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].

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Table of Contents

1. Introduction ................................. 2
2. Definitions and Acronyms ..................... 3
3. VXLAN-GPE .................................... 3
   3.1. Module Structure .......................... 3
   3.2. VXLAN-GPE Configuration Model .......... 3
4. Service Function (SF) ......................... 6
   4.1. Module Structure .......................... 6
   4.2. Service Function ......................... 6
5. Service Function Chain (SFC) ................. 10
   5.1. Module Structure .......................... 10
   5.2. Service Function Chain Configuration Model .. 10
6. Service Node (SN) .............................. 12
   6.1. Module Structure .......................... 13
   6.2. Service Node Configuration Model ........ 13
7. Service Function Path (SFP) ................... 15
   7.1. Module Structure .......................... 15
   7.2. Service Function Path Configuration Model .. 15
8. Service Function Forwarder (SFF) .............. 17
   8.1. Service Function Forwarder Configuration Model .. 17
9. IANA Considerations ........................... 20
10. Security Considerations ....................... 20
11. Acknowledgements ............................. 20
12. Changes ....................................... 20
13. References .................................... 21
   13.1. Normative References ...................... 21
   13.2. Informative References ..................... 21
Authors’ Addresses .............................. 22

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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Penno & Quinn Expires January 2, 2015 [Page 3]
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";
}

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;
    }
}
4. Service Function (SF)

This module describes 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.";

</CODE ENDS>
It follows closely the constructs of

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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-identity";
    description "Network Address and Port Translation 44";
}

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

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
defined 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
singly 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;
    }
}
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 (firewall 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 managing service function chains.

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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
    "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

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

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        This version of this YANG module is part of RFC XXXX; see the RFC itself for full legal notices."
}
```
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";
  }
}
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
    "This module contains a collection of YANG definitions for managing service function chains."

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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";
      }
    }
  }
}
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
        "This module contains a collection of YANG definitions for managing service function forwarders."

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

<CODE ENDS>
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;
    }
  }
}
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

o Service Node becomes a container for Service Functions. Moved data plane items to SFF.

o Fixed Service Function Forwarders into a list so we can have multiple in a system

o Fixed Service Function Chain so it becomes a list of lists.

o Created RPCs for Service Functions and Service Chain

-04

o Fixed list inside Service Function Chain to read service-function-type

o Small comment fixes

-03

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

-02

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

13. References

13.1. Normative References


13.2. Informative References


[I-D.quinn-sfc-nsh]
Quinn, P., Guichard, J., Fernando, R., Surendra, S.,
Smith, M., Yadav, N., Agarwal, P., Manur, R., Chauhan, A.,
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February 2014.

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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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