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D. Shytyi
L. Beylier
SFR
L. Iannone
Telecom ParisTech

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# A YANG Module for uCPE management. draft-shytyi-opsawg-vysm-03

## Abstract

This document provides a YANG data model for uCPE management (VYSM) and definition of the uCPE equipment. The YANG Service Model serves as a base framework for managing an universal Customer-Premises Equipment (uCPE) subsystem. The model can be used by a Network Service Orchestrator.

## Status of This Memo

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## 1. Introduction

Network Function Virtualization is a technology that allows to virtualize the network services running on dedicaded hardware. This technology became a base for universal Customer-Premises Equipment (uCPE). This document defines the uCPE as harware with x86 capabilities that has a hypervisor. In other words, uCPE is a host that may run multiple Virtual Machines with guest OSs, where each Guest OS may represent a Physical Network Function. This document presents the YANG Service Model (VYSM) to manage from an Orchestrator the infrastructure inside the uCPE.

## 2. Terminology

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 RFC 2119 [RFC2119].

Link - is an entity that enables link layer communication of nodes.

Port - node connector to the link.

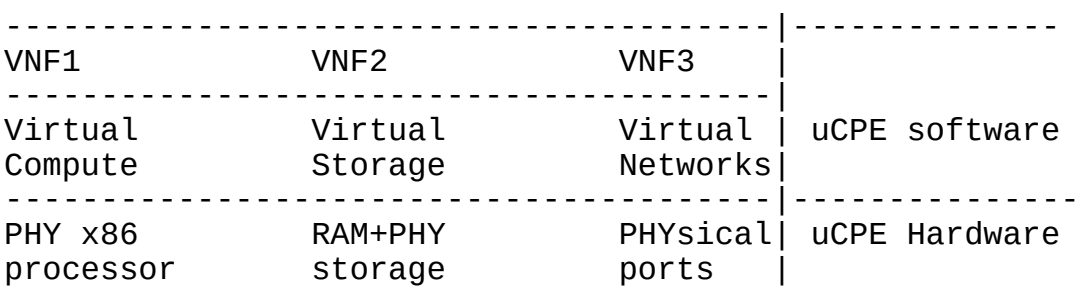
NE - Network Element.

NSYM - Network Service Yang Module.

VYSM - VNF YANG Service Model.

## 3. Universal CPE

Firstly, this document defines the platform that is controlled with VYSM - universal CPE (uCPE). The uCPE as harware with x86 capabilities that is generally running Linux distibution with additinal virtualisation layer. Virtualization layer provides virtual compute, virtual storage and virtual network resources. Each VNF runnning in the uCPE requires the amount of virtual resources (for example: 4 vCPUs, 4GB RAM, 40GB storege, 4 vPorts). VNFs MAY be interconnected between each other and physical ports via Virtual Networks. Topology construction and VM lifecycle management is allowed via high level interface (Configuration can be done in the same transaction). The figure below presents the uCPE architecture.

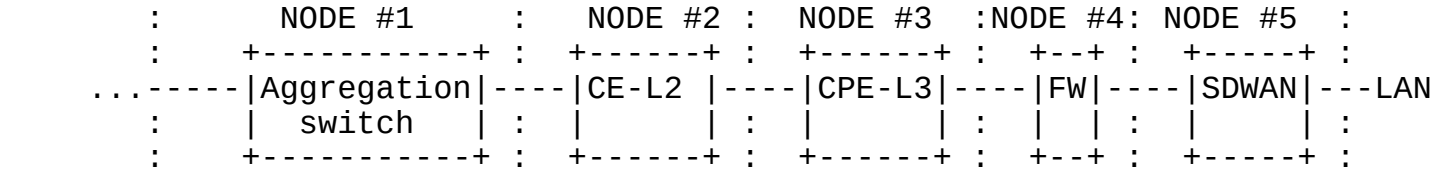


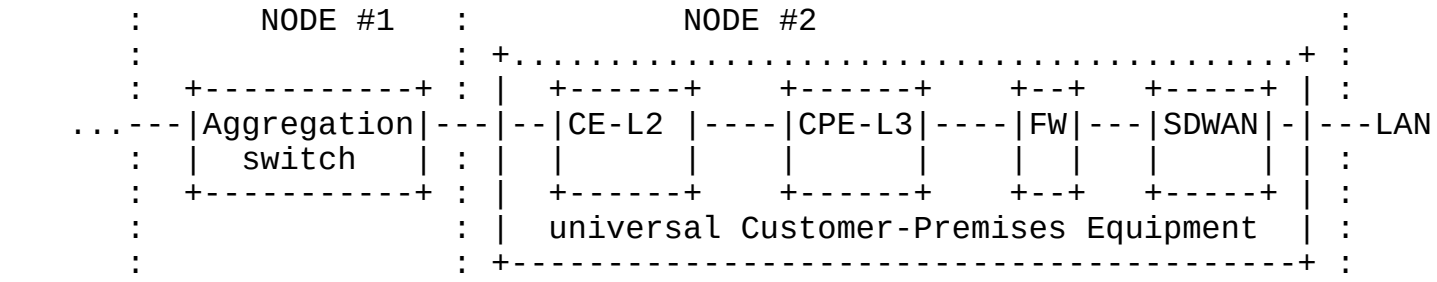

The next elements can be managed in the uCPE:

- Virtual Network Funcitons:
  - Number of assigned vCPUs.
  - Size of allocated RAM.
  - VNF day0 config (bootstrap).
  - vLinks that are attached to the VNF.
- Virtual Switches:
  - vLinks that are attached to the vSW.
- Virtual Links(vLinks).
- Physical Ports of the uCPE.

### 3.1. uCPE purpose

- uCPE replaces multiple types of equipment (Node#1 - Node#5) with 1 unit by virtualizing them as Virtual Network Functions on the top of NFVIs:




- uCPE falicitates the interconnection between the Network Funtions (NF) as interconnection between NF is performed via virtual links(that is part of the uCPE management). That meens that no need to hire technichian to cable the equipment, it could be done via orchestrator.

- uCPE falicitates the 0day configuration of the VNFs as its 0day configuration can be putted remotely.

### 3.2. uCPE VNF ecosystem example

uCPE supports a Virtual Network Funcitons of different type:

- SD-WAN

- vRouter(vCPE)

- vFirewall

- vLB(vLoad Balancer)

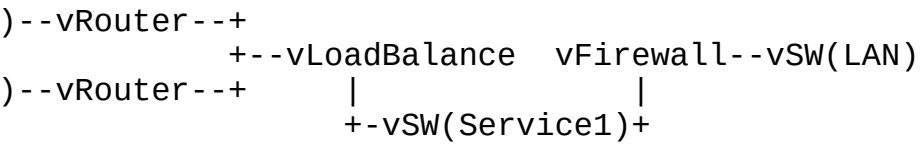
- vCGNAT(vCarrier Grade NAT)

- virtual WAN Optimistaion
- vWireless LAN controller
- Other...

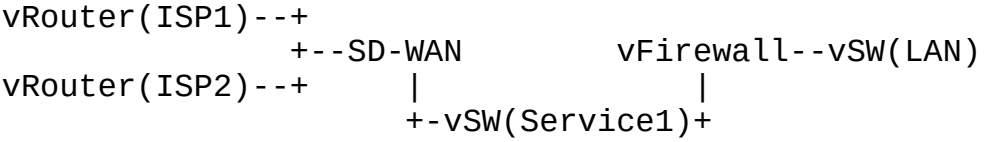
### 3.3. Internal uCPE service example

The VNF in the uCPE could be a vRouter or vFirewall or an SD-WAN that is not a default part of virtual network resources of the uCPE. Multiple VNFs MAY be instantiated in the uCPE. With support of links and swithes, VNFs MAY participate a service chains. Example of service chains (Note that virtual switch "vs(WAN)" connected to LAN ports and vSW(WAN) is connected to WAN ports):

- vSW(WAN)-l1-vRouter(vCPE)-l2-vSW(LAN).
- vSW(WAN)-l1-vRouter(vCPE)-l2-vSW(Service)-l3-vFirewall-l4-vSW(LAN).
- vSW(WAN)-l1-vRouter(vCPE)-l2-vSW(Service1)-l3-vFirewall-l4-vSW(Service2)-l5-SD-WAN-l6-vSW(LAN).
- vSW(WAN)-l1-SDWAN-l2-vSW(Service)-l3-vFirewall-l4-vSW(LAN).
- 




- 

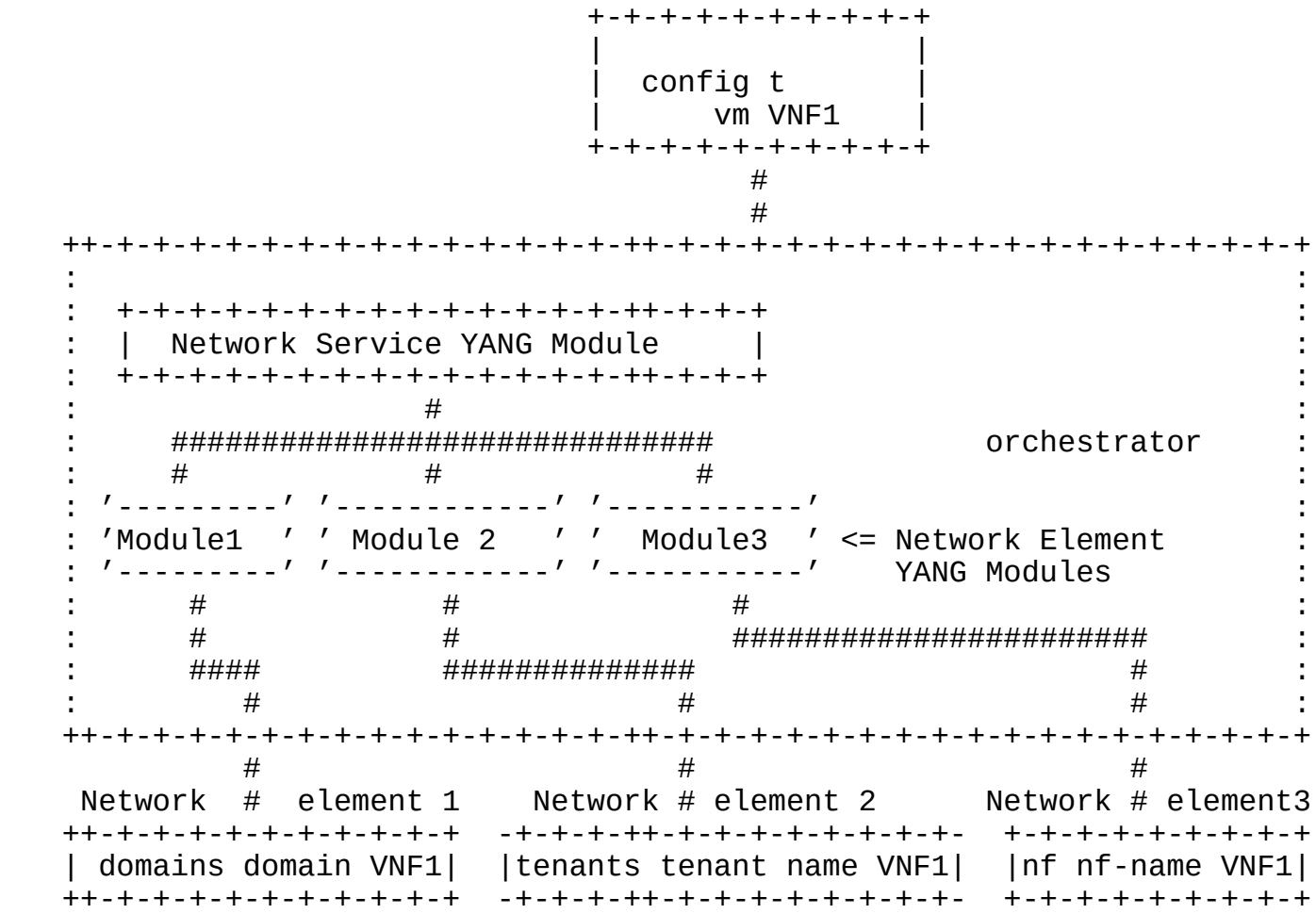



## 4. YANG Service Model for uCPE management

Secondly, this document defines and classifies the VYSM as Network Service YANG Module(NSYM) layer component RFC 8199 [RFC8199]. Thus it inherits the characteristics of the NSYM Layer. VYSM is a modeled

representation of the specific service requirements. It provides abstraction of services configuration and operations that MAY be implemented in Network Elemets (NEs). Thus VYSM does not describe all configuration to be performed on the devices, but provides the configuration that is required for the "Network Service to Network Element(s)" decomposition process RFC 8199 [RFC8199]. Example of the decomposition is presented in the figure below.

The Network Service YANG module exposes the configuration commands via the Northbound interfaces of the orchestrator. Therefore the set of the commands modeled in the VYSM can be inputed via Notrhbound interfaces(for example CLI). In the example the command "vm VNF1" is passed via Northbound interface to the orchestrator. It defines the virtual machine name. Further the same configuration MAY be transormed to the one or multiple Network Element payloads (for example xml for NETCONF) that carry an equivalent of commands such as "nf nf-name VNF1"




## 5. uCPE YANG Service Model tree diagram overview

This section provides an overview of the Service YANG Model (VSYM) that MAY be made with "pyang" utility. The figure below presents the tree diagram of VYSM.

```
module: ietf-ucpe
+--rw ietf-ucpe:ucpe* [name]
   +--rw ietf-ucpe:name                  -> /ncs:devices/device/name
   +--rw ietf-ucpe:device*               -> ../name
   +--rw ietf-ucpe:links* [link]
   |  +--rw ietf-ucpe:link    tring
   +--rw ietf-ucpe:switches* [switch]
   |  +--rw ietf-ucpe:switch    string
   |  +--rw ietf-ucpe:ports* [port]
   |     +--rw ietf-ucpe:port    uint64
```

```
|     +--rw ietf-ucpe:name?   string
|     +--rw ietf-ucpe:link?   -> ../../../links/link
+--rw ietf-ucpe:vms* [vm]
|  +--rw ietf-ucpe:vm             string
|  +--rw ietf-ucpe:ports* [port]
|  |  +--rw ietf-ucpe:port    string
|  |  +--rw ietf-ucpe:name?   string
|  |  +--rw ietf-ucpe:link?   -> ../../../links/link
|  +--rw ietf-ucpe:ram?           string
|  +--rw ietf-ucpe:cpu?           string
|  +--rw ietf-ucpe:storages* [id]
|  |  +--rw ietf-ucpe:id          string
|  |  +--rw ietf-ucpe:location?   string
|  +--rw ietf-ucpe:day0-config
|     +--rw ietf-ucpe:location?        string
|     +--rw ietf-ucpe:day0-var-path?   string
|     +--rw ietf-ucpe:variable* [name]
|        +--rw ietf-ucpe:name     string
|        +--rw ietf-ucpe:value?   string
+--rw ucpe-if:interfaces
|  +--rw ucpe-if:interface* [name]
|     +--rw ucpe-if:name                           string
|     +--rw ucpe-if:description?                   string
|     +--rw ucpe-if:type                           identityref
|     +--rw ucpe-if:enabled?                       boolean
|     +--rw ucpe-if:link-up-down-trap-enable?      enumeration {if-mib}?
|     +--ro ucpe-if:admin-status                   enumeration {if-mib}?
|     +--ro ucpe-if:oper-status                    enumeration
|     +--ro ucpe-if:last-change?                   yang:date-and-time
|     +--ro ucpe-if:if-index                       int32 {if-mib}?
|     +--ro ucpe-if:phys-address?                  yang:phys-address
|     +--ro ucpe-if:higher-layer-if*               interface-ref
|     +--ro ucpe-if:lower-layer-if*                interface-ref
|     +--ro ucpe-if:speed?                         yang:gauge64
|     +--ro ucpe-if:statistics
|     |  +--ro ucpe-if:discontinuity-time    yang:date-and-time
|     |  +--ro ucpe-if:in-octets?            yang:counter64
|     |  +--ro ucpe-if:in-unicast-pkts?      yang:counter64
|     |  +--ro ucpe-if:in-broadcast-pkts?    yang:counter64
|     |  +--ro ucpe-if:in-multicast-pkts?    yang:counter64
|     |  +--ro ucpe-if:in-discards?          yang:counter32
|     |  +--ro ucpe-if:in-errors?            yang:counter32
|     |  +--ro ucpe-if:in-unknown-protos?    yang:counter32
|     |  +--ro ucpe-if:out-octets?           yang:counter64
|     |  +--ro ucpe-if:out-unicast-pkts?     yang:counter64
|     |  +--ro ucpe-if:out-broadcast-pkts?   yang:counter64
|     |  +--ro ucpe-if:out-multicast-pkts?   yang:counter64
|     |  +--ro ucpe-if:out-discards?         yang:counter32
```

```
   |     |  +--ro ucpe-if:out-errors?           yang:counter32
   |     +--rw ucpe-interface:ports* [port]
   |        +--rw ucpe-interface:port    string
   |        +--rw ucpe-interface:link?-> ../../../../ietf-nfv:links/link
   x--ro ucpe-if:interfaces-state
      x--ro ucpe-if:interface* [name]
         x--ro ucpe-if:name             string
         x--ro ucpe-if:type             identityref
         x--ro ucpe-if:admin-status     enumeration {if-mib}?
         x--ro ucpe-if:oper-status      enumeration
         x--ro ucpe-if:last-change?     yang:date-and-time
         x--ro ucpe-if:if-index         int32 {if-mib}?
         x--ro ucpe-if:phys-address?    yang:phys-address
         x--ro ucpe-if:speed?           yang:gauge64
         x--ro ucpe-if:statistics
            x--ro ucpe-if:discontinuity-time    yang:date-and-time
            x--ro ucpe-if:in-octets?            yang:counter64
            x--ro ucpe-if:in-unicast-pkts?      yang:counter64
            x--ro ucpe-if:in-broadcast-pkts?    yang:counter64
            x--ro ucpe-if:in-multicast-pkts?    yang:counter64
            x--ro ucpe-if:in-discards?          yang:counter32
            x--ro ucpe-if:in-errors?            yang:counter32
            x--ro ucpe-if:in-unknown-protos?    yang:counter32
            x--ro ucpe-if:out-octets?           yang:counter64
            x--ro ucpe-if:out-unicast-pkts?     yang:counter64
            x--ro ucpe-if:out-broadcast-pkts?   yang:counter64
            x--ro ucpe-if:out-multicast-pkts?   yang:counter64
            x--ro ucpe-if:out-discards?         yang:counter32
            x--ro ucpe-if:out-errors?           yang:counter32
```

## 6. Specification of the VNF YANG Service Model

This section presents the specification of the VYSM.

```
      <CODE BEGINS> file "ietf-ucpe@2019-09-16.yang"
      module ietf-vysm-service {
        namespace "urn:ietf:params:xml:ns:yang:nfv-service";
        prefix ietf-ucpe;

        import tailf-ncs {
          prefix ncs;
        }

        organization "SFR";
        contact
          "Dmytro Shytyi
```

```
           EMail:ietf.dmytro@shytyi.net";
         description
           "This is a Network Function Virtualization (NFV) YANG
            service model.";

         revision 2019-09-16 {
           description
             "Added 0day config for VNFs.
              Yang model modified according
              to the received comments.";
           reference "draft-shytyi-opsawg-vysm-00";
         }
         revision 2018-01-07 {
           description
             "Initial revision.";
           reference "draft-shytyi-netmod-vysm-01";
         }

           list ucpe {
             key "name";
             leaf name {
               type leafref {
                 path "/ncs:devices/ncs:device/ncs:name";
               }
               description
                 "Name of the instance of the service";
             }
             leaf-list device {
               type leafref {
                 path "../name";
               }
               description
                 "List of the devices in available in the
                  orchestrator";
             }
             // replace with your own stuff here
             list links {
               key "link";
               leaf link {
                 type string {
                   pattern "[a-zA-Z0-9]*";
                 }
                 description
                   "Name of the virtual link from the pool of
                    the links";
               }
               description
                 "Pool of the virtual links that connect
```

```
          VMs and Interfaces";
      }
      list switches {
        key "switch";
        leaf switch {
          type string;
          description

        list ports {
          key "port";
          leaf port {
            type uint64 {
              range "10..15";
            }
            description
              "Name of the connector";
          }
          leaf name {
            type string;
            description
              "Name of the subconnector";
          }
          leaf link {
            type leafref {
              path "../../../links/link";
            }
            description
              "Link that is connected to the switch
               via port";
          }
          description
            "Set of the connectors the forwarding
             domain has";
        }
        description
          "Set of the forwarding domains";
      }
      list vms {
        key "vm";
        leaf vm {
          type string {
            pattern "[a-zA-Z]*";
          }
          description
            "Name of the Virtual Machine";
        }
        list ports {
          key "port";
```

```
                leaf port {
                  type string;
                  description
                    "Name of the connector";
                }
                leaf name {
                  type string;
                  description
                    "Name of the subconnector";
                }
                leaf link {
                  type leafref {
                    path "../../../links/link";
                  }
                  description
                    "Link that connects the VM with a
                     switch or Interface via connector";
                }
                description
                  "Set of Virtual Machine connectors";
              }
              leaf ram {
                type uint64;
                description
                  "Size of RAM to allocate for the
                   Guest OS";
              }
              leaf cpu {
                type uint64;
                description
                  "Number of vCPUs to allocate for the
                   Guest OS";
              }
              list storages {
                key "id";
                leaf id {
                  type string;
                  description
                    "Name of the Storage";
                }
                leaf location {
                  type string;
                  description
                    "External location where the image is
                     saved.";
                }
                description
                  "Virtual storge of the image for the
```

```
                    Virtual Machine";
                }
                container day0-config {
                  leaf location {
                    type string;
                    description
                      "0day configuration location";
                  }
                  leaf day0-var-path {
                    type string;
                    description
                      "path of the file that contains the
                       0day variables";
                  }
                  list variable {
                    key "name";
                    leaf name {
                      type string;
                      description
                        "variable name";
                    }
                    leaf value {
                      type string;
                      description
                        "variable value";
                    }
                  }
                  description
                    "0day configuration:init config";
                }
                description
                  "Set of the Virtual Machines configured on
                   the universal Customer-Premises Equipment";
              }
              description
                "This is an CFS virtualization service";
            }
          }
```

<CODE ENDS>

```
module ietf-vysm-interfaces {
 namespace "urn:ietf:params:xml:ns:yang:ucpe-interface";
 prefix ucpe-interface;

 import tailf-ncs {
```

```
        prefix ncs;
      }
      }
      import ietf-vysm-service {
        prefix ietf-nfv;
      }
      import ietf-interfaces {
        prefix ietf-if;
      }

      organization "SFR";
      contact
        "Dmytro Shytyi
         EMail:ietf.dmytro@shytyi.net";
      description
        "This is a Network Function Virtualization (NFV) YANG
         model for interfaces.";

      revision 2019-10-03 {
        description
          "Initial revision.";
        reference "draft-shytyi-opsawg-vysm-01";
      }

      augment "/ietf-nfv:ucpe/ietf-if:interfaces/ietf-if:interface" {
        list ports {
          key "port";
          leaf port {
            type string;
            description
              "Name of the connector";
          }
          leaf link {
            type leafref {
              path "../../../../ietf-nfv:links/ietf-nfv:link";
            }
            description
              "Link that is connected to the port
               via connector";
          }
          description
            "Set of the connectors the physical
             interface has";
        }
      }
    }
```

<CODE ENDS>

```
  module ietf-interfaces {
   yang-version 1.1;
   namespace "urn:ietf:params:xml:ns:yang:ietf-ucpe-interfaces";
   prefix ucpe-if;

   import ietf-yang-types {
     prefix yang;
   }
   import ietf-vysm-service {
     prefix ietf-vysm;
   }

   organization "IETF NETMOD (Network Modeling) Working Group";
   contact
     "WG Web:   <https://datatracker.ietf.org/wg/netmod/>
      WG List:  <mailto:netmod@ietf.org>

      Editor:   Martin Bjorklund
                <mailto:mbj@tail-f.com>";
   description
     "This module contains a collection of YANG definitions for
      managing network interfaces.

      Copyright (c) 2018 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
      (https://trustee.ietf.org/license-info).

      This version of this YANG module is part of RFC 8343; see
      the RFC itself for full legal notices.";

   revision 2018-02-20 {
     description
       "Updated to support NMDA.";
     reference "RFC 8343: A YANG Data Model for Interface Management";
   }
   revision 2014-05-08 {
     description
       "Initial revision.";
     reference "RFC 7223: A YANG Data Model for Interface Management";
   }

   /*
```

```
    * Typedefs
    */

   typedef interface-ref {
     type leafref {
     path "/ietf-vysm:ucpe/"+
         "ucpe-if:interfaces/ucpe-if:interface/ucpe-if:name";
     }
     description
       "This type is used by data models that need to reference
        interfaces.";
   }

   /*
    * Identities
    */

   identity interface-type {
     description
       "Base identity from which specific interface types are
        derived.";
   }

   /*
    * Features
    */

   feature arbitrary-names {
     description
       "This feature indicates that the device allows user-controlled
        interfaces to be named arbitrarily.";
   }

   feature pre-provisioning {
     description
       "This feature indicates that the device supports
        pre-provisioning of interface configuration, i.e., it is
        possible to configure an interface whose physical interface
        hardware is not present on the device.";
   }

   feature if-mib {
     description
       "This feature indicates that the device implements
        the IF-MIB.";
     reference "RFC 2863: The Interfaces Group MIB";
   }
```

```
   /*
    * Data nodes
    */

   augment "/ietf-vysm:ucpe" {
     container interfaces {
       description
         "Interface parameters.";
       list interface {
         key "name";
         description
           "The list of interfaces on the device.

            The status of an interface is available in this list in the
            operational state.  If the configuration of a
            system-controlled interface cannot be used by the system
            (e.g., the interface hardware present does not match the
            interface type), then the configuration is not applied to
            the system-controlled interface shown in the operational
            state.  If the configuration of a user-controlled interface
            cannot be used by the system, the configured interface is
            not instantiated in the operational state.

            System-controlled interfaces created by the system are
            always present in this list in the operational state,
            whether or not they are configured.";
         leaf name {
           type string;
           description
             "The name of the interface.

              A device MAY restrict the allowed values for this leaf,
              possibly depending on the type of the interface.
              For system-controlled interfaces, this leaf is the
              device-specific name of the interface.

              If a client tries to create configuration for a
              system-controlled interface that is not present in the
              operational state, the server MAY reject the request if
              the implementation does not support pre-provisioning of
              interfaces or if the name refers to an interface that can
              never exist in the system.  A Network Configuration
              Protocol (NETCONF) server MUST reply with an rpc-error
              with the error-tag 'invalid-value' in this case.

              If the device supports pre-provisioning of interface
              configuration, the 'pre-provisioning' feature is
              advertised.
```

```
            If the device allows arbitrarily named user-controlled
            interfaces, the 'arbitrary-names' feature is advertised.



            When a configured user-controlled interface is created by
            the system, it is instantiated with the same name in the
            operational state.

            A server implementation MAY map this leaf to the ifName
            MIB object.  Such an implementation needs to use some
            mechanism to handle the differences in size and
            characters
            allowed between this leaf and ifName.  The definition of
            such a mechanism is outside the scope of this document.";
          reference "RFC 2863: The Interfaces Group MIB - ifName";
        }
        leaf description {
          type string;
          description
            "A textual description of the interface.

            A server implementation MAY map this leaf to the ifAlias
            MIB object.  Such an implementation needs to use some
            mechanism to handle the differences in size and
            characters
            allowed between this leaf and ifAlias.  The definition of
            such a mechanism is outside the scope of this document.

            Since ifAlias is defined to be stored in non-volatile
            storage, the MIB implementation MUST map ifAlias to the
            value of 'description' in the persistently stored
            configuration.";
          reference "RFC 2863: The Interfaces Group MIB - ifAlias";
        }
        leaf type {
          type identityref {
            base interface-type;
          }
          mandatory true;
          description
            "The type of the interface.

            When an interface entry is created, a server MAY
            initialize the type leaf with a valid value, e.g., if it
            is possible to derive the type from the name of the
            interface.
```

```
            If a client tries to set the type of an interface to a
            value that can never be used by the system, e.g., if the
            type is not supported or if the type does not match the
            name of the interface, the server MUST reject the request.
            A NETCONF server MUST reply with an rpc-error with the
            error-tag 'invalid-value' in this case.";
          reference "RFC 2863: The Interfaces Group MIB - ifType";
        }
        leaf enabled {
          type boolean;
          default "true";
          description
            "This leaf contains the configured, desired state of the
             interface.

             Systems that implement the IF-MIB use the value of this
             leaf in the intended configuration to set
             IF-MIB.ifAdminStatus to 'up' or 'down' after an ifEntry
             has been initialized, as described in RFC 2863.

             Changes in this leaf in the intended configuration are
             reflected in ifAdminStatus.";
        reference "RFC 2863: The Interfaces Group MIB - ifAdminStatus";
        }
        leaf link-up-down-trap-enable {
          if-feature if-mib;
          type enumeration {
            enum "enabled" {
              value 1;
              description
                "The device will generate linkUp/linkDown SNMP
                 notifications for this interface.";
            }
            enum "disabled" {
              value 2;
              description
                "The device will not generate linkUp/linkDown SNMP
                 notifications for this interface.";
            }
          }
          description
            "Controls whether linkUp/linkDown SNMP notifications
             should be generated for this interface.



             If this node is not configured, the value 'enabled' is
```

```
           operationally used by the server for interfaces that do
           not operate on top of any other interface (i.e., there
           are
           no 'lower-layer-if' entries), and 'disabled' otherwise.";
        reference
          "RFC 2863: The Interfaces Group MIB -
                     ifLinkUpDownTrapEnable";
      }
      leaf admin-status {
        if-feature if-mib;
        type enumeration {
          enum "up" {
            value 1;
            description
              "Ready to pass packets.";
          }
          enum "down" {
            value 2;
            description
              "Not ready to pass packets and not in some test mode.";
          }
          enum "testing" {
            value 3;
            description
              "In some test mode.";
          }
        }
        config false;
        mandatory true;
        description
          "The desired state of the interface.

           This leaf has the same read semantics as ifAdminStatus.";
      reference "RFC 2863: The Interfaces Group MIB ifAdminStatus";
      }
      leaf oper-status {
        type enumeration {
          enum "up" {
            value 1;
            description
              "Ready to pass packets.";
          }
          enum "down" {
            value 2;
            description
              "The interface does not pass any packets.";
          }
          enum "testing" {
```

```
            value 3;
            description
              "In some test mode.  No operational packets can
               be passed.";
          }
          enum "unknown" {
            value 4;
            description
              "Status cannot be determined for some reason.";
          }
          enum "dormant" {
            value 5;
            description
              "Waiting for some external event.";
          }
          enum "not-present" {
            value 6;
            description
              "Some component (typically hardware) is missing.";
          }
          enum "lower-layer-down" {
            value 7;
            description
              "Down due to state of lower-layer interface(s).";
          }
        }
        config false;
        mandatory true;
        description
          "The current operational state of the interface.

           This leaf has the same semantics as ifOperStatus.";
      reference "RFC 2863: The Interfaces Group MIB - ifOperStatus";
      }
      leaf last-change {
        type yang:date-and-time;
        config false;
        description
          "The time the interface entered its current operational
           state.  If the current state was entered prior to the
           last re-initialization of the local network management
           subsystem, then this node is not present.";
      reference "RFC 2863: The Interfaces Group MIB - ifLastChange";
      }
      leaf if-index {
        if-feature if-mib;
        type int32 {
          range "1..2147483647";
```

```
        }
        config false;
        mandatory true;
        description
          "The ifIndex value for the ifEntry represented by this
           interface.";
        reference "RFC 2863: The Interfaces Group MIB - ifIndex";
      }
      leaf phys-address {
        type yang:phys-address;
        config false;
        description
          "The interface's address at its protocol sub-layer.  For
           example, for an 802.x interface, this object normally
           contains a Media Access Control (MAC) address.  The
           interface's media-specific modules must define the bit
           and byte ordering and the format of the value of this
           object.  For interfaces that do not have such an address
           (e.g., a serial line), this node is not present.";
      reference "RFC 2863: The Interfaces Group MIB ifPhysAddress";
      }
      leaf-list higher-layer-if {
        type interface-ref;
        config false;
        description
          "A list of references to interfaces layered on top of this
           interface.";
        reference "RFC 2863: The Interfaces Group MIB
                                                - ifStackTable";
      }
      leaf-list lower-layer-if {
        type interface-ref;
        config false;
        description
        "A list of references to interfaces layered
        underneath this interface.";
      reference "RFC 2863: The Interfaces Group MIB - ifStackTable";
      }
      leaf speed {
        type yang:gauge64;
        units "bits/second";
        config false;
        description
          "An estimate of the interface's current bandwidth in bits
           per second.  For interfaces that do not vary in
           bandwidth or for those where no accurate estimation can
           be made, this node should contain the nominal bandwidth.
           For interfaces that have no concept of bandwidth, this
```

```
            node is not present.";
          reference
            "RFC 2863: The Interfaces Group MIB -
                       ifSpeed, ifHighSpeed";
        }
        container statistics {
          config false;
          description
            "A collection of interface-related statistics objects.";
          leaf discontinuity-time {
            type yang:date-and-time;
            mandatory true;
            description
            "The time on the most recent occasion at which any one
            or more of this interface's counters suffered a
            discontinuity.  If no such discontinuities have occurred
            since the last re-initialization of the local management
            subsystem, then this node contains the time the local
            management subsystem re-initialized itself.";
          }
          leaf in-octets {
            type yang:counter64;
            description
              "The total number of octets received on the interface,
               including framing characters.

               Discontinuities in the value of this counter can occur
               at re-initialization of the management system and at
               other times as indicated by the value of
               'discontinuity-time'.";
         reference "RFC 2863: The Interfaces Group MIB ifHCInOctets";
          }
          leaf in-unicast-pkts {
            type yang:counter64;
            description
              "The number of packets, delivered by this sub-layer to a
               higher (sub-)layer, that were not addressed to a
               multicast or broadcast address at this sub-layer.

               Discontinuities in the value of this counter can occur
               at re-initialization of the management system and at
               other times as indicated by the value of
               'discontinuity-time'.";
            reference "RFC 2863: The Interfaces Group MIB -
                          ifHCInUcastPkts";
          }
          leaf in-broadcast-pkts {
            type yang:counter64;
```

```
            description
              "The number of packets, delivered by this sub-layer to a
               higher (sub-)layer, that were addressed to a broadcast
               address at this sub-layer.

               Discontinuities in the value of this counter can occur
               at re-initialization of the management system and at
               other times as indicated by the value of
               'discontinuity-time'.";
            reference
              "RFC 2863: The Interfaces Group MIB -
                         ifHCInBroadcastPkts";
          }
          leaf in-multicast-pkts {
            type yang:counter64;
            description
              "The number of packets, delivered by this sub-layer to a
               higher (sub-)layer, that were addressed to a multicast
               address at this sub-layer.  For a MAC-layer protocol,
               this includes both Group and Functional addresses.


               Discontinuities in the value of this counter can occur
               at re-initialization of the management system and at
               other times as indicated by the value of
               'discontinuity-time'.";
            reference
              "RFC 2863: The Interfaces Group MIB -
                         ifHCInMulticastPkts";
          }
          leaf in-discards {
            type yang:counter32;
            description
              "The number of inbound packets that were chosen to be
               discarded even though no errors had been detected to
               prevent their being deliverable to a higher-layer
               protocol.  One possible reason for discarding such a
               packet could be to free up buffer space.

               Discontinuities in the value of this counter can occur
               at re-initialization of the management system and at
               other times as indicated by the value of
               'discontinuity-time'.";
               reference "RFC 2863: The Interfaces Group MIB -
                                    ifInDiscards";
          }
          leaf in-errors {
            type yang:counter32;
```

```
            description
              "For packet-oriented interfaces, the number of inbound
              packets that contained errors preventing them from being
              deliverable to a higher-layer protocol.  For character-
              oriented or fixed-length interfaces, the number of
              inbound transmission units that contained errors
              preventing them from being deliverable to a higher-layer
              protocol.

              Discontinuities in the value of this counter can occur
              at re-initialization of the management system and at
              other times as indicated by the value of
              'discontinuity-time'.";
              reference "RFC 2863: The Interfaces Group MIB -
                                   ifInErrors";
          }
          leaf in-unknown-protos {
            type yang:counter32;
            description
              "For packet-oriented interfaces, the number of packets
              received via the interface that were discarded because
              of an unknown or unsupported protocol.  For
              character-oriented or fixed-length interfaces that
              support protocol multiplexing, the number of
              transmission units received via the interface that were
              discarded because of an unknown or unsupported protocol.
              For any interface that does not support protocol
              multiplexing, this counter is not present.

              Discontinuities in the value of this counter can occur
              at re-initialization of the management system and at
              other times as indicated by the value of
              'discontinuity-time'.";
              reference "RFC 2863: The Interfaces Group MIB -
                                   ifInUnknownProtos";
          }
          leaf out-octets {
            type yang:counter64;
            description
              "The total number of octets transmitted out of the
               interface, including framing characters.

               Discontinuities in the value of this counter can occur
               at re-initialization of the management system and at
               other times as indicated by the value of
               'discontinuity-time'.";
               reference "RFC 2863: The Interfaces Group MIB -
                                    ifHCOutOctets";
```

```
        }
        leaf out-unicast-pkts {
          type yang:counter64;
          description
            "The total number of packets that higher-level protocols
             requested be transmitted and that were not addressed
             to a multicast or broadcast address at this sub-layer,
             including those that were discarded or not sent.

             Discontinuities in the value of this counter can occur
             at re-initialization of the management system and at
             other times as indicated by the value of
             'discontinuity-time'.";
             reference "RFC 2863: The Interfaces Group MIB -
                                  ifHCOutUcastPkts";
        }
        leaf out-broadcast-pkts {
          type yang:counter64;
          description
            "The total number of packets that higher-level protocols
             requested be transmitted and that were addressed to a
             broadcast address at this sub-layer, including those
             that were discarded or not sent.

             Discontinuities in the value of this counter can occur
             at re-initialization of the management system and at
             other times as indicated by the value of
             'discontinuity-time'.";
          reference
            "RFC 2863: The Interfaces Group MIB -
                       ifHCOutBroadcastPkts";
        }
        leaf out-multicast-pkts {
          type yang:counter64;
          description
            "The total number of packets that higher-level protocols
             requested be transmitted and that were addressed to a
             multicast address at this sub-layer, including those
             that were discarded or not sent.  For a MAC-layer
             protocol, this includes both Group and Functional
             addresses.

             Discontinuities in the value of this counter can occur
             at re-initialization of the management system and at
             other times as indicated by the value of
             'discontinuity-time'.";
          reference
            "RFC 2863: The Interfaces Group MIB -
```

```
                        ifHCOutMulticastPkts";
          }
          leaf out-discards {
            type yang:counter32;
            description
              "The number of outbound packets that 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.


               Discontinuities in the value of this counter can occur
               at re-initialization of the management system and at
               other times as indicated by the value of
               'discontinuity-time'.";
               reference "RFC 2863: The Interfaces Group MIB -
                                    ifOutDiscards";
          }
          leaf out-errors {
            type yang:counter32;
            description
              "For packet-oriented interfaces, the number of outbound
               packets that could not be transmitted because of errors.
               For character-oriented or fixed-length interfaces, the
               number of outbound transmission units that could not be
               transmitted because of errors.

               Discontinuities in the value of this counter can occur
               at re-initialization of the management system and at
               other times as indicated by the value of
               'discontinuity-time'.";
               reference "RFC 2863: The Interfaces Group MIB -
                                               ifOutErrors";
          }
        }
      }
    }
    /*
     * Legacy typedefs
     */
    //  typedef interface-state-ref {
    //    type leafref {
    //      path "/ietf-vysm:ucpe"+
    //     "ucpe-if:interfaces-state/ucpe-if:interface/ucpe-if:name";
    //    }
    //    status deprecated;
    //    description
```

```
    //      "This type is used by data models that need to reference
    //       the operationally present interfaces.";
    //  }
    /*
     * Legacy operational state data nodes
     */
    container interfaces-state {
      config false;
      status deprecated;
      description
        "Data nodes for the operational state of interfaces.";
      list interface {
        key "name";
        status deprecated;
        description
          "The list of interfaces on the device.

           System-controlled interfaces created by the system are
           always present in this list, whether or not they are
           configured.";
        leaf name {
          type string;
          status deprecated;
          description
           "The name of the interface.

            A server implementation MAY map this leaf to the ifName
            MIB object.  Such an implementation needs to use some
            mechanism to handle the differences in size and characters
            allowed between this leaf and ifName.  The definition of
            such a mechanism is outside the scope of this document.";
          reference "RFC 2863: The Interfaces Group MIB - ifName";
        }
        leaf type {
        type identityref {
            base interface-type;
          }
          mandatory true;
          status deprecated;
          description
            "The type of the interface.";
          reference "RFC 2863: The Interfaces Group MIB - ifType";
        }
        leaf admin-status {
          if-feature if-mib;
          type enumeration {
            enum "up" {
              value 1;
```

```
            description
              "Ready to pass packets.";
          }
          enum "down" {
            value 2;
            description
             "Not ready to pass packets and not in some test mode.";
          }
          enum "testing" {
            value 3;
            description
              "In some test mode.";
          }
        }
        mandatory true;
        status deprecated;
        description
          "The desired state of the interface.

           This leaf has the same read semantics as ifAdminStatus.";
           reference "RFC 2863: The Interfaces Group MIB -
                                                ifAdminStatus";
      }
      leaf oper-status {
        type enumeration {
          enum "up" {
            value 1;
            description
              "Ready to pass packets.";
          }
          enum "down" {
            value 2;
            description
              "The interface does not pass any packets.";
          }
          enum "testing" {
            value 3;
            description
              "In some test mode.  No operational packets can
               be passed.";
          }
          enum "unknown" {
            value 4;
            description
              "Status cannot be determined for some reason.";
          }
          enum "dormant" {
            value 5;
```

```
            description
              "Waiting for some external event.";
          }
          enum "not-present" {
            value 6;
            description
              "Some component (typically hardware) is missing.";
          }
          enum "lower-layer-down" {
            value 7;
            description
              "Down due to state of lower-layer interface(s).";
          }
        }
        mandatory true;
        status deprecated;
        description
          "The current operational state of the interface.

           This leaf has the same semantics as ifOperStatus.";
           reference "RFC 2863: The Interfaces Group MIB -
                                                ifOperStatus";
      }
      leaf last-change {
        type yang:date-and-time;
        status deprecated;
        description
          "The time the interface entered its current operational
           state.  If the current state was entered prior to the
           last re-initialization of the local network management
           subsystem, then this node is not present.";
           reference "RFC 2863: The Interfaces Group MIB -
                                               ifLastChange";
      }
      leaf if-index {
        if-feature if-mib;
        type int32 {
          range "1..2147483647";
        }
        mandatory true;
        status deprecated;
        description
          "The ifIndex value for the ifEntry represented by this
           interface.";
        reference "RFC 2863: The Interfaces Group MIB - ifIndex";
      }
      leaf phys-address {
        type yang:phys-address;
```

```
          status deprecated;
          description
            "The interface's address at its protocol sub-layer.  For
             example, for an 802.x interface, this object normally
             contains a Media Access Control (MAC) address.  The
             interface's media-specific modules must define the bit
             and byte ordering and the format of the value of this
             object.  For interfaces that do not have such an address
             (e.g., a serial line), this node is not present.";
             reference "RFC 2863: The Interfaces Group MIB -
                                                    ifPhysAddress";
        }
        //      leaf-list higher-layer-if {
        //        type interface-state-ref;
        //        status deprecated;
        //        description
        //          "A list of references to interfaces layered on
        //           top of this
        //           interface.";
        //        reference
        //          "RFC 2863: The Interfaces Group MIB -
        //                                ifStackTable";
        //      }
        //
        //      leaf-list lower-layer-if {
        //        type interface-state-ref;
        //        status deprecated;
        //        description
        //          "A list of references to interfaces
        //           layered underneath this
        //           interface.";
        //        reference
        //          "RFC 2863: The Interfaces Group MIB -
        //                                ifStackTable";
        //      }
        leaf speed {
          type yang:gauge64;
          units "bits/second";
          status deprecated;
          description
            "An estimate of the interface's current bandwidth in bits
             per second.  For interfaces that do not vary in
             bandwidth or for those where no accurate estimation can

             be made, this node should contain the nominal bandwidth.
             For interfaces that have no concept of bandwidth, this
             node is not present.";
          reference
```

```
          "RFC 2863: The Interfaces Group MIB -
                     ifSpeed, ifHighSpeed";
        }
        container statistics {
          status deprecated;
          description
            "A collection of interface-related statistics objects.";
          leaf discontinuity-time {
            type yang:date-and-time;
            mandatory true;
            status deprecated;
            description
             "The time on the most recent occasion at which any one or
             more of this interface's counters suffered a
             discontinuity.  If no such discontinuities have occurred
             since the last re-initialization of the local management
             subsystem, then this node contains the time the local
             management subsystem re-initialized itself.";
          }
          leaf in-octets {
            type yang:counter64;
            status deprecated;
            description
              "The total number of octets received on the interface,
               including framing characters.

               Discontinuities in the value of this counter can occur
               at re-initialization of the management system and at
               other times as indicated by the value of
               'discontinuity-time'.";
               reference "RFC 2863: The Interfaces Group MIB -
                                                    ifHCInOctets";
          }
          leaf in-unicast-pkts {
            type yang:counter64;
            status deprecated;
            description
              "The number of packets, delivered by this sub-layer to a
               higher (sub-)layer, that were not addressed to a
               multicast or broadcast address at this sub-layer.
               Discontinuities in the value of this counter can occur
               at re-initialization of the management system and at
               other times as indicated by the value of
               'discontinuity-time'.";
               reference "RFC 2863: The Interfaces Group MIB -
                                                 ifHCInUcastPkts";
          }
          leaf in-broadcast-pkts {
```

```
            type yang:counter64;
            status deprecated;
            description
              "The number of packets, delivered by this sub-layer to a
               higher (sub-)layer, that were addressed to a broadcast
               address at this sub-layer.

               Discontinuities in the value of this counter can occur
               at re-initialization of the management system and at
               other times as indicated by the value of
               'discontinuity-time'.";
            reference
              "RFC 2863: The Interfaces Group MIB -
                         ifHCInBroadcastPkts";
          }
          leaf in-multicast-pkts {
            type yang:counter64;
            status deprecated;
            description
              "The number of packets, delivered by this sub-layer to a
               higher (sub-)layer, that were addressed to a multicast
               address at this sub-layer.  For a MAC-layer protocol,
               this includes both Group and Functional addresses.

               Discontinuities in the value of this counter can occur
               at re-initialization of the management system and at
               other times as indicated by the value of
               'discontinuity-time'.";
            reference
              "RFC 2863: The Interfaces Group MIB -
                         ifHCInMulticastPkts";
          }
          leaf in-discards {
            type yang:counter32;
            status deprecated;
            description
              "The number of inbound packets that were chosen to be
               discarded even though no errors had been detected to
               prevent their being deliverable to a higher-layer
               protocol.  One possible reason for discarding such a
               packet could be to free up buffer space.

               Discontinuities in the value of this counter can occur
               at re-initialization of the management system and at
               other times as indicated by the value of
               'discontinuity-time'.";
               reference "RFC 2863: The Interfaces Group MIB -
                                                 ifInDiscards";
```

```
        }
        leaf in-errors {
          type yang:counter32;
          status deprecated;
          description
            "For packet-oriented interfaces, the number of inbound
            packets that contained errors preventing them from being
            deliverable to a higher-layer protocol.  For character-
            oriented or fixed-length interfaces, the number of
            inbound transmission units that contained errors
            preventing them from being deliverable to a higher-layer
            protocol.

            Discontinuities in the value of this counter can occur
            at re-initialization of the management system and at
            other times as indicated by the value of
            'discontinuity-time'.";
            reference "RFC 2863: The Interfaces Group MIB -
                                              ifInErrors";
        }
        leaf in-unknown-protos {
          type yang:counter32;
          status deprecated;
          description
            "For packet-oriented interfaces, the number of packets
             received via the interface that were discarded because
             of an unknown or unsupported protocol.  For
             character-oriented or fixed-length interfaces that
             support protocol multiplexing, the number of
             transmission units received via the interface that were
             discarded because of an unknown or unsupported protocol.
             For any interface that does not support protocol
             multiplexing, this counter is not present.
             Discontinuities in the value of this counter can occur
             at re-initialization of the management system and at
             other times as indicated by the value of
             'discontinuity-time'.";
             reference "RFC 2863: The Interfaces Group MIB -
                                                 ifInUnknownProtos";
        }
        leaf out-octets {
          type yang:counter64;
          status deprecated;
          description
            "The total number of octets transmitted out of the
             interface, including framing characters.

             Discontinuities in the value of this counter can occur
```

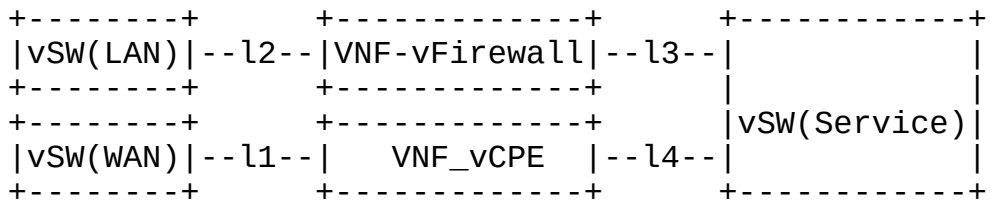
```
            at re-initialization of the management system and at
            other times as indicated by the value of
            'discontinuity-time'.";
            reference "RFC 2863: The Interfaces Group MIB -
                                                 ifHCOutOctets";
          }
          leaf out-unicast-pkts {
            type yang:counter64;
            status deprecated;
            description
              "The total number of packets that higher-level protocols
               requested be transmitted and that were not addressed
               to a multicast or broadcast address at this sub-layer,
               including those that were discarded or not sent.

               Discontinuities in the value of this counter can occur
               at re-initialization of the management system and at
               other times as indicated by the value of
               'discontinuity-time'.";
               reference "RFC 2863: The Interfaces Group MIB -
                                       ifHCOutUcastPkts";
          }
          leaf out-broadcast-pkts {
            type yang:counter64;
            status deprecated;
            description
              "The total number of packets that higher-level protocols
               requested be transmitted and that were addressed to a
               broadcast address at this sub-layer, including those
               that were discarded or not sent.

               Discontinuities in the value of this counter can occur
               at re-initialization of the management system and at
               other times as indicated by the value of
               'discontinuity-time'.";
            reference
              "RFC 2863: The Interfaces Group MIB -
                         ifHCOutBroadcastPkts";
          }
          leaf out-multicast-pkts {
            type yang:counter64;
            status deprecated;
            description
              "The total number of packets that higher-level protocols
               requested be transmitted and that were addressed to a
               multicast address at this sub-layer, including those
               that were discarded or not sent.  For a MAC-layer
               protocol, this includes both Group and Functional
```

```
            addresses.

            Discontinuities in the value of this counter can occur
            at re-initialization of the management system and at
            other times as indicated by the value of
            'discontinuity-time'.";
          reference
            "RFC 2863: The Interfaces Group MIB -
                       ifHCOutMulticastPkts";
        }
        leaf out-discards {
          type yang:counter32;
          status deprecated;
          description
            "The number of outbound packets that 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.




             Discontinuities in the value of this counter can occur
             at re-initialization of the management system and at
             other times as indicated by the value of
             'discontinuity-time'.";
             reference "RFC 2863: The Interfaces Group MIB -
                                          ifOutDiscards";
        }
        leaf out-errors {
          type yang:counter32;
          status deprecated;
          description
            "For packet-oriented interfaces, the number of outbound
             packets that could not be transmitted because of errors.
             For character-oriented or fixed-length interfaces, the
             number of outbound transmission units that could not be
             transmitted because of errors.

             Discontinuities in the value of this counter can occur
             at re-initialization of the management system and at
             other times as indicated by the value of
             'discontinuity-time'.";
             reference "RFC 2863: The Interfaces Group MIB -
                                          ifOutErrors";
        }
      }
```

```
      }
    }
  }
}
            <CODE ENDS>
```

## 7. XML example

The XML example below presents the configuration of the next service in the uCPE, where: vSW(LAN), vSW(WAN), vSW(Service) - virtual switches; l1,l2,l3,l4 - virtual links; VMs represent PNFs (Physical Network Fuctions) that could be bootstrapped with 0day config/ license.




```
<ucpe xmlns="urn:ietf:params:xml:ns:yang:ietf-ucpe">
    <name>ucpe1</name>
    <links>
      <link>l1</link>
    </links>
    <links>
      <link>l2</link>
    </links>
    <links>
      <link>l3</link>
    </links>
    <links>
      <link>l4</link>
    </links>
    <switches>
      <switch>lan</switch>
      <ports>
        <port>10</port>
        <name>l2p10</name>
        <link>l2</link>
      </ports>
    </switches>
    <switches>
```

```
          <switch>service</switch>
          <ports>
            <port>10</port>
            <name>l3p10</name>
            <link>l3</link>
          </ports>
          <ports>
            <port>11</port>
            <name>l4p10</name>
            <link>l4</link>
          </ports>
        </switches>
        <switches>
          <switch>wan</switch>
          <ports>
            <port>10</port>
            <link>l1</link>
          </ports>
        </switches>
        <vms>
          <vm>VNF-vCPE</vm>
          <ports>
            <port>1</port>
            <name>l1p1</name>
            <link>l1</link>
          </ports>
          <ports>
            <port>2</port>
            <name>l4p2</name>
            <link>l4</link>
          </ports>
          <ram>2048</ram>
          <cpu>2</cpu>
          <storages>
            <id>1</id>
            <location>http://192.168.2.1/vCPE-x86.qcow2</location>
          </storages>
          <day0-config>
            <location>https://192.168.2.1/vCPE-day0.iso</location>
            <day0-var-path>/config.rom</day0-var-path>
            <variable>
              <name>hostname</name>
              <value>IETF-vCPE</value>
            </variable>
            <variable>
              <name>ipaddress</name>
              <value>192.168.1.2 255.255.255.0</value>
            </variable>
```

```
          </day0-config>
        </vms>
        <vms>
          <vm>VNF-vFirewall</vm>
          <ports>
            <port>1</port>
            <name>l3p1</name>
            <link>l3</link>
          </ports>
          <ports>
            <port>2</port>
            <name>l2p2</name>
            <link>l2</link>
          </ports>
          <ram>2048</ram>
          <cpu>2</cpu>
          <storages>
            <id>1</id>
            <location>http://192.168.2.1/vFirewall-x86.qcow2</location>
          </storages>
          <day0-config>
            <location>https://192.168.2.1/vFirewall-day0.iso</location>
            <day0-var-path>/config.rom</day0-var-path>
            <variable>
              <name>hostname</name>
              <value>vFirewall</value>
            </variable>
            <variable>
              <name>ipaddress</name>
              <value>192.168.1.3 255.255.255.0</value>
            </variable>
          </day0-config>
        </vms>
      </ucpe>
```

## 8. Security Considerations

At this time, no security considerations are addressed by this memo.

## 9. IANA Considerations

No request to IANA at this time.

## 10. Acknowledgements

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## 11. Normative References

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## Authors' Addresses

Dmytro Shytyi
SFR
Paris , Ile-de-France
France

Email: ietf.dmytro@shytyi.net
URI: https://dmytro.shytyi.net

Laurent Beylier
SFR
Paris , Ile-de-France
France

Email: laurent.beylier@sfr.com

Luigi Iannone
Telecom ParisTech
Paris , Ile-de-France
France

Email: luigi.iannone@telecom-paristech.fr