

PCE Working Group
Internet-Draft
Intended status: Standards Track
Expires: September 13, 2017

D. Dhody, Ed.
Huawei Technologies
J. Hardwick
Metaswitch
V. Beeram
Juniper Networks
J. Tantsura
March 12, 2017

A YANG Data Model for Path Computation Element Communications Protocol
(PCEP)
draft-ietf-pce-pcep-yang-02

Abstract

This document defines a YANG data model for the management of Path Computation Element communications Protocol (PCEP) for communications between a Path Computation Client (PCC) and a Path Computation Element (PCE), or between two PCEs. The data model includes configuration data and state data (status information and counters for the collection of statistics).

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1. Introduction

The Path Computation Element (PCE) defined in [RFC4655] is an entity that is capable of computing a network path or route based on a network graph, and applying computational constraints. A Path Computation Client (PCC) may make requests to a PCE for paths to be computed.

PCEP is the communication protocol between a PCC and PCE and is defined in [RFC5440]. PCEP interactions include path computation requests and path computation replies as well as notifications of specific states related to the use of a PCE in the context of Multiprotocol Label Switching (MPLS) and Generalized MPLS (GMPLS) Traffic Engineering (TE). [I-D.ietf-pce-stateful-pce] specifies extensions to PCEP to enable stateful control of MPLS TE LSPs.

This document defines a YANG [RFC6020] data model for the management of PCEP speakers. It is important to establish a common data model for how PCEP speakers are identified, configured, and monitored. The data model includes configuration data and state data (status information and counters for the collection of statistics).

This document contains a specification of the PCEP YANG module, "ietf-pcep" which provides the PCEP [RFC5440] data model.

2. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

3. Terminology and Notation

This document uses the terminology defined in [RFC4655] and [RFC5440]. In particular, it uses the following acronyms.

- o Path Computation Request message (PCReq).
- o Path Computation Reply message (PCRep).
- o Notification message (PCNtf).
- o Error message (PCErr).
- o Request Parameters object (RP).
- o Synchronization Vector object (SVEC).
- o Explicit Route object (ERO).

This document also uses the following terms defined in [RFC7420]:

- o PCEP entity: a local PCEP speaker.
- o PCEP peer: to refer to a remote PCEP speaker.

- o PCEP speaker: where it is not necessary to distinguish between local and remote.

Further, this document also uses the following terms defined in [I-D.ietf-pce-stateful-pce] :

- o Stateful PCE, Passive Stateful PCE, Active Stateful PCE
- o Delegation, Revocation, Redelegation
- o LSP State Report, Path Computation Report message (PCRpt).
- o LSP State Update, Path Computation Update message (PCUpd).

[I-D.ietf-pce-pce-initiated-lsp] :

- o PCE-initiated LSP, Path Computation LSP Initiate Message (PCInitiate).

[I-D.ietf-pce-lsp-setup-type] :

- o Path Setup Type (PST).

[I-D.ietf-pce-segment-routing] :

- o Segment Routing (SR).

3.1. Tree Diagrams

A graphical representation of the complete data tree is presented in Section 5. The meaning of the symbols in these diagrams is as follows and as per [I-D.ietf-netmod-rfc6087bis]. Each node is printed as:

<status> <flags> <name> <opts> <type> <if-features>

<status> is one of:

- + for current
- x for deprecated
- o for obsolete

<flags> is one of:

- rw for configuration data
- ro for non-configuration data
- x for rpcs and actions
- n for notifications

<name> is the name of the node

- (<name>) means that the node is a choice node
- :(<name>) means that the node is a case node

If the node is augmented into the tree from another module, its name is printed as <prefix>:<name>.

<opts> is one of:

- ? for an optional leaf, choice, anydata or anyxml
- ! for a presence container
- * for a leaf-list or list
- [<keys>] for a list's keys

<type> is the name of the type for leafs and leaf-lists

If the type is a leafref, the type is printed as "-> TARGET", where TARGET is either the leafref path, with prefixed removed if possible.

<if-features> is the list of features this node depends on, printed within curly brackets and a question mark "{...}?"

3.2. Prefixes in Data Node Names

In this document, names of data nodes and other data model objects are often used without a prefix, as long as it is clear from the context in which YANG module each name is defined. Otherwise, names are prefixed using the standard prefix associated with the corresponding YANG module, as shown in Table 1.

Prefix	YANG module	Reference
yang	ietf-yang-types	[RFC6991]
inet	ietf-inet-types	[RFC6991]
te	ietf-te	[I-D.ietf-teas-yang-te]
te-types	ietf-te-types	[I-D.ietf-teas-yang-te]
key-chain	ietf-key-chain	[I-D.ietf-rtgwg-yang-key-chain]
nacm	ietf-netconf-acm	[RFC6536]

Table 1: Prefixes and corresponding YANG modules

4. Objectives

This section describes some of the design objectives for the model:

- o In case of existing implementations, it needs to map the data model defined in this document to their proprietary native data model. To facilitate such mappings, the data model should be simple.
- o The data model should be suitable for new implementations to use as is.
- o Mapping to the PCEP MIB Module should be clear.
- o The data model should allow for static configurations of peers.
- o The data model should include read-only counters in order to gather statistics for sent and received PCEP messages, received messages with errors, and messages that could not be sent due to errors. This could be in a separate model which augments the base data model.
- o It should be fairly straightforward to augment the base data model for advanced PCE features.

5. The Design of PCEP Data Model

The module, "ietf-pcep", defines the basic components of a PCE speaker.

```

module: ietf-pcep
  +--rw pcep!
  |   +--rw entity
  |   |   +--rw addr                               inet:ip-address
  |   |   +--rw enabled?                           boolean

```

```

+--rw role                                pcep-role
+--rw description?                        string
+--rw speaker-entity-id?                  string
|   {stateful-sync-opt}?
+--rw domain
|   +--rw domain* [domain-type domain]
|       +--rw domain-type    domain-type
|       +--rw domain          domain
+--rw capability
|   +--rw gmpls?                boolean {gmpls}?
|   +--rw bi-dir?                boolean
|   +--rw diverse?                boolean
|   +--rw load-balance?            boolean
|   +--rw synchronize?            boolean {svec}?
|   +--rw objective-function?    boolean
|       {objective-function}?
|   +--rw add-path-constraint?    boolean
|   +--rw prioritization?          boolean
|   +--rw multi-request?           boolean
|   +--rw gco?                    boolean {gco}?
|   +--rw p2mp?                   boolean {p2mp}?
|   +--rw stateful {stateful}?
|       +--rw enabled?            boolean
|       +--rw active?             boolean
|       +--rw pce-initiated?      boolean
|           {pce-initiated}?
|       +--rw include-db-ver?      boolean
|           {stateful-sync-opt}?
|       +--rw trigger-resync?      boolean
|           {stateful-sync-opt}?
|       +--rw trigger-initial-sync? boolean
|           {stateful-sync-opt}?
|       +--rw incremental-sync?    boolean
|           {stateful-sync-opt}?
|   +--rw sr {sr}?
|       +--rw enabled?            boolean
+--rw pce-info
|   +--rw scope
|       +--rw intra-area-scope?    boolean
|       +--rw intra-area-pref?     uint8
|       +--rw inter-area-scope?    boolean
|       +--rw inter-area-scope-default? boolean
|       +--rw inter-area-pref?     uint8
|       +--rw inter-as-scope?      boolean
|       +--rw inter-as-scope-default? boolean
|       +--rw inter-as-pref?       uint8
|       +--rw inter-layer-scope?   boolean
|       +--rw inter-layer-pref?    uint8

```

```

+--rw neigh-domains
|   +--rw domain* [domain-type domain]
|       +--rw domain-type    domain-type
|       +--rw domain         domain
+--rw path-key {path-key}?
|   +--rw enabled?           boolean
|   +--rw discard-timer?     uint32
|   +--rw reuse-time?       uint32
|   +--rw pce-id?           inet:ip-address
+--rw (auth-type-selection)?
|   +--:(auth-key-chain)
|   |   +--rw key-chain?
|   |   |   key-chain:key-chain-ref
|   +--:(auth-key)
|   |   +--rw crypto-algorithm          identityref
|   |   +--rw key-string
|   |   |   +--rw (key-string-style)?
|   |   |   |   +--:(keystring)
|   |   |   |   |   +--rw keystring?          string
|   |   |   |   +--:(hexadecimal)
|   |   |   |   |   {key-chain:hex-key-string}?
|   |   |   +--rw hexadecimal-string?      yang:hex-string
|   +--:(auth-tls) {tls}?
|   |   +--rw tls
+--rw connect-timer?          uint32
+--rw connect-max-retry?      uint32
+--rw init-backoff-timer?     uint32
+--rw max-backoff-timer?      uint32
+--rw open-wait-timer?        uint32
+--rw keep-wait-timer?        uint32
+--rw keep-alive-timer?       uint32
+--rw dead-timer?            uint32
+--rw allow-negotiation?      boolean
+--rw max-keep-alive-timer?    uint32
+--rw max-dead-timer?         uint32
+--rw min-keep-alive-timer?    uint32
+--rw min-dead-timer?         uint32
+--rw sync-timer?            uint32 {svec}?
+--rw request-timer?          uint32
+--rw max-sessions?           uint32
+--rw max-unknown-reqs?       uint32
+--rw max-unknown-msgs?       uint32
+--rw pcep-notification-max-rate uint32
+--rw stateful-parameter {stateful}?
|   +--rw state-timeout?       uint32
|   +--rw redelegation-timeout? uint32
|   +--rw rpt-non-pcep-lsp?    boolean
+--rw of-list {objective-function}?

```



```

|   +--rw objective-function* [of]
|   |   +--rw of      objective-function
+--rw peers
|   +--rw peer* [addr]
|   |   +--rw addr          inet:ip-address
|   |   +--rw description?  string
|   |   +--rw domain
|   |   |   +--rw domain* [domain-type domain]
|   |   |   |   +--rw domain-type  domain-type
|   |   |   |   +--rw domain      domain
+--rw capability
|   +--rw gmpls?              boolean {gmpls}?
|   +--rw bi-dir?             boolean
|   +--rw diverse?            boolean
|   +--rw load-balance?       boolean
|   +--rw synchronize?        boolean {svec}?
|   +--rw objective-function? boolean
|   |   {objective-function}?
+--rw add-path-constraint?    boolean
+--rw prioritization?         boolean
+--rw multi-request?          boolean
+--rw gco?                    boolean {gco}?
+--rw p2mp?                   boolean {p2mp}?
+--rw stateful {stateful}?
|   +--rw enabled?             boolean
|   +--rw active?              boolean
|   +--rw pce-initiated?       boolean
|   |   {pce-initiated}?
+--rw include-db-ver?         boolean
|   |   {stateful-sync-opt}?
+--rw trigger-resync?         boolean
|   |   {stateful-sync-opt}?
+--rw trigger-initial-sync?    boolean
|   |   {stateful-sync-opt}?
+--rw incremental-sync?        boolean
|   |   {stateful-sync-opt}?
+--rw sr {sr}?
|   |   +--rw enabled?         boolean
+--rw scope
|   +--rw intra-area-scope?     boolean
|   +--rw intra-area-pref?      uint8
|   +--rw inter-area-scope?     boolean
|   +--rw inter-area-scope-default? boolean
|   +--rw inter-area-pref?      uint8
|   +--rw inter-as-scope?       boolean
|   +--rw inter-as-scope-default? boolean
|   +--rw inter-as-pref?        uint8
|   +--rw inter-layer-scope?    boolean

```

```

|      |--rw inter-layer-pref?          uint8
+--rw neigh-domains
|      |--rw domain* [domain-type domain]
|      |      |--rw domain-type      domain-type
|      |      |--rw domain          domain
+--rw delegation-pref?      uint8 {stateful}?
+--rw (auth-type-selection)?
+--:(auth-key-chain)
|      |--rw key-chain?
|      |      key-chain:key-chain-ref
+--:(auth-key)
|      |--rw crypto-algorithm      identityref
|      |--rw key-string
|      |      |--rw (key-string-style)?
|      |      |      |--:(keystring)
|      |      |      |      |--rw keystring?          string
|      |      |      |      |--:(hexadecimal)
|      |      |      |      |      {key-chain:hex-key-string}?
|      |      |      |      |      |--rw hexadecimal-string?
|      |      |      |      |      yang:hex-string
+--:(auth-tls) {tls}?
+--rw tls
+--ro pcep-state
+--ro entity
+--ro addr?          inet:ip-address
+--ro index?         uint32
+--ro admin-status?  pcep-admin-status
+--ro oper-status?   pcep-admin-status
+--ro role?          pcep-role
+--ro description?   string
+--ro speaker-entity-id? string
|      {stateful-sync-opt}?
+--ro domain
|      |--ro domain* [domain-type domain]
|      |      |--ro domain-type      domain-type
|      |      |--ro domain          domain
+--ro capability
|      |--ro gmpls?          boolean {gmpls}?
|      |--ro bi-dir?         boolean
|      |--ro diverse?        boolean
|      |--ro load-balance?    boolean
|      |--ro synchronize?    boolean {svec}?
|      |--ro objective-function? boolean
|      |      {objective-function}?
|      |--ro add-path-constraint? boolean
|      |--ro prioritization?  boolean
|      |--ro multi-request?   boolean
|      |--ro gco?            boolean {gco}?

```

```

| +--ro p2mp?                               boolean {p2mp}?
| +--ro stateful {stateful}?
| | +--ro enabled?                           boolean
| | +--ro active?                           boolean
| | +--ro pce-initiated?                     boolean
| | | {pce-initiated}?
| | +--ro include-db-ver?                     boolean
| | | {stateful-sync-opt}?
| | +--ro trigger-resync?                     boolean
| | | {stateful-sync-opt}?
| | +--ro trigger-initial-sync?               boolean
| | | {stateful-sync-opt}?
| | +--ro incremental-sync?                   boolean
| | | {stateful-sync-opt}?
| +--ro sr {sr}?
| | +--ro enabled?   boolean
+--ro pce-info
| +--ro scope
| | +--ro intra-area-scope?                   boolean
| | +--ro intra-area-pref?                     uint8
| | +--ro inter-area-scope?                   boolean
| | +--ro inter-area-scope-default?           boolean
| | +--ro inter-area-pref?                     uint8
| | +--ro inter-as-scope?                     boolean
| | +--ro inter-as-scope-default?             boolean
| | +--ro inter-as-pref?                       uint8
| | +--ro inter-layer-scope?                   boolean
| | +--ro inter-layer-pref?                     uint8
| +--ro neigh-domains
| | +--ro domain* [domain-type domain]
| | | +--ro domain-type   domain-type
| | | +--ro domain       domain
| +--ro path-key {path-key}?
| | +--ro enabled?           boolean
| | +--ro discard-timer?     uint32
| | +--ro reuse-time?        uint32
| | +--ro pce-id?            inet:ip-address
+--ro (auth-type-selection)?
| +--:(auth-key-chain)
| | +--ro key-chain?
| | | key-chain:key-chain-ref
| +--:(auth-key)
| | +--ro crypto-algorithm   identityref
| | +--ro key-string
| | | +--ro (key-string-style)?
| | | | +--:(keystring)
| | | | | +--ro keystring?           string
| | | | +--:(hexadecimal)

```

```

| | | | {key-chain:hex-key-string}?
| | | | +--ro hexadecimal-string? yang:hex-string
| | | +--:(auth-tls) {tls}?
| | | | +--ro tls
+--ro connect-timer? uint32
+--ro connect-max-retry? uint32
+--ro init-backoff-timer? uint32
+--ro max-backoff-timer? uint32
+--ro open-wait-timer? uint32
+--ro keep-wait-timer? uint32
+--ro keep-alive-timer? uint32
+--ro dead-timer? uint32
+--ro allow-negotiation? boolean
+--ro max-keep-alive-timer? uint32
+--ro max-dead-timer? uint32
+--ro min-keep-alive-timer? uint32
+--ro min-dead-timer? uint32
+--ro sync-timer? uint32 {svec}?
+--ro request-timer? uint32
+--ro max-sessions? uint32
+--ro max-unknown-reqs? uint32
+--ro max-unknown-msgs? uint32
+--ro stateful-parameter {stateful}?
| | +--ro state-timeout? uint32
| | +--ro redelegation-timeout? uint32
| | +--ro rpt-non-pcep-lsp? boolean
+--ro lsp-db {stateful}?
| | +--ro db-ver? uint64
| | | {stateful-sync-opt}?
+--ro association-list*
| | | [id source global-source extended-id]
| | | +--ro type? assoc-type
| | | +--ro id uint16
| | | +--ro source inet:ip-address
| | | +--ro global-source uint32
| | | +--ro extended-id string
| | | +--ro lsp* [plsp-id pcc-id]
| | | | +--ro plsp-id leafref
| | | | +--ro pcc-id leafref
+--ro lsp* [plsp-id pcc-id]
| | +--ro plsp-id uint32
| | +--ro pcc-id inet:ip-address
| | +--ro lsp-ref
| | | +--ro source?
| | | | -> /te:te/lsp-state/lsp/source
| | | +--ro destination?
| | | | -> /te:te/lsp-state/lsp/destination
| | +--ro tunnel-id?

```

```

|         -> /te:te/lsp-state/lsp/tunnel-id
+--ro lsp-id?
|         -> /te:te/lsp-state/lsp/lsp-id
+--ro extended-tunnel-id?  leafref
+--ro type?
|         -> /te:te/lsp-state/lsp/type
+--ro admin-state?        boolean
+--ro operational-state?   operational-state
+--ro delegated
|   +--ro enabled?        boolean
|   +--ro peer?
|   |   -> /pcep-state/entity/peers/peer/addr
|   +--ro srp-id?         uint32
+--ro initiation {pce-initiated}?
|   +--ro enabled?        boolean
|   +--ro peer?
|   |   -> /pcep-state/entity/peers/peer/addr
+--ro symbolic-path-name?  string
+--ro last-error?          lsp-error
+--ro pst?                 pst
+--ro association-list*
|   [id source global-source extended-id]
|   +--ro id                leafref
|   +--ro source            leafref
|   +--ro global-source     leafref
|   +--ro extended-id       leafref
+--ro path-keys {path-key}?
+--ro path-keys* [path-key]
+--ro path-key             uint16
+--ro cps
|   +--ro explicit-route-objects* [index]
|   |   +--ro explicit-route-usage?  identityref
|   |   +--ro index                  uint32
|   |   +--ro (type)?
|   |   |   +--:(ip-address)
|   |   |   |   +--ro ip-address-hop
|   |   |   |   |   +--ro address?    inet:ip-address
|   |   |   |   |   +--ro hop-type?   te-hop-type
|   |   |   +--:(as-number)
|   |   |   |   +--ro as-number-hop
|   |   |   |   |   +--ro as-number?   binary
|   |   |   |   |   +--ro hop-type?   te-hop-type
|   |   |   +--:(unnumbered-link)
|   |   |   |   +--ro unnumbered-hop
|   |   |   |   |   +--ro router-id?   inet:ip-address
|   |   |   |   |   +--ro interface-id? uint32
|   |   |   |   |   +--ro hop-type?   te-hop-type
|   |   |   +--:(label)

```

```

|         |         | +--ro label-hop
|         |         |         | +--ro value?
|         |         |         |         | rt-types:generalized-label
|         |         | +---:(sid)
|         |         |         | +--ro sid-hop
|         |         |         |         | +--ro sid?
|         |         |         |         |         | rt-types:generalized-label
+--ro pcc-original?
|         |         | -> /pcep-state/entity/peers/peer/addr
+--ro req-id?          uint32
+--ro retrieved?       boolean
+--ro pcc-retrieved?
|         |         | -> /pcep-state/entity/peers/peer/addr
+--ro creation-time?   yang:timestamp
+--ro discard-time?    uint32
+--ro reuse-time?      uint32
+--ro of-list {objective-function}?
|         |         | +--ro objective-function* [of]
|         |         |         | +--ro of      objective-function
+--ro peers
|         |         | +--ro peer* [addr]
|         |         |         | +--ro addr          inet:ip-address
|         |         |         | +--ro role?         pcep-role
|         |         |         | +--ro domain
|         |         |         |         | +--ro domain* [domain-type domain]
|         |         |         |         |         | +--ro domain-type    domain-type
|         |         |         |         |         | +--ro domain        domain
+--ro capability
|         |         |         | +--ro gmpls?          boolean {gmpls}?
|         |         |         | +--ro bi-dir?          boolean
|         |         |         | +--ro diverse?          boolean
|         |         |         | +--ro load-balance?      boolean
|         |         |         | +--ro synchronize?      boolean {svec}?
|         |         |         | +--ro objective-function? boolean
|         |         |         |         | {objective-function}?
|         |         |         | +--ro add-path-constraint? boolean
|         |         |         | +--ro prioritization?    boolean
|         |         |         | +--ro multi-request?     boolean
|         |         |         | +--ro gco?              boolean {gco}?
|         |         |         | +--ro p2mp?             boolean {p2mp}?
+--ro stateful {stateful}?
|         |         |         | +--ro enabled?          boolean
|         |         |         | +--ro active?           boolean
|         |         |         | +--ro pce-initiated?     boolean
|         |         |         |         | {pce-initiated}?
|         |         |         | +--ro include-db-ver?    boolean
|         |         |         |         | {stateful-sync-opt}?
|         |         |         | +--ro trigger-resync?    boolean

```

```

|   |   |   {stateful-sync-opt}?
|   |   +---ro trigger-initial-sync?   boolean
|   |   |   {stateful-sync-opt}?
|   |   +---ro incremental-sync?       boolean
|   |   |   {stateful-sync-opt}?
+---ro sr {sr}?
|   +---ro enabled?   boolean
+---ro pce-info
|   +---ro scope
|   |   +---ro intra-area-scope?       boolean
|   |   +---ro intra-area-pref?       uint8
|   |   +---ro inter-area-scope?       boolean
|   |   +---ro inter-area-scope-default? boolean
|   |   +---ro inter-area-pref?       uint8
|   |   +---ro inter-as-scope?         boolean
|   |   +---ro inter-as-scope-default? boolean
|   |   +---ro inter-as-pref?         uint8
|   |   +---ro inter-layer-scope?      boolean
|   |   +---ro inter-layer-pref?      uint8
+---ro neigh-domains
|   +---ro domain* [domain-type domain]
|   |   +---ro domain-type   domain-type
|   |   +---ro domain        domain
+---ro delegation-pref?   uint8 {stateful}?
+---ro (auth-type-selection)?
|   +---:(auth-key-chain)
|   |   +---ro key-chain?
|   |   |   key-chain:key-chain-ref
+---:(auth-key)
|   +---ro crypto-algorithm   identityref
|   +---ro key-string
|   |   +---ro (key-string-style)?
|   |   |   +---:(keystring)
|   |   |   |   +---ro keystring?   string
|   |   |   +---:(hexadecimal)
|   |   |   |   {key-chain:hex-key-string}?
|   |   |   +---ro hexadecimal-string?
|   |   |   |   yang:hex-string
+---:(auth-tls) {tls}?
|   +---ro tls
+---ro discontinuity-time?   yang:timestamp
+---ro initiate-session?    boolean
+---ro session-exists?      boolean
+---ro session-up-time?     yang:timestamp
+---ro session-fail-time?   yang:timestamp
+---ro session-fail-up-time? yang:timestamp
+---ro sessions
|   +---ro session* [initiator]

```

```

+--ro initiator                pcep-initiator
+--ro role?                    -> ../../../../role
+--ro state-last-change?       yang:timestamp
+--ro state?                   pcep-sess-state
+--ro session-creation?        yang:timestamp
+--ro connect-retry?           yang:counter32
+--ro local-id?                uint32
+--ro remote-id?               uint32
+--ro keepalive-timer?         uint32
+--ro peer-keepalive-timer?    uint32
+--ro dead-timer?              uint32
+--ro peer-dead-timer?         uint32
+--ro ka-hold-time-rem?        uint32
+--ro overloaded?              boolean
+--ro overload-time?           uint32
+--ro peer-overloaded?         boolean
+--ro peer-overload-time?      uint32
+--ro lspdb-sync?              sync-state
|                               {stateful}?
+--ro recv-db-ver?             uint64
|                               {stateful,stateful-sync-opt}?
+--ro of-list {objective-function}?
|   +--ro objective-function* [of]
|   |   +--ro of objective-function
+--ro speaker-entity-id?       string
|                               {stateful-sync-opt}?
+--ro discontinuity-time?      yang:timestamp

```

rpcs:

```

+---x trigger-resync {stateful,stateful-sync-opt}?
+---w input
+---w pcc?    -> /pcep-state/entity/peers/peer/addr

```

notifications:

```

+---n pcep-session-up
|   +--ro peer-addr?
|   |   -> /pcep-state/entity/peers/peer/addr
|   +--ro session-initiator? leafref
|   +--ro state-last-change? yang:timestamp
|   +--ro state?             pcep-sess-state
+---n pcep-session-down
|   +--ro peer-addr?
|   |   -> /pcep-state/entity/peers/peer/addr
|   +--ro session-initiator? pcep-initiator
|   +--ro state-last-change? yang:timestamp
|   +--ro state?             pcep-sess-state
+---n pcep-session-local-overload
|   +--ro peer-addr?

```



```

| |           -> /pcep-state/entity/peers/peer/addr
| +---ro session-initiator?   leafref
| +---ro overloaded?          boolean
| +---ro overload-time?       uint32
+---n pcep-session-local-overload-clear
| +---ro peer-addr?          -> /pcep-state/entity/peers/peer/addr
| +---ro overloaded?         boolean
+---n pcep-session-peer-overload
| +---ro peer-addr?
| |           -> /pcep-state/entity/peers/peer/addr
| +---ro session-initiator?   leafref
| +---ro peer-overloaded?     boolean
| +---ro peer-overload-time?  uint32
+---n pcep-session-peer-overload-clear
| +---ro peer-addr?
| |           -> /pcep-state/entity/peers/peer/addr
| +---ro peer-overloaded?     boolean

```

5.1. The Entity

The PCEP yang module may contain status information for the local PCEP entity.

The entity has an IP address (using ietf-inet-types [RFC6991]) and a "role" leaf (the local entity PCEP role) as mandatory.

Note that, the PCEP MIB module [RFC7420] uses an entity list and a system generated entity index as a primary index to the read only entity table. If the device implements the PCEP MIB, the "index" leaf MUST contain the value of the corresponding pcePcepEntityIndex and only one entity is assumed.

5.2. The Peer Lists

The peer list contains peer(s) that the local PCEP entity knows about. A PCEP speaker is identified by its IP address. If there is a PCEP speaker in the network that uses multiple IP addresses then it looks like multiple distinct peers to the other PCEP speakers in the network.

Since PCEP sessions can be ephemeral, the peer list tracks a peer even when no PCEP session currently exists to that peer. The statistics contained are an aggregate of the statistics for all successive sessions to that peer.

To limit the quantity of information that is stored, an implementation MAY choose to discard this information if and only if no PCEP session exists to the corresponding peer.

The data model for PCEP peer presented in this document uses a flat list of peers. Each peer in the list is identified by its IP address (addr-type, addr).

There is one list for static peer configuration ("/pcep/entity/peers"), and a separate list for the operational state of all peers (i.e. static as well as discovered)("/pcep-state/entity/peers"). The former is used to enable remote PCE configuration at PCC (or PCE) while the latter has the operational state of these peers as well as the remote PCE peer which were discovered and PCC peers that have initiated session.

5.3. The Session Lists

The session list contains PCEP session that the PCEP entity (PCE or PCC) is currently participating in. The statistics in session are semantically different from those in peer since the former applies to the current session only, whereas the latter is the aggregate for all sessions that have existed to that peer.

Although [RFC5440] forbids more than one active PCEP session between a given pair of PCEP entities at any given time, there is a window during session establishment where two sessions may exist for a given pair, one representing a session initiated by the local PCEP entity and the other representing a session initiated by the peer. If either of these sessions reaches active state first, then the other is discarded.

The data model for PCEP session presented in this document uses a flat list of sessions. Each session in the list is identified by its initiator. This index allows two sessions to exist transiently for a given peer, as discussed above.

There is only one list for the operational state of all sessions ("/pcep-state/entity/peers/peer/sessions/session").

5.4. Notifications

This YANG model defines a list of notifications to inform client of important events detected during the protocol operation. The notifications defined cover the PCEP MIB notifications.

5.5. RPC

This YANG model defines a RPC to trigger state resynchronization to a particular PCEP peer.

6. The Design of PCEP Statistics Data Model

The module, "ietf-pcep-stats", augments the ietf-pcep module to include statistics at the PCEP peer and session level.

```
module: ietf-pcep-stats
  augment /p:pcep-state/p:entity/p:peers/p:peer:
    +--ro num-sess-setup-ok?      yang:counter32
    +--ro num-sess-setup-fail?    yang:counter32
    +--ro pcep-stats
      +--ro avg-rsp-time?          uint32
      +--ro lwm-rsp-time?          uint32
      +--ro hwm-rsp-time?          uint32
      +--ro num-pcreq-sent?         yang:counter32
      +--ro num-pcreq-rcvd?         yang:counter32
      +--ro num-pcrep-sent?         yang:counter32
      +--ro num-pcrep-rcvd?         yang:counter32
      +--ro num-pcerr-sent?         yang:counter32
      +--ro num-pcerr-rcvd?         yang:counter32
      +--ro num-pcntf-sent?         yang:counter32
      +--ro num-pcntf-rcvd?         yang:counter32
      +--ro num-keepalive-sent?     yang:counter32
      +--ro num-keepalive-rcvd?     yang:counter32
      +--ro num-unknown-rcvd?       yang:counter32
      +--ro num-corrupt-rcvd?       yang:counter32
      +--ro num-req-sent?           yang:counter32
      +--ro num-req-sent-pend-rep?  yang:counter32
      +--ro num-req-sent-ero-rcvd?  yang:counter32
      +--ro num-req-sent-nopath-rcvd? yang:counter32
      +--ro num-req-sent-cancel-rcvd? yang:counter32
      +--ro num-req-sent-error-rcvd? yang:counter32
      +--ro num-req-sent-timeout?   yang:counter32
      +--ro num-req-sent-cancel-sent? yang:counter32
      +--ro num-req-rcvd?           yang:counter32
      +--ro num-req-rcvd-pend-rep?  yang:counter32
      +--ro num-req-rcvd-ero-sent?   yang:counter32
      +--ro num-req-rcvd-nopath-sent? yang:counter32
      +--ro num-req-rcvd-cancel-sent? yang:counter32
      +--ro num-req-rcvd-error-sent? yang:counter32
      +--ro num-req-rcvd-cancel-rcvd? yang:counter32
      +--ro num-rep-rcvd-unknown?    yang:counter32
      +--ro num-req-rcvd-unknown?    yang:counter32
      +--ro svec {p:svec}?
```

```

    |   +--ro num-svec-sent?          yang:counter32
    |   +--ro num-svec-req-sent?     yang:counter32
    |   +--ro num-svec-rcvd?         yang:counter32
    |   +--ro num-svec-req-rcvd?     yang:counter32
+--ro stateful {p:stateful}?
    |   +--ro num-pcrpt-sent?        yang:counter32
    |   +--ro num-pcrpt-rcvd?        yang:counter32
    |   +--ro num-pcupd-sent?        yang:counter32
    |   +--ro num-pcupd-rcvd?        yang:counter32
    |   +--ro num-rpt-sent?          yang:counter32
    |   +--ro num-rpt-rcvd?          yang:counter32
    |   +--ro num-rpt-rcvd-error-sent? yang:counter32
    |   +--ro num-upd-sent?          yang:counter32
    |   +--ro num-upd-rcvd?          yang:counter32
    |   +--ro num-upd-rcvd-unknown?   yang:counter32
    |   +--ro num-upd-rcvd-undelgated? yang:counter32
    |   +--ro num-upd-rcvd-error-sent? yang:counter32
    |   +--ro initiation {p:pce-initiated}?
    |       +--ro num-pcinitiate-sent?        yang:counter32
    |       +--ro num-pcinitiate-rcvd?        yang:counter32
    |       +--ro num-initiate-sent?          yang:counter32
    |       +--ro num-initiate-rcvd?          yang:counter32
    |       +--ro num-initiate-rcvd-error-sent? yang:counter32
+--ro path-key {p:path-key}?
    |   +--ro num-unknown-path-key?   yang:counter32
    |   +--ro num-exp-path-key?       yang:counter32
    |   +--ro num-dup-path-key?       yang:counter32
    |   +--ro num-path-key-no-attempt? yang:counter32
+--ro num-req-sent-closed?            yang:counter32
+--ro num-req-rcvd-closed?           yang:counter32
augment /p:pcep-state/p:entity/p:peers/p:peer/p:sessions/p:session:
+--ro pcep-stats
    +--ro avg-rsp-time?                uint32
    +--ro lwm-rsp-time?                uint32
    +--ro hwm-rsp-time?                uint32
    +--ro num-pcreq-sent?              yang:counter32
    +--ro num-pcreq-rcvd?              yang:counter32
    +--ro num-pcrep-sent?              yang:counter32
    +--ro num-pcrep-rcvd?              yang:counter32
    +--ro num-pcerr-sent?              yang:counter32
    +--ro num-pcerr-rcvd?              yang:counter32
    +--ro num-pcntf-sent?              yang:counter32
    +--ro num-pcntf-rcvd?              yang:counter32
    +--ro num-keepalive-sent?          yang:counter32
    +--ro num-keepalive-rcvd?          yang:counter32
    +--ro num-unknown-rcvd?            yang:counter32
    +--ro num-corrupt-rcvd?            yang:counter32
    +--ro num-req-sent?                yang:counter32

```

```

+--ro num-req-sent-pend-rep?          yang:counter32
+--ro num-req-sent-ero-rcvd?          yang:counter32
+--ro num-req-sent-nopath-rcvd?       yang:counter32
+--ro num-req-sent-cancel-rcvd?       yang:counter32
+--ro num-req-sent-error-rcvd?        yang:counter32
+--ro num-req-sent-timeout?           yang:counter32
+--ro num-req-sent-cancel-sent?       yang:counter32
+--ro num-req-rcvd?                   yang:counter32
+--ro num-req-rcvd-pend-rep?          yang:counter32
+--ro num-req-rcvd-ero-sent?          yang:counter32
+--ro num-req-rcvd-nopath-sent?       yang:counter32
+--ro num-req-rcvd-cancel-sent?       yang:counter32
+--ro num-req-rcvd-error-sent?        yang:counter32
+--ro num-req-rcvd-cancel-rcvd?       yang:counter32
+--ro num-rep-rcvd-unknown?           yang:counter32
+--ro num-req-rcvd-unknown?           yang:counter32
+--ro svec {p:svec}?
|   +--ro num-svec-sent?               yang:counter32
|   +--ro num-svec-req-sent?           yang:counter32
|   +--ro num-svec-rcvd?               yang:counter32
|   +--ro num-svec-req-rcvd?           yang:counter32
+--ro stateful {p:stateful}?
|   +--ro num-pcrpt-sent?               yang:counter32
|   +--ro num-pcrpt-rcvd?               yang:counter32
|   +--ro num-pcupd-sent?               yang:counter32
|   +--ro num-pcupd-rcvd?               yang:counter32
|   +--ro num-rpt-sent?                 yang:counter32
|   +--ro num-rpt-rcvd?                 yang:counter32
|   +--ro num-rpt-rcvd-error-sent?      yang:counter32
|   +--ro num-upd-sent?                 yang:counter32
|   +--ro num-upd-rcvd?                 yang:counter32
|   +--ro num-upd-rcvd-unknown?         yang:counter32
|   +--ro num-upd-rcvd-undelegated?     yang:counter32
|   +--ro num-upd-rcvd-error-sent?      yang:counter32
|   +--ro initiation {p:pce-initiated}?
|       +--ro num-pcinitiate-sent?      yang:counter32
|       +--ro num-pcinitiate-rcvd?      yang:counter32
|       +--ro num-initiate-sent?        yang:counter32
|       +--ro num-initiate-rcvd?        yang:counter32
|       +--ro num-initiate-rcvd-error-sent? yang:counter32
+--ro path-key {p:path-key}?
|   +--ro num-unknown-path-key?         yang:counter32
|   +--ro num-exp-path-key?             yang:counter32
|   +--ro num-dup-path-key?             yang:counter32
|   +--ro num-path-key-no-attempt?      yang:counter32

```

7. Advanced PCE Features

This document contains a specification of the base PCEP YANG module, "ietf-pcep" which provides the basic PCEP [RFC5440] data model.

This document further handles advanced PCE features like -

- o Capability and Scope
- o Domain information (local/neighbour)
- o Path-Key
- o OF
- o GCO
- o P2MP
- o GMPLS
- o Inter-Layer
- o Stateful PCE
- o Segment Routing
- o Authentication including PCEPS (TLS)

[Editor's Note - TLS would be added in a future revision]

7.1. Stateful PCE's LSP-DB

In the operational state of PCEP which supports stateful PCE mode, the list of LSP state are maintained in LSP-DB. The key is the PLSP-ID and the PCC IP address.

The PCEP data model contains the operational state of LSPs (/pcep-state/entity/lsp-db/lsp/) with PCEP specific attributes. The generic TE attributes of the LSP are defined in [I-D.ietf-teas-yang-te]. A reference to LSP state in TE model is maintained.

8. Open Issues and Next Step

This section is added so that open issues can be tracked. This section would be removed when the document is ready for publication.

8.1. The PCE-Initiated LSP

The TE Model at [I-D.ietf-teas-yang-te] should support creationg of tunnels at the controller (PCE) and marking them as PCE-Initiated. The LSP-DB in the PCEP Yang (/pcep-state/entity/lsp-db/lsp/initiation) also marks the LSPs which are PCE-initiated.

8.2. PCEP over TLS (PCEPS)

A future version of this document would add TLS related configurations.

9. PCEP YANG Modules

9.1. ietf-pcep module

RFC Ed.: In this section, replace all occurrences of 'XXXX' with the actual RFC number and all occurrences of the revision date below with the date of RFC publication (and remove this note).

```
<CODE BEGINS> file "ietf-pcep@2017-03-12.yang"
module ietf-pcep {

    yang-version 1.1;

    namespace "urn:ietf:params:xml:ns:yang:ietf-pcep";
    prefix pcep;

    import ietf-inet-types {
        prefix "inet";
    }

    import ietf-yang-types {
        prefix "yang";
    }

    import ietf-te {
        prefix "te";
    }

    import ietf-te-types {
        prefix "te-types";
    }

    import ietf-key-chain {
```

```
    prefix "key-chain";
}

import ietf-netconf-acm {
    prefix nacm;
}

organization
    "IETF PCE (Path Computation Element) Working Group";

contact
    "WG Web:      <http://tools.ietf.org/wg/pce/>
    WG List:      <mailto:pce@ietf.org>
    WG Chair:     JP Vasseur
                  <mailto:jpv@cisco.com>
    WG Chair:     Julien Meuric
                  <mailto:julien.meuric@orange.com>
    WG Chair:     Jonathan Hardwick
                  <mailto:Jonathan.Hardwick@metaswitch.com>
    Editor:       Dhruv Dhody
                  <mailto:dhruv.ietf@gmail.com>";

description
    "The YANG module defines a generic configuration and
    operational model for PCEP common across all of the
    vendor implementations.";

revision 2017-03-12 {
    description "Initial revision.";
    reference
        "RFC XXXX: A YANG Data Model for Path Computation
        Element Communications Protocol
        (PCEP)";
}

/*
 * Identities
 */

identity pcep {
    description "Identity for the PCEP protocol.";
}

/*
 * Typedefs
 */
```



```
typedef pcep-role {
  type enumeration {
    enum unknown {
      value "0";
      description
        "An unknown role";
    }
    enum pcc {
      value "1";
      description
        "The role of a Path Computation Client";
    }
    enum pce {
      value "2";
      description
        "The role of Path Computation Element";
    }
    enum pcc-and-pce {
      value "3";
      description
        "The role of both Path Computation Client and
        Path Computation Element";
    }
  }
}

description
  "The role of a PCEP speaker.
  Takes one of the following values
  - unknown(0): the role is not known.
  - pcc(1): the role is of a Path Computation
    Client (PCC).
  - pce(2): the role is of a Path Computation
    Server (PCE).
  - pccAndPce(3): the role is of both a PCC and
    a PCE.";

}

typedef pcep-admin-status {
  type enumeration {
    enum admin-status-up {
      value "1";
      description
        "Admin Status is Up";
    }
    enum admin-status-down {
      value "2";
      description
```

```
        "Admin Status is Down";
    }
}

description
"The Admin Status of the PCEP entity.
Takes one of the following values
- admin-status-up(1): Admin Status is Up.
- admin-status-down(2): Admin Status is Down";
}

typedef pcep-oper-status {
    type enumeration {
        enum oper-status-up {
            value "1";
            description
            "The PCEP entity is active";
        }
        enum oper-status-down {
            value "2";
            description
            "The PCEP entity is inactive";
        }
        enum oper-status-going-up {
            value "3";
            description
            "The PCEP entity is activating";
        }
        enum oper-status-going-down {
            value "4";
            description
            "The PCEP entity is deactivating";
        }
        enum oper-status-failed {
            value "5";
            description
            "The PCEP entity has failed and will recover
            when possible.";
        }
        enum oper-status-failed-perm {
            value "6";
            description
            "The PCEP entity has failed and will not recover
            without operator intervention";
        }
    }
}
description
"The operational status of the PCEP entity.
```

```
    Takes one of the following values
    - oper-status-up(1): Active
    - oper-status-down(2): Inactive
    - oper-status-going-up(3): Activating
    - oper-status-going-down(4): Deactivating
    - oper-status-failed(5): Failed
    - oper-status-failed-perm(6): Failed Permanantly";
}

typedef pcep-initiator {
  type enumeration {
    enum local {
      value "1";
      description
        "The local PCEP entity initiated the session";
    }

    enum remote {
      value "2";
      description
        "The remote PCEP peer initiated the session";
    }
  }
  description
    "The initiator of the session, that is, whether the TCP
    connection was initiated by the local PCEP entity or
    the remote peer.
    Takes one of the following values
    - local(1): Initiated locally
    - remote(2): Initiated remotely";
}

typedef pcep-sess-state {
  type enumeration {
    enum tcp-pending {
      value "1";
      description
        "The tcp-pending state of PCEP session.";
    }

    enum open-wait {
      value "2";
      description
        "The open-wait state of PCEP session.";
    }

    enum keep-wait {
      value "3";
    }
  }
}
```

```
        description
            "The keep-wait state of PCEP session.";
    }

    enum session-up {
        value "4";
        description
            "The session-up state of PCEP session.";
    }
}
description
    "The current state of the session.
    The set of possible states excludes the idle state
    since entries do not exist in the idle state.
    Takes one of the following values
    - tcp-pending(1): PCEP TCP Pending state
    - open-wait(2): PCEP Open Wait state
    - keep-wait(3): PCEP Keep Wait state
    - session-up(4): PCEP Session Up state";
}

typedef domain-type {
    type enumeration {
        enum ospf-area {
            value "1";
            description
                "The OSPF area.";
        }
        enum isis-area {
            value "2";
            description
                "The IS-IS area.";
        }
        enum as {
            value "3";
            description
                "The Autonomous System (AS).";
        }
    }
    description
        "The PCE Domain Type";
}

typedef domain-ospf-area {
    type union {
        type uint32;
        type yang:dotted-quad;
    }
}
```

```
        description
            "OSPF Area ID.";
    }

    typedef domain-isis-area {
        type string {
            pattern '[0-9A-Fa-f]{2}\.([0-9A-Fa-f]{4}\.){0,3}';
        }
        description
            "IS-IS Area ID.";
    }

    typedef domain-as {
        type uint32;
        description
            "Autonomous System number.";
    }

    typedef domain {
        type union {
            type domain-ospf-area;
            type domain-isis-area;
            type domain-as;
        }
        description
            "The Domain Information";
    }

    typedef operational-state {
        type enumeration {
            enum down {
                value "0";
                description
                    "not active.";
            }
            enum up {
                value "1";
                description
                    "signalled.";
            }
            enum active {
                value "2";
                description
                    "up and carrying traffic.";
            }
            enum going-down {
                value "3";
            }
        }
    }
```

```
        description
            "LSP is being torn down, resources are
            being released.";
    }
    enum going-up {
        value "4";
        description
            "LSP is being signalled.";
    }
}
description
    "The operational status of the LSP";
}

typedef lsp-error {
    type enumeration {
        enum no-error {
            value "0";
            description
                "No error, LSP is fine.";
        }
        enum unknown {
            value "1";
            description
                "Unknown reason.";
        }
        enum limit {
            value "2";
            description
                "Limit reached for PCE-controlled LSPs.";
        }
        enum pending {
            value "3";
            description
                "Too many pending LSP update requests.";
        }
        enum unacceptable {
            value "4";
            description
                "Unacceptable parameters.";
        }
        enum internal {
            value "5";
            description
                "Internal error.";
        }
        enum admin {
            value "6";
        }
    }
}
```

```
        description
            "LSP administratively brought down.";
    }
    enum preempted {
        value "7";
        description
            "LSP preempted.";
    }
    enum rsvp {
        value "8";
        description
            "RSVP signaling error.";
    }
}
description
    "The LSP Error Codes.";
}

typedef sync-state {
    type enumeration {
        enum pending {
            value "0";
            description
                "The state synchronization
                 has not started.";
        }
        enum ongoing {
            value "1";
            description
                "The state synchronization
                 is ongoing.";
        }
        enum finished {
            value "2";
            description
                "The state synchronization
                 is finished.";
        }
    }
}
description
    "The LSP-DB state synchronization operational
    status.";
}

typedef pst{
    type enumeration{
        enum rsvp-te{
            value "0";
```

```
        description
            "RSVP-TE signaling protocol";
    }
    enum sr{
        value "1";
        description
            "Segment Routing Traffic Engineering";
    }
}
description
    "The Path Setup Type";
}

typedef assoc-type{
    type enumeration{
        enum protection{
            value "1";
            description
                "Path Protection Association Type";
        }
        enum policy{
            value "2";
            description
                "Policy Association Type";
        }
        enum diversity{
            value "3";
            description
                "Diversity Association Type";
        }
    }
    description
        "The PCEP Association Type";
}

typedef objective-function{
    type enumeration{
        enum mcp{
            value "1";
            description
                "Minimum Cost Path (MCP)";
        }
        enum mlp{
            value "2";
            description
                "Minimum Load Path (MLP)";
        }
        enum mbp{
```



```
        value "3";
        description
            "Maximum residual Bandwidth Path (MBP)";
    }
    enum mbc{
        value "4";
        description
            "Minimize aggregate Bandwidth Consumption
            (MBC)";
    }
    enum mll{
        value "5";
        description
            "Minimize the Load of the most loaded Link
            (MLL)";
    }
    enum mcc{
        value "6";
        description
            "Minimize the Cumulative Cost of a set of
            paths (MCC)";
    }
    enum spt{
        value "7";
        description
            "Shortest Path Tree (SPT)";
    }
    enum mct{
        value "8";
        description
            "Minimum Cost Tree (MCT)";
    }
    enum mplp{
        value "9";
        description
            "Minimum Packet Loss Path (MPLP)";
    }
    enum mup{
        value "10";
        description
            "Maximum Under-Utilized Path (MUP)";
    }
    enum mrup{
        value "11";
        description
            "Maximum Reserved Under-Utilized Path
            (MRUP)";
    }
}
```

```
    }
    description
        "The PCEP Objective functions";
}

/*
 * Features
 */

feature svec {
    description
        "Support synchronized path computation.";
}

feature gmpls {
    description
        "Support GMPLS.";
}

feature objective-function {
    description
        "Support OF as per RFC 5541.";
}

feature gco {
    description
        "Support GCO as per RFC 5557.";
}

feature path-key {
    description
        "Support path-key as per RFC 5520.";
}

feature p2mp {
    description
        "Support P2MP as per RFC 6006.";
}

feature stateful {
    description
        "Support stateful PCE.";
}

feature stateful-sync-opt {
    description
        "Support stateful sync optimization";
}
```

```
feature pce-initiated {
  description
    "Support PCE-Initiated LSP.";
}

feature tls {
  description
    "Support PCEP over TLS.";
}

feature sr {
  description
    "Support Segment Routing for PCE.";
}

/*
 * Groupings
 */

grouping pcep-entity-info{
  description
    "This grouping defines the attributes for PCEP entity.";
  leaf connect-timer {
    type uint32 {
      range "1..65535";
    }
    units "seconds";
    default 60;
    description
      "The time in seconds that the PCEP entity will wait
      to establish a TCP connection with a peer. If a
      TCP connection is not established within this time
      then PCEP aborts the session setup attempt.";
    reference
      "RFC 5440: Path Computation Element (PCE)
      Communication Protocol (PCEP)";
  }

  leaf connect-max-retry {
    type uint32;
    default 5;
    description
      "The maximum number of times the system tries to
      establish a TCP connection to a peer before the
      session with the peer transitions to the idle
      state.";
  }
}
```

```
        reference
          "RFC 5440: Path Computation Element (PCE)
            Communication Protocol (PCEP)";
    }

    leaf init-backoff-timer {
      type uint32 {
        range "1..65535";
      }
      units "seconds";
      description
        "The initial back-off time in seconds for retrying
        a failed session setup attempt to a peer.
        The back-off time increases for each failed
        session setup attempt, until a maximum back-off
        time is reached. The maximum back-off time is
        max-backoff-timer.";
    }

    leaf max-backoff-timer {
      type uint32;
      units "seconds";
      description
        "The maximum back-off time in seconds for retrying
        a failed session setup attempt to a peer.
        The back-off time increases for each failed session
        setup attempt, until this maximum value is reached.
        Session setup attempts then repeat periodically
        without any further increase in back-off time.";
    }

    leaf open-wait-timer {
      type uint32 {
        range "1..65535";
      }
      units "seconds";
      default 60;
      description
        "The time in seconds that the PCEP entity will wait
        to receive an Open message from a peer after the
        TCP connection has come up.
        If no Open message is received within this time then
        PCEP terminates the TCP connection and deletes the
        associated sessions.";
      reference
        "RFC 5440: Path Computation Element (PCE)
          Communication Protocol (PCEP)";
    }
  }
```

```
leaf keep-wait-timer {
  type uint32 {
    range "1..65535";
  }
  units "seconds";
  default 60;
  description
    "The time in seconds that the PCEP entity will wait
    to receive a Keepalive or PCErr message from a peer
    during session initialization after receiving an
    Open message. If no Keepalive or PCErr message is
    received within this time then PCEP terminates the
    TCP connection and deletes the associated
    sessions.";
  reference
    "RFC 5440: Path Computation Element (PCE)
    Communication Protocol (PCEP)";
}

leaf keep-alive-timer {
  type uint32 {
    range "0..255";
  }
  units "seconds";
  default 30;
  description
    "The keep alive transmission timer that this PCEP
    entity will propose in the initial OPEN message of
    each session it is involved in. This is the
    maximum time between two consecutive messages sent
    to a peer. Zero means that the PCEP entity prefers
    not to send Keepalives at all.
    Note that the actual Keepalive transmission
    intervals, in either direction of an active PCEP
    session, are determined by negotiation between the
    peers as specified by RFC 5440, and so may differ
    from this configured value.";
  reference
    "RFC 5440: Path Computation Element (PCE)
    Communication Protocol (PCEP)";
}

leaf dead-timer {
  type uint32 {
    range "0..255";
  }
  units "seconds";
  must "(. > ../keep-alive-timer)" {
```

```
        error-message "The dead timer must be "
            + "larger than the keep alive timer";
        description
            "This value MUST be greater than
            keep-alive-timer.";
    }
    default 120;
    description
        "The dead timer that this PCEP entity will propose
        in the initial OPEN message of each session it is
        involved in. This is the time after which a peer
        should declare a session down if it does not
        receive any PCEP messages. Zero suggests that the
        peer does not run a dead timer at all." ;
    reference
        "RFC 5440: Path Computation Element (PCE)
        Communication Protocol (PCEP)";
}

leaf allow-negotiation{
    type boolean;
    description
        "Whether the PCEP entity will permit negotiation of
        session parameters.";
}

leaf max-keep-alive-timer{
    type uint32 {
        range "0..255";
    }
    units "seconds";
    description
        "In PCEP session parameter negotiation in seconds,
        the maximum value that this PCEP entity will
        accept from a peer for the interval between
        Keepalive transmissions. Zero means that the PCEP
        entity will allow no Keepalive transmission at
        all." ;
}

leaf max-dead-timer{
    type uint32 {
        range "0..255";
    }
    units "seconds";
    description
        "In PCEP session parameter negotiation in seconds,
```

```
        the maximum value that this PCEP entity will accept
        from a peer for the Dead timer.  Zero means that
        the PCEP entity will allow not running a Dead
        timer.";
    }

    leaf min-keep-alive-timer{
        type uint32 {
            range "0..255";
        }
        units "seconds";
        description
            "In PCEP session parameter negotiation in seconds,
            the minimum value that this PCEP entity will
            accept for the interval between Keepalive
            transmissions. Zero means that the PCEP entity
            insists on no Keepalive transmission at all.";
    }

    leaf min-dead-timer{
        type uint32 {
            range "0..255";
        }
        units "seconds";
        description
            "In PCEP session parameter negotiation in
            seconds, the minimum value that this PCEP entity
            will accept for the Dead timer.  Zero means that
            the PCEP entity insists on not running a Dead
            timer.";
    }

    leaf sync-timer{
        if-feature svec;
        type uint32 {
            range "0..65535";
        }
        units "seconds";
        default 60;
        description
            "The value of SyncTimer in seconds is used in the
            case of synchronized path computation request
            using the SVEC object. Consider the case where a
            PCReq message is received by a PCE that contains
            the SVEC object referring to M synchronized path
            computation requests. If after the expiration of
            the SyncTimer all the M path computation requests
            have not been, received a protocol error is
```

```
        triggered and the PCE MUST cancel the whole set
        of path computation requests.
        The aim of the SyncTimer is to avoid the storage
        of unused synchronized requests should one of
        them get lost for some reasons (for example, a
        misbehaving PCC).
        Zero means that the PCEP entity does not use the
        SyncTimer.";
    reference
        "RFC 5440: Path Computation Element (PCE)
        Communication Protocol (PCEP)";
}

leaf request-timer{
    type uint32 {
        range "1..65535";
    }
    units "seconds";
    description
        "The maximum time that the PCEP entity will wait
        for a response to a PCReq message.";
}

leaf max-sessions{
    type uint32;
    description
        "Maximum number of sessions involving this PCEP
        entity that can exist at any time.";
}

leaf max-unknown-reqs{
    type uint32;
    default 5;
    description
        "The maximum number of unrecognized requests and
        replies that any session on this PCEP entity is
        willing to accept per minute before terminating
        the session.
        A PCRep message contains an unrecognized reply
        if it contains an RP object whose request ID
        does not correspond to any in-progress request
        sent by this PCEP entity.
        A PCReq message contains an unrecognized request
        if it contains an RP object whose request ID is
        zero.";
    reference
        "RFC 5440: Path Computation Element (PCE)";
}
```



```

        Communication Protocol (PCEP)";
    }

    leaf max-unknown-msgs{
        type uint32;
        default 5;
        description
            "The maximum number of unknown messages that any
             session on this PCEP entity is willing to accept
             per minute before terminating the session.";
        reference
            "RFC 5440: Path Computation Element (PCE)
             Communication Protocol (PCEP)";
    }
}

} // pcep-entity-info

grouping pce-scope{
    description
        "This grouping defines PCE path computation scope
         information which maybe relevant to PCE selection.
         This information corresponds to PCE auto-discovery
         information.";
    reference
        "RFC 5088: OSPF Protocol Extensions for Path
         Computation Element (PCE)
         Discovery
         RFC 5089: IS-IS Protocol Extensions for Path
         Computation Element (PCE)
         Discovery";
    leaf intra-area-scope{
        type boolean;
        default true;
        description
            "PCE can compute intra-area paths.";
    }
    leaf intra-area-pref{
        type uint8{
            range "0..7";
        }
        description
            "The PCE's preference for intra-area TE LSP
             computation.";
    }
    leaf inter-area-scope{
        type boolean;
        default false;
        description

```

```
        "PCE can compute inter-area paths.";
    }
    leaf inter-area-scope-default{
        type boolean;
        default false;
        description
            "PCE can act as a default PCE for inter-area
            path computation.";
    }
    leaf inter-area-pref{
        type uint8{
            range "0..7";
        }
        description
            "The PCE's preference for inter-area TE LSP
            computation.";
    }
    leaf inter-as-scope{
        type boolean;
        default false;
        description
            "PCE can compute inter-AS paths.";
    }
    leaf inter-as-scope-default{
        type boolean;
        default false;
        description
            "PCE can act as a default PCE for inter-AS
            path computation.";
    }
    leaf inter-as-pref{
        type uint8{
            range "0..7";
        }
        description
            "The PCE's preference for inter-AS TE LSP
            computation.";
    }
    leaf inter-layer-scope{
        type boolean;
        default false;
        description
            "PCE can compute inter-layer paths.";
    }
    leaf inter-layer-pref{
        type uint8{
            range "0..7";
        }
    }
```

```
        description
          "The PCE's preference for inter-layer TE LSP
           computation.";
      }
    }//pce-scope

    grouping domain{
      description
        "This grouping specifies a Domain where the
         PCEP speaker has topology visibility.";
      leaf domain-type{
        type domain-type;
        description
          "The domain type.";
      }
      leaf domain{
        type domain;
        description
          "The domain Information.";
      }
    }//domain

    grouping capability{
      description
        "This grouping specifies a capability
         information of local PCEP entity. This maybe
         relevant to PCE selection as well. This
         information corresponds to PCE auto-discovery
         information.";
      reference
        "RFC 5088: OSPF Protocol Extensions for Path
         Computation Element (PCE)
         Discovery
         RFC 5089: IS-IS Protocol Extensions for Path
         Computation Element (PCE)
         Discovery";
      leaf gmpls{
        if-feature gmpls;
        type boolean;
        description
          "Path computation with GMPLS link
           constraints.";
      }
      leaf bi-dir{
        type boolean;
        description
          "Bidirectional path computation.";
      }
    }
```

```
leaf diverse{
  type boolean;
  description
    "Diverse path computation.";
}
leaf load-balance{
  type boolean;
  description
    "Load-balanced path computation.";
}
leaf synchronize{
  if-feature svec;
  type boolean;
  description
    "Synchronized paths computation.";
}
leaf objective-function{
  if-feature objective-function;
  type boolean;
  description
    "Support for multiple objective functions.";
}
leaf add-path-constraint{
  type boolean;
  description
    "Support for additive path constraints (max
    hop count, etc.).";
}
leaf prioritization{
  type boolean;
  description
    "Support for request prioritization.";
}
leaf multi-request{
  type boolean;
  description
    "Support for multiple requests per message.";
}
leaf gco{
  if-feature gco;
  type boolean;
  description
    "Support for Global Concurrent Optimization
    (GCO).";
}
leaf p2mp{
  if-feature p2mp;
  type boolean;
```

```
        description
        "Support for P2MP path computation.";
    }

    container stateful{
        if-feature stateful;
        description
            "If stateful PCE feature is present";
        leaf enabled{
            type boolean;
            description
                "Enabled or Disabled";
        }
        leaf active{
            type boolean;
            description
                "Support for active stateful PCE.";
        }
        leaf pce-initiated{
            if-feature pce-initiated;
            type boolean;
            description
                "Support for PCE-initiated LSP.";
        }
        leaf include-db-ver{
            if-feature stateful-sync-opt;
            type boolean;
            description
                "Support inclusion of LSP-DB-VERSION
                in LSP object";
        }
        leaf trigger-resync{
            if-feature stateful-sync-opt;
            type boolean;
            description
                "Support PCE triggered re-synchronization";
        }
        leaf trigger-initial-sync{
            if-feature stateful-sync-opt;
            type boolean;
            description
                "PCE triggered initial synchronization";
        }
        leaf incremental-sync{
            if-feature stateful-sync-opt;
            type boolean;
            description
                "Support incremental (delta) sync";
        }
    }
}
```

```
    }
  }
  container sr{
    if-feature sr;
    description
      "If segment routing is supported";
    leaf enabled{
      type boolean;
      description
        "Enabled or Disabled";
    }
  }
}
} //capability

grouping info{
  description
    "This grouping specifies all information which
    maybe relevant to both PCC and PCE.
    This information corresponds to PCE auto-discovery
    information.";
  container domain{
    description
      "The local domain for the PCEP entity";
    list domain{
      key "domain-type domain";
      description
        "The local domain.";
      uses domain{
        description
          "The local domain for the PCEP entity.";
      }
    }
  }
  container capability{
    description
      "The PCEP entity capability";
    uses capability{
      description
        "The PCEP entity supported
        capabilities.";
    }
  }
}

} //info

grouping pce-info{
```

```
description
  "This grouping specifies all PCE information
  which maybe relevant to the PCE selection.
  This information corresponds to PCE auto-discovery
  information.";
container scope{
  description
    "The path computation scope";
  uses pce-scope;
}

container neigh-domains{
  description
    "The list of neighbour PCE-Domain
    toward which a PCE can compute
    paths";
  list domain{
    key "domain-type domain";

    description
      "The neighbour domain.";
    uses domain{
      description
        "The PCE neighbour domain.";
    }
  }
}

} //pce-info

grouping lsp-state{
  description
    "This grouping defines the attributes for LSP in LSP-DB.
    These are the attributes specifically from the PCEP
    perspective";
  leaf plsp-id{
    type uint32{
      range "1..1048575";
    }
    description
      "A PCEP-specific identifier for the LSP. A PCC
      creates a unique PLSP-ID for each LSP that is
      constant for the lifetime of a PCEP session.
      PLSP-ID is 20 bits with 0 and 0xFFFFF are
      reserved";
  }
  leaf pcc-id{
    type inet:ip-address;
    description
```

```
        "The local internet address of the PCC, that
        generated the PLSP-ID.";
    }

    container lsp-ref{
        description
            "reference to ietf-te lsp state";

        leaf source {
            type leafref {
                path "/te:te/te:lsps-state/te:lsp/te:source";
            }
            description
                "Tunnel sender address extracted from
                SENDER_TEMPLATE object";
            reference "RFC3209";
        }
        leaf destination {
            type leafref {
                path "/te:te/te:lsps-state/te:lsp/te:"
                    + "destination";
            }
            description
                "Tunnel endpoint address extracted from
                SESSION object";
            reference "RFC3209";
        }
        leaf tunnel-id {
            type leafref {
                path "/te:te/te:lsps-state/te:lsp/te:tunnel-id";
            }
            description
                "Tunnel identifier used in the SESSION
                that remains constant over the life
                of the tunnel.";
            reference "RFC3209";
        }
        leaf lsp-id {
            type leafref {
                path "/te:te/te:lsps-state/te:lsp/te:lsp-id";
            }
            description
                "Identifier used in the SENDER_TEMPLATE
                and the FILTER_SPEC that can be changed
                to allow a sender to share resources with
                itself.";
            reference "RFC3209";
        }
    }
```



```
    leaf extended-tunnel-id {
      type leafref {
        path "/te:te/te:lsps-state/te:lsp/te:"
          + "extended-tunnel-id";
      }
      description
        "Extended Tunnel ID of the LSP.";
      reference "RFC3209";
    }
    leaf type {
      type leafref {
        path "/te:te/te:lsps-state/te:lsp/te:type";
      }
      description "LSP type P2P or P2MP";
    }
  }

  leaf admin-state{
    type boolean;
    description
      "The desired operational state";
  }
  leaf operational-state{
    type operational-state;
    description
      "The operational status of the LSP";
  }
  container delegated{
    description
      "The delegation related parameters";
    leaf enabled{
      type boolean;
      description
        "LSP is delegated or not";
    }
    leaf peer{
      type leafref {
        path "/pcep-state/entity/peers/peer/addr";
      }
      must "(../enabled = true())"
      {
        error-message
          "The LSP must be delegated";
        description
          "When LSP is a delegated LSP";
      }
      description
        "At the PCC, the reference to the PCEP peer to
```

```
        which LSP is delegated; At the PCE, the
        reference to the PCEP peer which delegated this
        LSP";
    }
    leaf srp-id{
        type uint32;
        description
            "The last SRP-ID-number associated with this
            LSP.";
    }
}
container initiation {
    if-feature pce-initiated;
    description
        "The PCE initiation related parameters";
    leaf enabled{
        type boolean;
        description
            "LSP is PCE-initiated or not";
    }
    leaf peer{
        type leafref {
            path "/pcep-state/entity/peers/peer/addr";
        }
        must "(../enabled = true())"
        {
            error-message
                "The LSP must be PCE-Initiated";
            description
                "When the LSP must be PCE-Initiated";
        }
        description
            "At the PCC, the reference to the PCEP peer
            that initiated this LSP; At the PCE, the
            reference to the PCEP peer where the LSP
            is initiated";
    }
}
leaf symbolic-path-name{
    type string;
    description
        "The symbolic path name associated with the LSP.";
}
leaf last-error{
    type lsp-error;
    description
        "The last error for the LSP.";
}
```

```
    leaf pst{
        type pst;
        default "rsvp-te";
        description
            "The Path Setup Type";
    }

} //lsp-state

grouping notification-instance-hdr {
    description
        "This group describes common instance specific data
        for notifications.";

    leaf peer-addr {
        type leafref {
            path "/pcep-state/entity/peers/peer/addr";
        }
        description
            "Reference to peer address";
    }
} // notification-instance-hdr

grouping notification-session-hdr {
    description
        "This group describes common session instance specific
        data for notifications.";

    leaf session-initiator {
        type leafref {
            path "/pcep-state/entity/peers/peer/sessions/" +
                "session/initiator";
        }
        description
            "Reference to pcep session initiator leaf";
    }
} // notification-session-hdr

grouping stateful-pce-parameter {
    description
        "This group describes stateful PCE specific
        parameters.";
    leaf state-timeout{
        type uint32;
        units "seconds";
        description
```

```
        "When a PCEP session is terminated, a PCC
        waits for this time period before flushing
        LSP state associated with that PCEP session
        and reverting to operator-defined default
        parameters or behaviours.";
    }
    leaf redelegation-timeout{
        when "../role = 'pcc'" +
            "or " +
            "../role = 'pcc-and-pce'"
        {
            description
                "Valid at PCC";
        }
        type uint32;
        units "seconds";
        description
            "When a PCEP session is terminated, a PCC
            waits for this time period before revoking
            LSP delegation to a PCE and attempting to
            redelegate LSPs associated with the
            terminated PCEP session to an alternate
            PCE.";
    }
    leaf rpt-non-pcep-lsp{
        when "../role = 'pcc'" +
            "or " +
            "../role = 'pcc-and-pce'"
        {
            description
                "Valid at PCC";
        }
        type boolean;
        default true;
        description
            "If set, a PCC reports LSPs that are not
            controlled by any PCE (for example, LSPs
            that are statically configured at the
            PCC). ";
    }
}

grouping authentication {
    description "Authentication Information";
    choice auth-type-selection {
        description
            "Options for expressing authentication setting.";
    }
}
```

```
case auth-key-chain {
  leaf key-chain {
    type key-chain:key-chain-ref;
    description
      "key-chain name.";
  }
}
case auth-key {
  leaf crypto-algorithm {
    type identityref {
      base key-chain:crypto-algorithm;
    }
    mandatory true;
    description
      "Cryptographic algorithm associated with key.";
  }
  container key-string {
    description
      "The key string.";
    nacm:default-deny-all;
    choice key-string-style {
      description
        "Key string styles";
      case keystack {
        leaf keystack {
          type string;
          description
            "Key string in ASCII format.";
        }
      }
      case hexadecimal {
        if-feature "key-chain:hex-key-string";
        leaf hexadecimal-string {
          type yang:hex-string;
          description
            "Key in hexadecimal string format. When
            compared to ASCII, specification in
            hexadecimal affords greater key
            entropy with the same number of
            octets. Additionally, it discourages
            usage of well-known words or
            numbers.";
        }
      }
    }
  }
}
case auth-tls {
```

```
        if-feature tls;
        container tls {
            description
                "TLS related information - TBD";
        }
    }
}

grouping path-key {
    description "Path-key related information";
    leaf enabled {
        type boolean;
        description
            "Enabled or Disabled";
    }
    leaf discard-timer {
        type uint32;
        units "minutes";
        default 10;
        description
            "A timer to discard unwanted path-keys";
    }
    leaf reuse-time {
        type uint32;
        units "minutes";
        default 30;
        description
            "A time after which the path-keys could be reused";
    }
    leaf pce-id {
        type inet:ip-address;
        description
            "PCE Address to be used in each Path-Key Subobject
            (PKS)";
    }
}

grouping path-key-state {
    description "Table to allow inspection of path-keys";
    list path-keys {
        key "path-key";

        description
            "The list of path-keys generated by the PCE";

        leaf path-key {
            type uint16;
        }
    }
}
```

```
    description
      "The identifier, or token used to represent
       the Confidential Path Segment (CPS) within
       the context of the PCE";
  }
  container cps {
    description
      "The Confidential Path Segment (CPS)";
    list explicit-route-objects {
      key "index";
      description
        "List of explicit route objects";

      leaf explicit-route-usage {
        type identityref {
          base te-types:route-usage-type;
        }
        description
          "An explicit-route hop action.";
      }

      uses te-types:explicit-route-hop_config;
    }
  }
  leaf pcc-original {
    type leafref {
      path "/pcep-state/entity/peers/peer/addr";
    }
    description
      "Reference to PCC peer address of
       the original request";
  }
  leaf req-id {
    type uint32;
    description
      "The request ID of the original PCReq.";
  }
  leaf retrieved {
    type boolean;
    description
      "If path-key has been retrieved yet";
  }
  leaf pcc-retrieved {
    type leafref {
      path "/pcep-state/entity/peers/peer/addr";
    }
    must "(../retrieved = true())"
    {
```

```
        error-message
          "The Path-key should be retrieved";
        description
          "When Path-Key has been retrieved";
      }
    description
      "Reference to PCC peer address which
       retrieved the path-key";
  }
  leaf creation-time {
    type yang:timestamp;
    description
      "The timestamp value at the time this Path-Key
       was created.";
  }
  leaf discard-time {
    type uint32;
    units "minutes";
    description
      "A time after which thispath-keys will be
       discarded";
  }
  leaf reuse-time {
    type uint32;
    units "minutes";
    description
      "A time after which this path-keys could be
       reused";
  }
}

grouping of-list {
  description "List of OF";
  list objective-function{
    key "of";

    description
      "The list of authorized OF";

    leaf of {
      type objective-function;
      description
        "The OF authorized";
    }
  }
}

grouping association {
```



```
description
  "Generic Association parameters";
leaf type {
  type "assoc-type";
  description
    "The PCEP association type";
}
leaf id {
  type uint16;
  description
    "PCEP Association ID";
}
leaf source {
  type inet:ip-address;
  description
    "PCEP Association Source.";
}
leaf global-source {
  type uint32;
  description
    "PCEP Association Global
    Source.";
}
leaf extended-id{
  type string;
  description
    "Additional information to
    support unique identification.";
}
}
grouping association-ref {
  description
    "Generic Association parameters";
  leaf id {
    type leafref {
      path "/pcep-state/entity/lsp-db/"
        + "association-list/id";
    }
    description
      "PCEP Association ID";
  }
  leaf source {
    type leafref {
      path "/pcep-state/entity/lsp-db/"
        + "association-list/source";
    }
    description
      "PCEP Association Source.";
```

```
    }
    leaf global-source {
      type leafref {
        path "/pcep-state/entity/lsp-db/"
          + "association-list/global-source";
      }
      description
        "PCEP Association Global
        Source.";
    }
    leaf extended-id{
      type leafref {
        path "/pcep-state/entity/lsp-db/"
          + "association-list/extended-id";
      }
      description
        "Additional information to
        support unique identification.";
    }
  }
  /*
  * Configuration data nodes
  */
  container pcep{
    presence
      "The PCEP is enabled";

    description
      "Parameters for list of configured PCEP entities
      on the device.";

    container entity {

      description
        "The configured PCEP entity on the device.";

      leaf addr {
        type inet:ip-address;
        mandatory true;
        description
          "The local Internet address of this PCEP
          entity.
          If operating as a PCE server, the PCEP
          entity listens on this address.
          If operating as a PCC, the PCEP entity
          binds outgoing TCP connections to this
          address.
```

```
        It is possible for the PCEP entity to
        operate both as a PCC and a PCE Server, in
        which case it uses this address both to
        listen for incoming TCP connections and to
        bind outgoing TCP connections.";
    }

    leaf enabled {
        type boolean;
        default true;
        description
            "The administrative status of this PCEP
            Entity.";
    }

    leaf role {
        type pcep-role;
        mandatory true;
        description
            "The role that this entity can play.
            Takes one of the following values.
            - unknown(0): this PCEP Entity role is not
              known.
            - pcc(1): this PCEP Entity is a PCC.
            - pce(2): this PCEP Entity is a PCE.
            - pcc-and-pce(3): this PCEP Entity is both
              a PCC and a PCE.";
    }

    leaf description {
        type string;
        description
            "Description of the PCEP entity configured
            by the user";
    }

    leaf speaker-entity-id {
        if-feature stateful-sync-opt;
        type string;
        description
            "The Speaker Entity Identifier";
    }

    uses info {
        description
            "Local PCEP entity information";
    }
}
```

```
container pce-info {
  when "../role = 'pce'" +
    "or " +
    "../role = 'pcc-and-pce'"
  {
    description
      "Valid at PCE";
  }
  uses pce-info {
    description
      "Local PCE information";
  }
  container path-key {
    if-feature path-key;
    uses path-key {
      description
        "Path-Key Configuration";
    }
    description
      "Path-Key Configuration";
  }

  description
    "The Local PCE Entity PCE information";
}

uses authentication {
  description
    "Local PCEP entity authentication information";
}

uses pcep-entity-info {
  description
    "The configuration related to the PCEP
    entity.";
}

leaf pcep-notification-max-rate {
  type uint32;
  mandatory true;
  description
    "This variable indicates the maximum number of
    notifications issued per second. If events
    occur more rapidly, the implementation may
    simply fail to emit these notifications during
```

```
        that period, or may queue them until an
        appropriate time. A value of 0 means no
        notifications are emitted and all should be
        discarded (that is, not queued).";
    }

    container stateful-parameter{
        if-feature stateful;
        must "(/pcep/entity/capability/stateful/enabled" +
            " = true())"
        {
            error-message
                "The Stateful PCE must be enabled";
            description
                "When PCEP entity is stateful
                enabled";
        }
        uses stateful-pce-parameter;

        description
            "The configured stateful parameters";
    }

    container of-list{
        when "../role = 'pce'" +
            "or " +
            "../role = 'pcc-and-pce'"
        {
            description
                "Valid at PCE";
        }
        if-feature objective-function;

        uses of-list;

        description
            "The authorized OF-List at PCE for all peers";
    }

    container peers{
        when "../role = 'pcc'" +
            "or " +
            "../role = 'pcc-and-pce'"
        {
            description
                "Valid at PCC";
        }
    }
```

```
description
  "The list of configured peers for the
  entity (remote PCE)";
list peer{
  key "addr";

  description
    "The peer configured for the entity.
    (remote PCE)";

  leaf addr {
    type inet:ip-address;
    description
      "The local Internet address of this
      PCEP peer.";
  }

  leaf description {
    type string;
    description
      "Description of the PCEP peer
      configured by the user";
  }
  uses info {
    description
      "PCE Peer information";
  }
  uses pce-info {
    description
      "PCE Peer information";
  }

  leaf delegation-pref{
    if-feature stateful;
    type uint8{
      range "0..7";
    }
    must "(/pcep/entity/capability/stateful" +
      "/active = true())"
    {
      error-message
        "The Active Stateful PCE must be
        enabled";
      description
        "When PCEP entity is active stateful
        enabled";
    }
    description

```

```
        "The PCE peer delegation preference.";
    }
    uses authentication {
        description
            "PCE Peer authentication";
    }
    }//peer
} //peers
} //entity
} //pcep

/*
 * Operational data nodes
 */

container pcep-state{
    config false;
    description
        "The list of operational PCEP entities on the
        device.";

    container entity{
        description
            "The operational PCEP entity on the device.";

        leaf addr {
            type inet:ip-address;
            description
                "The local Internet address of this PCEP
                entity.
                If operating as a PCE server, the PCEP
                entity listens on this address.
                If operating as a PCC, the PCEP entity
                binds outgoing TCP connections to this
                address.
                It is possible for the PCEP entity to
                operate both as a PCC and a PCE Server, in
                which case it uses this address both to
                listen for incoming TCP connections and to
                bind outgoing TCP connections.";
        }

        leaf index{
            type uint32;
            description
                "The index of the operational PCEP
                entity";
        }
    }
}
```

```
leaf admin-status {
  type pcep-admin-status;
  description
    "The administrative status of this PCEP Entity.
    This is the desired operational status as
    currently set by an operator or by default in
    the implementation. The value of enabled
    represents the current status of an attempt
    to reach this desired status.";
}

leaf oper-status {
  type pcep-admin-status;
  description
    "The operational status of the PCEP entity.
    Takes one of the following values.
    - oper-status-up(1): the PCEP entity is
      active.
    - oper-status-down(2): the PCEP entity is
      inactive.
    - oper-status-going-up(3): the PCEP entity is
      activating.
    - oper-status-going-down(4): the PCEP entity is
      deactivating.
    - oper-status-failed(5): the PCEP entity has
      failed and will recover when possible.
    - oper-status-failed-perm(6): the PCEP entity
      has failed and will not recover without
      operator intervention.";
}

leaf role {
  type pcep-role;
  description
    "The role that this entity can play.
    Takes one of the following values.
    - unknown(0): this PCEP entity role is
      not known.
    - pcc(1): this PCEP entity is a PCC.
    - pce(2): this PCEP entity is a PCE.
    - pcc-and-pce(3): this PCEP entity is
      both a PCC and a PCE.";
}

leaf description {
  type string;
  description
    "Description of the PCEP entity configured
```



```
        by the user";
    }

    leaf speaker-entity-id{
        if-feature stateful-sync-opt;
        type string;
        description
            "The Speaker Entity Identifier";
    }

    uses info {
        description
            "Local PCEP entity information";
    }

    container pce-info {
        when "../role = 'pce'" +
            "or " +
            "../role = 'pcc-and-pce'"
        {
            description
                "Valid at PCE";
        }
        uses pce-info {
            description
                "Local PCE information";
        }

        container path-key {
            if-feature path-key;
            uses path-key {
                description
                    "Path-Key Configuration";
            }
            description
                "Path-Key Configuration";
        }

        description
            "The Local PCE Entity PCE information";
    }

    uses authentication {
        description
            "Local PCEP Entity authentication information";
    }

    uses pcep-entity-info{
```

```
        description
            "The operational information related to the
            PCEP entity.";
    }

    container stateful-parameter{
        if-feature stateful;
        must "(/pcep/entity/capability/stateful/enabled" +
            " = true())"
        {
            error-message
                "The Stateful PCE must be enabled";
            description
                "When PCEP entity is stateful
                enabled";
        }
        uses stateful-pce-parameter;

        description
            "The operational stateful parameters";
    }

    container lsp-db{
        if-feature stateful;
        description
            "The LSP-DB";
        leaf db-ver{
            when "../role = 'pcc'" +
                "or " +
                "../role = 'pcc-and-pce'"
            {
                description
                    "Valid at PCC";
            }
            if-feature stateful-sync-opt;
            type uint64;
            description
                "The LSP State Database Version Number";
        }
        list association-list {
            key "id source global-source extended-id";
            description
                "List of all PCEP associations";
            uses association {
                description
                    "The Association attributes";
            }
        }
    }
}
```

```

    }
    list lsp {
        key "plsp-id pcc-id";
        description
            "List of all LSP in this association";
        leaf plsp-id {
            type leafref {
                path "/pcep-state/entity/lsp-db/"
                    + "lsp/plsp-id";
            }
            description
                "Reference to PLSP-ID in LSP-DB";
        }
        leaf pcc-id {
            type leafref {
                path "/pcep-state/entity/lsp-db/"
                    + "lsp/pcc-id";
            }
            description
                "Reference to PCC-ID in LSP-DB";
        }
    }
}
list lsp{
    key "plsp-id pcc-id";
    description
        "List of all LSPs in LSP-DB";
    uses lsp-state{
        description
            "The PCEP specific attributes for
            LSP-DB.";
    }
    list association-list {
        key "id source global-source extended-id";
        description
            "List of all PCEP associations";
        uses association-ref {
            description
                "Reference to the Association
                attributes";
        }
    }
}
}
container path-keys {
    when "../role = 'pce'" +
        "or " +

```

```
        "../role = 'pcc-and-pce'"
    {
        description
            "Valid at PCE";
    }
    if-feature path-key;
    uses path-key-state;
    description
        "The path-keys generated by the PCE";
}
container of-list{
    when "../role = 'pce'" +
        "or " +
        "../role = 'pcc-and-pce'"
    {
        description
            "Valid at PCE";
    }
    if-feature objective-function;

    uses of-list;

    description
        "The authorized OF-List at PCE for all peers";
}
container peers{
    description
        "The list of peers for the entity";

    list peer{
        key "addr";

        description
            "The peer for the entity.";

        leaf addr {
            type inet:ip-address;
            description
                "The local Internet address of this PCEP
                peer.";
        }

        leaf role {
            type pcep-role;
            description
                "The role of the PCEP Peer.
                Takes one of the following values.
                - unknown(0): this PCEP peer role";
        }
    }
}
```

```
        is not known.
        - pcc(1): this PCEP peer is a PCC.
        - pce(2): this PCEP peer is a PCE.
        - pcc-and-pce(3): this PCEP peer
          is both a PCC and a PCE.";
    }

    uses info {
        description
            "PCEP peer information";
    }

    container pce-info {
        when "../role = 'pce'" +
            "or " +
            "../role = 'pcc-and-pce'"
        {
            description
                "When the peer is PCE";
        }

        uses pce-info {
            description
                "PCE Peer information";
        }
    }
    description
        "The PCE Peer information";
}

leaf delegation-pref{
    when "../role = 'pce'" +
        "or " +
        "../role = 'pcc-and-pce'"
    {
        description
            "When the peer is PCE";
    }
    if-feature stateful;
    type uint8{
        range "0..7";
    }
    must "(/pcep/entity/capability/stateful" +
        "/active = true())"
    {
        error-message
            "The Active Stateful PCE must be
```

```
        enabled";
    description
        "When PCEP entity is active stateful
        enabled";
    }
    description
        "The PCE peer delegation preference.";
}

uses authentication {
    description
        "PCE Peer authentication";
}

leaf discontinuity-time {
    type yang:timestamp;
    description
        "The timestamp of the time when the
        information and statistics were
        last reset.";
}

leaf initiate-session {
    type boolean;
    description
        "Indicates whether the local PCEP
        entity initiates sessions to this peer,
        or waits for the peer to initiate a
        session.";
}

leaf session-exists{
    type boolean;
    description
        "Indicates whether a session with
        this peer currently exists.";
}

leaf session-up-time{
    type yang:timestamp;
    description
        "The timestamp value of the last time a
        session with this peer was successfully
        established.";
}

leaf session-fail-time{
    type yang:timestamp;
```

```
    description
      "The timestamp value of the last time a
       session with this peer failed to be
       established.";
  }

  leaf session-fail-up-time{
    type yang:timestamp;
    description
      "The timestamp value of the last time a
       session with this peer failed from
       active.";
  }

  container sessions {
    description
      "This entry represents a single PCEP
       session in which the local PCEP entity
       participates.
       This entry exists only if the
       corresponding PCEP session has been
       initialized by some event, such as
       manual user configuration, auto-
       discovery of a peer, or an incoming
       TCP connection.";

    list session {
      key "initiator";

      description
        "The list of sessions, note that
         for a time being two sessions
         may exist for a peer";

      leaf initiator {
        type pcep-initiator;
        description
          "The initiator of the session,
           that is, whether the TCP
           connection was initiated by
           the local PCEP entity or the
           peer.
           There is a window during
           session initialization where
```

```
        two sessions can exist between
        a pair of PCEP speakers, each
        initiated by one of the
        speakers. One of these
        sessions is always discarded
        before it leaves OpenWait
        state. However, before it is
        discarded, two sessions to the
        given peer appear transiently
        in this MIB module. The
        sessions are distinguished by
        who initiated them, and so this
        field is the key.";
    }
    leaf role {
        type leafref {
            path "../.../role";
        }
        description
            "The reference to peer role .";
    }

    leaf state-last-change {
        type yang:timestamp;
        description
            "The timestamp value at the
            time this session entered its
            current state as denoted by
            the state leaf.";
    }

    leaf state {
        type pcep-sess-state;
        description
            "The current state of the
            session.
            The set of possible states
            excludes the idle state since
            entries do not exist in the
            idle state.";
    }

    leaf session-creation {
        type yang:timestamp;
        description
            "The timestamp value at the
            time this session was
            created.";
```



```
}  
  
leaf connect-retry {  
    type yang:counter32;  
    description  
        "The number of times that the  
        local PCEP entity has  
        attempted to establish a TCP  
        connection for this session  
        without success. The PCEP  
        entity gives up when this  
        reaches connect-max-retry.";  
}  
  
leaf local-id {  
    type uint32 {  
        range "0..255";  
    }  
    description  
        "The value of the PCEP session  
        ID used by the local PCEP  
        entity in the Open message  
        for this session.  
        If state is tcp-pending then  
        this is the session ID that  
        will be used in the Open  
        message. Otherwise, this is  
        the session ID that was sent  
        in the Open message.";  
}  
  
leaf remote-id {  
    type uint32 {  
        range "0..255";  
    }  
    must "((../state != 'tcp-pending'" +  
        "and " +  
        "../state != 'open-wait' )" +  
        "or " +  
        "((../state = 'tcp-pending'" +  
        " or " +  
        "../state = 'open-wait' )" +  
        "and (. = 0)))" {  
        error-message  
            "Invalid remote-id";  
        description  
            "If state is tcp-  
            pending or open-wait
```

```

        then this leaf is not
        used and MUST be set
        to zero.";
    }
    description
        "The value of the PCEP session
        ID used by the peer in its
        Open message for this
        session.";
}

leaf keepalive-timer {
    type uint32 {
        range "0..255";
    }
    units "seconds";
    must "(../state = 'session-up' +
        'or ' +
        '(../state != 'session-up' +
        'and (.= 0)))" {
        error-message
            "Invalid keepalive
            timer";
        description
            "This field is used if
            and only if state is
            session-up. Otherwise,
            it is not used and
            MUST be set to
            zero.";
    }
    description
        "The agreed maximum interval at
        which the local PCEP entity
        transmits PCEP messages on
        this PCEP session. Zero means
        that the local PCEP entity
        never sends Keepalives on this
        session.";
}

leaf peer-keepalive-timer {
    type uint32 {
        range "0..255";
    }
    units "seconds";
    must "(../state = 'session-up' +
        'or ' +

```

```

        "(../state != 'session-up'" +
        "and " +
        "(. = 0)))" {
            error-message
                "Invalid Peer keepalive
                timer";
            description
                "This field is used if
                and only if state is
                session-up. Otherwise,
                it is not used and MUST
                be set to zero.";
        }
    description
        "The agreed maximum interval at
        which the peer transmits PCEP
        messages on this PCEP session.
        Zero means that the peer never
        sends Keepalives on this
        session.";
}

leaf dead-timer {
    type uint32 {
        range "0..255";
    }
    units "seconds";
    description
        "The dead timer interval for
        this PCEP session.";
}

leaf peer-dead-timer {
    type uint32 {
        range "0..255";
    }
    units "seconds";
    must "((../state != 'tcp-pending'" +
        "and " +
        "../state != 'open-wait' )" +
        "or " +
        "((../state = 'tcp-pending'" +
        " or " +
        "../state = 'open-wait' )" +
        "and " +
        "(. = 0)))" {
        error-message
            "Invalid Peer Dead

```

```
        timer";
    description
        "If state is tcp-
        pending or open-wait
        then this leaf is not
        used and MUST be set to
        zero.";
    }
    description
        "The peer's dead-timer interval
        for this PCEP session.";
}

leaf ka-hold-time-rem {
    type uint32 {
        range "0..255";
    }
    units "seconds";
    must "((../state != 'tcp-pending' " +
        "and " +
        "../state != 'open-wait' ) " +
        "or " +
        "((../state = 'tcp-pending' " +
        "or " +
        "../state = 'open-wait' )" +
        "and " +
        "(. = 0)))" {
        error-message
            "Invalid Keepalive hold
            time remaining";
        description
            "If state is tcp-pending
            or open-wait then this
            field is not used and
            MUST be set to zero.";
    }
    description
        "The keep alive hold time
        remaining for this session.";
}

leaf overloaded {
    type boolean;
    description
        "If the local PCEP entity has
        informed the peer that it is
        currently overloaded, then
        this is set to true.
```

```
        Otherwise, it is set to
        false.";
    }

    leaf overload-time {
        type uint32;
        units "seconds";
        must "((../overloaded = true()) " +
            "or ((../overloaded != true()) " +
            "and (. = 0)))" {
            error-message
                "Invalid overload-time";
            description
                "This field is only used
                if overloaded is set to
                true. Otherwise, it is
                not used and MUST be
                set to zero.";
        }
        description
            "The interval of time that is
            remaining until the local PCEP
            entity will cease to be
            overloaded on this session.";
    }

    leaf peer-overloaded {
        type boolean;
        description
            "If the peer has informed the
            local PCEP entity that it is
            currently overloaded, then
            this is set to true.
            Otherwise, it is set to
            false.";
    }

    leaf peer-overload-time {
        type uint32;
        units "seconds";
        must "((../peer-overloaded = " +
            "true()) or " +
            "((../peer-overloaded != " +
            "true())" +
            " and " +
            "(. = 0)))" {
            error-message
                "Invalid peer overload
```

```
        time";
    description
        "This field is only used
        if peer-overloaded is
        set to true. Otherwise,
        it is not used and MUST
        be set to zero.";
    }
    description
        "The interval of time that is
        remaining until the peer will
        cease to be overloaded. If it
        is not known how long the peer
        will stay in overloaded state,
        this leaf is set to zero.";
}
leaf lspdb-sync {
    if-feature stateful;
    type sync-state;
    description
        "The LSP-DB state
        synchronization status.";
}
leaf recv-db-ver{
    when "../role = 'pcc'" +
        "or " +
        "../role = 'pcc-and-pce'"
    {
        description
            "Valid for PCEP Peer as
            PCC";
    }

    if-feature stateful;
    if-feature stateful-sync-opt;

    type uint64;

    description
        "The last received LSP State
        Database Version Number";
}

container of-list{
    when "../role = 'pce'" +
        "or " +
        "../role = 'pcc-and-pce'"
    {
```

```

        description
            "Valid for PCEP Peer as
            PCE";
    }
    if-feature objective-function;

    uses of-list;

    description
        "Indicate the list of supported
        OF on this session";
    }

    leaf speaker-entity-id{
        if-feature stateful-sync-opt;
        type string;
        description
            "The Speaker Entity Identifier";
    }

    leaf discontinuity-time {
        type yang:timestamp;
        description
            "The timestamp value of the
            time when the statistics were
            last reset.";
    }
    } // session
    } // sessions
    } // peer
    } // peers
    } // entity
} // pcep-state

/*
 * Notifications
 */
notification pcep-session-up {
    description
        "This notification is sent when the value of
        '/pcep/pcep-state/peers/peer/sessions/session/state'
        enters the 'session-up' state.";

    uses notification-instance-hdr;

    uses notification-session-hdr;

    leaf state-last-change {

```

```
        type yang:timestamp;
        description
            "The timestamp value at the time this session
            entered its current state as denoted by the state
            leaf.";
    }

    leaf state {
        type pcep-sess-state;
        description
            "The current state of the session.
            The set of possible states excludes the idle state
            since entries do not exist in the idle state.";
    }
} //notification

notification pcep-session-down {
    description
        "This notification is sent when the value of
        '/pcep/pcep-state/peers/peer/sessions/session/state'
        leaves the 'session-up' state.";

    uses notification-instance-hdr;

    leaf session-initiator {
        type pcep-initiator;
        description
            "The initiator of the session.";
    }

    leaf state-last-change {
        type yang:timestamp;
        description
            "The timestamp value at the time this session
            entered its current state as denoted by the state
            leaf.";
    }

    leaf state {
        type pcep-sess-state;
        description
            "The current state of the session.
            The set of possible states excludes the idle state
            since entries do not exist in the idle state.";
    }
} //notification

notification pcep-session-local-overload {
```



```
    description
        "This notification is sent when the local PCEP entity
        enters overload state for a peer.";

    uses notification-instance-hdr;

    uses notification-session-hdr;

    leaf overloaded {
        type boolean;
        description
            "If the local PCEP entity has informed the peer
            that it is currently overloaded, then this is set
            to true. Otherwise, it is set to false.";
    }

    leaf overload-time {
        type uint32;
        units "seconds";
        description
            "The interval of time that is remaining until the
            local PCEP entity will cease to be overloaded on
            this session.";
    }
} //notification

notification pcep-session-local-overload-clear {
    description
        "This notification is sent when the local PCEP entity
        leaves overload state for a peer.";

    uses notification-instance-hdr;

    leaf overloaded {
        type boolean;
        description
            "If the local PCEP entity has informed the peer
            that it is currently overloaded, then this is set
            to true. Otherwise, it is set to false.";
    }
} //notification

notification pcep-session-peer-overload {
    description
        "This notification is sent when a peer enters overload
        state.";

    uses notification-instance-hdr;
```

```
    uses notification-session-hdr;

    leaf peer-overloaded {
        type boolean;
        description
            "If the peer has informed the local PCEP entity that
             it is currently overloaded, then this is set to
             true. Otherwise, it is set to false.";
    }

    leaf peer-overload-time {
        type uint32;
        units "seconds";
        description
            "The interval of time that is remaining until the
             peer will cease to be overloaded. If it is not
             known how long the peer will stay in overloaded
             state, this leaf is set to zero.";
    }
} //notification

notification pcep-session-peer-overload-clear {
    description
        "This notification is sent when a peer leaves overload
         state.";

    uses notification-instance-hdr;

    leaf peer-overloaded {
        type boolean;
        description
            "If the peer has informed the local PCEP entity that
             it is currently overloaded, then this is set to
             true. Otherwise, it is set to false.";
    }
} //notification

/*
 * RPC
 */

rpc trigger-resync {
    if-feature stateful;
    if-feature stateful-sync-opt;
    description
        "Trigger the resyncrinization at the PCE";
    input {
        leaf pcc {
```

```
        type leafref {
            path "/pcep-state/entity/peers/peer/addr";
        }
    description
        "The IP address to identify the PCC. The state
        synchronization is re-triggered for all LSPs from
        the PCC. The rpc on the PCC will be ignored.";
    }
}
} //rpc
} //module
```

<CODE ENDS>

9.2. ietf-pcep-stats module

```
<CODE BEGINS> file "ietf-pcep-stats@2017-03-12.yang"
module ietf-pcep-stats {

    yang-version 1.1;

    namespace "urn:ietf:params:xml:ns:yang:ietf-pcep-stats";
    prefix ps;

    import ietf-pcep {
        prefix p;
    }

    import ietf-yang-types {
        prefix "yang";
    }

    organization
        "IETF PCE (Path Computation Element) Working Group";

    contact
        "WG Web:    <http://tools.ietf.org/wg/pce/>
        WG List:    <mailto:pce@ietf.org>
        WG Chair:   JP Vasseur
                   <mailto:jpv@cisco.com>
```

```
WG Chair: Julien Meuric
          <mailto:julien.meuric@orange.com>
WG Chair: Jonathan Hardwick
          <mailto:Jonathan.Hardwick@metaswitch.com>
Editor:   Dhruv Dhody
          <mailto:dhruv.ietf@gmail.com>;
```

description

```
"The YANG module augments the PCEP yang operational
model with statistics, counters and telemetry data";
```

revision 2017-03-12 {

```
  description "Initial revision.";
```

reference

```
    "RFC XXXX:  A YANG Data Model for Path Computation
                Element Communications Protocol
                (PCEP)";
```

}

```
/*
```

```
 * Groupings
```

```
*/
```

grouping pcep-stats{

description

```
    "This grouping defines statistics for PCEP. It is used
    for both peer and current session.";
```

leaf avg-rsp-time{

```
    when "../p:role = 'pce' " +
       "or " +
       "../p:role = 'pcc-and-pce' "
```

```
    {
```

description

```
        "Valid for PCEP Peer as PCE";
```

```
    }
```

```
    type uint32;
```

```
    units "milliseconds";
```

description

```
    "The average response time.
    If an average response time has not been
    calculated then this leaf has the value zero.";
```

}

```
leaf lwm-rsp-time{
  when "../..//p:role = 'pce'" +
    "or " +
    "../..//p:role = 'pcc-and-pce'"
  {
    description
      "Valid for PCEP Peer as PCE";
  }
  type uint32;
  units "milliseconds";

  description
    "The smallest (low-water mark) response time seen.
    If no responses have been received then this
    leaf has the value zero.";
}

leaf hwm-rsp-time{
  when "../..//p:role = 'pce'" +
    "or " +
    "../..//p:role = 'pcc-and-pce'"
  {
    description
      "Valid for PCEP Peer as PCE";
  }
  type uint32;
  units "milliseconds";

  description
    "The greatest (high-water mark) response time seen.
    If no responses have been received then this object
    has the value zero.";
}

leaf num-pcreq-sent{
  when "../..//p:role = 'pce'" +
    "or " +
    "../..//p:role = 'pcc-and-pce'"
  {
    description
      "Valid for PCEP Peer as PCE";
  }
  type yang:counter32;
  description
    "The number of PCReq messages sent.";
}

leaf num-pcreq-rcvd{
```

```
    when "../..//p:role = 'pcc'" +
      "or " +
      "../..//p:role = 'pcc-and-pce'"
    {
      description
        "Valid for PCEP Peer as PCC";
    }
    type yang:counter32;
    description
      "The number of PCReq messages received.";
  }

  leaf num-pcrep-sent{
    when "../..//p:role = 'pcc'" +
      "or " +
      "../..//p:role = 'pcc-and-pce'"
    {
      description
        "Valid for PCEP Peer as PCC";
    }

    type yang:counter32;
    description
      "The number of PCRep messages sent.";
  }

  leaf num-pcrep-rcvd{
    when "../..//p:role = 'pce'" +
      "or " +
      "../..//p:role = 'pcc-and-pce'"
    {
      description
        "Valid for PCEP Peer as PCE";
    }

    type yang:counter32;
    description
      "The number of PCRep messages received.";
  }

  leaf num-pcerr-sent{
    type yang:counter32;
    description
      "The number of PCErr messages sent.";
  }

  leaf num-pcerr-rcvd{
    type yang:counter32;
```

```
        description
          "The number of PCErr messages received.";
      }

      leaf num-pcntf-sent{
        type yang:counter32;
        description
          "The number of PCNtf messages sent.";
      }

      leaf num-pcntf-rcvd{
        type yang:counter32;
        description
          "The number of PCNtf messages received.";
      }

      leaf num-keepalive-sent{
        type yang:counter32;
        description
          "The number of Keepalive messages sent.";
      }

      leaf num-keepalive-rcvd{
        type yang:counter32;
        description
          "The number of Keepalive messages received.";
      }

      leaf num-unknown-rcvd{
        type yang:counter32;
        description
          "The number of unknown messages received.";
      }

      leaf num-corrupt-rcvd{
        type yang:counter32;
        description
          "The number of corrupted PCEP message received.";
      }

      leaf num-req-sent{
        when "../p:role = 'pce'" +
          "or " +
          "../p:role = 'pcc-and-pce'"
        {
          description
            "Valid for PCEP Peer as PCE";
        }
      }
```

```
    type yang:counter32;
    description
      "The number of requests sent. A request corresponds
      1:1 with an RP object in a PCReq message. This might
      be greater than num-pcreq-sent because multiple
      requests can be batched into a single PCReq
      message.";
  }

  leaf num-req-sent-pend-rep{
    when "../p:role = 'pce'" +
      "or " +
      "../p:role = 'pcc-and-pce'"
    {
      description
        "Valid for PCEP Peer as PCE";
    }
    type yang:counter32;
    description
      "The number of requests that have been sent for
      which a response is still pending.";
  }

  leaf num-req-sent-ero-rcvd{
    when "../p:role = 'pce'" +
      "or " +
      "../p:role = 'pcc-and-pce'"
    {
      description
        "Valid for PCEP Peer as PCE";
    }
    type yang:counter32;
    description
      "The number of requests that have been sent for
      which a response with an ERO object was received.
      Such responses indicate that a path was
      successfully computed by the peer.";
  }

  leaf num-req-sent-nopath-rcvd{
    when "../p:role = 'pce'" +
      "or " +
      "../p:role = 'pcc-and-pce'"
    {
      description
        "Valid for PCEP Peer as PCE";
    }
    type yang:counter32;
```



```
description
  "The number of requests that have been sent for
  which a response with a NO-PATH object was
  received. Such responses indicate that the peer
  could not find a path to satisfy the
  request.";
}

leaf num-req-sent-cancel-rcvd{
  when "../p:role = 'pce'" +
    "or " +
    "../p:role = 'pcc-and-pce'"
  {
    description
      "Valid for PCEP Peer as PCE";
  }
  type yang:counter32;
  description
    "The number of requests that were cancelled with
    a PCNtf message.
    This might be different than num-pcntf-rcvd because
    not all PCNtf messages are used to cancel requests,
    and a single PCNtf message can cancel multiple
    requests.";
}

leaf num-req-sent-error-rcvd{
  when "../p:role = 'pce'" +
    "or " +
    "../p:role = 'pcc-and-pce'"
  {
    description
      "Valid for PCEP Peer as PCE";
  }
  type yang:counter32;
  description
    "The number of requests that were rejected with a
    PCErr message.
    This might be different than num-pcerr-rcvd because
    not all PCErr messages are used to reject requests,
    and a single PCErr message can reject multiple
    requests.";
}

leaf num-req-sent-timeout{
  when "../p:role = 'pce'" +
    "or " +
    "../p:role = 'pcc-and-pce'"
}
```

```
{
  description
    "Valid for PCEP Peer as PCE";
}
type yang:counter32;
description
  "The number of requests that have been sent to a peer
  and have been abandoned because the peer has taken too
  long to respond to them.";
}

leaf num-req-sent-cancel-sent{
  when "../..p:role = 'pce'" +
    "or " +
    "../..p:role = 'pcc-and-pce'"
  {
    description
      "Valid for PCEP Peer as PCE";
  }
  type yang:counter32;
  description
    "The number of requests that were sent to the peer and
    explicitly cancelled by the local PCEP entity sending
    a PCNtf.";
}

leaf num-req-rcvd{
  when "../..p:role = 'pcc'" +
    "or " +
    "../..p:role = 'pcc-and-pce'"
  {
    description
      "Valid for PCEP Peer as PCC";
  }
  type yang:counter32;
  description
    "The number of requests received. A request
    corresponds 1:1 with an RP object in a PCReq
    message.
    This might be greater than num-pcreq-rcvd because
    multiple requests can be batched into a single
    PCReq message.";
}

leaf num-req-rcvd-pend-rep{
  when "../..p:role = 'pcc'" +
    "or " +
    "../..p:role = 'pcc-and-pce'"
}
```

```
    {
      description
        "Valid for PCEP Peer as PCC";
    }
    type yang:counter32;
    description
      "The number of requests that have been received for
       which a response is still pending.";
  }

  leaf num-req-rcvd-ero-sent{
    when "../..p:role = 'pcc'" +
      "or " +
      "../..p:role = 'pcc-and-pce'"
    {
      description
        "Valid for PCEP Peer as PCC";
    }
    type yang:counter32;
    description
      "The number of requests that have been received for
       which a response with an ERO object was sent. Such
       responses indicate that a path was successfully
       computed by the local PCEP entity.";
  }

  leaf num-req-rcvd-nopath-sent{
    when "../..p:role = 'pcc'" +
      "or " +
      "../..p:role = 'pcc-and-pce'"
    {
      description
        "Valid for PCEP Peer as PCC";
    }
    type yang:counter32;
    description
      "The number of requests that have been received for
       which a response with a NO-PATH object was sent. Such
       responses indicate that the local PCEP entity could
       not find a path to satisfy the request.";
  }

  leaf num-req-rcvd-cancel-sent{
    when "../..p:role = 'pcc'" +
      "or " +
      "../..p:role = 'pcc-and-pce'"
    {
      description
```

```
        "Valid for PCEP Peer as PCC";
    }
    type yang:counter32;
    description
        "The number of requests received that were cancelled
        by the local PCEP entity sending a PCNtf message.
        This might be different than num-pcntf-sent because
        not all PCNtf messages are used to cancel requests,
        and a single PCNtf message can cancel multiple
        requests.";
}

leaf num-req-rcvd-error-sent{
    when "../..p:role = 'pcc'" +
        "or " +
        "../..p:role = 'pcc-and-pce'"
    {
        description
            "Valid for PCEP Peer as PCC";
    }
    type yang:counter32;
    description
        "The number of requests received that were cancelled
        by the local PCEP entity sending a PCErr message.
        This might be different than num-pcerr-sent because
        not all PCErr messages are used to cancel requests,
        and a single PCErr message can cancel multiple
        requests.";
}

leaf num-req-rcvd-cancel-rcvd{
    when "../..p:role = 'pcc'" +
        "or " +
        "../..p:role = 'pcc-and-pce'"
    {
        description
            "Valid for PCEP Peer as PCC";
    }
    type yang:counter32;
    description
        "The number of requests that were received from the
        peer and explicitly cancelled by the peer sending
        a PCNtf.";
}

leaf num-rep-rcvd-unknown{
    when "../..p:role = 'pce'" +
        "or " +
```

```
        ".../.../p:role = 'pcc-and-pce'"
    {
        description
            "Valid for PCEP Peer as PCE";
    }
    type yang:counter32;
    description
        "The number of responses to unknown requests
        received. A response to an unknown request is a
        response whose RP object does not contain the
        request ID of any request that is currently
        outstanding on the session.";
}

leaf num-req-rcvd-unknown{
    when ".../.../p:role = 'pcc'" +
        "or " +
        ".../.../p:role = 'pcc-and-pce'"
    {
        description
            "Valid for PCEP Peer as PCC";
    }
    type yang:counter32;
    description
        "The number of unknown requests that have been
        received. An unknown request is a request
        whose RP object contains a request ID of
        zero.";
}

container svec{
    if-feature p:svec;
    description
        "If synchronized path computation is supported";
    leaf num-svec-sent{
        when ".../.../.../p:role = 'pce'" +
            "or " +
            ".../.../.../p:role = 'pcc-and-pce'"
        {
            description
                "Valid for PCEP Peer as PCE";
        }
        type yang:counter32;
        description
            "The number of SVEC objects sent in PCReq messages.
            An SVEC object represents a set of synchronized
            requests.";
    }
}
```

```
leaf num-svec-req-sent{
  when "../../../p:role = 'pce'" +
    "or " +
    "../../../p:role = 'pcc-and-pce'"
  {
    description
      "Valid for PCEP Peer as PCE";
  }
  type yang:counter32;
  description
    "The number of requests sent that appeared in one
    or more SVEC objects.";
}

leaf num-svec-rcvd{
  when "../../../p:role = 'pcc'" +
    "or " +
    "../../../p:role = 'pcc-and-pce'"
  {
    description
      "Valid for PCEP Peer as PCC";
  }
  type yang:counter32;
  description
    "The number of SVEC objects received in PCReq
    messages. An SVEC object represents a set of
    synchronized requests.";
}

leaf num-svec-req-rcvd{
  when "../../../p:role = 'pcc'" +
    "or " +
    "../../../p:role = 'pcc-and-pce'"
  {
    description
      "Valid for PCEP Peer as PCC";
  }
  type yang:counter32;
  description
    "The number of requests received that appeared
    in one or more SVEC objects.";
}
}

container stateful{
  if-feature p:stateful;
  description
    "Stateful PCE related statistics";
  leaf num-pcrpt-sent{
```

```
when "../../../p:role = 'pce'" +
  "or " +
  "../../../p:role = 'pcc-and-pce'"
{
  description
    "Valid for PCEP Peer as PCE";
}
type yang:counter32;
description
  "The number of PCRpt messages sent.";
}

leaf num-pcrpt-rcvd{
  when "../../../p:role = 'pcc'" +
    "or " +
    "../../../p:role = 'pcc-and-pce'"
  {
    description
      "Valid for PCEP Peer as PCC";
  }
  type yang:counter32;
  description
    "The number of PCRpt messages received.";
}

leaf num-pcupd-sent{
  when "../../../p:role = 'pcc'" +
    "or " +
    "../../../p:role = 'pcc-and-pce'"
  {
    description
      "Valid for PCEP Peer as PCC";
  }
  type yang:counter32;
  description
    "The number of PCUpd messages sent.";
}

leaf num-pcupd-rcvd{
  when "../../../p:role = 'pce'" +
    "or " +
    "../../../p:role = 'pcc-and-pce'"
  {
    description
      "Valid for PCEP Peer as PCE";
  }
  type yang:counter32;
  description
```

```
        "The number of PCUpd messages received.";
    }

    leaf num-rpt-sent{
        when "../.../p:role = 'pce'" +
            "or " +
            "../.../p:role = 'pcc-and-pce'"
        {
            description
                "Valid for PCEP Peer as PCE";
        }
        type yang:counter32;
        description
            "The number of LSP Reports sent.  A LSP report
            corresponds 1:1 with an LSP object in a PCRpt
            message. This might be greater than
            num-pcrpt-sent because multiple reports can
            be batched into a single PCRpt message.";
    }

    leaf num-rpt-rcvd{
        when "../.../p:role = 'pcc'" +
            "or " +
            "../.../p:role = 'pcc-and-pce'"
        {
            description
                "Valid for PCEP Peer as PCC";
        }
        type yang:counter32;
        description
            "The number of LSP Reports received.  A LSP report
            corresponds 1:1 with an LSP object in a PCRpt
            message.
            This might be greater than num-pcrpt-rcvd because
            multiple reports can be batched into a single
            PCRpt message.";
    }

    leaf num-rpt-rcvd-error-sent{
        when "../.../p:role = 'pcc'" +
            "or " +
            "../.../p:role = 'pcc-and-pce'"
        {
            description
                "Valid for PCEP Peer as PCC";
        }
        type yang:counter32;
        description
```



```
        "The number of reports of LSPs received that were
        responded by the local PCEP entity by sending a
        PCErr message.";
    }

    leaf num-upd-sent{
        when "../.../p:role = 'pcc'" +
            "or " +
            "../.../p:role = 'pcc-and-pce'"
        {
            description
                "Valid for PCEP Peer as PCC";
        }
        type yang:counter32;
        description
            "The number of LSP updates sent. A LSP update
            corresponds 1:1 with an LSP object in a PCUpd
            message. This might be greater than
            num-pcupd-sent because multiple updates can
            be batched into a single PCUpd message.";
    }

    leaf num-upd-rcvd{
        when "../.../p:role = 'pce'" +
            "or " +
            "../.../p:role = 'pcc-and-pce'"
        {
            description
                "Valid for PCEP Peer as PCE";
        }
        type yang:counter32;
        description
            "The number of LSP Updates received. A LSP update
            corresponds 1:1 with an LSP object in a PCUpd
            message.
            This might be greater than num-pcupd-rcvd because
            multiple updates can be batched into a single
            PCUpd message.";
    }

    leaf num-upd-rcvd-unknown{
        when "../.../p:role = 'pce'" +
            "or " +
            "../.../p:role = 'pcc-and-pce'"
        {
            description
                "Valid for PCEP Peer as PCE";
        }
    }
```

```
    type yang:counter32;
    description
      "The number of updates to unknown LSPs
      received. An update to an unknown LSP is a
      update whose LSP object does not contain the
      PLSP-ID of any LSP that is currently
      present.";
  }

  leaf num-upd-rcvd-undelegated{
    when "../.../p:role = 'pce'" +
      "or " +
      "../.../p:role = 'pcc-and-pce'"
    {
      description
        "Valid for PCEP Peer as PCE";
    }
    type yang:counter32;
    description
      "The number of updates to not delegated LSPs
      received. An update to an undelegated LSP is a
      update whose LSP object does not contain the
      PLSP-ID of any LSP that is currently
      delegated to current PCEP session.";
  }

  leaf num-upd-rcvd-error-sent{
    when "../.../p:role = 'pce'" +
      "or " +
      "../.../p:role = 'pcc-and-pce'"
    {
      description
        "Valid for PCEP Peer as PCE";
    }
    type yang:counter32;
    description
      "The number of updates to LSPs received that were
      responded by the local PCEP entity by sending a
      PCErr message.";
  }
  container initiation {
    if-feature p:pce-initiated;
    description
      "PCE-Initiated related statistics";
    leaf num-pcinitiate-sent{
      when "../.../.../p:role = 'pcc'" +
        "or " +
        "../.../.../p:role = 'pcc-and-pce'"
    }
```

```
    {
      description
        "Valid for PCEP Peer as PCC";
    }
    type yang:counter32;
    description
      "The number of PCInitiate messages sent.";
  }

  leaf num-pcinitiate-rcvd{
    when "../.../.../p:role = 'pce'" +
      "or " +
      "../.../.../p:role = 'pcc-and-pce'"
    {
      description
        "Valid for PCEP Peer as PCE";
    }
    type yang:counter32;
    description
      "The number of PCInitiate messages received.";
  }

  leaf num-initiate-sent{
    when "../.../.../p:role = 'pcc'" +
      "or " +
      "../.../.../p:role = 'pcc-and-pce'"
    {
      description
        "Valid for PCEP Peer as PCC";
    }
    type yang:counter32;
    description
      "The number of LSP Initiation sent via PCE.
      A LSP initiation corresponds 1:1 with an LSP
      object in a PCInitiate message. This might be
      greater than num-pcinitiate-sent because
      multiple initiations can be batched into a
      single PCInitiate message.";
  }

  leaf num-initiate-rcvd{
    when "../.../.../p:role = 'pce'" +
      "or " +
      "../.../.../p:role = 'pcc-and-pce'"
    {
      description
        "Valid for PCEP Peer as PCE";
    }
  }
```

```
    type yang:counter32;
    description
      "The number of LSP Initiation received from
      PCE. A LSP initiation corresponds 1:1 with
      an LSP object in a PCInitiate message. This
      might be greater than num-pcinitiate-rcvd
      because multiple initiations can be batched
      into a single PCInitiate message.";
  }

  leaf num-initiate-rcvd-error-sent{
    when "../../../p:role = 'pce'" +
      "or " +
      "../../../p:role = 'pcc-and-pce'"
    {
      description
        "Valid for PCEP Peer as PCE";
    }
    type yang:counter32;
    description
      "The number of initiations of LSPs received
      that were responded by the local PCEP entity
      by sending a PCErr message.";
  }
}

container path-key {
  when "../../../p:role = 'pcc'" +
    "or " +
    "../../../p:role = 'pcc-and-pce'"
  {
    description
      "Valid for PCEP Peer as PCC";
  }
  if-feature p:path-key;
  description
    "If Path-Key is supported";
  leaf num-unknown-path-key{
    type yang:counter32;
    description
      "The number of attempts to expand an unknown
      path-key.";
  }
  leaf num-exp-path-key{
    type yang:counter32;
    description
      "The number of attempts to expand an expired
      path-key.";
```

```
    }
    leaf num-dup-path-key{
      type yang:counter32;
      description
        "The number of duplicate attempts to expand same
        path-key.";
    }
    leaf num-path-key-no-attempt{
      type yang:counter32;
      description
        "The number of expired path-keys with no attempt to
        expand it.";
    }
  }
} //pcep-stats

/*
 * Augment modules to add statistics
 */

augment "/p:pcep-state/p:entity/p:peers/p:peer" {
  description
    "Augmenting the statistics";
  leaf num-sess-setup-ok{
    type yang:counter32;
    description
      "The number of PCEP sessions successfully
      successfully established with the peer,
      including any current session. This
      counter is incremented each time a
      session with this peer is successfully
      established.";
  }

  leaf num-sess-setup-fail{
    type yang:counter32;
    description
      "The number of PCEP sessions with the peer
      that have been attempted but failed
      before being fully established. This
      counter is incremented each time a
      session retry to this peer fails.";
  }
}
container pcep-stats {
  description
    "The container for all statistics at peer
    level.";
  uses pcep-stats{

```

```
        description
            "Since PCEP sessions can be
            ephemeral, the peer statistics tracks
            a peer even when no PCEP session
            currently exists to that peer. The
            statistics contained are an aggregate
            of the statistics for all successive
            sessions to that peer.";
    }

    leaf num-req-sent-closed{
        when "../p:role = 'pce'" +
            "or " +
            "../p:role = 'pcc-and-pce'"
        {
            description
                "Valid for PCEP Peer as PCE";
        }
        type yang:counter32;
        description
            "The number of requests that were
            sent to the peer and implicitly
            cancelled when the session they were
            sent over was closed.";
    }

    leaf num-req-rcvd-closed{
        when "../p:role = 'pcc'" +
            "or " +
            "../p:role = 'pcc-and-pce'"
        {
            description
                "Valid for PCEP Peer as PCC";
        }
        type yang:counter32;
        description
            "The number of requests that were
            received from the peer and
            implicitly cancelled when the
            session they were received over
            was closed.";
    }
} //pcep-stats
} //augment

augment "/p:pcep-state/p:entity/p:peers/p:peer/" +
    "p:sessions/p:session" {
    description
```

```
        "Augmenting the statistics";
    container pcep-stats {
        description
            "The container for all statistics
            at session level.";
        uses pcep-stats{
            description
                "The statistics contained are
                for the current sessions to
                that peer. These are lost
                when the session goes down.
                ";
        }
    } //pcep-stats
} //augment
} //module
```

<CODE ENDS>

10. Security Considerations

The YANG module defined in this memo is designed to be accessed via the NETCONF protocol [RFC6241]. The lowest NETCONF layer is the secure transport layer and the mandatory-to-implement secure transport is SSH [RFC6242]. The NETCONF access control model [RFC6536] provides the means to restrict access for particular NETCONF users to a pre-configured subset of all available NETCONF protocol operations and content.

There are a number of data nodes defined in the YANG module which are writable/creatable/deletable (i.e., config true, which is the default). These data nodes may be considered sensitive or vulnerable in some network environments. Write operations (e.g., <edit-config>) to these data nodes without proper protection can have a negative effect on network operations. These are the subtrees and data nodes and their sensitivity/vulnerability:

/pcep/entity/ - configure local parameters, capabilities etc.

/pcep/entity/peers - configure remote peers to setup PCEP session.

Unauthorized access to above list can adversely affect the PCEP session between the local entity and the peers. This may lead to

inability to compute new paths, stateful operations on the delegated as well as PCE-initiated LSPs.

Some of the readable data nodes in this YANG module may be considered sensitive or vulnerable in some network environments. It is thus important to control read access (e.g., via get, get-config, or notification) to these data nodes. These are the subtrees and data nodes and their sensitivity/vulnerability:

/pcep-state/lsp-db - All the LSPs in the network. Unauthorized access to this could provide the all path and network usage information.

/pcep-state/path-keys/ - The Confidential Path Segments (CPS) are hidden using path-keys. Unauthorized access to this could leak confidential path information.

Some of the RPC operations in this YANG module may be considered sensitive or vulnerable in some network environments. It is thus important to control access to these operations. These are the operations and their sensitivity/vulnerability:

trigger-resync - trigger resynchronization with the PCE.
Unauthorized access to this could force a PCEP session into continuous state synchronization.

11. IANA Considerations

This document registers a URI in the "IETF XML Registry" [RFC3688]. Following the format in RFC 3688, the following registration has been made.

URI: urn:ietf:params:xml:ns:yang:ietf-pcep

Registrant Contact: The PCE WG of the IETF.

XML: N/A; the requested URI is an XML namespace.

This document registers a YANG module in the "YANG Module Names" registry [RFC6020].

Name:	ietf-pcep
Namespace:	urn:ietf:params:xml:ns:yang:ietf-pcep
Prefix:	pcep
Reference:	This I-D

12. Acknowledgements

The initial document is based on the PCEP MIB [RFC7420]. Further this document structure is based on Routing Yang Module [I-D.ietf-netmod-routing-cfg]. We would like to thank the authors of aforementioned documents.

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Appendix A. Contributor Addresses

Rohit Pobbathi
Huawei Technologies
Divyashree Techno Park, Whitefield
Bangalore, Karnataka 560066
India

EMail: rohit.pobbathi@huawei.com

Vinod KumarS
Huawei Technologies
Divyashree Techno Park, Whitefield
Bangalore, Karnataka 560066
India

EMail: vinods.kumar@huawei.com

Zafar Ali
Cisco Systems
Canada

EMail: zali@cisco.com

Xufeng Liu
Jabil
8281 Greensboro Drive, Suite 200
McLean VA 22102
USA

EMail: Xufeng_Liu@jabil.com

Young Lee
Huawei Technologies
5340 Legacy Drive, Building 3
Plano, TX 75023, USA

Phone: (469) 277-5838
EMail: leeyoung@huawei.com

Udayasree Palle
Huawei Technologies
Divyashree Techno Park, Whitefield
Bangalore, Karnataka 560066
India

EMail: udayasree.palle@huawei.com

Xian Zhang
Huawei Technologies
Bantian, Longgang District
Shenzhen 518129
P.R.China

EMail: zhang.xian@huawei.com

Avantika
Huawei Technologies
Divyashree Techno Park, Whitefield
Bangalore, Karnataka 560066
India

EMail: avantika.sushilkumar@huawei.com

Authors' Addresses

Dhruv Dhody (editor)
Huawei Technologies
Divyashree Techno Park, Whitefield
Bangalore, Karnataka 560066
India

EMail: dhruv.ietf@gmail.com

Jonathan Hardwick
Metaswitch
100 Church Street
Enfield EN2 6BQ
UK

EMail: jonathan.hardwick@metaswitch.com

Vishnu Pavan Beeram
Juniper Networks
USA

EMail: vbeeram@juniper.net

Jeff Tantsura
USA

EMail: jefftant@gmail.com