**PCEP Protocol**

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**Team**

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patrick Liu</td>
<td>Huawei Technologies</td>
<td><a href="mailto:Patrick.Liu@huawei.com">Patrick.Liu@huawei.com</a></td>
</tr>
<tr>
<td>Suresh B R</td>
<td>Huawei Technologies</td>
<td><a href="mailto:Suresh.B.R@huawei.com">Suresh.B.R@huawei.com</a></td>
</tr>
<tr>
<td>Mahesh Poojary</td>
<td>Huawei Technologies</td>
<td><a href="mailto:mahesh.poojary@huawei.com">mahesh.poojary@huawei.com</a></td>
</tr>
<tr>
<td>Phaneendra Manda</td>
<td>Huawei Technologies</td>
<td><a href="mailto:phaneendra.manda@huawei.com">phaneendra.manda@huawei.com</a></td>
</tr>
<tr>
<td>Bharat Saraswal</td>
<td>Huawei Technologies</td>
<td><a href="mailto:bharat.saraswal@huawei.com">bharat.saraswal@huawei.com</a></td>
</tr>
<tr>
<td>Priyanka B</td>
<td>Huawei Technologies</td>
<td><a href="mailto:priyanka.b@huawei.com">priyanka.b@huawei.com</a></td>
</tr>
<tr>
<td>Rajakumar Gootla</td>
<td>Huawei Technologies</td>
<td><a href="mailto:rajakumarg@huawei.com">rajakumarg@huawei.com</a></td>
</tr>
</tbody>
</table>

**Overview**

This project adds Path Computation Element Protocol (PCEP) as a southbound plugin in ONOS.

**Proposed work**

Add PCEP South Bound Interface (SBI) for MPLS TE tunnel management which will implement TunnelProvider API to support initiating, updating and releasing of PCE initiated tunnels using PCE communication protocol. The implementation will also support learning of existing active tunnels which are on the network.

Implement PCEP protocol handler, which acts as a server to listen on PCEP port 4189 to establish and manage session with PCCs. A channel handler will be created for each PCEP session to maintain the state machine and state of each PCC.

Implement PCEP message handler, which will encode and decode PCEP messages between ONOS PCEP SBI and PCC. Currently the messages supported are Open, KeepAlive, PCInitiate, PCUpd, PCRpt, PCLabelUpd, TERpt, PCLRResv, PCErr and Close.

Implementation supports state synchronization with PCC reporting reporting LSPs’ state to PCEP protocol handler running on ONOS immediately after session established. These report messages are notified to PCEP Tunnel Provider via message listener which in turn will inform the ONOS Core about the existing tunnels in the network. The Report message can also be the result of PCE initiated messages for creating, updating or releasing tunnels. In this case PCEP Tunnel Provider will invoke the respective API to notify ONOS Core about the result of create or update or release tunnels. All communication between PCEP provider and ONOS Core uses Provider Service interface.

**Pcep Tunnel Provider API**

The below API are implemented for tunnel provider in PCEP SBI

**SetupTunnel API**
Arguments: Tunnel, Path
Return Value: None

Details: This API is responsible for setting up a tunnel on the device. It gets the tunnel parameters from the input parameters Tunnel and Path. The API implementation builds the PCInitiate protocol message from the input parameters. The ingress and egress are taken from src and dst members of Tunnel class. The ingress is considered as source for the tunnel and PCInitiate message is sent to ingress device for which a session is already established with the PCEP protocol handler. The explicit route object is built from the link parameter in the input Path class. The API implementation will take care of generating unique ID for sending the message to PCC and mapping the response from PCC. Finally the response is given to ONOS core using PCEP tunnel provider service.

UpdateTunnel API
Arguments: Tunnel, Path
Return Value: None

Details: This API is responsible for modifying an existing tunnel on the device. It gets the tunnel parameters from the input parameters Tunnel and Path. The API implementation builds the PCUpd protocol message from the input parameters. To send a PCUpd message the ingress device should have a tunnel which is already created and the PCE must be the owner of this tunnel. The ingress and egress for the tunnel are taken from src and dst of Tunnel class. The ingress is considered as source for the tunnel and PCUpd message is sent to ingress device for which a session is already established with the PCEP protocol handler. The explicit route object is built from link parameter in the Path class. The API implementation will take care of generating unique ID for sending the message to PCC and mapping the response from PCC. Finally the response is given to ONOS core using PCEP tunnel provider service.

ReleaseTunnel API
Arguments: Tunnel
Return Value: None

Details: This API is responsible for deleting an existing tunnel on the device. It gets the tunnel parameters from the input parameter Tunnel. The API implementation builds the PCInitiate protocol message from the input parameters. To send a PCInitiate message with delete flag set, the ingress device should have a tunnel which is already created and the PCE must be the owner of this tunnel. The tunnel id, ingress and egress for the tunnel are taken from tunnel id, src and dst of Tunnel class. The ingress is considered as source for the tunnel and PCInitiate message is sent to ingress device for which a session is already established with the PCEP protocol handler. The API implementation will take care of generating unique ID for sending the message to PCC and mapping the response from PCC. Finally the response is given to ONOS core using PCEP tunnel provider service.

Messages Supported

Open Message
Open message is used to establish a PCEP session between PCEP peers. This carries various session characteristics like keep alive time, dead time and capability.

Supported TLVs
- Gmpls-capability TLV
- Stateful-Pce-capability TLV
- Pcecc capability TLV

KeepAlive Message
Keep alive message used to keep the session active and also in response to open messages while session establishment to acknowledge Open messages and session characteristics are acceptable.

Supported TLVs
Not Applicable

PCInitiate Message
Setup Tunnel API will build the PCInitiate message to setup a tunnel at the PCC. The objects supported in PCInitiate message are

SRP Object
The SRP (Stateful PCE request parameters) object set the unique identifier for mapping request/response between PCEP and PCC.

**Supported TLV's**
- Symbolic path name TLV

**LSP Object**
The LSP contains a set of fields used to specify the target LSP, the operation to be performed on the LSP and LSP delegation. It also contains a flag indicating to a PCE that the LSP state synchronization in progress.

**Supported TLV's**
- LSP identifiers TLV (IPV4)
- Symbolic path name TLV
- LSP Error code TLV
- RSVP Error Spec TLV

**END POINTS Object**
The END POINTS object used to specify the source and destination IP addresses of the tunnel.

**Supported TLVs**
- None.

**ERO Object**
Explicit route objects contain list of variable length SubObjects.

**Supported SubObjects**
- IPv4 Prefix
- IPv6 Prefix
- Autonomous System number
- SR-ERO SubObject
- Path Key SubObject

**BANDWIDTH Object**
This object used to specify the requested bandwidth for a TE LSP.

**PCUpd Message**
Update Tunnel API will build the PCUpd message to update a tunnel at the PCC. The objects supported in PCUpd message are

**SRP Object**
The SRP (Stateful PCE request parameters) object set the unique identifier for mapping request/response between PCEP and PCC.

**Supported TLV's**
- Symbolic path name TLV

**LSP Object**
The LSP contains a set of fields used to specify the target LSP, the operation to be performed on the LSP and LSP delegation. It also contains a flag indicating to a PCE that the LSP state synchronization in progress.

**Supported TLV's**
LSP identifiers TLV (IPV4)
Symbolic path name TLV
LSP Error code TLV
RSVP Error Spec TLV

ERO Object

Explicit route objects contain list of variable length SubObjects.

**Supported SubObjects**

- IPv4 Prefix
- IPv6 Prefix
- Autonomous System number
- SR-ERO SubObject
- Path Key SubObject

BANDWIDTH Object

This object used to specify the requested bandwidth for a TE LSP.

PCRpt message

Report message is sent by PCC in response to PCInitiate/PCUpd messages. Report message is also sent for synchronizing LSP state DB between PCC and PCE immediately after the session establishment. The objects supported in PCRpt message are

SRP Object

The SRP (Stateful PCE request parameters) object set the unique identifier for mapping request/response between PCEP and PCC. SRP object is optional in report messages sent for LSP state synchronization.

**Supported TLV's**

- Symbolic path name TLV

LSP Object

The LSP contains a set of fields used to specify the target LSP, the operation to be performed on the LSP and LSP delegation. It contains a S flag when true indicates to a PCE that the LSP state synchronization in progress.

**Supported TLV's**

- LSP identifiers TLV (IPV4)
- Symbolic path name TLV
- LSP Error code TLV
- RSVP Error Spec TLV

RRO Object

Record route objects contain list of variable length SubObjects.

**Supported SubObjects**

- IPv4SubObject
- IPv6SubObject
- LabelSubObject
**BANDWIDTH Object**
This object used to report the bandwidth for an existing TE LSP.

**PCLabelUpd message**
This message is sent by PCE to PCC to download the label or update the label map. The same message is also used to clean the label entry. The objects supported are

**SRP Object**
The SRP (Stateful PCE request parameters) object set the unique identifier for mapping request/response between PCEP and PCC. SRP object is optional in report messages sent for LSP state synchronization.

**Supported TLVs**
Symbolic path name TLV

**LABEL Object**
The LABEL object used to specify the label information and must be carried within PLabelUpd message.

**Supported TLVs**
NexthopIPv4addressTlv
NexthopUnnumberedIPv4IDTlv

**FEC Object**
The FEC object is used to specify FEC information. The types of FEC objects supported are
- IPv4 Node ID
- IPv6 Node ID
- IPv4 Adjacency
- IPv6 Adjacency

**TERpt message**
This message is sent by PCC to PCE to report any changes in the TE DB. The objects supported in TE Report are

**TE Object**
TE Object contains a set of fields used to specify target TE node or link. It also contains a flag indicating to a PCE that the TED synchronization in progress.

**Supported TLVs**
Routing Universe TLV
Local TE Node Descriptors TLV
Remote TE Node Descriptors TLV
TE Node Descriptors TLV
TE Link Descriptors TLV
TE Node Attributes TLV
TE Link Attributes TLV

**PCLRResv message**
This message is bidirectional between PCC and PCE. This message is sent by PCC to PCE for the reservation of label range. This message is sent by PCE to PCC to send reserved label range for the network. The objects supported in this message are

**SRP Object**

The SRP (Stateful PCE request parameters) object sets the unique identifier for mapping request/response between PCEP and PCC. SRP object is optional in report messages sent for LSP state synchronization.

*Supported TLVs*

Symbolic path name TLV

**Label Range Object**

This object carries label range information based on the label type.

**PCErr message**

This message is sent by either PCC or PCE in several situations like, when a protocol error condition is met, when a request is not compliant with PCEP specification, policy violation, unexpected message etc. The objects supported in this message are

**PCEP Error Object**

This object is carried in PCErr message to notify PCEP error

**Open Object**

When the parameters in open message are not accepted, then PCErr message is sent to PCEP peer with Open object.