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A YANG Model for VPN Service Performance Monitoring
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Abstract

As specified in [RFC8345], the data model defined in [RFC8345] introduces vertical layering relationships between networks that can be augmented to cover network/service topologies. This document defines a YANG Model for VPN Service Performance Monitoring that can be used to monitor and manage network Performance between VPN sites and it is an augmentation to the I2RS network topology YANG data model.

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1. Introduction

[RFC8345] defines an abstract YANG data model for network/service topologies and inventories. Service topology in [RFC8345] includes the a virtual topology for a service layer above the L1, L2, and L3 layers. This virtual topology has the generic topology elements of node,link, and terminating point. One typical example of a service topology is described in figure 3 of [RFC8345],two VPN service topologies instantiated over a common L3 topology. Each VPN service topology is mapped onto a subset of nodes from the common L3 topology.

In [RFC8299], the 3 types of VPN service topologies proposed for L3VPN service data model are any to any, hub and spoke, hub and spoke disjoint. These VPN topology types can be used to describe how VPN

sites are communicating with each other.

This document defines a YANG Model for VPN Service Performance Monitoring that can be used to monitor and manage network Performance

between VPN sites and it is an augmentation to the I2RS network topology YANG data model.

2. Conventions used in this document

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]. In this document, these words will appear with that interpretation only when in ALL CAPS. Lower case uses of these words are not to be interpreted as carrying [RFC2119] significance.

The following notations are used within the data tree and carry the meaning as below.

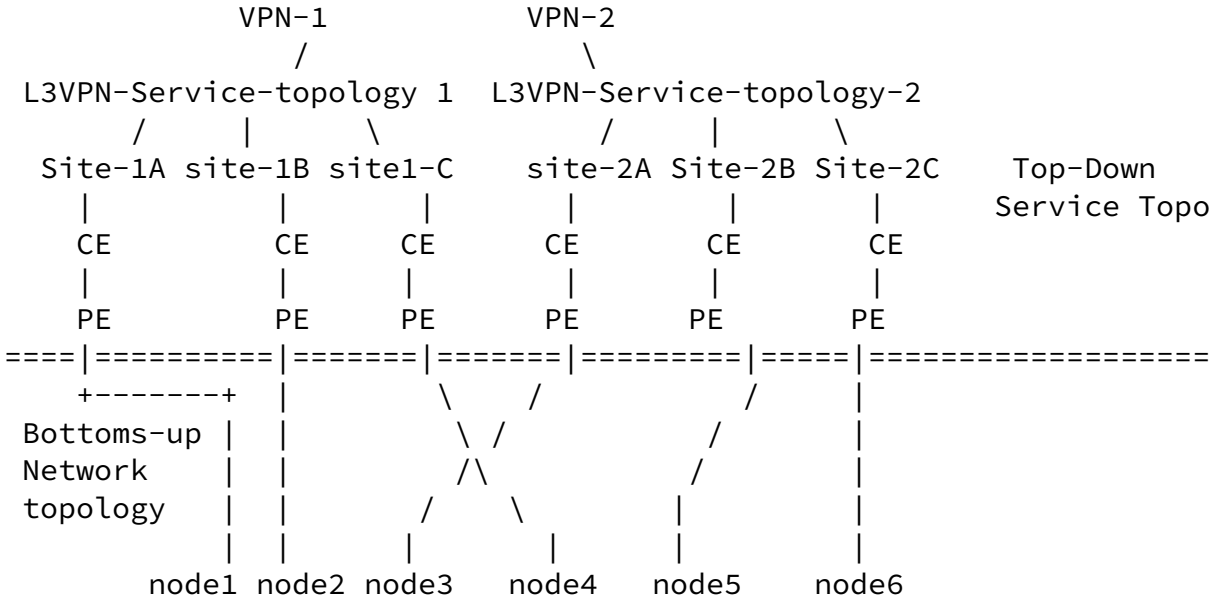
Each node is printed as:

```
<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
    -w for writable

<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
      (choice)/:(case) Parentheses enclose choice and case nodes,
      and case nodes are also marked with a colon (":")
      <type> is the name of the type for leafs and leaf-lists
```


3. VPN Service Topology Overview

As specified in [RFC8345], the data model defined in [RFC8345] can describe vertical layering relationships between networks that can be augmented to cover network/service topologies. The following figure describes relationships between L3VPN Service Topo and Underlying network:



layering relationships between L3VPN Service Topo and Underlying network

As shown in figure 1, the Site-1,A,B,C are mapped to node 1,2,3 while

Site-2 A,B,C are mapped to node 4,5,6 in the underlying physical network. In this figure, an L3SM has two VPN services topologies with both built on top of one common underlying physical network.

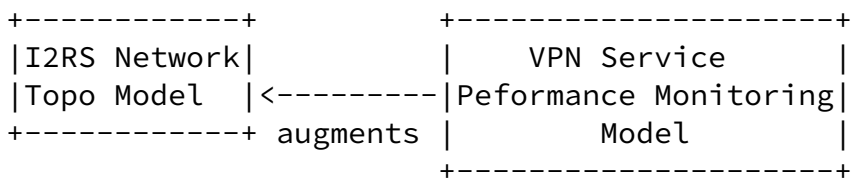
VPN-svc 1: supporting hub-spoke communication for Customer 1 connecting the customers access at 3 sites

VPN-svc 2: supporting hub-spoke disjoint communication for Customer 2 connecting the customers access at 3 sites

L3VPN service topology 1 is hub and spoke topology while L3VPN service topology 2 is hub and spoke disjoint topology. In L3VPN service topology1, Site-1 A plays the role of hub while Site-2 B and C plays the role of spoke. In L3VPN service topoogy2, Site-2 A and B play the role of hub while Site-2 C plays the role of spoke.

4. VPN service assurance model

This module describes VPN Service assurance that can be used to monitor and manage network Performance between VPN sites and it is a augmentation to the I2RS network topology YANG data model. The performance monitoring data is augmented to service topology.



5. Model Usage Guideline

An SP must be able to manage the capabilities and characteristics of their VPN services when VPN sites are setup to communicate with each other. VPN service topology such as hub and spoke describes how these VPN sites are communicating with each other.

5.1. Performance Monitoring Data Source

As described in section 2, once the mapping between VPN Service topology and underlying physical network has been setup, the performance monitoring data per link in the underlying network can be collected using network performance measurement method such as MPLS Loss and Delay Measurement [RFC6374]. The performance monitoring information reflecting the quality of the VPN service such as end to end network performance data between VPN sites can be aggregated or calculated using PCEP solution [RFC5440] or LMAP solution [RFC8194]. The information can be fed into data source such as the management system or network devices. The measurement interval and report interval associated with these performance data usually depends on configuration parameters.

5.2. Retrieval via I2RS Pub/Sub

Some applications such as service-assurance applications, which must maintain a continuous view of operational data and state, can use subscription model [I-D.ietf-netconf-yang-push] to subscribe to the VPN service performance data they are interested in, at the data source.

The data source can then use VPN service assurance model and push model [I-D.ietf-netconf-yang-push] to publish specific telemetry data to target recipients.

5.3. On demand Retrieval via RPC model

To obtain a snapshot of a large amount of performance data from the network element, service-assurance applications can also use polling based solution such as RPC model to fetch performance data on demand.

6. Design of the Data Model

This document defines the YANG module "ietf-vpn-svc-pm", which has the following structure

6.1. Network Level

```
module: ietf-vpn-svc-pm
  augment /nw:networks/nw:network/nw:network-types:
```

```
    +--rw svc-topo-type?   identityref
  augment /nw:networks/nw:network:
    +--rw svc-topo-attributes
       +--rw vpn-topo?   identityref
```

Network Level View of the hierarchies

The VPN service performance monitoring model defines only the following minimal set of Network level service topology attributes:

- svc-topo-type: Indicate the network type is service topology type such as L3VPN service topology, L2VPN service topology.

- vpn-topo: The type of VPN service topology, Ourproposed model supports any-to-any, Hub and Spoke (where Hubs can exchange traffic), and "Hub and Spoke disjoint" (where Hubs cannot exchange traffic).

6.2. Node Level

```
augment /nw:networks/nw:network/nw:node:
    +--rw node-attributes
       +--rw node-type?   identityref
       +--rw site-id?     string
       +--rw site-role?   Identityref
```

Node Level View of the hierarchies

The VPN service performance monitoring model defines only the following minimal set of Node level service topology attributes and constraints:

- Node-type (Attribute): Indicate the type of the node, such as PE or ASBR.

- Site-id (Constraint): Uniquely identifies the site within the overall network infrastructure.

- Site-role (Constraint):Defines the role of the site in a particular VPN topology.

6.3. Link and Termination Point Level

```
augment /nw:networks/nw:network/nt:link:
  +--ro svc-telemetry-attributes
     +--ro loss-statistics
     |  +--ro direction                  identityref
     |  +--ro packet-loss-count?           uint32
     |  +--ro loss-ratio?                  percentage
     |  +--ro packet-reorder-count?        uint32
     |  +--ro packets-out-of-seq-count?    uint32
     |  +--ro packets-dup-count?           uint32
     +--ro delay-statistics
     |  +--ro direction?        identityref
     |  +--ro min-delay-value?        uint32
     |  +--ro max-delay-value?        uint32
     |  +--ro average-delay-value?    uint32
     +--ro jitter-statistics
        +--ro direction?              identityref
        +--ro min-jitter-value?        uint32
        +--ro max-jitter-value?        uint32
        +--ro average-jitter-value?    uint32
```

Link and Termination point Level View of the hierarchies

The VPN service performance monitoring model defines only the following minimal set of Link level service topology attributes:

Loss Statistics: A set of loss statistics attributes that are used to measure end to end loss between VPN sites.

Delay Statistics: A set of delay statistics attributes that are used to measure end to end latency between VPN sites.

Jitter Statistics: A set of jitter statistics attributes that are used to measure end to end jitter between VPN sites.

7. Example of I2RS Pub/Sub Retrieval

This example shows the way for a client to subscribe for the Performance monitoring information for VPN service between VPN sites. The performance monitoring parameter that the client is interested in is end to end loss attribute.

```
<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-subscribed-notifications">
       <stream-subtree-filter>
          <networks xmlns="urn:ietf:params:xml:ns:yang:ietf-network-topo">
             <network>
              <network-id>vpn1</network-id>
               <node>
                <node-id>A</node-id>
                <node-type xmlns="urn:ietf:params:xml:ns:yang:ietf-svc-topo"
               </node>
               <node>
                <node-id>B</node-id>
                <node-type xmlns="urn:ietf:params:xml:ns:yang:ietf-svc-topo"
               </node>
               <link xmlns="urn:ietf:params:xml:ns:yang:ietf-network-topolog
                <link-id>A-B</link-id>
                <source>
                 <source-node>A</source-node>
                </source>
                <destination>
                 <dest-node>B</dest-node>
                </destination>
                 <svc-telemetry-attributes
                  xmlns="urn:ietf:params:xml:ns:yang:ietf-svc-topo">
                  <loss-statistics>
                   <packet-loss-count/>
                  </loss-statistics>
                 </svc-telemetry-attributes>
                </link>
             </network>
          </networks>
       </stream-subtree-filter>
       <period xmlns="urn:ietf:params:xml:ns:yang:ietf-yang-push:1.0">500</p
    </establish-subscription>
 </rpc>
```

8. Example of RPC model based Retrieval

This example shows the way for the client to use RPC model to fetch performance data on demand,e.g., the client requests packet-loss-count between PE1 in site 1 and PE2 in site 2 belonging to VPN1.

```
<rpc xmlns="urn:ietf:params:xml:ns:netconf:base:1.0"
     message-id="1">
  <report xmlns="urn:ietf:params:xml:ns:yang:example-service-pm-report">
   <networks xmlns="urn:ietf:params:xml:ns:yang:ietf-network-topo">
     <network>
       <network-id>vpn1</network-id>
       <node>
           <node-id>A</node-id>
           <node-type xmlns="urn:ietf:params:xml:ns:yang:ietf-svc-topo">pe</
      </node>
      <node>
         <node-id>B</node-id>
         <node-type xmlns="urn:ietf:params:xml:ns:yang:ietf-svc-topo">pe</no
      </node>
      <link-id>A-B</link-id>
         <source>
         <source-node>A</source-node>
         </source>
         <destination>
         <dest-node>B</dest-node>
          </destination>
          <svc-telemetry-attributes xmlns="urn:ietf:params:xml:ns:yang:ietf-
          <loss-statistics>
            <packet-loss-count/>
            </loss-statistics>
          </svc-telemetry-attributes>
      </link>
  </report>
</rpc>
```

9. VPN Service Assurance YANG Module

```
<CODE BEGINS> file "ietf-vpn-svc-pm.yang"
module ietf-vpn-svc-pm {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-vpn-svc-pm";
  prefix svc-topo;
  import ietf-network {
    prefix nw;
  }
```

```
  import ietf-network-topology {
    prefix nt;
```



```
  }
  import ietf-l3vpn-svc {
   prefix l3vpn-svc;
  }
  organization
    "IETF xxx Working Group";
  contact
    "Zitao Wang: wangzitao@huawei.com
     Qin Wu: bill.wu@huawei.com";
  description
    "This module defines a model for the service topology.";

  revision 2018-08-29 {
    description
      "Initial revision.";
    reference "foo";
  }

  identity service-type {
    description
      "Base type for service topology";
  }

  identity l3vpn-svc {
    base service-type;
    description
      "Indentity for layer3 vpn service";
  }

  identity l2vpn-svc {
    base service-type;
    description
      "Identity for layer2 vpn service";
  }

  identity node-type {
    description
      "Base identity for node type";
  }
```

```
  identity pe {
    base node-type;
    description
      "Identity for PE type";
  }

  identity ce {
    base node-type;
```



```
    description
      "Identity for CE type";
  }

  identity asbr {
    base node-type;
    description
      "Identity for ASBR type";
  }

  identity p {
    base node-type;
    description
      "Identity for P type";
  }

  identity direction {
    description
      "Base Identity for measurement direction including
       one way measurement and two way measurement.";
  }

  identity oneway {
    base direction;
    description
      "Identity for one way measurement.";
  }

  identity twoway {
    base direction;
    description
      "Identity for two way measurement.";
```

```
  }

  typedef percentage {
    type decimal64 {
      fraction-digits 5;
      range "0..100";
    }
    description
      "Percentage.";
  }

  grouping link-error-statistics {
    description
      "Grouping for per link error statistics";
    container loss-statistics {
      description
```



```
        "Per link loss statistics.";
       leaf direction {
        type identityref {
          base direction;
        }
        default "oneway";
        description
          "Define measurement direction including one way
           measurement and two way measurement.";
      }
      leaf packet-loss-count {
        type uint32 {
          range "0..4294967295";
        }
        default "0";
        description
          "Total received packet drops count.
           The value of count will be set to zero (0)
           on creation and will thereafter increase
           monotonically until it reaches a maximum value
           of 2^32-1 (4294967295 decimal), when it wraps
           around and starts increasing again from zero.";
      }
      leaf loss-ratio {
        type percentage;
```

```
        description
          "Loss ratio of the packets. Express as percentage
           of packets lost with respect to packets sent.";
      }
      leaf packet-reorder-count {
        type uint32 {
          range "0..4294967295";
        }
        default "0";
        description
          "Total received packet reordered count.
           The value of count will be set to zero (0)
           on creation and will thereafter increase
           monotonically until it reaches a maximum value
           of 2^32-1 (4294967295 decimal), when it wraps
           around and starts increasing again from zero.";
      }
      leaf packets-out-of-seq-count {
        type uint32 {
          range "0..4294967295";
        }
        description
          "Total received out of sequence count.
```



```
           The value of count will be set to zero (0)
           on creation and will thereafter increase
           monotonically until it reaches a maximum value
           of 2^32-1 (4294967295 decimal), when it wraps
           around and starts increasing again from zero..";
      }
      leaf packets-dup-count {
        type uint32 {
          range "0..4294967295";
        }
        description
          "Total received packet duplicates count.
           The value of count will be set to zero (0)
           on creation and will thereafter increase
           monotonically until it reaches a maximum value
           of 2^32-1 (4294967295 decimal), when it wraps
           around and starts increasing again from zero.";
      }
```

```
    }
  }

  grouping link-delay-statistics {
    description
      "Grouping for per link delay statistics";
    container delay-statistics {
      description
        "Link delay summarised information. By default,
         one way measurement protocol (e.g., OWAMP) is used
         to measure delay.";
      leaf direction {
        type identityref {
          base direction;
        }
        default "oneway";
        description
          "Define measurement direction including one way
           measurement and two way measurement.";
      }
      leaf min-delay-value {
        type uint32;
        description
          "Minimum delay value observed.";
      }
      leaf max-delay-value {
        type uint32;
        description
          "Maximum delay value observed.";
      }
```



```
      leaf average-delay-value {
        type uint32;
        description
          "Average delay value observed.";
      }
    }
  }

  grouping link-jitter-statistics {
    description
      "Grouping for per link jitter statistics";
```

```
    container jitter-statistics {
      description
        "Link jitter summarised information. By default,
         jitter is measured using IP Packet Delay Variation
         (IPDV) as defined in RFC3393.";
      leaf direction {
        type identityref {
          base direction;
        }
        default "oneway";
        description
          "Define measurement direction including one way
           measurement and two way measurement.";
      }
      leaf min-jitter-value {
        type uint32;
        description
          "Minimum jitter value observed.";
      }
      leaf max-jitter-value {
        type uint32;
        description
          "Maximum jitter value observed.";
      }
      leaf average-jitter-value {
        type uint32;
        description
          "Average jitter value observed.";
      }
    }
  }

  augment "/nw:networks/nw:network/nw:network-types" {
    description
      "Augment the network-types with service topologyies types";
    leaf svc-topo-type {
      type identityref {
```



```
        base service-type;
      }
      description
        "Identify the topology type to be composited service topology";
```

```
    }
  }
  augment "/nw:networks/nw:network" {
    description
      "Augment the network with service topology attributes";
    container svc-topo-attributes {
      leaf vpn-topology {
        type identityref {
          base l3vpn-svc:vpn-topology;
        }
        description
          "VPN service topology, e.g. hub-spoke, any-to-any, hub-spoke-disjoint
      }
      description
        "Container for vpn services";
    }
  }
  augment "/nw:networks/nw:network/nw:node" {
    description
      "Augment the network node with serice attributes";
    container node-attributes {
      leaf node-type {
        type identityref {
          base node-type;
        }
        description
          "Node type, e.g. PE, P, ASBR, etc";
      }
      leaf site-id {
        type string;
        description
          "Asscoiated vpn site";
      }
      leaf site-role {
        type identityref {
          base l3vpn-svc:site-role;
        }
        default "l3vpn-svc:any-to-any-role";
        description
          "Role of the site in the IP VPN.";
      }
      description
        "Container for service topology attributes";
    }
```

```
  }
  augment "/nw:networks/nw:network/nt:link" {
    description
      "Augment the network topology link with vpn service attributes";
    container svc-telemetry-attributes {
      config false;
      uses link-error-statistics;
      uses link-delay-statistics;
      uses link-jitter-statistics;
      description
        "Container for service telemetry attributes";
    }
  }
}
<CODE ENDS>
```

10. Security Considerations

The YANG modules defined in this document MAY be accessed via the RESTCONF protocol [RFC8040] or NETCONF protocol ([RFC6241]). The lowest RESTCONF or NETCONF layer requires that the transport-layer protocol provides both data integrity and confidentiality, see Section 2 in [RFC8040] and [RFC6241]. 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.

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:

- /ni:network-instances/ni:network-instance/svc-topo:svc-telemetry-attributes

11. 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-vpn-svc-pm

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-vpn-svc-pm
Namespace:	urn:ietf:params:xml:ns:yang:ietf-vpn-svc-pm
Prefix:	vnrsc
Reference:	RFC xxxx

---

12. Normative References

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[RFC7952] Lhotka, L., "Defining and Using Metadata with YANG", RFC 7952, DOI 10.17487/RFC7952, August 2016, <https://www.rfc-editor.org/info/rfc7952>.

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