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A YANG Model for Network and VPN Service Performance Monitoring
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Abstract

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 both Network Performance Monitoring and VPN Service Performance Monitoring that can be used to monitor and manage network performance on the topology at higher layer or the service topology between VPN sites. This model is an augmentation to the network topology YANG data model defined in [[RFC8345](#)].

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[1.](#) Introduction

[RFC8345] defines an abstract YANG data model for network/service topologies and inventories. Service topology described in [[RFC8345](#)] includes the a virtual topology for a service layer above the L1, L2,

and L3 layers. This service 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 [\[RFC8299\]](#), 3 types of VPN service topologies are defined for the L3VPN service data model: any to any; hub and spoke; and hub and spoke disjoint. These VPN topology types can be used to describe how VPN sites communicate with each other.

This document defines a YANG Model for both Network performance monitoring and VPN Service Performance Monitoring that can be used to monitor and manage network Performance on the topology at higher layer or the service topology between VPN sites and it is an augmentation to the network topology YANG data model defined in [\[RFC8345\]](#).

[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.

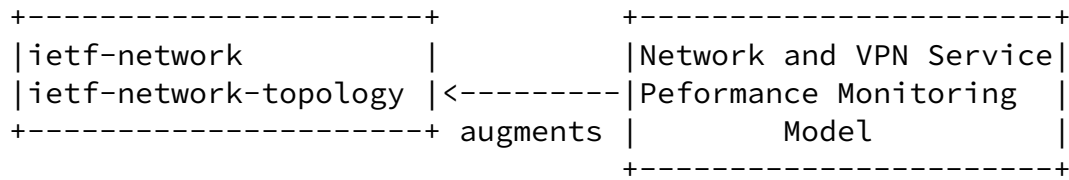
[2.1.](#) Tree Diagrams

Tree diagrams used in this document follow the notation defined in [\[RFC8340\]](#).

[3.](#) Network and VPN service assurance module

This module defined in this document is a Network and VPN Service assurance module that can be used to monitor and manage the network Performance on the topology at higher layer layer or the service topology between VPN sites and it is an augmentation to the "ietf-network" and "ietf-network-topology" YANG data model [\[RFC8345\]](#). The

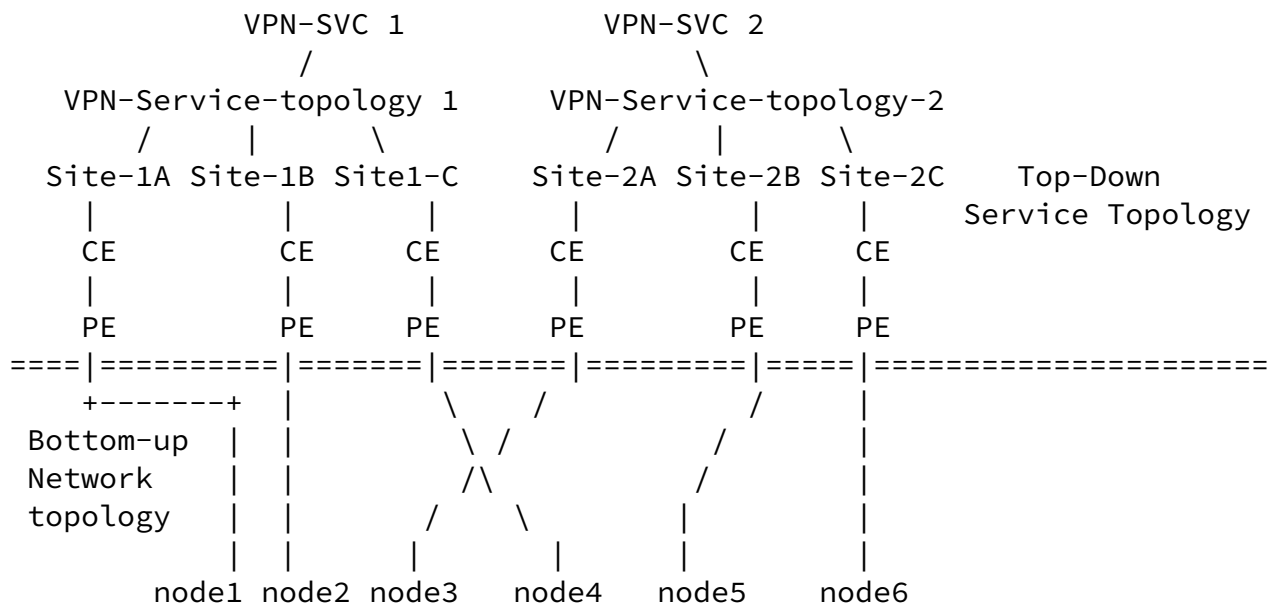
performance monitoring data is augmented to service topology.



4. Layering relationship between multiple layers of topology

The data model defined in [[RFC8345](#)] can describe vertical layering relationships between networks. That model can be augmented to cover network/service topologies.

Figure 1 describes an example on topology mapping between the VPN service topology and the underlying network:



Example of topology mapping between VPN Service Topo and Underlying network

As shown in Figure 1, Site-1A, Site-1B, and Site-1C are mapped to nodes 1, 2, and 3, while Site-2A, Site-2B, and Site-2C are mapped to nodes 4, 5, and 6 in the underlying physical network. In this figure, two VPN services topologies are 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

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

5. Model Usage Guideline

An SP must be able to manage the capabilities and characteristics of their Network/VPN services when Network connection is established or 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 4](#), 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 Network or VPN service such as end to end network performance data between source node and destination node in the network or 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 [[RFC7923](#)]

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 Network performance data or VPN service performance data they are interested in, at the data source.

The data source can then use the Network and VPN service assurance model defined in this document and push model [I-D.ietf-netconf-yang-push] to distribute 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-network-vpn-pm", which has the following structure

[6.1.](#) Network Level

```
module: ietf-network-vpn-pm
  augment /nw:networks/nw:network/nw:network-types:
    +--rw network-technology-type*  identityref
  augment /nw:networks/nw:network:
    +--rw vpn-topo-attributes
      +--rw vpn-topo?  identityref
```

Network Level View of the hierarchies

For VPN service performance monitoring, this model defines only the following minimal set of Network level network topology attributes:

- o Network-technology-type: Indicate the network technology type such

as L3VPN, L2VPN,ISIS, OSPF. If the network-technology-type is VPN type,e.g.,L3VPN, L2VPN, the VPN-topo should be set.

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

For network performance monitoring, the attributes of "Network Level" that defined in [[RFC8345](#)] do not need to be extended.

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

- o Node-type (Attribute): Indicate the type of the node, such as PE or ASBR.
- o Site-id (Constraint): Uniquely identifies the site within the overall network infrastructure.
- o 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:
  +--rw link-type?           identityref
  +--ro link-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
augment /nw:networks/nw:network/nw:node/nt:termination-point:
+--ro tp-telemetry-attributes
    +--ro in-octets?                 uint32
    +--ro inbound-unicast?           uint32
    +--ro inbound-nunicast?         uint32
    +--ro inbound-discards?         uint32
    +--ro inbound-errors?           uint32
    +--ro inunknown-protos?         uint32
    +--ro out-octets?                uint32
    +--ro outbound-unicast?          uint32
    +--ro outbound-nunicast?        uint32
    +--ro outbound-discards?        uint32
    +--ro outbound-errors?          uint32
    +--ro outbound-qlen?             uint32

```

Link and Termination point Level View of the hierarchies

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

- o Link-type (Attribute): Indicate the type of the link, such as GRE,IP in IP.
- o Loss Statistics: A set of loss statistics attributes that are used to measure end to end loss between VPN sites.

- o Delay Statistics: A set of delay statistics attributes that are

used to measure end to end latency between VPN sites.

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

The Network and VPN service performance monitoring defines the following minimal set of Termination point level network topology attributes:

- o Inbound statistics: A set of inbound statistics attributes that are used to measure the inbound statistics of the termination point, such as "the total number of octets received on the termination point", "The number of inbound packets which were chosen to be discarded", "The number of inbound packets that contained errors", etc.
- o Outbound statistics: A set of outbound statistics attributes that are used to measure the outbound statistics of the termination point, such as "the total number of octets transmitted out of the termination point", "The number of outbound packets which were chosen to be discarded", "The number of outbound packets that contained errors", etc.

7. Example of I2RS Pub/Sub Retrieval [[RFC7923](#)]

This example shows the way for a client to subscribe for the Performance monitoring information between node A and node B in the L3 network topology built on top of the underlying network . 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>l3-network</network-id>
          <network-technology-type xmlns="urn:ietf:params:xml:ns:yang:ie
L3VPN
          </network-technology-type>
          <node>
            <node-id>A</node-id>
            <node-attributes xmlns="urn:ietf:params:xml:ns:yang:ietf-net
          <node-type>pe</node-type>
          </node-attributes>
```

```
<termination-point xmlns="urn:ietf:params:xml:ns:yang:ietf-n
  <tp-id>1-0-1</tp-id>
  <tp-telemetry-attributes xmlns="urn:ietf:params:xml:ns:yang:
    <in-octets>100</in-octets>
    <out-octets>150</out-octets>
  </tp-telemetry-attributes>
</termination-point>
</node>
<node>
  <node-id>B</node-id>
  <node-attributes xmlns="urn:ietf:params:xml:ns:yang:ietf-net
    <node-type>pe</node-type>
  </node-attributes>
  <termination-point xmlns="urn:ietf:params:xml:ns:yang:ietf-n
    <tp-id>2-0-1</tp-id>
    <tp-telemetry-attributes xmlns="urn:ietf:params:xml:ns:yang:
      <in-octets>150</in-octets>
      <out-octets>100</out-octets>
    </tp-telemetry-attributes>
  </termination-point>
</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>
  <link-type>mpls-te</link-type>
  <link-telemetry-attributes
    xmlns="urn:ietf:params:xml:ns:yang:ietf-network-vpn-pm">
    <loss-statistics>
      <packet-loss-count>100</packet-loss-count>
    </loss-statistics>
  </link-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 the same 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-attributes xmlns="urn:ietf:params:xml:ns:yang:ietf-network-vpn-
            <node-type>pe</node-type>
          </node-attributes>
          <termination-point xmlns="urn:ietf:params:xml:ns:yang:ietf-network-to
            <tp-id>1-0-1</tp-id>
            <tp-telemetry-attributes xmlns="urn:ietf:params:xml:ns:yang:ietf-net
              <in-octets>100</in-octets>
              <out-octets>150</out-octets>
            </tp-telemetry-attributes>
          </termination-point>
        </node>
        <node>
          <node-id>B</node-id>
          <node-attributes xmlns="urn:ietf:params:xml:ns:yang:ietf-network-vpn-
            <node-type>pe</node-type>
          </node-attributes>
          <termination-point xmlns="urn:ietf:params:xml:ns:yang:ietf-network-to
            <tp-id>2-0-1</tp-id>
            <tp-telemetry-attributes xmlns="urn:ietf:params:xml:ns:yang:ietf-net
              <in-octets>150</in-octets>
              <out-octets>100</out-octets>
            </tp-telemetry-attributes>
          </termination-point>
        </node>
      </network>
    </networks>
  </report>
</rpc>
```

```
<link-id>A-B</link-id>
  <source>
    <source-node>A</source-node>
  </source>
  <destination>
    <dest-node>B</dest-node>
  </destination>
  <link-type>mpls-te</link-type>
  <telemetry-attributes xmlns="urn:ietf:params:xml:ns:yang:ietf-network"
```

```
    <loss-statistics>
      <packet-loss-count>120</packet-loss-count>
    </loss-statistics>
  </telemetry-attributes>
</link>
</network>
</report>
</rpc>
```

[9.](#) Network and VPN Service Assurance YANG Module

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

  import ietf-network {
    prefix nw;
  }
  import ietf-network-topology {
    prefix nt;
  }
  import ietf-l3vpn-svc {
    prefix l3vpn-svc;
  }

  organization
    "IETF BESS Working Group";
  contact
    "Zitao Wang: wangzitao@huawei.com
     Qin Wu: bill.wu@huawei.com";
```

```
description
  "This module defines a model for the VPN Service Performance monitoring.";

revision 2019-03-01 {
  description
    "Initial revision.";
  reference
    "foo";
}

identity network-type {
  description
    "Base type for Overlay network topology";
}

identity l3vpn {
```

```
  base network-type;
  description
    "Identity for layer3 vpn network type.";
}

identity l2vpn {
  base network-type;
  description
    "Identity for layer2 vpn network type.";
}

identity ospf {
  base network-type;
  description
    "Identity for OSPF network type.";
}

identity isis {
  base network-type;
  description
    "Identity for ISIS network type.";
}

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 link-type {
  description
    "Base identity for link type,e.g.,GRE, MPLS TE, VXLAN.";
}
identity gre {
  base link-type;
  description
    "Base identity for GRE Tunnel.";
}
identity VXLAN {
  base link-type;
  description
    "Base identity for VXLAN Tunnel.";
}
identity ip-in-ip {

```

```

    base link-type;
    description
        "Base identity for IP in IP Tunnel.";
}
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 is calculated on all the packets of a sample
        and is a simple computation to be performed for single marking metho
    }
  }
}

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 is calculated on all the packets of a sample
        and is a simple computation to be performed for single marking metho
    }
  }
}
```

```
}
```

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```
}
```

```
grouping tp-svc-telemetry {
```

```
  leaf in-octets {
```

```
    type uint32;
```

```
    description
```

```
      "The total number of octets received on the  
      interface, including framing characters.";
```

```
  }
```

```
  leaf inbound-unicast {
```

```
    type uint32;
```

```
    description
```

```
      "Inbound unicast packets were received, and delivered  
      to a higher layer during the last period.";
```

```
  }
```

```
  leaf inbound-nunicast {
```

```
    type uint32;
```

```
    description
```

```
      "The number of non-unicast (i.e., subnetwork-  
      broadcast or subnetwork-multicast) packets  
      delivered to a higher-layer protocol.";
```

```
  }
```

```
  leaf inbound-discards {
```

```
    type uint32;
```

```
    description
```

```
      "The number of inbound packets which were chosen  
      to be discarded even though no errors had been  
      detected to prevent their being deliverable to a  
      higher-layer protocol.";
```

```
  }
```

```
  leaf inbound-errors {
```

```
    type uint32;
```

```
    description
```

```
      "The number of inbound packets that contained  
      errors preventing them from being deliverable to a  
      higher-layer protocol.";
```

```
  }
```

```
  leaf inunknow-protos {
```

```
    type uint32;
```

```
description
  "The number of packets received via the interface
  which were discarded because of an unknown or
  unsupported protocol";
}
leaf out-octets {
  type uint32;
  description
```

```
  "The total number of octets transmitted out of the
  interface, including framing characters";
}
leaf outbound-unicast {
  type uint32;
  description
    "The total number of packets that higher-level
    protocols requested be transmitted to a
    subnetwork-unicast address, including those that
    were discarded or not sent.";
}
leaf outbound-nunicast {
  type uint32;
  description
    "The total number of packets that higher-level
    protocols requested be transmitted to a non-
    unicast (i.e., a subnetwork-broadcast or
    subnetwork-multicast) address, including those
    that were discarded or not sent.";
}
leaf outbound-discards {
  type uint32;
  description
    "The number of outbound packets which were chosen
    to be discarded even though no errors had been
    detected to prevent their being transmitted. One
    possible reason for discarding such a packet could
    be to free up buffer space.";
}
leaf outbound-errors {
  type uint32;
  description
    "The number of outbound packets that contained
```

```

        errors preventing them from being deliverable to a
        higher-layer protocol.";
    }
    leaf outbound-qlen {
        type uint32;
        description
            " Length of the queue of the interface from where
            the packet is forwarded out.  The queue depth could
            be the current number of memory buffers used by the
            queue and a packet can consume one or more memory buffers
            thus constituting device-level information.";
    }
    description
        "Grouping for interface service telemetry";
}

```

```

augment "/nw:networks/nw:network/nw:network-types" {
    description
        "Augment the network-types with service topology types";
    leaf-list network-technology-type {
        type identityref {
            base network-type;
        }
        description
            "Identify the network technology type,e.g.,L3VPN,L2VPN, ISIS, OSPF.";
    }
}
augment "/nw:networks/nw:network" {
    description
        "Augment the network with service topology attributes";
    container overlay-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 overlay topology 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 VPN.";
  }
  description
    "Container for overlay topology attributes";
}
}
augment "/nw:networks/nw:network/nt:link" {
  description
    "Augment the network topology link with overlay topology attributes";
  leaf link-type {
    type identityref {
      base link-type;
    }
    description
      "Link type, e.g. GRE,VXLAN,IP in IP, etc";
  }
  container link-telemetry-attributes {
    config false;
    uses link-error-statistics;

```

```

    uses link-delay-statistics;
    uses link-jitter-statistics;
    description
      "Container for service telemetry attributes";
  }
}
augment "/nw:networks/nw:network/nw:node/nt:termination-point" {
  description
    "Augment the network topology termination point with vpn service attributes";
  container tp-telemetry-attributes {
    config false;
    uses tp-svc-telemetry;
    description
      "Container for termination point 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:

- o /nw:networks/nw:network/svc-topo:svc-telemetry-attributes
- o /nw:networks/nw:network/nw:node/svc-topo:node-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-network-vpn-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-network-vpn-pm
Namespace: urn:ietf:params:xml:ns:yang:ietf-network-vpn-pm
Prefix: nvp
Reference: RFC xxxx

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