: Single LSP

   State-sync PCE: None

   PCC: 10.52.2.2

   LSP is subdelegated to: None

   Reported path:

     Metric type: TE, Accumulated Metric 2

      SID[0]: Adj, Label 25, Address: local 10.105.3.1 remote 10.105.3.2

      SID[1]: Adj, Label 24, Address: local 10.104.8.2 remote 10.104.8.1

      SID[2]: Adj, Label 38, Address: local 10.107.10.1 remote 10.107.10.2

   Computed path: (Local PCE)

     None

     Computed Time: Not computed yet

   Recorded path:

     None

   Disjoint Group Information:

     None
```

Step 3 **show pce client peer**

Use this command to verify a PCEP session output on a PCC and to verify if the **force-autoroute** command is enabled.

```
Device# show pce client peer


PCC's peer database:

------------------------------

Peer address: 10.51.1.1, Precedence: 255

  State up

  Capabilities: Stateful, Update, Segment-Routing,Force-autoroute
```

Step 4 **show mpls traffic-eng tunnel tunnel** *number*

Use this command to verify the output of the initiated LSP tunnel on a PCC.

```
Device# show mpls traffic-eng tunnel tunnel 2000


Name: Test1                                (Tunnel2000) Destination: 10.57.7.7 Ifhandle: 0x11E
(auto-tunnel for pce client)

  Status:

    Admin: up         Oper: up     Path: valid       Signalling: connected

    path option 1, (SEGMENT-ROUTING) (PCE) type dynamic (Basis for Setup)


  Config Parameters:

    Bandwidth: 0        kbps (Global)  Priority: 7  7   Affinity: 0x0/0xFFFF

    Metric Type: TE (default)

    Path Selection:

     Protection: any (default)

    Path-selection Tiebreaker:

      Global: not set   Tunnel Specific: not set   Effective: min-fill (default)

    Hop Limit: disabled
```

```
  Cost Limit: disabled
  Path-invalidation timeout: 10000 msec (default), Action: Tear
  AutoRoute: enabled  LockDown: disabled Loadshare: 0 [0] bw-based
  auto-bw: disabled
  Fault-OAM: disabled, Wrap-Protection: disabled, Wrap-Capable: No
Active Path Option Parameters:
  State: dynamic path option 1 is active
  BandwidthOverride: disabled  LockDown: disabled  Verbatim: disabled


PCEP Info:
  Delegation state: Working: yes   Protect: no
  Delegation peer: 10.51.1.1
  Working Path Info:
    Request status: delegated
    SRP-ID: 1
    Created via PCInitiate message from PCE server: 10.51.1.1-----' IP address
    PCE metric: 2, type: TE
  Reported paths:
    Tunnel Name: Test1
     LSPs:
      LSP[0]:
       source 10.52.2.2, destination 10.57.7.7, tunnel ID 2000, LSP ID 1
       State: Admin up, Operation active
      Binding SID: 26
       Setup type: SR
```

```
          Bandwidth: requested 0, used 0

          LSP object:

            PLSP-ID 0x807D0, flags: D:0 S:0 R:0 A:1 O:2

          Metric type: TE, Accumulated Metric 2

          ERO:

            SID[0]: Adj, Label 25, NAI: local 10.105.3.1 remote 10.105.3.2

            SID[1]: Adj, Label 24, NAI: local 10.104.8.2 remote 10.104.8.1

            SID[2]: Adj, Label 38, NAI: local 10.107.10.1 remote 10.107.10.2

        PLSP Event History (most recent first):

          Mon Jul 17 08:55:04.448: PCRpt update LSP-ID:1, SRP-ID:1, PST:1, METRIC_TYPE:2, REQ_BW:0,
USED_BW:0

          Mon Jul 17 08:55:04.436: PCRpt create LSP-ID:1, SRP-ID:1, PST:1, METRIC_TYPE:2, REQ_BW:0,
USED_BW:0

  History:

    Tunnel:

      Time since created: 2 hours, 42 minutes

      Time since path change: 2 hours, 42 minutes

      Number of LSP IDs (Tun_Instances) used: 1

    Current LSP: [ID: 1]

      Uptime: 2 hours, 42 minutes

  Tun_Instance: 1

  Segment-Routing Path Info (isis  level-2)

    Segment0[Link]: 10.105.3.1 - 10.105.3.2, Label: 25

    Segment1[Link]: 10.104.8.2 - 10.104.8.1, Label: 24

    Segment2[Link]: 10.107.10.1 - 10.107.10.2, Label: 38
```

Additional References for SR: PCE Initiated LSPs

Standards and RFCs

Standard/RFC	Title
draft-ietf-pce-pce-initiated-lsp-11	*PCEP Extensions for PCE-initiated LSP Setup in a Stateful PCE Model*
RFC 5440	*Path Computation Element (PCE) Communication Protocol (PCEP)*
RFC 8231	*Path Computation Element (PCE) Communication Protocol Generic Requirements*

Feature Information for SR: PCE Initiated LSPs

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to https://cfnng.cisco.com/. An account on Cisco.com is not required.

Table 1: Feature Information for SR: PCE Initiated LSPs

Feature Name	Releases	Feature Information
SR: PCE Initiated LSPs	Cisco IOS XE Amsterdam 17.3.2	The SR: PCE Initiated LSPs provides support for PCE-initiated LSPs in stateful PCE model on segment routing networks. The following commands were introduced or modified: **mpls traffic-eng pcc**, **pce**, **show mpls traffic-eng tunnel**, **show pce client peer**, **show pce ipv4 peer**, **show pce lsp**.