Dynamic PCC

The 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).

SR-TE and RSVP-TE LSPs require link-state routing protocols such as OSPF or ISIS to distribute and learn traffic engineering topology. A stateful PCE can learn the traffic engineering topology through BGP Link-State protocol. You can use the verbatim path option in the case when all or some of the intermediate nodes in a network do not support IGP extensions for TE.

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Information About Dynamic PCC

Path Computation Element Protocol Functions

A Path Computation Element Protocol (PCEP) session is a TCP session between a PCC and a PCE with protocol messages. The PCEP functions are verified based on the PCC functions. The configuration and verification show that the request is accepted and path computation is provided based on PCReq message from the client. The passive reporting enables a router to report a tunnel instead of delegating it to a PCE. The PCE is aware of the tunnel even though it cannot modify the tunnel.

PCEP functions are useful when a network has both router-controlled and PCE delegated tunnels. The PCE is aware of both the tunnels and can make an accurate decision on path computation.

Redundant Path Computation Elements

For redundancy it may be required to deploy redundant PCE servers. A PCC uses precedence to select stateful PCEs for delegating LSPs. Precedence can take any value between 0 and 255. The default precedence value

is 255. When there are multiple stateful PCEs with active PCEP session, PCC chooses the PCE with the lowest precedence value. In case where primary PCE server session goes down, PCC router re-delegates all tunnels to next available PCE server. You can use the following CLIs in the case of redundant PCEs:

```
R2(config)#mpls traffic-eng pcc peer 77.77.77.77 source 22.22.22.22 precedence 255
R2(config)#mpls traffic-eng pcc peer 88.88.88.88  source 22.22.22.22 precedence 100
!
end
```

In the above example PCE server with IP address 88.88.88.88 is the primary PCE server since it has lower precedence value.

How to Configure Dynamic PCC

Configuring Dynamic PCC Globally

Perform the following task to configure dynamic PCC globally

```
enable
configure terminal
mpls traffic-eng tunnels
mpls traffic-eng pcc peer 10.0.0.1    ----□(10.0.0.1 is the PCE server address)
mpls traffic-eng pcc report-all
end
```

Note **mpls traffic-eng pcc report-all** is not mandatory for PCE/PCC basic operational delegated tunnels. It is required to report locally calculated LSPs to the PCE server.

Configuring Dynamic PCC on an Interface

Perform the following task to configure dynamic PCC on an interface

```
interface Tunnel1
 ip unnumbered Loopback0
 tunnel mode mpls traffic-eng
 tunnel destination 7.7.7.7
 tunnel mpls traffic-eng autoroute announce
 tunnel mpls traffic-eng priority 5 5
 tunnel mpls traffic-eng bandwidth 200
 tunnel mpls traffic-eng path-option 10 dynamic pce segment-routing
end
```

Configuring Dynamic PCC With Verbatim Path Option

To enable Dynamic PCC with verbatim path option, use the following CLI under the SR-TE tunnel interface:

```
R1#
interface Tunnel2
```

```
ip unnumbered Loopback11
tunnel mode mpls traffic-eng
tunnel destination 66.66.66.66
tunnel mpls traffic-eng autoroute destination
tunnel mpls traffic-eng path-option 1 dynamic segment-routing pce verbatim
```

Verifying Dynamic PCC

The following sample output is from the **show pce client peer detail** command.

```
Device# show pce client peer detail

PCC's peer database:
--------------------

Peer address: 1.1.1.1
  State up
  Capabilities: Stateful, Update, Segment-Routing
  PCEP has been up for: 23:44:58
  PCEP session ID: local 1, remote: 0
  Sending KA every 30 seconds
  Minimum acceptable KA interval: 20 seconds
  Peer timeout after 120 seconds
  Statistics:
    Keepalive messages: rx    2798 tx    2112
    Request messages:   rx       0 tx      32
    Reply messages:     rx      32 tx       0
    Error messages:     rx       0 tx       0
    Open messages:      rx       1 tx       1
    Report messages:    rx       0 tx      57
    Update messages:    rx      72 tx       0
```

The following sample output is from the **show mpls traffic-eng tunnels tunnel 1** command which shows the LSP details.

```
Device# show mpls traffic-eng tunnels tunnel 1

Name: d1_t1                        (Tunnel1) Destination: 7.7.7.7
  Status:
    Admin: up         Oper: up     Path: valid       Signalling: connected
    path option 10, (SEGMENT-ROUTING) (PCE) type dynamic (Basis for Setup, path weight 0)

  Config Parameters:
    Bandwidth: 200      kbps (Global)  Priority: 5  5   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: 200 [10000000] bw-based
    auto-bw: disabled
    Fault-OAM: disabled, Wrap-Protection: disabled, Wrap-Capable: No
  Active Path Option Parameters:
    State: dynamic path option 10 is active
    BandwidthOverride: disabled  LockDown: disabled  Verbatim: disabled
```

```
  PCEP Info:
    Delegation state: Working: yes   Protect: no
    Current Path Info:
      Request status: processed
      Created via PCRep message from PCE server: 1.1.1.1
    Reported paths:
      Tunnel Name: csr551_t2001
       LSPs:
        LSP[0]:
         source 2.2.2.2, destination 7.7.7.7, tunnel ID 1, LSP ID 5
         State: Admin up, Operation active
         Setup type: SR
         Bandwidth: signaled 0
         LSP object:
           PLSP-ID 0x807D1, flags: D:0 S:0 R:0 A:1 O:2
         Reported path:
           Metric type: TE, Accumulated Metric 0

  History:
    Tunnel:
      Time since created: 34 minutes, 3 seconds
      Time since path change: 1 minutes, 44 seconds
      Number of LSP IDs (Tun_Instances) used: 5
    Current LSP: [ID: 5]
      Uptime: 1 minutes, 44 seconds
    Prior LSP: [ID: 3]
      ID: path option unknown
      Removal Trigger: path verification failed
  Tun_Instance: 5
  Segment-Routing Path Info (isis  level-1)
    Segment0[Node]: 3.3.3.3, Label: 20270
    Segment1[Node]: 6.6.6.6, Label: 20120
    Segment2[Node]: 7.7.7.7, Label: 20210
```

The following sample output is from the **show pce client lsp detail** command.

```
Device# show pce client lsp detail

PCC's tunnel database:
----------------------
Tunnel Name: d1_t1
 LSPs:
  LSP[0]:
   source 2.2.2.2, destination 7.7.7.7, tunnel ID 1, LSP ID 5
   State: Admin up, Operation active
   Setup type: SR
   Bandwidth: signaled 0
   LSP object:
     PLSP-ID 0x807D1, flags: D:0 S:0 R:0 A:1 O:2
   Reported path:
     Metric type: TE, Accumulated Metric 0
```

The following sample output is from the **show pce lsp detail** command which shows the tunnel is delegated.

```
Device# show pce lsp detail

Thu Jul  7 10:24:30.836 EDT

PCE's tunnel database:
----------------------
PCC 102.103.2.1:
```

```
Tunnel Name: d1_t1
 LSPs:
  LSP[0]:
   source 2.2.2.2, destination 7.7.7.7, tunnel ID 1, LSP ID 5
   State: Admin up, Operation active
   Binding SID: 0
   PCEP information:
     plsp-id 526289, flags: D:1 S:0 R:0 A:1 O:2
   Reported path:
     Metric type: TE, Accumulated Metric 0
      SID[0]: Node, Label 20270, Address 3.3.3.3
      SID[1]: Node, Label 20120, Address 6.6.6.6
      SID[2]: Node, Label 20210, Address 7.7.7.7
   Computed path:
     Metric type: TE, Accumulated Metric 30
      SID[0]: Node, Label 20270, Address 3.3.3.3
      SID[1]: Node, Label 20120, Address 6.6.6.6
      SID[2]: Node, Label 20210, Address 7.7.7.7
   Recorded path:
     None
```

The following sample output is from the **show pce client lsp detail** command for reported tunnel.

```
Device# show pce client lsp detail

PCC's tunnel database:
----------------------
Tunnel Name: d1_t2
 LSPs:
  LSP[0]:
   source 2.2.2.2, destination 7.7.7.7, tunnel ID 2, LSP ID 1
   State: Admin up, Operation active
   Setup type: SR
   Bandwidth: signaled 0
   LSP object:
     PLSP-ID 0x807D2, flags: D:0 S:0 R:0 A:1 O:2
   Reported path:
     Metric type: TE, Accumulated Metric 30
```

The following sample output is from the **show pce lsp detail** command which shows the tunnel is not delegated.

```
Device# show pce lsp detail

Thu Jul  7 10:29:48.754 EDT

PCE's tunnel database:
----------------------
PCC 10.0.0.1:

Tunnel Name: d1_t2
 LSPs:
  LSP[0]:
   source 2.2.2.2, destination 7.7.7.7, tunnel ID 2, LSP ID 1
   State: Admin up, Operation active
   Binding SID: 0
   PCEP information:
     plsp-id 526290, flags: D:0 S:0 R:0 A:1 O:2
   Reported path:
     Metric type: TE, Accumulated Metric 30
      SID[0]: Adj, Label 74, Address: local 172.16.0.1 remote 172.16.0.2
```

```
      SID[1]: Adj, Label 63, Address: local 173.17.0.1 remote 173.17.0.2
      SID[2]: Adj, Label 67, Address: local 174.18.0.1 remote 174.18.0.2
      SID[3]: Node, Label unknownAddress 7.7.7.7
  Computed path:
    None
  Recorded path:
    None
```

Verifying Verbatim Path Option With Dynamic PCC

To verify proper operation with verbatim path option, use the following command:

```
R1#sh mpl tr tun tun 2
Name: R1_t2                                (Tunnel2) Destination: 66.66.66.66
  Status:
    Admin: up         Oper: up     Path: valid       Signalling: connected
    path option 1, (SEGMENT-ROUTING) (PCE) type dynamic (verbatim) (Basis for Setup)

  Config Parameters:
    Bandwidth: 0        kbps (Global)  Priority: 7  7   Affinity: 0x0/0xFFFF
    Metric Type: TE (interface)
    Path Selection:
     Protection: any (default)
    Path-selection Tiebreaker:
      Global: not set   Tunnel Specific: not set   Effective: min-fill (default)
    Hop Limit: disabled [ignore: Verbatim Path Option]
    Cost Limit: disabled
    Path-invalidation timeout: 10000 msec (default), Action: Tear
    AutoRoute: disabled LockDown: disabled Loadshare: 0 [0] bw-based
    AutoRoute destination: enabled
    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: enabled

  PCEP Info:
    Delegation state: Working: yes   Protect: no
    Delegation peer: 77.77.77.77
    Working Path Info:
      Request status: processed
      Created via PCRep message from PCE server: 77.77.77.77
      PCE metric: 4, type: TE
    Reported paths:
      Tunnel Name: Tunnel2_w
       LSPs:
        LSP[0]:
         source 11.11.11.11, destination 66.66.66.66, tunnel ID 2, LSP ID 1
         State: Admin up, Operation active
         Binding SID: 17
         Setup type: SR
         Bandwidth: requested 0, used 0
         LSP object:
           PLSP-ID 0x80002, flags: D:0 S:0 R:0 A:1 O:2
         ERO:
           SID[0]: Adj, Label 24, NAI: local 12.12.12.1 remote 12.12.12.2
           SID[1]: Adj, Label 26, NAI: local 25.25.25.2 remote 25.25.25.5
           SID[2]: Adj, Label 22, NAI: local 56.56.56.5 remote 56.56.56.6

  History:
```

```
    Tunnel:
      Time since created: 39 days, 19 hours, 9 minutes
      Time since path change: 1 minutes, 3 seconds
      Number of LSP IDs (Tun_Instances) used: 1
    Current LSP: [ID: 1]
      Uptime: 1 minutes, 3 seconds
  Tun_Instance: 1
  Segment-Routing Path Info (IGP information is not used)
    Segment0[Link]: 12.12.12.1 - 12.12.12.2, Label: 24
    Segment1[Link]: 25.25.25.2 - 25.25.25.5, Label: 26
    Segment2[Link]: 56.56.56.5 - 56.56.56.6, Label: 22
!
end
```

Additional References for Dynamic PCC

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases

Feature Information for Dynamic PCC

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 Dynamic PCC

Feature Name	Releases	Feature Information
Dynamic PCC	Cisco IOS XE Everest 16.6.1	The Dynamic Path Computation Client (PCC) feature supports an LSP delegated to a Path Computation Element (PCE).Dynamic PCC aupports both RSVP-TE and SR-TE. The following commands were added or modified: **show pce client peer detail**, **show mpls traffic-eng tunnels tunnel 1**, **show pce client lsp detail**, **show pce lsp detail**.