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.

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**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 addressese 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.

```bash
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

```bash
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

```bash
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 203.0.113.2 becomes the primary PCE and the device with 203.0.113.1 becomes the standby PCE.

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**

**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: 52.2.2.2----’ 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 52.2.2.2 ----’ PCC IP address

Tunnel Name: Test1-------’ tunnel name set by REST Call

LSPs:

LSP[0]:

    source 52.2.2.2, destination 57.7.7.7, 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 0:2 C:1

    LSP Role: Single LSP

    State-sync PCE: None
PCC: 52.2.2.2

LSP is subdelegated to: None

Reported path:

Metric type: TE, Accumulated Metric 2

SID[0]: Adj, Label 25, Address: local 102.105.3.1 remote 102.105.3.2

SID[1]: Adj, Label 24, Address: local 104.105.8.2 remote 104.105.8.1

SID[2]: Adj, Label 38, Address: local 104.107.10.1 remote 104.107.10.2

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: 51.1.1.1, 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: 57.7.7.7 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: 51.1.1.1

Working Path Info:

Request status: delegated

SRP-ID: 1

Created via PCInitiate message from PCE server: 51.1.1.1--" IP address

PCE metric: 2, type: TE

Reported paths:

Tunnel Name: Test1

LSPs:

LSP[0]:

source 52.2.2.2, destination 57.7.7.7, 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 102.105.3.1 remote 102.105.3.2

SID[1]: Adj, Label 24, NAI: local 104.105.8.2 remote 104.105.8.1

SID[2]: Adj, Label 38, NAI: local 104.107.10.1 remote 104.107.10.2
Additional References for SR: PCE Initiated LSPs

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<td>PCEP Extensions for PCE-initiated LSP Setup in a Stateful PCE Model</td>
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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 www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 1: Feature Information for SR: PCE Initiated LSPs

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<tr>
<th>Feature Name</th>
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<td>SR: PCE Initiated LSPs</td>
<td>Cisco IOS XE Fuji 16.7.1</td>
<td>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 pce, pce, show mpls traffic-eng tunnel, show pce client peer, show pce ipv4 peer, show pce lsp.</td>
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