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Yang Data Model for Service Function Chaining
draft-penno-sfc-yang-05

Abstract

This document defines a YANG data model that can be used to configure and manage Service Function Chains.

Requirements Language

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].

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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This Internet-Draft will expire on January 2, 2015.

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1. Introduction

YANG [RFC6020] is a data definition language that was introduced to define the contents of a conceptual data store that allows networked devices to be managed using NETCONF [RFC6241]. YANG is proving relevant beyond its initial confines, as bindings to other interfaces (e.g. ReST) and encodings other than XML (e.g. JSON) are being defined. Furthermore, YANG data models can be used as the basis of implementation for other interfaces, such as CLI and programmatic APIs.

This document defines a YANG data model that can be used to configure and manage Service Function Chains

2. Definitions and Acronyms

The reader should be familiar with the terms contained in [I-D.quinn-sfc-arch], [I-D.ietf-sfc-problem-statement] ,[I-D.quinn-sfc-nsh] and [I-D.quinn-vxlan-gpe]

3. VXLAN-GPE

This model describes the VXLAN-GPE encapsulation when used as a overlay mechanism to create service function paths. VXLAN is one of many transport protocols that can be used to setup service chaining overlays.

3.1. Module Structure

```
module: vxlan-gpe
   +--rw vxlan-gpe-header
      +--rw gpe-header-flag-value?   vxlan-gpw-header-flag-type
      +--rw reserved?                uint8
      +--rw protocol-type?           uint16
      +--rw vni*                     uint8
      +--rw reserved2?               uint8
```

3.2. VXLAN -GPE Configuration Model

<CODE BEGINS> file "vxlan-gpe@2013-12-04.yang"

```
module vxlan-gpe {

  namespace "urn:cisco:params:xml:ns:yang:vxlan-gpe";

  prefix vxlan-gpe;

  import ietf-inet-types { prefix inet; }
  import ietf-yang-types { prefix yang; }


  organization "Cisco Systems, Inc.";
  contact "Reinaldo Penno <repenno@cisco.com>";


  description
    "This module contains a collection of YANG definitions for
     managing service function chains.

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```

```
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     // note.

     // RFC Ed.: update the date below with the date of RFC publication
     // and remove this note.

  revision 2013-11-26 {
    description
    "Initial revision.";
  }


//    0                   1                   2                   3
//    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
//   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
//   |       Source Port = xxxx      |       Dest Port = 4789        |
//   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
//   |           UDP Length          |        UDP Checksum           |
//   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
//   |R|R|R|R|I|P|R|R|   Reserved    |   Protocol Type               |
//   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
//   |                VXLAN Network Identifier (VNI) |   Reserved    |
//   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

  typedef vxlan-gpw-header-flag-type {
    type bits {
      bit r1 {
        position 0;
        description "reserved";
      }
      bit r2 {
        position 1;
        description "reserved";
      }
      bit r3 {
        position 2;
        description "reserved";
      }
```

```
      bit r4 {
        position 3;
        description "reserved";
      }
      bit i {
        position 5;
        description "Some description";
      }
      bit p {
        position 6;
        description "Some description";
      }
      bit r7 {
        position 7;
        description "reserved";
      }
      bit r8 {
        position 8;
        description "reserved";
      }
    }
    description "vxlan-gpe Header Flags";
    reference "http://tools.ietf.org/html/draft-quinn-vxlan-gpe-01";
  }

  container vxlan-gpe-header {
    description "Network Service Base header";

    leaf gpe-header-flag-value {
        type vxlan-gpw-header-flag-type;
    }

    leaf reserved {
      default 0;
      type uint8;
    }

    leaf protocol-type {
      type uint16;
      // Reinaldo: Another option is to import Opendaylight L2 Types so have
ethertype
    }

    leaf vni-low {
      type uint8;
    }

    leaf vni-med {
```

```
      type uint8;
```

```
    }

    leaf vni-hi {
      type uint8;
    }

    leaf reserved2 {
      default 0;
      type uint8 {
        range "0 .. 255";
      }
      description "Reserved field";
    }
  }
}

</CODE ENDS>
```

4. Service Function (SF)

This module describe a Service Function, which is an essential building block of other modules.

4.1. Module Structure

4.2. Service Function

```
<CODE BEGINS> file "service-function@2014-06-05.yang"

module service-function {

  namespace "urn:cisco:params:xml:ns:yang:sfc-sf";

  prefix sfc-sf;

  import ietf-inet-types { prefix inet; }
  import ietf-yang-types { prefix yang; }


  organization "Cisco Systems, Inc.";
  contact "Reinaldo Penno <repenno@cisco.com>";


  description
    "This module contains a collection of YANG definitions for
     managing service function.
```

```
    It follows closely the constructs of
    http://tools.ietf.org/html/draft-ietf-netmod-interfaces-cfg-12

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  revision 2014-06-29 {
    description
    "Changes based on Opendaylight Testing.";
  }


  // Service Function

  // Service Function Type definitions

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

  identity firewall {
    base "service-function-type-indentity";
    description "Firewall";
  }

  identity dpi {
    base "service-function-type-indentity";
    description "Deep Packet Inspection";
  }
```

```
  identity napt44 {
    base "service-function-type-indentity";
    description "Network Address and Port Translation 44";
  }

  typedef service-function-type {
    type identityref {
      base "service-function-type-indentity";
    }
  }

  typedef service-function-type-ref {
    type leafref {
      path "/sfc-sf:service-function-type";
    }
    description
      "This type is used by data models that need to reference
       registered service types.";
  }

  typedef service-function-ref {
    type leafref {
      path "/sfc-sf:service-functions/sfc-sf:service-function/sfc-sf:name";
    }
    description
      "This type is used by data models that need to reference
       configured service functions.";
  }

  container service-functions {
    description
      "A network or application based packet
      treatment, application, compute or storage resource, used
      singularly or in concert with other service functions within a
      service chain to enable a service offered by an operator.

      A non-exhaustive list of Service Functions includes: firewalls,
      WAN and application acceleration, Deep Packet Inspection (DPI),
      server load balancers, NAT44 [RFC3022], NAT64 [RFC6146], HOST_ID
      injection, HTTP Header Enrichment functions, TCP optimizer, etc.";

    list service-function {
      key "name";
      leaf name {
        type string;
        description
            "The name of the service function.";
      }
```

```
      leaf type {
        type service-function-type;
        mandatory true;
      }
      leaf ip-mgmt-address {
        type inet:ip-address;
      }
    }
  }

  rpc delete-all-service-function {
  }

  rpc put-service-function {
    input {
      leaf name {
        type string;
        mandatory true;
        description "The name of the service function.";
      }
      leaf type {
        type service-function-type;
      }
      leaf ip-mgmt-address {
        type inet:ip-address;
      }
    }
  }
  rpc read-service-function {
    input {
      leaf name {
        type string;
        mandatory true;
        description "The name of the service function.";
      }
    }
    output {
      leaf name {
        type string;
        mandatory true;
        description "The name of the service function.";
      }
      leaf type {
        type service-function-type;
      }
      leaf ip-mgmt-address {
        type inet:ip-address;
      }
```

```
    }
  }

  rpc delete-service-function {
    input {
      leaf name {
        type string;
        mandatory true;
        description "The name of the service function.";
      }
    }
  }
}

</CODE ENDS>
```

5. Service Function Chain (SFC)

This model describes a service function chain which is basically an ordered list of services. But a service function chain does not specify exactly which service (firewal1 vs. firewall2) will be used to actually process packets.

5.1. Module Structure

```
module: service-function-chain
   +--rw service-function
   |  +--rw name               string
   |  +--rw type?              service-function-type
   |  +--rw ip-host-address?   inet:ip-address
   |  +--rw context-headers*   uint32
   +--rw service-function-chain
      +--rw service-function*   string
```

5.2. Service Function Chain Configuration Model

```
<CODE BEGINS> file "service-function-chain@2014-06-16.yang"

module service-function-chain {

  namespace "urn:cisco:params:xml:ns:yang:sfc-sfc";

  prefix sfc-sfc;

  import ietf-inet-types { prefix inet; }
  import ietf-yang-types { prefix yang; }
  import service-function {prefix sfc-sf; }
```

```
  organization "Cisco Systems, Inc.";
  contact "Reinaldo Penno <repenno@cisco.com>";


  description
    "This module contains a collection of YANG definitions for
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     // and remove this note.

  revision 2014-06-30 {
    description
    "Revised based on Opendaylight Project feedback";
  }

  grouping service-function-chain-grouping {
    list service-function-chain {
      description
        "A service chain defines the required functions and
        associated order (service-function1 --> service-function 2) that
        must be applied to packets and/or frames.  A service chain does
        not specify the network location or specific instance of service
        functions (e.g. firewall1 vs. firewall2).";
      key "name";
      leaf name {
        type string;
        description
          "the name of the service function chain";
      }
      list service-function-type {
        key "name";
```

```
        leaf name {
          type string;
          description
              "The name of this service function type. This could be the
              same as the registered type or in the case where
              multiple service functions of the same type are used in
              the chain, something like ingress-firewall and egress-firewall";
        }
        leaf type {
          type string;
          description
              "The registered service function type.";
        }
        ordered-by user;
        description
          "A list of service functions that compose the service chain";
      }
    }
  }

  // Service Function Chains

  container service-function-chains {
    uses service-function-chain-grouping;
  }

  rpc put-service-function-chains {
    input {
      uses service-function-chain-grouping;
    }
  }
}



</CODE ENDS>
```

6. Service Node (SN)

A Service Node is a virtual or physical element that houses one or more service functions. A Service node might contain an entire service function chain or be part of a larger service function chain.

6.1. Module Structure

```
   module: service-node
      +--rw service-node
         +--rw name                string
         +--rw type?               service-node-type
         +--rw transport?          transport-type
         +--rw service-function*   string
         +--rw ip-host-address?    inet:ip-address
```

6.2. Service Node Configuration Model

```
<CODE BEGINS> file "service-node@2014-06-05.yang"


module service-node {

  namespace "urn:cisco:params:xml:ns:yang:sfc-sn";

  prefix sfc-sn;

  import ietf-inet-types { prefix inet; }
  import ietf-yang-types { prefix yang; }
  import service-function {prefix sfc-sf; }



  organization "Cisco Systems, Inc.";
  contact "Reinaldo Penno <repenno@cisco.com>";


  description
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```

```
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     // RFC Ed.: update the date below with the date of RFC publication
     // and remove this note.

  revision 2014-06-30 {
    description
      "Revision based on Opendaylight project feedback";
  }



    // Service Nodes

  typedef service-node-ref {
      type leafref {
          path "/sfc-sn:service-nodes/sfc-sn:service-node/sfc-sn:name";
      }
      description
          "This type is used by data models that need to reference
           configured service functions.";
  }


  container service-nodes {
    description
        "Physical or virtual element that hosts one or
        more service functions and has one or more network locators
        associated with it for reachability and service delivery.";
    list service-node {
      key "name";
      leaf name {
        type string;
        description
             "The name of the service node.";
      }

      leaf ip-mgmt-address {
        type inet:ip-address;
      }
      leaf-list service-function {
        type sfc-sf:service-function-ref;
        description
            "A list of service functions resident in this service node";
      }
    }
  }
```

```
}
```

</CODE ENDS>

7. Service Function Path (SFP)

A Service Function Path is an instantiation of a service function chain. It specifies the actual service functions (e.g. firewall1) and the transport encapsulation used in the overlay.

7.1. Module Structure

```
module: service-function-path
   +--rw service-function-path
      +--rw service-function*            string
      +--rw transport?                   sfc-sn:transport-type
      +--rw service-header-flag-value?   service-header-flag-type
      +--rw protocol-type?               uint8
      +--rw service-index?               uint8
      +--rw service-path*                uint8
      +--rw reserved?                    uint8
```

7.2. Service Function Path Configuration Model

<CODE BEGINS> file "service-function-path@2014-06-05.yang"

```
module service-function-path {

  namespace "urn:TBD:params:xml:ns:yang:sfc-path";

  prefix sfc-path;

  import ietf-inet-types { prefix inet; }
  import ietf-yang-types { prefix yang; }
  import service-function {prefix sfc-sf; }

  organization "Cisco Systems, Inc.";
  contact "Reinaldo Penno <repenno@cisco.com>";


  description
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  revision 2014-06-16 {
    description
      "Changes based on Opendaylight Testing and IETF SFC ml.";
  }

  // Service Function Path

  container service-function-paths {
    list service-function-path {
      description
        "A Service Function Path is an instantiation of a Service Chain. It
         specifies the actual firewall (say, firewall-3) that will be traversed
by
         the packets. The Service Path needs to be known before hand or
stitched
         run-time (given the dynamic LB decision) since a forwarding decision
need
         to be made regardless.";
      key "name";
      leaf name {
        type string;
        description
          "the name of this service function path";
      }
      leaf-list service-function-instance {
        type sfc-sf:service-function-ref;
        ordered-by user;
        description
          "A list of service function instances that compose the service path";
      }
    }
  }
```

```
}
```

<CODE ENDS>

8. Service Function Forwarder (SFF)

This module describes the configuration a SFF needs to have in order to route packets to the service functions it serves. the SFF needs to have a table with service function name and associated locator. The locator could be an IP address and port, an internal function call or some other unique identifier.

8.1. Service Function Forwarder Configuration Model

<CODE BEGINS> file "service-function-forwarder@2014-06-05.yang"

```
module service-function-forwarder {

  namespace "urn:cisco:params:xml:ns:yang:sfc-sff";

  prefix sfc-sff;

  import ietf-inet-types { prefix inet; }
  import ietf-yang-types { prefix yang; }
  import service-function {prefix sfc-sf; }

  organization "Cisco Systems, Inc.";
  contact "Reinaldo Penno <repenno@cisco.com>";


  description
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```

```
     // RFC Ed.: replace XXXX with actual RFC number and remove this
     // note.

     // RFC Ed.: update the date below with the date of RFC publication
     // and remove this note.

  revision 2014-06-30 {
      description
      "Revision based on Opendaylight project feedback";
  }

  // Transport type definitions
  identity transport-type-identity {
    description
        "Base identity from which specific transport types are
        derived.";
  }

  identity vxlan-gpe {
    base "transport-type-identity";
    description "Programmable vxlan transport type";
  }

  typedef transport-type {
    type identityref {
        base "transport-type-identity";
    }
  }

  // Failmode type definitions

  identity failmode-type-identity {
    description
      "Base identity from which specific failmode
       types are derived. Fail mode specifies the behavior
       when the interface does not have connectivity to the
       service node.";
  }

  typedef failmode-type {
    type identityref {
        base "failmode-type-identity";
    }
  }

  identity close {
    base "failmode-type-identity";
    description "When service-function can not reach service function, packets
will be dropped";
```

```
  }

  identity open {
    base "failmode-type-identity";
    description "When service-function can not reach service function, packets
will be forwarded";
  }


  // Service Function Forwarding Map

  container service-function-forwarders {
    description
        "This dictionary holds the configuration for a service function
forwarder.
        For each service function, it has the location information.

        Example of a working Python Implementation of a SFF Map. A service
function
        can be reached through IP:port or internal function call. ";
        //sfi_map = {"fw1": {"function": "fw1_process_packet", "ip_address":"",
"port":""}, \
        //           "fw2": {"function": "", "ip_address": "192.168.0.2",
"port":""}, \
        //           "dpi1":{"function": "", "ip_address": "192.168.0.4",
"port":10000}, \
        //           "nat1":{"function": "nat1_process_packet", "ip_address":
"", "port":""}}
    list service-function-forwarder {
      key "name";
      leaf name {
        type string;
        description
          "The name of this service function forwarder";
      }
      leaf transport {
        type transport-type;
      }
      list service-map {
        ordered-by user;
        key "service-function-name";
        leaf service-function-name {
          type sfc-sf:service-function-ref;
        }
        leaf failmode {
            type failmode-type;
        }
        container service-function-location {
```

```
      leaf ip {
        type inet:ip-address;
      }
      leaf port {
        type inet:port-number;
      }
    }
```

```
      }
    }
  }
}
```

<CODE ENDS>

9. IANA Considerations

TBD

10. Security Considerations

11. Acknowledgements

Thanks to Jan Medved, Ron Parker, Jan Lindblad, David Goldberg, Vina Ermagan for reviews and suggestions.

12. Changes

-05

Changes based on Opendaylight Implementation Testing and Sfc-dev mailing list feedback

- Service Node becomes a container for Service Functions. Moved data plane items to SFF.
- Fixed Service Function Forwarders into a list so we cna have multiple in a system
- Fixed Service Function Chain so it becomes a list of lists.
- Created RPCs for Service Functions and Service Chain

-04

- Fixed list inside Service Function Chain to read service-function-type
- Small comment fixes

-03

- Revision dates consistent

- Service function chain to container + list in order to allow multiple
- Service Function Path to cotainer + list
- VXLAN-gpe vni to multiple 8-bit fields
- Consistent typeref use
- Other consistency fixes

-02

- After Opendaylight Testing converted multiple leafs to lists throughout all models
- Removed transport dependency. Transport could be layer-2, layer-3, etc
- Used pathrefs similar to ietf-interfaces to reference configuration names
- Other consistency fixes

13. References

13.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

[RFC2616] Fielding, R., Gettys, J., Mogul, J., Frystyk, H., Masinter, L., Leach, P., and T. Berners-Lee, "Hypertext Transfer Protocol -- HTTP/1.1", RFC 2616, June 1999.

13.2. Informative References

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[I-D.quinn-sfc-nsh]
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Agarwal, P., Fernando, R., Lewis, D., Kreeger, L., Quinn, P., Yong, L., Xu, X., Smith, M., Yadav, N., and U. Elzur, "Generic Protocol Extension for VXLAN", draft-quinn-vxlan-gpe-02 (work in progress), December 2013.

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