TEAS Working Group
Internet Draft
Intended Status: Standard Track
Expires: October 9, 2019

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April 9, 2019

YANG models for VN & TE Performance Monitoring Telemetry and Scaling Intent Autonomics

draft-lee-teas-actn-pm-telemetry-autonomics-13

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Abstract

This document provides YANG data models that describe performance monitoring telemetry and scaling intent mechanism for TE-tunnels and Virtual Networks (VN).

The models presented in this draft allow customers to subscribe and monitor their key performance data of their interest on the level of TE-tunnel or VN. The models also provide customers with the ability to program autonomic scaling intent mechanism on the level of TE-tunnel as well as VN.

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1. Introduction

The YANG model discussed in [VN] is used to operate customer-driven Virtual Networks (VNs) during the VN instantiation, VN computation, and its life-cycle service management and operations. YANG model discussed in [TE-Tunnel] is used to operate TE-tunnels during the tunnel instantiation, and its life-cycle management and operations.

The models presented in this draft allow the applications hosted by the customers to subscribe and monitor their key performance data of their interest on the level of VN [VN] or TE-tunnel [TE-Tunnel]. The key characteristic of the models presented in this document is a top-down programmability that allows the applications hosted by the customers to subscribe and monitor key performance data of their interest and autonomic scaling intent mechanism on the level of VN as well as TE-tunnel.

According to the classification of [RFC8309], the YANG data models presented in this document can be classified as customer service models, which is mapped to CMI (Customer Network Controller (CNC)-Multi-Domain Service Coordinator (MSDC) interface) of ACTN [RFC8453].

[RFC8233] describes key network performance data to be considered for end-to-end path computation in TE networks. Key performance indicator is a term that describes critical performance data that may affect VN/TE-tunnel service. The services provided can be optimized to meet the requirements (such as traffic patterns, quality, and reliability) of the applications hosted by the customers.

This document provides YANG data models generically applicable to any VN/TE-Tunnel service clients to provide an ability to program their customized performance monitoring subscription and publication data models and automatic scaling in/out intent data models. These models can be utilized by a client network controller to initiate these capability to a transport network controller communicating with the client controller via a NETCONF [RFC8341] or a RESTCONF [RFC8040] interface.

The data model includes configuration and state data according to the new Network Management Datastore Architecture [RFC8342].

1.1. Terminology

Refer to [RFC8453], [RFC7926], and [RFC8309] for the key terms used in this document.

1.2. Tree diagram

A simplified graphical representation of the data model is used in Section 5 of this this document. The meaning of the symbols in these diagrams is defined in [RFC8340].

1.3. Prefixes in Data Node Names

In this document, names of data nodes and other data model objects are prefixed using the standard prefix associated with the corresponding YANG imported modules, as shown in Table 1.

Prefix	YANG module	Reference
rt	ietf-routing-types	[RFC8294]
te	ietf-te	[TE-Tunnel]
te-types	ietf-te-types	[TE-Types]
te-kpi	ietf-te-kpi-telemetry	[This I-D]
vn	ietf-vn	[VN]
vn-tel	ietf-vn-kpi-telemetry	[This I-D]

Table 1: Prefixes and corresponding YANG modules

2. Use-Cases

[PERF] describes use-cases relevant to this draft. It introduces the dynamic creation, modification and optimization of services based on the performance monitoring. Figure 1 shows a high-level workflows for dynamic service control based on traffic monitoring.

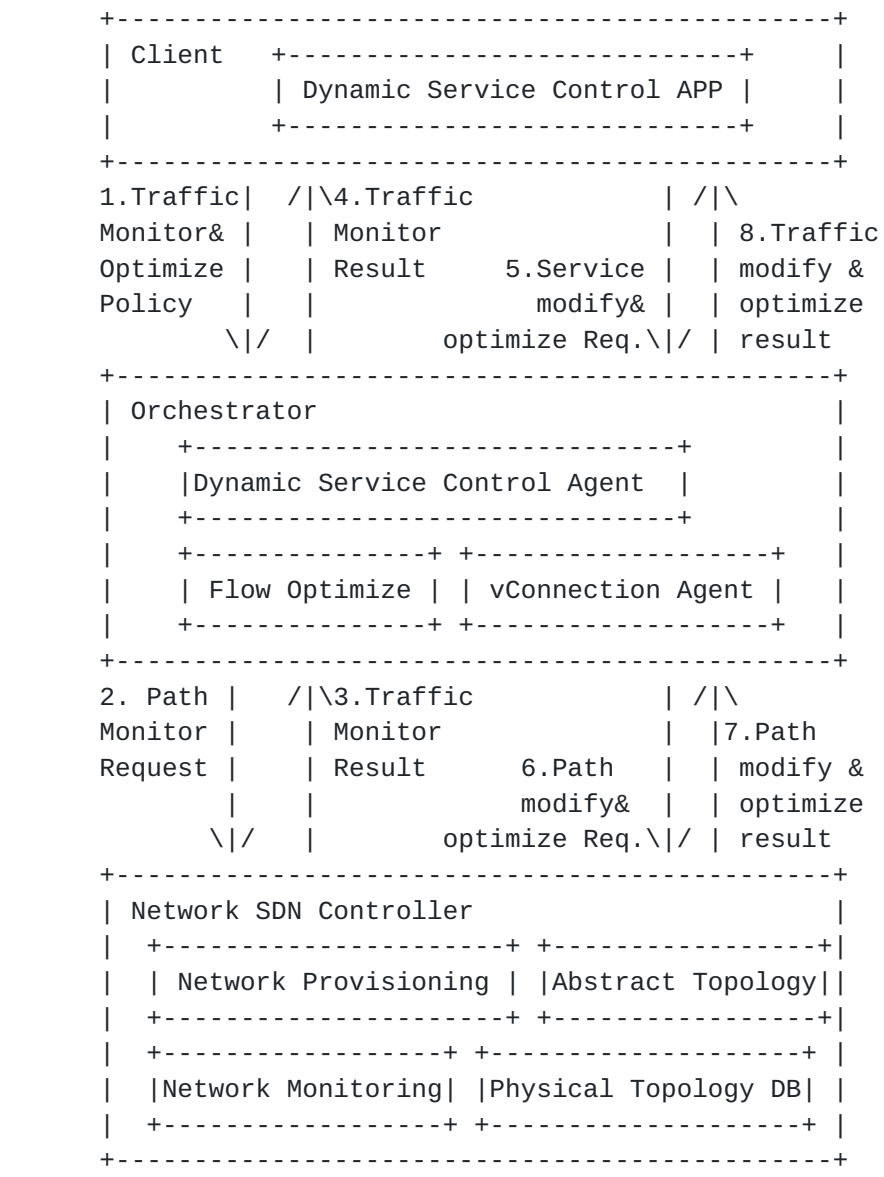


Figure 1 Workflows for dynamic service control based on traffic monitoring

Some of the key points from [PERF] are as follows:

. Network traffic monitoring is important to facilitate automatic discovery of the imbalance of network traffic, and initiate the network optimization, thus helping the network operator or the virtual network service provider to use the network more efficiently and save CAPEX/OPEX.

. Customer services have various SLA requirements, such as service availability, latency, latency jitter, packet loss rate, BER, etc. The transport network can satisfy service availability and BER requirements by providing different protection and restoration mechanisms. However, for other performance parameters, there are no such mechanisms. In order to provide high quality services according to customer SLA, one possible solution is to measure the service SLA related performance parameters, and dynamically provision and optimize services based on the performance monitoring results.
. Performance monitoring in a large scale network could generate a huge amount of performance information. Therefore, the appropriate way to deliver the information in the client and network interfaces should be carefully considered.

3. Design of the Data Models

The YANG models developed in this document describe two models:

(i) TE KPI Telemetry Model which provides the TE-Tunnel level of performance monitoring mechanism and scaling intent mechanism that allows scale in/out programming by the customer. (See Section 3.1 & 7.1 for details).

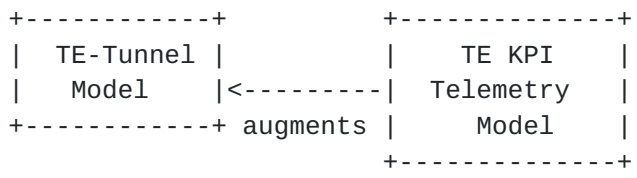
(ii) VN KPI Telemetry Model which provides the VN level of the aggregated performance monitoring mechanism and scaling intent mechanism that allows scale in/out programming by the customer (See Section 3.2 & 7.2 for details).

3.1. TE KPI Telemetry Model

This module describes performance telemetry for TE-tunnel model. The telemetry data is augmented to tunnel state. This module also allows autonomic traffic engineering scaling intent configuration mechanism on the TE-tunnel level. Various conditions can be set for auto-scaling based on the telemetry data (See Section 5 for details)

The TE KPI Telemetry Model augments the TE-Tunnel Model to enhance TE performance monitoring capability. This monitoring capability will facilitate proactive re-optimization and reconfiguration of TEs

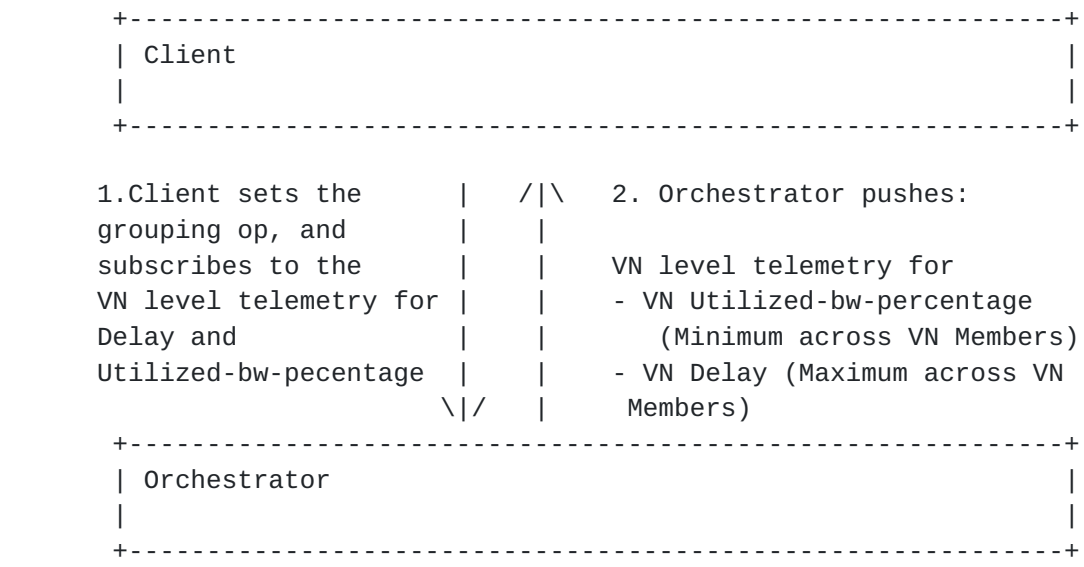
based on the performance monitoring data collected via the TE KPI Telemetry YANG model.



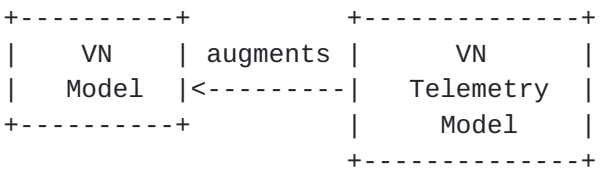
3.2. VN KPI Telemetry Model

This module describes performance telemetry for VN model. The telemetry data is augmented both at the VN Level as well as individual VN member level. This module also allows autonomic traffic engineering scaling intent configuration mechanism on the VN level. Scale in/out criteria might be used for network autonomics in order the controller to react to a certain set of variations in monitored parameters (See Section 4 for illustrations).

Moreover, this module also provides mechanism to define aggregated telemetry parameters as a grouping of underlying VN level telemetry parameters. Grouping operation (such as maximum, mean) could be set at the time of configuration. For example, if maximum grouping operation is used for delay at the VN level, the VN telemetry data is reported as the maximum {delay_vn_member_1, delay_vn_member_2,.. delay_vn_member_N}. Thus, this telemetry abstraction mechanism allows the grouping of a certain common set of telemetry values under a grouping operation. This can be done at the VN-member level to suggest how the E2E telemetry be inferred from the per domain tunnel created and monitored by PNCs. One proposed example is the following:



The VN Telemetry Model augments the basic VN model to enhance VN monitoring capability. This monitoring capability will facilitate proactive re-optimization and reconfiguration of VNs based on the performance monitoring data collected via the VN Telemetry YANG model.



4. Autonomic Scaling Intent Mechanism

Scaling intent configuration mechanism allows the client to configure automatic scale-in and scale-out mechanisms on both the TE-tunnel and the VN level. Various conditions can be set for auto-scaling based on the PM telemetry data.

There are a number of parameters involved in the mechanism:

- scale-out-intent or scale-in-intent: whether to scale-out or scale-in.
- performance-type: performance metric type (e.g., one-way-delay, one-way-delay-min, one-way-delay-max, two-way-delay, two-way-delay-min, two-way-delay-max, utilized bandwidth, etc.)

. threshold-value: the threshold value for a certain performance-type that triggers scale-in or scale-out.
. scaling-operation-type: in case where scaling condition can be set with one or more performance types, then scaling-operation-type (AND, OR, MIN, MAX, etc.) is applied to these selected performance types and its threshold values.
. Threshold-time: the duration for which the criteria must hold true.
. Cooldown-time: the duration after a scaling action has been triggered, for which there will be no further operation.

The following tree is a part of ietf-te-kpi-telemetry tree whose model is presented in full detail in Sections 6 & 7.

```
module: ietf-te-kpi-telemetry
  augment /te:te/te:tunnels/te:tunnel:
    +-rw te-scaling-intent
    |  +-rw scale-in-intent
    |  |  +-rw threshold-time?            uint32
    |  |  +-rw cooldown-time?             uint32
    |  |  +-rw scale-in-operation-type?   scaling-criteria-operation
    |  |  +-rw scaling-condition* [performance-type]
    |  |     +-rw performance-type           identityref
    |  |     +-rw threshold-value?           string
    |  |     +-rw te-telemetry-tunnel-ref?
    |  |        -> /te:te/tunnels/tunnel/name
    |  +-rw scale-out-intent
    |     +-rw threshold-time?            uint32
    |     +-rw cooldown-time?             uint32
    |     +-rw scale-out-operation-type?   scaling-criteria-operation
    |     +-rw scaling-condition* [performance-type]
    |        +-rw performance-type           identityref
    |        +-rw threshold-value?           string
    |        +-rw te-telemetry-tunnel-ref?
    |           -> /te:te/tunnels/tunnel/name
```

Let say the client wants to set the scaling out operation based on two performance-types (e.g., two-way-delay and utilized-bandwidth for a te-tunnel), it can be done as follows:

. Set Threshold-time: 3600 (sec) (duration for which the criteria must hold true)

. Set Cooldown-time: 60 (sec) (the duration after a scaling action has been triggered, for which there will be no further operation)
. Set AND for the scale-out-operation-type

In the scaling condition's list, the following two components can be set:

List 1: Scaling Condition for Two-way-delay

. performance type: Two-way-delay
. threshold-value: 300 mile-seconds

List 2: Scaling Condition for Utilized bandwidth

. performance type: Utilized bandwidth
. threshold-value: 300 megabytes

5. Notification

This model does not define specific notifications. To enable notifications, the mechanism defined in [YANG-PUSH] and [Event-Notification] can be used. This mechanism currently allows the user to:

. Subscribe notifications on a per client basis.

. Specify subtree filters or xpath filters so that only interested contents will be sent.

. Specify either periodic or on-demand notifications.

5.1. YANG Push Subscription Examples

[YANG-PUSH] allows subscriber applications to request a continuous, customized stream of updates from a YANG datastore.

Below example shows the way for a client to subscribe for the telemetry information for a particular tunnel (Tunnel1). The telemetry parameter that the client is interested in is one-way-delay.

```
<netconf:rpc netconf:message-id="101"
    xmlns:netconf="urn:ietf:params:xml:ns:netconf:base:1.0">
    <establish-subscription
       xmlns="urn:ietf:params:xml:ns:yang:ietf-yang-push:1.0">
       <filter netconf:type="subtree">
          <te xmlns="urn:ietf:params:xml:ns:yang:ietf-te">
             <tunnels>
                <tunnel>
                  <name>Tunnel1</name>
                  <identifier/>
                  <state>
                    <te-telemetry xmlns="urn:ietf:params:xml:ns:yang:
                                         ietf-te-kpi-telemetry">
                        <one-way-delay/>
                     </te-telemetry>
                  </state>
                 </tunnel>
              </tunnels>
          </te>
       </filter>
       <period>500</period>
       <encoding>encode-xml</encoding>
    </establish-subscription>
 </netconf:rpc>
```

This example shows the way for a client to subscribe for the telemetry information for all VNs. The telemetry parameter that the client is interested in is one-way-delay and one-way-utilized-bandwidth.

```
<netconf:rpc netconf:message-id="101"
    xmlns:netconf="urn:ietf:params:xml:ns:netconf:base:1.0">
    <establish-subscription
       xmlns="urn:ietf:params:xml:ns:yang:ietf-yang-push:1.0">
       <filter netconf:type="subtree">
          <vn-state xmlns="urn:ietf:params:xml:ns:yang:ietf-vn">
             <vn>
                <vn-list>
                  <vn-id/>
                  <vn-name/>
                  <vn-telemetry xmlns="urn:ietf:params:xml:ns:yang:
                                        ietf-vn-kpi-telemetry">
                      <one-way-delay/>
                      <one-way-utilized-bandwidth/>
                  </vn-telemetry >
                </vn-list>
              </vn>
```

```
            </vn-state>
          </filter>
          <period>500</period>
        </establish-subscription>
    </netconf:rpc>
```

6. YANG Data Tree

```
module: ietf-te-kpi-telemetry
  augment /te:te/te:tunnels/te:tunnel:
    +--rw te-scaling-intent
    |  +--rw scale-in-intent
    |  |  +--rw threshold-time?            uint32
    |  |  +--rw cooldown-time?             uint32
    |  |  +--rw scale-in-operation-type?   scaling-criteria-operation
    |  |  +--rw scaling-condition* [performance-type]
    |  |     +--rw performance-type           identityref
    |  |     +--rw threshold-value?           string
    |  |     +--rw te-telemetry-tunnel-ref?
    |  |             -> /te:te/tunnels/tunnel/name
    |  +--rw scale-out-intent
    |     +--rw threshold-time?            uint32
    |     +--rw cooldown-time?             uint32
    |     +--rw scale-out-operation-type?   scaling-criteria-operation
    |     +--rw scaling-condition* [performance-type]
    |        +--rw performance-type           identityref
    |        +--rw threshold-value?           string
    |        +--rw te-telemetry-tunnel-ref?
    |                -> /te:te/tunnels/tunnel/name
    +--ro te-telemetry
       +--ro id?                            string
       +--ro performance-metrics-one-way
       |  +--ro one-way-delay?                           uint32
       |  +--ro one-way-delay-normality?
       |  |       te-types:performance-metrics-normality
       |  +--ro one-way-residual-bandwidth?
       |  |       rt-types:bandwidth-ieee-float32
       |  +--ro one-way-residual-bandwidth-normality?
       |  |       te-types:performance-metrics-normality
       |  +--ro one-way-available-bandwidth?
       |  |       rt-types:bandwidth-ieee-float32
       |  +--ro one-way-available-bandwidth-normality?
       |  |       te-types:performance-metrics-normality
       |  +--ro one-way-utilized-bandwidth?
       |  |       rt-types:bandwidth-ieee-float32
       |  +--ro one-way-utilized-bandwidth-normality?
       |          te-types:performance-metrics-normality
       +--ro performance-metrics-two-way
       |  +--ro two-way-delay?             uint32
       |  +--ro two-way-delay-normality?
       |          te-types:performance-metrics-normality
```

```
       +--ro te-ref?
               -> /te:te/tunnels/tunnel/name


module: ietf-vn-kpi-telemetry
  augment /vn:vn/vn:vn-list:
```

```
    +--rw vn-scaling-intent
    |  +--rw scale-in-intent
    |  |  +--rw threshold-time?            uint32
    |  |  +--rw cooldown-time?             uint32
    |  |  +--rw scale-in-operation-type?   scaling-criteria-operation
    |  |  +--rw scaling-condition* [performance-type]
    |  |     +--rw performance-type           identityref
    |  |     +--rw threshold-value?           string
    |  |     +--rw te-telemetry-tunnel-ref?
    |  |             -> /te:te/tunnels/tunnel/name
    |  +--rw scale-out-intent
    |     +--rw threshold-time?             uint32
    |     +--rw cooldown-time?              uint32
    |     +--rw scale-out-operation-type?   scaling-criteria-operation
    |     +--rw scaling-condition* [performance-type]
    |        +--rw performance-type           identityref
    |        +--rw threshold-value?           string
    |        +--rw te-telemetry-tunnel-ref?
    |                -> /te:te/tunnels/tunnel/name
    +--ro vn-telemetry
       +--ro performance-metrics-one-way
       |  +--ro one-way-delay?                           uint32
       |  +--ro one-way-delay-normality?
       |  |       te-types:performance-metrics-normality
       |  +--ro one-way-residual-bandwidth?
       |  |       rt-types:bandwidth-ieee-float32
       |  +--ro one-way-residual-bandwidth-normality?
       |  |       te-types:performance-metrics-normality
       |  +--ro one-way-available-bandwidth?
       |  |       rt-types:bandwidth-ieee-float32
       |  +--ro one-way-available-bandwidth-normality?
       |  |       te-types:performance-metrics-normality
       |  +--ro one-way-utilized-bandwidth?
       |  |       rt-types:bandwidth-ieee-float32
       |  +--ro one-way-utilized-bandwidth-normality?
       |          te-types:performance-metrics-normality
       +--ro performance-metrics-two-way
       |  +--ro two-way-delay?             uint32
       |  +--ro two-way-delay-normality?
       |          te-types:performance-metrics-normality
       +--ro grouping-operation?            grouping-operation
  augment /vn:vn/vn:vn-list/vn:vn-member-list:
    +--ro vn-member-telemetry
       +--ro performance-metrics-one-way
       |  +--ro one-way-delay?                           uint32
       |  +--ro one-way-delay-normality?
       |  |       te-types:performance-metrics-normality
       |  +--ro one-way-residual-bandwidth?
```

```
|  |       rt-types:bandwidth-ieee-float32
|  +--ro one-way-residual-bandwidth-normality?
|  |       te-types:performance-metrics-normality
|  +--ro one-way-available-bandwidth?
|  |       rt-types:bandwidth-ieee-float32
|  +--ro one-way-available-bandwidth-normality?
|  |       te-types:performance-metrics-normality
```

```
       |  +--ro one-way-utilized-bandwidth?
       |  |       rt-types:bandwidth-ieee-float32
       |  +--ro one-way-utilized-bandwidth-normality?
       |          te-types:performance-metrics-normality
       +--ro performance-metrics-two-way
       |  +--ro two-way-delay?             uint32
       |  +--ro two-way-delay-normality?
       |          te-types:performance-metrics-normality
       +--ro te-grouped-params*
       |       -> /te:te/tunnels/tunnel/te-kpi:te-telemetry/id
       +--ro grouping-operation?            grouping-operation
```

7. Yang Data Model

7.1. ietf-te-kpi-telemetry model

The YANG code is as follows:

<CODE BEGINS> file "ietf-te-kpi-telemetry@2019-04-08.yang"

```
module ietf-te-kpi-telemetry {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-te-kpi-telemetry";
  prefix te-tel;

  import ietf-te {
    prefix te;
   reference
     "RFC YYYY: A YANG Data Model for Traffic Engineering
      Tunnels and Interfaces";
  }

  /* Note: The RFC Editor will replace YYYY with the number
     assigned to the RFC once draft-ietf-teas-yang-te
    becomes an RFC.*/

  import ietf-te-types {
    prefix te-types;
   reference
     "RFC ZZZZ: Traffic Engineering Common YANG Types";
  }

  /* Note: The RFC Editor will replace ZZZZ with the number
     assigned to the RFC once draft-ietf-teas-yang-te-types
    becomes an RFC.*/
```

```
  organization
    "IETF Traffic Engineering Architecture and Signaling (TEAS)
     Working Group";
  contact
    "Editor: Young Lee <leeyoung@huawei.com>
     Editor: Dhruv Dhody <dhruv.ietf@gmail.com>
     Editor: Ricard Vilalta <ricard.vilalta@cttc.es>
     Editor: Satish Karunanithi <satish.karunanithi@gmail.com>";
  description
    "This module describes YANG data model for performance
    monitoring telemetry for te tunnels.

    Copyright (c) 2019 IETF Trust and the persons identified
     as authors of the code.  All rights reserved.

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     BSD License set forth in Section 4.c of the IETF Trust's
     Legal Provisions Relating to IETF Documents
     (http://trustee.ietf.org/license-info).";

  revision 2019-04-08 {
    description
      "Initial revision. This YANG file defines
       a YANG model for TE telemetry.";
    reference "Derived from earlier versions of base YANG files";
  }

  identity telemetry-param-type {
    description
      "Base identity for telemetry param types";
  }

  identity one-way-delay {
    base telemetry-param-type;
    description
      "To specify average Delay in one (forward)
       direction";
  }

  identity two-way-delay {
    base telemetry-param-type;
    description
      "To specify average Delay in both (forward and reverse)
       directions";
```

```
  }

  identity one-way-delay-variation {
    base telemetry-param-type;
    description
      "To specify average Delay Variation in one (forward) direction";
  }

  identity two-way-delay-variation {
    base telemetry-param-type;
    description
      "To specify average Delay Variation in both (forward and reverse)
       directions";
  }

  identity utilized-bandwidth {
    base telemetry-param-type;
    description
      "To specify utilized bandwidth over the specified source
       and destination.";
  }

  identity utilized-percentage {
    base telemetry-param-type;
    description
      "To specify utilization percentage of the entity
       (e.g., tunnel, link, etc.)";
  }

  typedef scaling-criteria-operation {
    type enumeration {
      enum AND {
        description
          "AND operation";
      }
      enum OR {
        description
          "OR operation";
      }
    }
    description
      "Operations to analize list of scaling criterias";
  }

  grouping scaling-duration {
    description
      "Base scaling criteria durations";
```

```
    leaf threshold-time {
      type uint32;
      units "seconds";
      description
        "The duration for which the criteria must hold true";
    }
    leaf cooldown-time {
      type uint32;
      units "seconds";
      description
        "The duration after a scaling-in/scaling-out action has been
         triggered, for which there will be no further operation";
    }
  }

  grouping scaling-criteria {
    description
      "Grouping for scaling criteria";
    leaf performance-type {
      type identityref {
        base telemetry-param-type;
      }
      description
        "Reference to the tunnel level telemetry type";
    }
    leaf threshold-value {
      type string;
      description
        "Scaling threshold for the telemetry parameter type";
    }
    leaf te-telemetry-tunnel-ref {
      type leafref {
        path "/te:te/te:tunnels/te:tunnel/te:name";
      }
      description
        "Reference to tunnel";
    }
  }

  grouping scaling-in-intent {
    description
      "Basic scaling in intent";
    uses scaling-duration;
    leaf scale-in-operation-type {
      type scaling-criteria-operation;
      default "AND";
      description
```

```
        "Operation to be applied to check between
         scaling criterias to check if the scale in
         threshold condition has been met.
         Defaults to AND";
    }
    list scaling-condition {
      key "performance-type";
      description
        "Scaling conditions";
      uses scaling-criteria;
    }
  }

  grouping scaling-out-intent {
    description
      "Basic scaling out intent";
    uses scaling-duration;
    leaf scale-out-operation-type {
      type scaling-criteria-operation;
      default "OR";
      description
        "Operation to be applied to check between
         scaling criterias to check if the scale out
         threshold condition has been met.
         Defauls to OR";
    }
    list scaling-condition {
      key "performance-type";
      description
        "Scaling conditions";
      uses scaling-criteria;
    }
  }

  augment "/te:te/te:tunnels/te:tunnel" {
    description
      "Augmentation parameters for config scaling-criteria
       TE tunnel topologies. Scale in/out criteria might be used
       for network autonomics in order the controller
       to react to a certain set of monitored params.";
    container te-scaling-intent {
      description
        "scaling intent";
      container scale-in-intent {
        description
          "scale-in";
        uses scaling-in-intent;
```

```
      }
      container scale-out-intent {
        description
          "scale-out";
        uses scaling-out-intent;
      }
    }
    container te-telemetry {
      config false;
      description
        "telemetry params";
      leaf id {
        type string;
        description
          "Id of telemetry param";
      }
      uses te-types:performance-metrics-attributes;
      leaf te-ref {
        type leafref {
          path "/te:te/te:tunnels/te:tunnel/te:name";
        }
        description
          "Reference to measured te tunnel";
      }
    }
  }
}
<CODE ENDS>
```

7.2. ietf-vn-kpi-telemetry model

The YANG code is as follows:

```
<CODE BEGINS> file "ietf-vn-kpi-telemetry@2019-04-08.yang"

module ietf-vn-kpi-telemetry {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-vn-kpi-telemetry";
  prefix vn-tel;

  import ietf-vn {
    prefix vn;
   reference
     "RFC XXXX: A YANG Data Model for VN Operation";
```

```
  }

  /* Note: The RFC Editor will replace XXXX with the number
     assigned to the RFC once draft-ietf-teas-actn-vn-yang
    becomes an RFC.*/

  import ietf-te {
    prefix te;
   reference
     "RFC YYYY: A YANG Data Model for Traffic Engineering
      Tunnels and Interfaces";
  }

  /* Note: The RFC Editor will replace YYYY with the number
     assigned to the RFC once draft-ietf-teas-yang-te
    becomes an RFC.*/

  import ietf-te-types {
    prefix te-types;
   reference
     "RFC ZZZZ: Traffic Engineering Common YANG Types";
  }

  /* Note: The RFC Editor will replace ZZZZ with the number
     assigned to the RFC once draft-ietf-teas-yang-te-types
    becomes an RFC.*/

  import ietf-te-kpi-telemetry {
    prefix te-kpi;
   reference
     "RFC WWWW: YANG models for VN & TE Performance Monitoring
      Telemetry and Scaling Intent Autonomics";
  }

  /* Note: The RFC Editor will replace WWWW with the number
     assigned to the RFC once draft-lee-teas-actn-pm-telemetry
    -autonomics becomes an RFC.*/

  organization
    "IETF Traffic Engineering Architecture and Signaling (TEAS)
     Working Group";
  contact
    "Editor: Young Lee <leeyoung@huawei.com>
     Editor: Dhruv Dhody <dhruv.ietf@gmail.com>
     Editor: Ricard Vilalta <ricard.vilalta@cttc.es>
     Editor: Satish Karunanithi <satish.karunanithi@gmail.com>";
```

```
  description
    "This module describes YANG data models for performance
    monitoring telemetry for vn.

    Copyright (c) 2019 IETF Trust and the persons identified
     as authors of the code.  All rights reserved.

     Redistribution and use in source and binary forms, with
     or without modification, is permitted pursuant to, and
     subject to the license terms contained in, the Simplified
     BSD License set forth in Section 4.c of the IETF Trust's
     Legal Provisions Relating to IETF Documents
     (http://trustee.ietf.org/license-info).";

  revision 2019-04-08 {
    description
      "Initial revision. This YANG file defines
       the VN telemetry.";
    reference "Derived from earlier versions of base YANG files";
  }

  typedef grouping-operation {
    type enumeration {
      enum MINIMUM {
        description
          "Select the minimum param";
      }
      enum MAXIMUM {
        description
          "Select the maximum param";
      }
      enum MEAN {
        description
          "Select the MEAN of the params";
      }
      enum STD_DEV {
        description
          "Select the standard deviation of the
           monitored params";
      }
      enum AND {
        description
          "Select the AND of the params";
      }
      enum OR {
        description
          "Select the OR of the params";
```

```
      }
    }
    description
      "Operations to analize list of monitored params";
  }

  grouping vn-telemetry-param {
    description
      "augment of te-kpi:telemetry-param for VN specific params";
    leaf-list te-grouped-params {
      type leafref {
        path "/te:te/te:tunnels/te:tunnel/te-kpi:te-telemetry/"
           + "te-kpi:id";
      }
      description
        "Allows the definition of a vn-telemetry param
         as a grouping of underlying TE params";
    }
    leaf grouping-operation {
      type grouping-operation;
      description
        "describes the operation to apply to
         te-grouped-params";
    }
  }

  augment "/vn:vn/vn:vn-list" {
    description
      "Augmentation parameters for state TE VN topologies.";
    container vn-scaling-intent {
      description
        "scaling intent";
      container scale-in-intent {
        description
          "VN scale-in";
        uses te-kpi:scaling-in-intent;
      }
      container scale-out-intent {
        description
          "VN scale-out";
        uses te-kpi:scaling-out-intent;
      }
    }
    container vn-telemetry {
      config false;
      description
        "VN telemetry params";
```

```
      uses te-types:performance-metrics-attributes;
      leaf grouping-operation {
        type grouping-operation;
        description
          "describes the operation to apply to the VN-members";
      }
    }
  }
  augment "/vn:vn/vn:vn-list/vn:vn-member-list" {
    description
      "Augmentation parameters for state TE vn member topologies.";
    container vn-member-telemetry {
      config false;
      description
        "VN member telemetry params";
      uses te-types:performance-metrics-attributes;
      uses vn-telemetry-param;
    }
  }
}
<CODE ENDS>
```

8. Security Considerations

The YANG module specified in this document defines a schema for data that 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 [RFC8446].

The NETCONF access control model [RFC8341] provides the means to restrict access for particular NETCONF users to a preconfigured subset of all available NETCONF protocol operations and content. The NETCONF Protocol over Secure Shell (SSH) [RFC6242] describes a method for invoking and running NETCONF within a Secure Shell (SSH) session as an SSH subsystem. The Network Configuration Access Control Model (NACM) [RFC8341] 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.

A number of configuration data nodes defined in this document are writable/deletable (i.e., "config true"). These data nodes may be considered sensitive or vulnerable in some network environments.

There are a number of data nodes defined in this YANG module that 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:

/te:te/te:tunnels/te:tunnel/te-scaling-intent/scale-in-intent
/te:te/te:tunnels/te:tunnel/te-scaling-intent/scale-out-intent

/vn:vn/vn:vn-list/vn-scaling-intent/scale-in-intent
/vn:vn/vn:vn-list/vn-scaling-intent/scale-out-intent

9. IANA Considerations

This document registers the following namespace URIs in the IETF XML registry [RFC3688]:

URI: urn:ietf:params:xml:ns:yang:ietf-te-kpi-telemetry
Registrant Contact: The IESG.
XML: N/A, the requested URI is an XML namespace.

URI: urn:ietf:params:xml:ns:yang:ietf-kpi-telemetry
Registrant Contact: The IESG.
XML: N/A, the requested URI is an XML namespace.

This document registers the following YANG modules in the YANG Module.

Names registry [RFC7950]:

---
name: ietf-te-kpi-telemetry

```
   namespace:    urn:ietf:params:xml:ns:yang:ietf-te-kpi-telemetry
   reference:    RFC XXXX (TDB)
   ------------------------------------------------------------------

   ------------------------------------------------------------------
   name:         ietf-vn-kpi-telemetry
   namespace:    urn:ietf:params:xml:ns:yang:ietf-vn-kpi-telemetry
   reference:    RFC XXXX (TDB)
   ------------------------------------------------------------------
```

10. Acknowledgements

We thank Rakesh Gandhi, Tarek Saad and Igor Bryskin for useful discussions and their suggestions for this work.

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