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ISOCORE

MPLS Interoperability

Path Computation Element Communication Protocol Extension for Stateful PCE

DRAFT

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Revisions

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8/2013	**First Draft/ New tests**

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1 Introduction

This document provides a test plan to validate deployment of the PCEP extension for Stateful PCE, Path Computation Element (Communication) Protocol and related technologies. The protocol enables communication between a PCC and a PCE, or between two PCEs. The protocol enables the PCE and PCC to be separated; without it, they must be collocated and considered as one logical unit that serves both functions. This test plan validates a set of extension to PCEP to enable stateful control of LSPs between and across PCEP sessions. The set of extension includes mechanism to effect LSP state synchronization between PCCs and PCEs, delegation of control over LSPs to PCEs, and PCE control of timing and sequence of path computations within and across PCEP sessions.

If the PCE has a global view of all the current reservations, its computation can be much more accurate. Sateful PCE has such capability, so it can perform more interesting functions such as computing disjoint paths for the primary and secondary, or avoiding links that failed in a previous computation.

Some test scenarios have been designed for peripheral features of PCEP extension for Stateful PCE that some vendors may not plan to implement. It is also understood that some of the systems under test are in beta or even alpha stages in the development process. It is NOT necessary to implement all the functions defined in the test cases in order to participate in the upcoming test activity.

One of the goals of this program is to promote rapid adoption of Stateful PCE technology in products destined for the commercial marketplace. We will support this objective by validating implementations of Stateful PCE in an independent, multi-vendor network infrastructure. The results of the tests will be used to provide input to the IETF which will help correct any discrepancies in the specifications. In the event that problems or issues are discovered, they will be addressed individually between the vendors involved in full confidentiality.

This document is work-in-progress and will be refined and updated based on input from test participants (vendors) and carrier members of Isocore Internetworking lab.

The topologies shown in this document are only preliminary examples. After vendor implementation details have been confirmed, a final topology capable of supporting all tests will be designed and distributed. We expect it will be desirable to configure multiple MPLS TE paths in the final topology.

2 Abbreviations

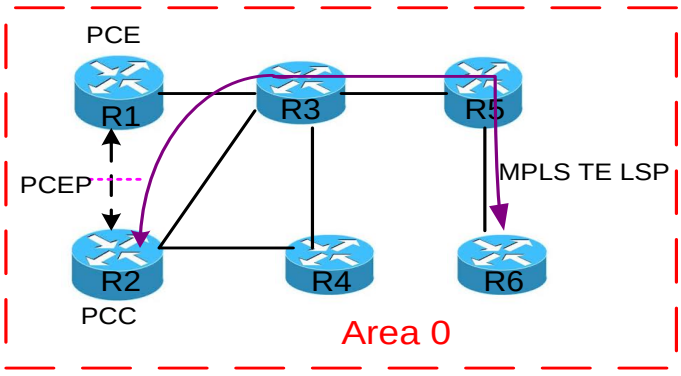
- PCC – Path Computation Client
- PCE – Path Computation Element
- MPLS TE – Multiprotocol Label Switching Traffic Engineering
- PCRpt- Path Computation State Report
- PCUpd- Path Computation LSP Update Request
- PCInitiate- Path Computation LSP Initiate
- PCCreate- Path Computation LSP Create
- LSP- Label Switched Path
- PCReq- Path Computation Request Message
- PCRep- Path Computation Reply Message

3 PCEP extension for Stateful PCE

3.1 Test case: PCEP Session Initiation

Purpose: To ensure that sessions are correctly initialized and only one session can be initiated per PCC/PCE.

Topology:



3.1.1 PCC to PCE Communication

Procedure:

1. Retain topology.
2. Configure R1 with PCE role and R2 with PCC role. (R1 must have enough information to compute path across the network).
3. Establish a PCEP session between R1 and R2.
4. Attempt to establish an additional PCEP session between R1 and R2.

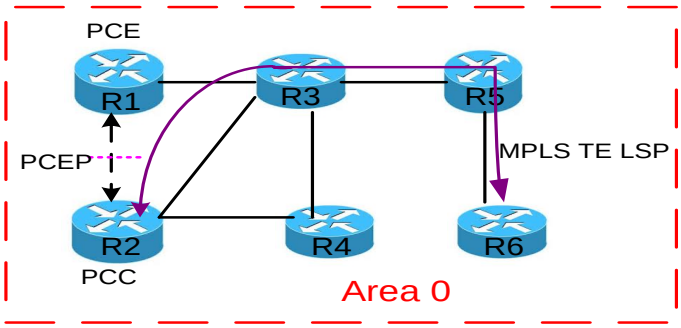
5. If provided by the implementation, query and observe the following parameters: PCEP Session failure count, amount of time the session has been in active state, number of corrupted messages, response time, number of requests not replied to, and number of failed computations. Report any anomalies. If an optional error log is maintained, check it for anomalies.

Expected Result: Session is successfully established. Attempts to establish additional sessions do not create duplicate PCEP connections between the devices.

3.2 Test case: Capability Negotiation

Purpose: To ensure that both PCE and PCC support PCEP Stateful PCE extension.

Topology:



Procedure:

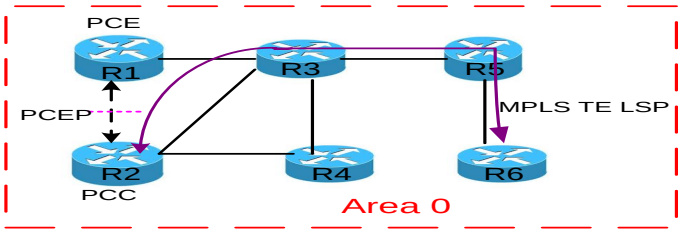
1. Retain topology.
2. Configure R1 with PCE role and R2 with PCC role. (R1 must have enough information to compute path across the network).
3. Establish a PCEP session between R1 and R2.
4. Make sure that there is a Stateful PCE capability TLV in PCEP speakers (PCE pr PCC) OPEN message.
5. Make sure that the 'LSP update' flag "U" is present and is equal to one, in Stateful Capability TLV.

Expected result: Both PCC and PCE must announce that they support PCEP Stateful PCE extension during PCEP session establishment.

3.3 Test case: State Synchronization

Purpose: To ensure a timely synchronization of LSP state between PCE and PCC, including path computation result, and LSP setup or deletion result.

Topology:



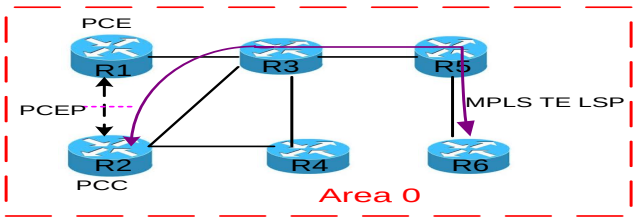
Procedure:

1. Construct the topology as shown.
2. Configure R1 with PCE role and R2 with PCC role. (R1 must have enough information to compute path across the network).
3. Establish a PCEP session between R1 and R2.
4. Make sure that the PCC sends the path setup result to PCE with notification value equal to 3/4.
5. For success: make sure that PCE saved the resources for the <path> carried in the PCNtf.
6. For failure: make sure that PCE removed the resources for the <path> carried in the PCNtf.
7. Make sure that the PCC sends the path deletion result to PCE with notification value equal to 5.
8. Make sure that the resources of deleted LSP are removed from its local TED.

3.4 Test case: PCE Initiated LSP (PCcreate)

Purpose: To ensure that the LSP can be dynamically created and torn down as per the application requirements.

Topology:

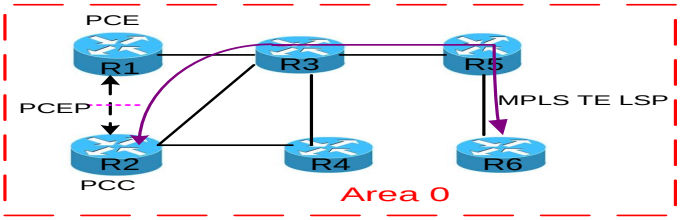


Procedure:

1. Construct the topology as shown above**.**
2. Configure R1 with PCE role and R2 with PCC role. (R1 must have enough information to compute path across the network).
3. Establish a PCEP session between R1 and R2.
4. Make sure that PCC (R2) supports provisioned dynamic LSPs during the PCEP Initialization Phase via a new flag in the STATEFUL- PCE-CAPABILITY TLV.
5. In order to support PCE-initiated LSP instantiation, make sure that the LSP-INSTANTIATION-CAPABILITY flag "I" is set to 1 by both PCC and PCE.
6. Configure R1 to send a PCcreate message to R2 to trigger an LSP instantiation.
7. Make sure that the PCcreate message contains end-points and the LSPA objects.
8. Make sure that the End-Points objects contain source and destination addresses.
9. Make sure that the LSPA Object contains SYMBOLIC-PATH-NAME TLV, which is used to correlate between the PCC-assigned LSP-ID and the LSP.
10. Configure R1 to remove the PCE- Initiated LSP, and make sure that the "R" Flag is set to 1 in LSP Object in the PCUpd request from R1.
11. Once the PCC (R2) received the PCUpd message with "R" Flag set to 1, make sure that the PCC tears down the LSP and removes its state, and sends back the PCRpt message to PCE (R1) with "R" Flag set to 1.
12. Make sure that the PCC cannot revoke the delegation for PCE-initiated LSPs for an active PCEP session.

3.5 Test case: Path Computation Update Request (PCUpd)

Topology:



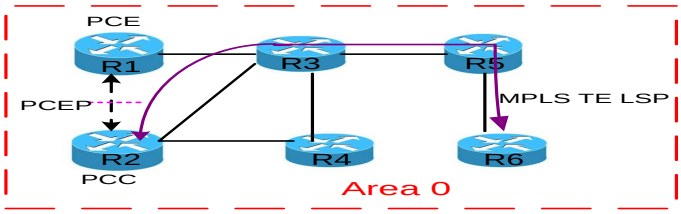
Procedure:

1. Construct the topology shown as above.
2. Configure a LSP1 from R2 to R6 where no constraint is applied.

3. Configure a PCE (R1) to send a LSP update request to PCC (R2) for LSPs. A constraint metric (bandwidth) should be specified on a LSP update request message in order to fulfill the desires of PCE for LSPs.
4. Make sure that the LSP update request message must have SRP objects, LSP objects and ERO objects.
5. If any one of these objects is missing on the LSP update request message, the receiving PCC must send PCError message with Error-type = 6.
6. Make sure that the PCC respond with an LSP state report to each LSP update request it processed (even the processing didn't result in changing the state of the LSP).
7. Make sure that the SRP-ID number in the PCRpt is exactly same as in the PCUpd.
8. Configure R2 to delegate an LSP to R1, and make sure that R2 sends the State Report to R1 by setting Delegate Flag to 1.
9. In order to confirm the acceptance of delegation, make sure that the PCE sends the PCUpd message to PCC (R2) by setting the Delegate flag to 1, or if PCE wishes to decline the LSP Delegation, it must send the PCUpd message to PCC by setting the Delegate Flag to Zero.
10. Configure R1 to return a LSP delegation to R2, and make sure that R1 sends an empty LSP Update Request to R2 by setting Delegate Flag to 0.
11. If provided by the implementation, query and observe the following parameters:
    Total number of LSP updates, Number of successful LSP updates, Number for dropped LSP updates, Number of LSP updates for failed LSP set up. Report any anomalies. If an optional error log is maintained, check it for anomalies.

3.6 Test case: LSP state from the Network (PCRpt)

Topology:



Procedure:

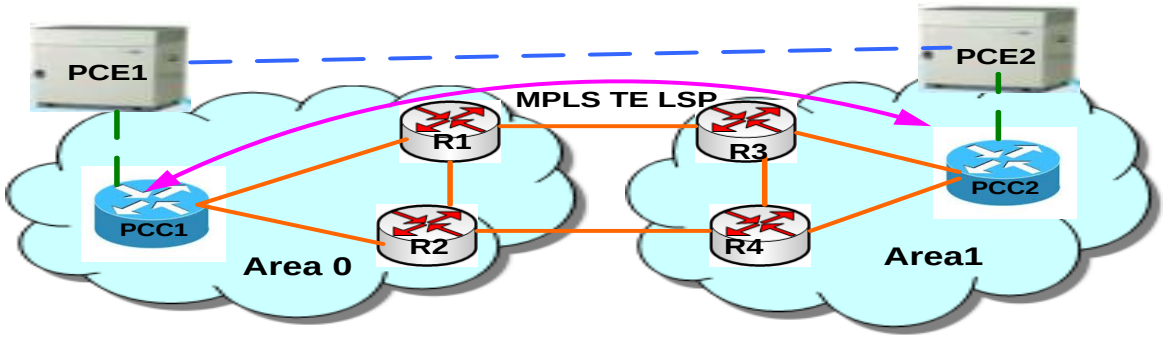
1. Construct the topology as shown above**.**
2. Configure R1 with PCE role and R2 with PCC role. (R1 must have enough information to compute path across the network).
3. Establish a PCEP session between R1 and R2.
4. Make sure that the LSP state is synchronized between PCC (R2) and PCE (R1), and during synchronization phase the SYNC Flag of LSP object should be set to 1 in each LSP State Report.

5. Make sure that the PCC (R2) responds with an LSP state report to each LSP update request it processed from R2 (even the processing didn't result in changing the state of the LSP).
6. Configure R2 to delegate an LSP to R1, and make sure that R2 sends the State Report to R1 by setting Delegate Flag to 1.
7. Configure R2 to revoke a Delegation from R1, and make sure that R2 sends a LSP State Report to R1 by setting Delegate Flag to 0.
8. If provided by the implementation, query and observe the following parameters:
   Total number of LSP State Reports, number of successful LSP State Reports, number for dropped LSP State Reports, number of LSP State Reports for failed LSP set up. Report any anomalies. If an optional error log is maintained, check it for anomalies.

4 Inter-area Path Communication

4.1 Test Case: Passive Stateful PCE Path Computation Request/Response

Topology:



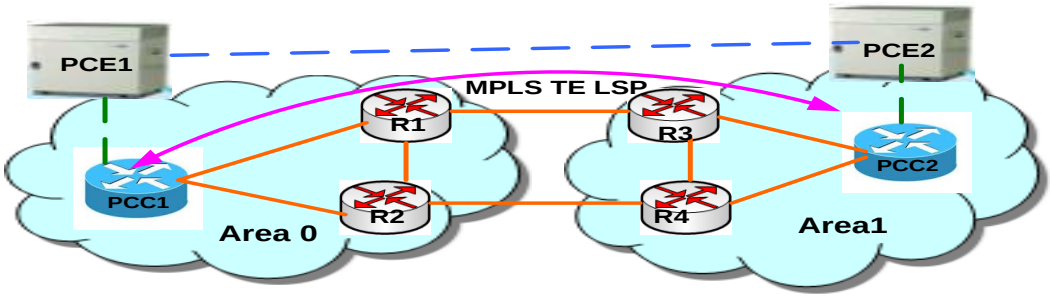
Procedure:

1. Construct the topology as shown above**.**
2. Establish a PCEP session between PCC1 and PCE1, PCC2 and PCE2, and PCE1 and PCE2 respectively.
3. Make sure that the LSP state is synchronized between PCC1 and PCE1, and PCC2 and PCE2 respectively and also in between PCE1 and PCE2.
4. Configure PCC1 to send a request to PCE1 for a path from PCC1 to PCC2. A constraint metric should be specified, such that the PCE1 and PCE2 are able to satisfy the request.
5. Make sure that the PCReq message is synchronized between PCE1 and PCE2.
6. Make sure that PCE2 must return the path route to PCE1 and PCE1 to PCC1.
7. Make sure that the PCC1 sends the LSP State Report (PCRpt) message to PCE1 after setting up the requested LSPs, and also the state is synchronized with PCE2.

Expected Result: PCE router provides a path when it is able to satisfy the request and no path when it is unable to. PCC router is able to interpret the path reply provided by PCE router correctly.

4.2 Test Case: Active Stateful PCE LSP Update

Topology:



Procedure:

1. Construct the topology as shown above**.**
2. Establish a PCEP session between PCC1 and PCE1, PCC2 and PCE2, and PCE1 and PCE2 respectively.
3. Make sure that the LSP state is synchronized between PCC1 and PCE1, and PCC2 and PCE2 respectively and also in between PCE1 and PCE2.
4. Configure a PCE1 to send a LSP update request to PCC1 for LSP1. A constraint metric (bandwidth) should be specified on a LSP update request message in order to fulfill the desires of PCE1 for LSP1.
5. Make sure that the PCC1 and PCC2 respond with an LSP state report to each LSP update request it processed from PCE1 and PCE2 respectively (even the processing didn't result in changing the state of the LSP).
6. Configure PCC1 to delegate an LSP to PCE1, and make sure that PCC1 sends the State Report to PCE1 by setting Delegate Flag to 1.
7. In order to confirm the acceptance of delegation, make sure that the PCE1 sends the PCUpd message to PCC1 by setting the Delegate flag to 1, or if PCE1 wishes to decline the LSP Delegation, it must send the PCUpd message to PCC1 by setting the Delegation Flag to Zero.
8. Configure PCC1 to revoke a Delegation from PCE1, and make sure that PCC1 sends a LSP State Report to PCE1 by setting Delegate Flag to 0.
9. Configure PCE1 to return a LSP delegation to PCC1, and make sure that PCE1 sends an empty LSP Update Request to PCC1 by setting Delegate Flag to 0.
10. If provided by the implementation, query and observe the following parameters:

Total number of LSP updates, Number of successful LSP updates, Number for dropped LSP updates, Number of LSP updates for failed LSP set up. Report any anomalies. If an optional error log is maintained, check it for anomalies.

4 References:

[1]. PCEP Extensions for Stateful PCE, *draft-ietf-pce-stateful-pce-03*

[2]. PCEP Extensions for PCE-initiated LSP Setup in a Stateful PCE Model, *draft-crabbe-pce-pce-initiated-lsp-00*

[3]. Applicability of Stateful Path Computation Element (PCE)*, draft-zhang-pce-stateful-pce-app-03*

[4]. Stateful PCE*, draft-tang-pce-stateful-pce-02*