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**Retrieval Methods YANG Data Model for Connectionless Operations,
Administration, and Maintenance(OAM) protocols
draft-ietf-lime-yang-connectionless-oam-methods-07**

Abstract

This document presents a retrieval method YANG Data model for connectionless OAM protocols. It provides technology-independent RPC operations for connectionless OAM protocols. The retrieval methods model presented here can be extended to include technology specific details. This is leading to uniformity between OAM protocols and support both nested OAM workflows (i.e., performing OAM functions at different levels through a unified interface) and interacting OAM workflows (i.e., performing OAM functions at same levels through a unified interface).

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Table of Contents

1.	Introduction	2
2.	Conventions used in this document	3
2.1.	Terminology	3
2.2.	Tree Diagrams	4
3.	Overview of the Connectionless OAM retrieval methods Model .	4
3.1.	RPC operation definitions	5
3.2.	OAM Retrieval Methods Hierarchy	7
4.	OAM Retrieval Methods YANG Module	14
5.	Security Considerations	19
6.	IANA Considerations	19
7.	References	20
7.1.	Normative References	20
7.2.	Informative References	21
Appendix A.	Appendix A.1 Extending Connectionless OAM Method Module Example	21
Appendix B.	Appendix A.2 Example of new retrieval procedures Model	22
Authors' Addresses		30

[1.](#) Introduction

Operations, Administration, and Maintenance (OAM) are important networking functions that allow operators to:

1. Monitor reachability of destinations (Reachability Verification, Continuity Check).
2. Troubleshoot failures (Fault verification and localization).
3. Monitor Performance

An overview of OAM tools is presented at [[RFC7276](#)].

Ping and Traceroute [[RFC792](#)], [[RFC4443](#)] and BFD [[RFC5880](#)] are well-known fault verification and isolation tools, respectively, for IP networks. Over the years, different technologies have developed similar tools for similar purposes.

In this document, we present an on-demand retrieval method YANG Data model for connectionless OAM protocols. This model provides technology-independent RPC operations for connectionless OAM protocols. It is separated from the generic YANG model for connectionless OAM [[I-D.ietf-lime-yang-connectionless-oam](#)] and can avoid mixing the models for the retrieved-data from the retrieval procedures. It is expected that retrieval procedures would evolve faster than the data model [[I-D.ietf-lime-yang-connectionless-oam](#)] and will allow new procedures to be defined for retrieval of the same data defined by the base data model.

2. Conventions used in this document

The following terms are defined in [[RFC6241](#)] and are not redefined here:

- o client
- o configuration data
- o server
- o state data

The following terms are defined in [[RFC6020](#)] and are not redefined here:

- o augment
- o data model
- o data node

The terminology for describing YANG data models is found in [[RFC6020](#)].

2.1. Terminology

TP - Test Point

MAC - Media Access Control

RPC - A Remote Procedure Call

RPC operation - A specific Remote Procedure Call

2.2. Tree Diagrams

A simplified graphical representation of the data model is used in this document. The meaning of the symbols in these diagrams is as follows:

Each node is printed as:

`<status> <flags> <name> <opts> <type>`

`<status>` is one of:

- + for current

`<flags>` is one of:

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

`<name>` is the name of the 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 or choice
- ! 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

3. Overview of the Connectionless OAM retrieval methods Model

In this document, we present an on-demand retrieval method YANG Data model for connectionless OAM protocols. This model provides technology-independent retrieval procedures (RPC operations) for connectionless OAM protocols. It provides a flexible way to retrieve the data which defined by the "ietf-connectionless-oam.yang" [[I-D.ietf-lime-yang-connectionless-oam](#)].

3.1. RPC operation definitions

The RPC model facilitates issuing commands to a NETCONF server (in this case to the device that need to execute the OAM command) and obtaining a response.

Under 'connectionless-oam-methods' module, we summarize common OAM functions and define two generic RPC operations: 'continuity-check' and 'path-discovery'. In practice, these RPC operations are activated on-demand and supported by corresponding technology-specific OAM tools [[RFC7276](#)]. For example, for the IP OAM model, the continuity-check RPC corresponds to the IP Ping [[RFC792](#)] [[RFC4443](#)], while the path-discovery RPC operation corresponds to IP Traceroute [[RFC792](#)] [[RFC4443](#)].

Note that the RPC operation presented in this document is the base building block, which is used to derive a model for a technology-specific OAM (i.e., ICMP ping [[RFC792](#)] [[RFC4443](#)], LSP ping [[RFC8029](#)]), the base building block should be extended with corresponding technology specific parameters. To facilitate this for future enhancements to data retrieval methods, the RPCs are captured under a separate module.

The generic 'path-discovery-data' and 'continuity-check-data' groupings are used as data outputs from different RPCs described in this document. Similar methods including other RPCs can retrieve the data using the same data model.

```
rpc continuity-check {
  if-feature coam:continuity-check;
  description
    "Continuity-check RPC operation as per RFC7276.";
  input {
    uses rpc-input-parameters;
    ....
  }
  output {
    container error-code {
      leaf status-code {
        type identityref{
          base status-code;
        }
      }
      mandatory true;
      description
        "Error code for CC.";
    }
    leaf status-sub-code {
      type identityref{
```



```
        base status-sub-code;
    }
    mandatory true;
    description
        "Sub code for CC.";
    }
    description
        "Error code and Sub Code for CC.";
    }
    uses coam:continuity-check-data;
}
}

rpc path-discovery {
    description
        "path discovery RPC operation as per RFC7276";
    input {
        uses rpc-input-parameters;
        .....
    }
    output {
        list response-list {
            key "response-index";
            description
                "Path discovery response list.";
            leaf response-index {
                type uint32;
                mandatory true;
                description
                    "Response index.";
            }

            leaf status-code {
                type identityref{
                    base status-code;
                }
                mandatory true;
                description
                    "Error code for Path Discovery. ";
            }
            leaf status-sub-code {
                type identityref{
                    base status-sub-code;
                }
                mandatory true;
                description
                    "Sub code for Path Discovery. ";
            }
        }
    }
}
```



```

    }
    uses coam:path-discovery-data;
  }
}

```

Snippet of data hierarchy related to RPC operations

[3.2.](#) OAM Retrieval Methods Hierarchy

The complete data hierarchy related to the Connectionless OAM Retrieval Methods YANG model is presented below.

module: ietf-connectionless-oam-methods

rpcs:

```

+---x continuity-check {coam:continuity-check}?
| +---w input
| | +---w destination-tp
| | | +---w tp-location-type      identityref
| | | +---w tp-address
| | |   +---w mac-address
| | |   | +---w mac-address      yang:mac-address
| | |   +---w ipv4-address
| | |   | +---w ipv4-address     inet:ipv4-address
| | |   +---w ipv6-address
| | |   | +---w ipv6-address     inet:ipv6-address
| | |   +---w tp-attribute
| | |   | +---w tp-attribute-type? address-attribute-type
| | |   | +---w (tp-attribute-value)?
| | |   |   +--:(ip-prefix)
| | |   |   | +---w ip-prefix?      inet:ip-prefix
| | |   |   +--:(bgp)
| | |   |   | +---w bgp?            inet:ip-prefix
| | |   |   +--:(tunnel)
| | |   |   | +---w tunnel-interface? uint32
| | |   |   +--:(pw)
| | |   |   | +---w remote-pe-address? inet:ip-address
| | |   |   | +---w pw-id?          uint32
| | |   |   +--:(vpls)
| | |   |   | +---w route-distinguisher? rt:route-distinguisher
| | |   |   | +---w sender-ve-id?      uint16
| | |   |   | +---w receiver-ve-id?    uint16
| | |   |   +--:(mpls-mldp)
| | |   |   | +---w (root-address)?
| | |   |   |   +--:(ip-address)
| | |   |   |   | +---w source-address?      inet:ip-address
| | |   |   |   | +---w group-ip-address?    inet:ip-address
| | |   |   |   +--:(vpn)
| | |   |   |   | +---w as-number?          inet:as-number

```



```

| | | | +--:(global-id)
| | | | +---w lsp-id? string
| | | +---w system-info
| | | | +---w system-id? rt:router-id
| | +---w source-interface if:interface-ref
| | +---w outbound-interface if:interface-ref
| | +---w vrf? coam:routing-instance-ref
| | +---w count? uint32
| | +---w ttl? uint8
| | +---w packet-size? uint32
| +--ro output
| | +--ro error-code
| | | +--ro status-code identityref
| | | +--ro status-sub-code identityref
| | +--ro src-test-point
| | | +--ro ni? routing-instance-ref
| | | +--ro tp-location-type identityref
| | | +--ro tp-address
| | | | +--ro mac-address
| | | | | +--ro mac-address yang:mac-address
| | | | +--ro ipv4-address
| | | | | +--ro ipv4-address inet:ipv4-address
| | | | +--ro ipv6-address
| | | | | +--ro ipv6-address inet:ipv6-address
| | | +--ro tp-attribute
| | | | +--ro tp-attribute-type? address-attribute-type
| | | | +--ro (tp-attribute-value)?
| | | | +--:(ip-prefix)
| | | | | +--ro ip-prefix? inet:ip-prefix
| | | | +--:(bgp)
| | | | | +--ro bgp? inet:ip-prefix
| | | | +--:(tunnel)
| | | | | +--ro tunnel-interface? uint32
| | | | +--:(pw)
| | | | | +--ro remote-pe-address? inet:ip-address
| | | | | +--ro pw-id? uint32
| | | | +--:(vpls)
| | | | | +--ro route-distinguisher? rt:route-distinguisher
| | | | | +--ro sender-ve-id? uint16
| | | | | +--ro receiver-ve-id? uint16
| | | | +--:(mpls-mldp)
| | | | | +--ro (root-address)?
| | | | | | +--:(ip-address)
| | | | | | | +--ro source-address? inet:ip-address
| | | | | | | +--ro group-ip-address? inet:ip-address
| | | | | +--:(vpn)
| | | | | | +--ro as-number? inet:as-number
| | | | +--:(global-id)

```



```

|         |         |         |         +--ro lsp-id?                string
|         |         |         |         +--ro system-info
|         |         |         |         +--ro system-id?    rt:router-id
|         |         |         |         +--ro egress-intf-name? if:interface-ref
|         +--ro dest-test-point
|         |         +--ro ni?                routing-instance-ref
|         |         +--ro tp-location-type    identityref
|         |         +--ro tp-address
|         |         |         +--ro mac-address    yang:mac-address
|         |         |         |         +--ro mac-address    inet:mac-address
|         |         |         |         +--ro ipv4-address    inet:ipv4-address
|         |         |         |         +--ro ipv6-address    inet:ipv6-address
|         |         |         |         +--ro ipv6-address    inet:ipv6-address
|         |         |         +--ro tp-attribute
|         |         |         |         +--ro tp-attribute-type? address-attribute-type
|         |         |         |         +--ro (tp-attribute-value)?
|         |         |         |         |         +--:(ip-prefix)
|         |         |         |         |         |         +--ro ip-prefix?    inet:ip-prefix
|         |         |         |         |         |         +--:(bgp)
|         |         |         |         |         |         +--ro bgp?          inet:ip-prefix
|         |         |         |         |         |         +--:(tunnel)
|         |         |         |         |         |         +--ro tunnel-interface? uint32
|         |         |         |         |         |         +--:(pw)
|         |         |         |         |         |         +--ro remote-pe-address? inet:ip-address
|         |         |         |         |         |         +--ro pw-id?          uint32
|         |         |         |         |         |         +--:(vpls)
|         |         |         |         |         |         +--ro route-distinguisher? rt:route-distinguisher
|         |         |         |         |         |         +--ro sender-ve-id?    uint16
|         |         |         |         |         |         +--ro receiver-ve-id?   uint16
|         |         |         |         |         |         +--:(mpls-mlbp)
|         |         |         |         |         |         +--ro (root-address)?
|         |         |         |         |         |         |         +--:(ip-address)
|         |         |         |         |         |         |         |         +--ro source-address?    inet:ip-address
|         |         |         |         |         |         |         |         +--ro group-ip-address?    inet:ip-address
|         |         |         |         |         |         |         |         +--:(vpn)
|         |         |         |         |         |         |         |         +--ro as-number?        inet:as-number
|         |         |         |         |         |         |         |         +--:(global-id)
|         |         |         |         |         |         |         |         +--ro lsp-id?            string
|         |         |         |         |         |         +--ro system-info
|         |         |         |         |         |         +--ro system-id?    rt:router-id
|         |         |         |         |         |         +--ro ingress-intf-name? if:interface-ref
|         +--ro sequence-number?            uint64
|         +--ro hop-cnt?                    uint8
|         +--ro session-packet-statistics
|         |         +--ro rx-packet-count?    uint32
|         |         +--ro tx-packet-count?    uint32
|         |         +--ro rx-bad-packet?      uint32

```



```

|   | +---ro tx-packet-failed?   uint32
|   +---ro session-error-statistics
|   | +---ro packet-drops-count?   uint32
|   | +---ro packet-reorder-count?  uint32
|   | +---ro packets-out-of-seq-count?  uint32
|   | +---ro packets-dup-count?   uint32
|   +---ro session-delay-statistics
|   | +---ro time-resolution-value?  identityref
|   | +---ro min-delay-value?       uint32
|   | +---ro max-delay-value?       uint32
|   | +---ro average-delay-value?   uint32
|   +---ro session-jitter-statistics
|       +---ro time-resolution-value?  identityref
|       +---ro min-jitter-value?      uint32
|       +---ro max-jitter-value?      uint32
|       +---ro average-jitter-value?  uint32
+---x path-discovery {coam:path-discovery}?
    +---w input
    | +---w destination-tp
    | | +---w tp-location-type   identityref
    | | +---w tp-address
    | |   +---w mac-address
    | |   | +---w mac-address   yang:mac-address
    | |   +---w ipv4-address
    | |   | +---w ipv4-address  inet:ipv4-address
    | |   +---w ipv6-address
    | |   | +---w ipv6-address  inet:ipv6-address
    | |   +---w tp-attribute
    | |   | +---w tp-attribute-type?  address-attribute-type
    | |   | +---w (tp-attribute-value)?
    | |   |   +---:(ip-prefix)
    | |   |   | +---w ip-prefix?      inet:ip-prefix
    | |   |   +---:(bgp)
    | |   |   | +---w bgp?            inet:ip-prefix
    | |   |   +---:(tunnel)
    | |   |   | +---w tunnel-interface?  uint32
    | |   |   +---:(pw)
    | |   |   | +---w remote-pe-address?  inet:ip-address
    | |   |   | +---w pw-id?            uint32
    | |   |   +---:(vpls)
    | |   |   | +---w route-distinguisher?  rt:route-distinguisher
    | |   |   | +---w sender-ve-id?        uint16
    | |   |   | +---w receiver-ve-id?      uint16
    | |   |   +---:(mpls-mldp)
    | |   |   +---w (root-address)?
    | |   |   +---:(ip-address)
    | |   |   | +---w source-address?      inet:ip-address
    | |   |   | +---w group-ip-address?    inet:ip-address

```



```

| | | +--:(vpn)
| | | | +---w as-number? inet:as-number
| | | +--:(global-id)
| | | | +---w lsp-id? string
| | +---w system-info
| | | +---w system-id? rt:router-id
| +---w source-interface if:interface-ref
| +---w outbound-interface if:interface-ref
| +---w vrf? coam:routing-instance-ref
| +---w max-ttl? uint8
+--ro output
+--ro response-list* [response-index]
| +--ro response-index uint32
| +--ro status-code identityref
| +--ro status-sub-code identityref
+--ro src-test-point
| +--ro ni? routing-instance-ref
| +--ro tp-location-type identityref
| +--ro tp-address
| | +--ro mac-address
| | | +--ro mac-address yang:mac-address
| | +--ro ipv4-address
| | | +--ro ipv4-address inet:ipv4-address
| | +--ro ipv6-address
| | | +--ro ipv6-address inet:ipv6-address
| | +--ro tp-attribute
| | | +--ro tp-attribute-type? address-attribute-type
| | | +--ro (tp-attribute-value)?
| | | | +--:(ip-prefix)
| | | | | +--ro ip-prefix? inet:ip-prefix
| | | | +--:(bgp)
| | | | | +--ro bgp? inet:ip-prefix
| | | | +--:(tunnel)
| | | | | +--ro tunnel-interface? uint32
| | | | +--:(pw)
| | | | | +--ro remote-pe-address? inet:ip-address
| | | | | +--ro pw-id? uint32
| | | | +--:(vpls)
| | | | | +--ro route-distinguisher? rt:route-distinguisher
| | | | | +--ro sender-ve-id? uint16
| | | | | +--ro receiver-ve-id? uint16
| | | +--:(mpls-mldp)
| | | | +--ro (root-address)?
| | | | | +--:(ip-address)
| | | | | | +--ro source-address? inet:ip-address
| | | | | | +--ro group-ip-address? inet:ip-address
| | | | +--:(vpn)
| | | | | +--ro as-number? inet:as-number

```



```

|         |         +---:(global-id)
|         |         +---ro lsp-id?                string
|         +---ro system-info
|         +---ro system-id?    rt:router-id
+---ro dest-test-point
| +---ro ni?                routing-instance-ref
| +---ro tp-location-type    identityref
| +---ro tp-address
|     +---ro mac-address
|         | +---ro mac-address    yang:mac-address
|     +---ro ipv4-address
|         | +---ro ipv4-address    inet:ipv4-address
|     +---ro ipv6-address
|         | +---ro ipv6-address    inet:ipv6-address
|     +---ro tp-attribute
|         | +---ro tp-attribute-type?    address-attribute-type
|         | +---ro (tp-attribute-value)?
|         |     +---:(ip-prefix)
|         |         | +---ro ip-prefix?        inet:ip-prefix
|         |         +---:(bgp)
|         |         | +---ro bgp?                inet:ip-prefix
|         |         +---:(tunnel)
|         |         | +---ro tunnel-interface?    uint32
|         |         +---:(pw)
|         |         | +---ro remote-pe-address?    inet:ip-address
|         |         | +---ro pw-id?                uint32
|         |         +---:(vpls)
|         |         | +---ro route-distinguisher?    rt:route-distinguisher
|         |         | +---ro sender-ve-id?            uint16
|         |         | +---ro receiver-ve-id?          uint16
|         |         +---:(mpls-mldp)
|         |         +---ro (root-address)?
|         |         +---:(ip-address)
|         |         | +---ro source-address?        inet:ip-address
|         |         | +---ro group-ip-address?      inet:ip-address
|         |         +---:(vpn)
|         |         | +---ro as-number?            inet:as-number
|         |         +---:(global-id)
|         |         +---ro lsp-id?                string
|     +---ro system-info
|     +---ro system-id?    rt:router-id
+---ro sequence-number?    uint64
+---ro hop-cnt?            uint8
+---ro session-packet-statistics
| +---ro rx-packet-count?    uint32
| +---ro tx-packet-count?    uint32
| +---ro rx-bad-packet?      uint32
| +---ro tx-packet-failed?    uint32

```



```

+--ro session-error-statistics
| +--ro packet-drops-count?      uint32
| +--ro packet-reorder-count?    uint32
| +--ro packets-out-of-seq-count? uint32
| +--ro packets-dup-count?       uint32
+--ro session-delay-statistics
| +--ro time-resolution-value?    identityref
| +--ro min-delay-value?          uint32
| +--ro max-delay-value?          uint32
| +--ro average-delay-value?      uint32
+--ro session-jitter-statistics
| +--ro time-resolution-value?    identityref
| +--ro min-jitter-value?         uint32
| +--ro max-jitter-value?         uint32
| +--ro average-jitter-value?     uint32
+--ro path-verification
| +--ro flow-info?                string
| +--ro session-path-verification-statistics
|   +--ro verified-count?         uint32
|   +--ro failed-count?          uint32
+--ro path-trace-info
  +--ro path-trace-info-list* [index]
    +--ro index                    uint32
    +--ro ni?                      routing-instance-ref
    +--ro tp-location-type         identityref
    +--ro tp-address
      | +--ro mac-address
      | | +--ro mac-address        yang:mac-address
      | +--ro ipv4-address
      | | +--ro ipv4-address       inet:ipv4-address
      | +--ro ipv6-address
      | | +--ro ipv6-address       inet:ipv6-address
      | +--ro tp-attribute
      | | +--ro tp-attribute-type?  address-attribute-type
      | | +--ro (tp-attribute-value)?
      | |   +--:(ip-prefix)
      | |   | +--ro ip-prefix?      inet:ip-prefix
      | |   +--:(bgp)
      | |   | +--ro bgp?             inet:ip-prefix
      | |   +--:(tunnel)
      | |   | +--ro tunnel-interface? uint32
      | |   +--:(pw)
      | |   | +--ro remote-pe-address? inet:ip-address
      | |   | +--ro pw-id?           uint32
      | |   +--:(vpls)
      | |   | +--ro route-distinguisher? rt:route-distinguisher
      | |   | +--ro sender-ve-id?     uint16
      | |   | +--ro receiver-ve-id?   uint16

```



```

| |      +--:(mpls-mldp)
| |      +--ro (root-address)?
| |      +--:(ip-address)
| |      | +--ro source-address?      inet:ip-address
| |      | +--ro group-ip-address?    inet:ip-address
| |      +--:(vpn)
| |      | +--ro as-number?            inet:as-number
| |      +--:(global-id)
| |      +--ro lsp-id?                string
| +--ro system-info
|   +--ro system-id?      rt:router-id
+--ro timestamp-type?      uint32
+--ro timestamp-sec?       uint32
+--ro timestamp-nanosec?   uint32
+--ro ingress-intf-name?   if:interface-ref
+--ro egress-intf-name?    if:interface-ref
+--ro queue-depth?         uint32
+--ro transit-delay?       uint32
+--ro app-meta-data?       uint64

```

data hierarchy of OAM Retrieval Methods

4. OAM Retrieval Methods YANG Module

<CODE BEGINS> file "ietf-connectionless-oam-methods@2017-09-06.yang"

```

module ietf-connectionless-oam-methods {
namespace "urn:ietf:params:xml:ns:yang:ietf-connectionless-oam-methods";
prefix coam-methods;
import ietf-interfaces {
prefix if;
}
import ietf-connectionless-oam {
prefix coam;
}
organization
  "IETF LIME Working Group";
contact
  "Deepak Kumar dekumar@cisco.com
  Qin Wu bill.wu@huawei.com
  S Raghavan srihari@cisco.com
  Zitao Wang wangzitao@huawei.com
  R Rahman rrahman@cisco.com";
description
  "This YANG module defines the RPC operations for
  connectionless OAM to be used within IETF
  in a protocol Independent manner.
  It is assumed that each protocol maps

```


corresponding abstracts to its native format.
Each protocol may extend the YANG model defined
here to include protocol specific extensions";

```
revision 2017-09-06{
  description
    "08 version";
  reference "draft-ietf-lime-yang-connectionless-oam-methods";
}
```

```
identity status-code{
  description
    "Base status code";
}
```

```
identity invalid-cc{
  base status-code;
  description
    "Indicates that the Continuity check message is invalid";
}
```

```
identity invalid-pd {
  base status-code;
  description
    "Indicates that the path discovery message is invalid";
}
```

```
identity status-sub-code {
  description
    "Base status sub code";
}
```

```
grouping rpc-input-parameters {
  container destination-tp {
    uses coam:tp-address;
    description
      "Destination test point.";
  }
  leaf source-interface {
    type if:interface-ref;
    mandatory true;
    description
      "Source interface.";
  }
  leaf outbound-interface {
    type if:interface-ref;
    mandatory true;
    description
```



```
        "Outbound interface.";
    }
    leaf vrf {
        type coam:routing-instance-ref;
        description
            "VRF instance.";
    }
    description
        "Grouping for RPC input parameters";
}
rpc continuity-check {
    if-feature "coam:continuity-check";
    description
        "Continuity-check RPC operation as per RFC7276";
    input {
        uses rpc-input-parameters;
        uses coam:session-type {
            description "If session-type is specified, then session-type
                must be set to on-demand";
        }
        leaf count {
            type uint32;
            default "5";
            description
                "Specifies the number of
                 packets that will be sent. By
                 default, the packet number is
                 set to 5.";
        }
        leaf ttl {
            type uint8;
            default "255";
            description
                "Time to live (TTL) used to limit lifetime
                 of data packet transmitted in the network
                 and prevent looping. The TTL value is decremented
                 for every hop which the packet traverses. If the
                 TTL is zero, the data packet will be discarded.";
        }
    }
    leaf packet-size {
        type uint32 {
            range "64..10000";
        }
        default "64";
        description
            "Packet size of continuity-check message, in octets.
             By default, the packet size is set to 64 octets.";
    }
}
```



```
}
output {
  container error-code {
    leaf status-code {
      type identityref{
        base status-code;
      }
    }
    mandatory true;
    description
      "Error code for continuity-check message. For example, Error code in
      ICMPv6 message includes
      1-Destination Unreachable
      2- Packet Too Big
      3- Time Exceeded
      4- Parameter Problem [RFC4443].";
  }
  leaf status-sub-code {
    type identityref{
      base status-sub-code;
    }
  }
  mandatory true;
  description
    "Sub code for continuity-check message. For example Sub code in
    ICMPv6 Parameter Problem Message includes:
    1-Erroneous header field encountered
    2-Unrecognized Next Header type encountered
    3-Unrecognized IPv6 option encountered.";
  }
  description
    "Error code and Sub Code for continuity-check message.";
}
uses coam:continuity-check-data;
}

rpc path-discovery {
  if-feature "coam:path-discovery";
  description
    "Path discovery RPC operation as per RFC7276.";
  input {
    uses rpc-input-parameters;
    uses coam:session-type {
      description "If session-type is specified, then session-type
      must be set to on-demand";
    }
  }
  leaf max-ttl {
    type uint8;
    default "255";
  }
}
```



```
    description
      "Maximum TTL indicates the maximum number of hops that
      a packet is permitted to travel before being discarded
      by a router. By default, the maximum TTL is set to 255.";
  }
}
output {
  list response-list {
    key "response-index";
    description
      "Path discovery response list.";
    leaf response-index {
      type uint32;
      mandatory true;
      description
        "Response index.";
    }
    leaf status-code {
      type identityref{
        base status-code;
      }
      mandatory true;
      description
        "Error code for Path Discovery message.
        For example, Error code in ICMPv6 message includes
        1-Destination Unreachable
        2- Packet Too Big
        3- Time Exceeded
        4- Parameter Problem [RFC4443]. ";
    }
    leaf status-sub-code {
      type identityref{
        base status-sub-code;
      }
      mandatory true;
      description
        "Sub code for Path Discovery message. For example Sub code in
        ICMPv6 Parameter Problem Message includes:
        1-Erroneous header field encountered
        2-Unrecognized Next Header type encountered
        3-Unrecognized IPv6 option encountered ";
    }
    description
      "List of Error code and Sub Code for Path Discovery.";
  }
  uses coam:path-discovery-data;
}
```


<CODE ENDS>

5. Security Considerations

The YANG module defined in this document is designed to be accessed via network management protocols such as NETCONF [[RFC6241](#)] or RESTCONF [[RFC8040](#)]. The lowest NETCONF layer is the secure transport layer, and the mandatory-to-implement secure transport is Secure Shell (SSH) [[RFC6242](#)]. The lowest RESTCONF layer is HTTPS, and the mandatory-to-implement secure transport is TLS [[RFC5246](#)].

The NETCONF access control model [[RFC6536](#)] provides the means to restrict access for particular NETCONF or RESTCONF users to a preconfigured subset of all available NETCONF or RESTCONF protocol operations and content.

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:

- o continuity-check: Generates continuity check.
- o path-discovery: Generates path discovery.

which may lead to Denial-of-Service attack on both the local device and the network or unauthorized source access to some sensitive information.

6. IANA Considerations

This document registers a URI in the IETF XML registry [[RFC3688](#)]. Following the format in [[RFC3688](#)], the following registration is requested to be made:

URI: urn:ietf:params:xml:ns:yang:ietf-connectionless-oam-methods

Registrant Contact: The IESG.

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-connectionless-oam-methods

namespace: urn:ietf:params:xml:ns:yang:ietf-connectionless-oam-methods

prefix: coam-methods

reference: RFC XXXX

7. References

7.1. Normative References

- [I-D.ietf-lime-yang-connectionless-oam]
Kumar, D., Wang, Z., Wu, Q., Rahman, R., and S. Raghavan,
"Generic YANG Data Model for Connectionless Operations,
Administration, and Maintenance(OAM) protocols", [draft-ietf-lime-yang-connectionless-oam-09](#) (work in progress),
August 2017.
- [RFC3688] Mealling, M., "The IETF XML Registry", [BCP 81](#), [RFC 3688](#),
DOI 10.17487/RFC3688, January 2004,
<<https://www.rfc-editor.org/info/rfc3688>>.
- [RFC5246] Dierks, T. and E. Rescorla, "The Transport Layer Security
(TLS) Protocol Version 1.2", [RFC 5246](#),
DOI 10.17487/RFC5246, August 2008,
<<https://www.rfc-editor.org/info/rfc5246>>.
- [RFC6020] Bjorklund, M., Ed., "YANG - A Data Modeling Language for
the Network Configuration Protocol (NETCONF)", [RFC 6020](#),
DOI 10.17487/RFC6020, October 2010,
<<https://www.rfc-editor.org/info/rfc6020>>.
- [RFC6241] Enns, R., Ed., Bjorklund, M., Ed., Schoenwaelder, J., Ed.,
and A. Bierman, Ed., "Network Configuration Protocol
(NETCONF)", [RFC 6241](#), DOI 10.17487/RFC6241, June 2011,
<<https://www.rfc-editor.org/info/rfc6241>>.
- [RFC6242] Wasserman, M., "Using the NETCONF Protocol over Secure
Shell (SSH)", [RFC 6242](#), DOI 10.17487/RFC6242, June 2011,
<<https://www.rfc-editor.org/info/rfc6242>>.
- [RFC6536] Bierman, A. and M. Bjorklund, "Network Configuration
Protocol (NETCONF) Access Control Model", [RFC 6536](#),
DOI 10.17487/RFC6536, March 2012,
<<https://www.rfc-editor.org/info/rfc6536>>.
- [RFC7011] Claise, B., Ed., Trammell, B., Ed., and P. Aitken,
"Specification of the IP Flow Information Export (IPFIX)
Protocol for the Exchange of Flow Information", STD 77,
[RFC 7011](#), DOI 10.17487/RFC7011, September 2013,
<<https://www.rfc-editor.org/info/rfc7011>>.

- [RFC792] Postel, J., "Internet Control Message Protocol", [RFC 792](#), September 1981.
- [RFC8040] Bierman, A., Bjorklund, M., and K. Watsen, "RESTCONF Protocol", [RFC 8040](#), DOI 10.17487/RFC8040, January 2017, <<https://www.rfc-editor.org/info/rfc8040>>.

7.2. Informative References

- [I-D.ietf-netconf-yang-push]
Clemm, A., Voit, E., Prieto, A., Tripathy, A., Nilsen-Nygaard, E., Bierman, A., and B. Lengyel, "Subscribing to YANG datastore push updates", [draft-ietf-netconf-yang-push-08](#) (work in progress), August 2017.
- [RFC4443] Conta, A., Deering, S., and M. Gupta, Ed., "Internet Control Message Protocol (ICMPv6) for the Internet Protocol Version 6 (IPv6) Specification", STD 89, [RFC 4443](#), DOI 10.17487/RFC4443, March 2006, <<https://www.rfc-editor.org/info/rfc4443>>.
- [RFC5880] Katz, D. and D. Ward, "Bidirectional Forwarding Detection (BFD)", [RFC 5880](#), DOI 10.17487/RFC5880, June 2010, <<https://www.rfc-editor.org/info/rfc5880>>.
- [RFC6087] Bierman, A., "Guidelines for Authors and Reviewers of YANG Data Model Documents", [RFC 6087](#), DOI 10.17487/RFC6087, January 2011, <<https://www.rfc-editor.org/info/rfc6087>>.
- [RFC7276] Mizrahi, T., Sprecher, N., Bellagamba, E., and Y. Weingarten, "An Overview of Operations, Administration, and Maintenance (OAM) Tools", [RFC 7276](#), DOI 10.17487/RFC7276, June 2014, <<https://www.rfc-editor.org/info/rfc7276>>.
- [RFC8029] Kompella, K., Swallow, G., Pignataro, C., Ed., Kumar, N., Aldrin, S., and M. Chen, "Detecting Multiprotocol Label Switched (MPLS) Data-Plane Failures", [RFC 8029](#), DOI 10.17487/RFC8029, March 2017, <<https://www.rfc-editor.org/info/rfc8029>>.

Appendix A. Appdendix A.1 Extending Connectionless OAM Method Module Example

The following is an example of extensions possible to "ietf-connectionless-oam-methods" YANG model defined in this document.

The snippet below depicts an example of augmenting the "ietf-connectionless-oam-methods" YANG model with ICMP ping attributes:

```
augment "/coam-methods:continuity-check"
+ "/coam-methods:output" {
  container session-rtt-statistics {
    leaf min-rtt {
      type uint32;
    }
    description
      "This minimum ping round-trip-time(RTT) received.";
  }
    leaf max-rtt {
      type uint32;
    }
    description
      "This maximum ping round-trip-time(RTT) received.";
  }
    leaf avg-rtt {
      type uint32;
    }
    description
      "The current average ping round-trip-time(RTT)";
  }
    description
      "This container presents the ping round-trip-time statistics.";
  }
}
```

[Appendix B.](#) [Appendix A.2](#) Example of new retrieval procedures Model

As discussed in introduction section of this document, the new retrieval procedures can be defined for retrieval of the same data defined by base YANG Data model for connectionless OAM protocols. This appendix demonstrates how the base connectionless OAM data model can be extended to support persistent data retrieval besides on demand retrieval procedures defined in [section 3](#), i.e., first retrieve persistent-id based on destination test point location information and then retrieve export details based on persistent-id. Internet Protocol Flow Information Export (IPFIX) [\[RFC7011\]](#) or YANG-push [\[I-D.ietf-netconf-yang-push\]](#). are currently outlined here as data export options and more can be added in future.

The YANG module "example-cl-oam-persistent-methods" shown below is intended as an illustration rather than a real definition of a RPC operation model for persistent data retrieval. For the sake of brevity, this module does not obey all the guidelines specified in [\[RFC6087\]](#).

```
module example-cl-oam-persistent-methods {
  namespace "http://example.com/cl-oam-persistent-methods";
```



```
prefix pcoam-methods;
import ietf-interfaces {
  prefix if;
}
import ietf-connectionless-oam {
  prefix coam;
}
import ietf-yang-types {
  prefix yang;
}
identity export-method {
  description
    "Base identity to represent a conceptual export-method.";
}
identity ipfix-export {
  base export-method;
  description
    "IPFIX based export. Configuration provided separately.";
}
identity yang-push-export {
  base export-method;
  description
    "Yang-push from draft-ietf-netconf-yang-push";
}
typedef export-method {
  type identityref {
    base export-method;
  }
  description
    "Export method type.";
}
typedef change-type {
  type enumeration {
    enum "create" {
      description
        "Change due to a create.";
    }
    enum "delete" {
      description
        "Change due to a delete.";
    }
    enum "modify" {
      description
        "Change due to an update.";
    }
  }
  description
    "Different types of changes that may occur.";
```



```
}

rpc cc-get-persistent-id {
  if-feature "coam:continuity-check";
  description
    "Obtains continuity-check persistent identification given mapping
    parameters as input.";
  input {
    container destination-tp {
      uses coam:tp-address;
      description
        "Destination test point.";
    }
    uses coam:session-type;
    leaf source-interface {
      type if:interface-ref;
      description
        "Source interface.";
    }
    leaf outbound-interface {
      type if:interface-ref;
      description
        "Outbound interface.";
    }
    leaf vrf {
      type coam:routing-instance-ref;
      description
        "VRF instance.";
    }
  }
}
output {
  container error-code {
    leaf status-code {
      type identityref{
        base status-code;
      }
      mandatory true;
      description
        "Error code.";
    }
    leaf status-sub-code {
      type identityref{
        base status-sub-code;
      }
      mandatory true;
      description
        "Sub code for CC.";
    }
  }
}
```



```
        description
            "Error code and Sub Code.";
    }

    leaf cc-persistent-id {
        type string;
        description
            "Id to act as a cookie.";
    }
}

rpc cc-persistent-get-export-details {
    if-feature "coam:continuity-check";
    description
        "Given the persistent id, gets the configuration
        options, details related to the configured data
        export.";
    input {
        leaf cc-persistent-id {
            type string;
            description
                "Persistent Id for use as a key in search.";
        }
    }
    output {
        container error-code {
            leaf status-code {
                type identityref{
                    base status-code;
                }
                mandatory true;
                description
                    "Error code.";
            }
            leaf status-sub-code {
                type identityref{
                    base status-sub-code;
                }
                mandatory true;
                description
                    "Sub code for CC.";
            }
        }
        description
            "Error code and Sub Code.";
    }

    leaf data-export-method {
```



```
    type export-method;
    description
      "Type of export in use.";
  }

  choice cc-trigger {
    description
      "Necessary conditions for
      periodic or on-change trigger.";
    case periodic {
      description
        "Periodic reports.";
      leaf period {
        type yang:timeticks;
        description
          "Time interval between reports.";
      }
      leaf start-time {
        type yang:date-and-time;
        description
          "Timestamp from which reports were started.";
      }
    }
    case on-change {
      description
        "On-change trigger and not periodic.";
      leaf all-data-on-start {
        type boolean;
        description
          "Full update done on start or not.";
      }
      leaf-list excluded-change {
        type change-type;
        description
          "Changes that will not trigger an update.";
      }
    }
  }
}

rpc pd-get-persistent-id {
  if-feature "coam:path-discovery";
  description
    "Obtains persistent path discovery identification.";

  input {
    container destination-tp {
```



```
    uses coam:tp-address;
    description
        "Destination test point.";
}
uses coam:session-type;
leaf source-interface {
    type if:interface-ref;
    description
        "Source interface.";
}
leaf outbound-interface {
    type if:interface-ref;
    description
        "Outbound interface.";
}
leaf vrf {
    type coam:routing-instance-ref;
    description
        "VRF";
}
}
output {
    list response-list {
        key "response-index";
        description
            "Path discovery response list.";
        leaf response-index {
            type uint32;
            mandatory true;
            description
                "Response index.";
        }
        leaf status-code {
            type identityref {
                base status-code;
            }
            mandatory true;
            description
                "Error code for Persistent Path Discovery Information. ";
        }
        leaf status-sub-code {
            type identityref {
                base status-sub-code;
            }
            mandatory true;
            description
                "Sub code for Persistent Path Discovery Information. ";
        }
    }
}
```



```
    leaf pd-persistent-id {
      type string;
      description
        "Id to act as a cookie.";
    }
  }
}

rpc pd-persistent-get-export-details {
  if-feature "coam:path-discovery";
  description
    "Given the persistent id, gets the configuration
    options, details related to the configured data
    export.";
  input {
    leaf cc-persistent-id {
      type string;
      description
        "Persistent Id for use as a key in search.";
    }
  }

  output {
    list response-list {
      key "response-index";
      description
        "Path discovery response list.";
      leaf response-index {
        type uint32;
        mandatory true;
        description
          "Response index.";
      }
      leaf status-code {
        type identityref{
          base status-code;
        }
        mandatory true;
        description
          "Error code for Persistent Path Discovery Creation. ";
      }
      leaf status-sub-code {
        type identityref{
          base status-sub-code;
        }
        mandatory true;
        description
```



```
        "Sub code for Persistent Path Discovery Creation. ";
    }
    leaf data-export-method {
        type export-method;
        description
            "Type of export.";
    }
    choice pd-trigger {
        description
            "Necessary conditions
            for periodic or on-change
            trigger.";
        case periodic {
            description
                "Periodic reports.";
            leaf period {
                type yang:timeticks;
                description
                    "Time interval between reports.";
            }
            leaf start-time {
                type yang:date-and-time;
                description
                    "Timestamp from which reports are started.";
            }
        }
        case on-change {
            description
                "On-change trigger and not periodic.";
            leaf all-data-on-start {
                type boolean;
                description
                    "Full update done on start or not.";
            }
            leaf-list excluded-change {
                type change-type;
                description
                    "Changes that will not trigger an update.";
            }
        }
    }
}
}
```


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