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B. Wu
D. Dhody
Huawei Technologies
V.P. Beeram
Juniper Networks
T. Saad
Cisco Systems
S. Peng
ZTE Corporation
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YANG Data Models for Network Resource Partitions (NRPs)
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Abstract

RFC 9543 describes a framework for Network Slices in networks built from IETF technologies. In this framework, the network resource partition (NRP) is introduced as a collection of network resources allocated from the underlay network to carry a specific set of Network Slice Service traffic and meet specific Service Level Objective (SLO) and Service Level Expectation (SLE) characteristics.

This document defines YANG data models for Network Resource Partitions (NRPs), applicable to devices and network controllers. The models can be used, in particular, for the realization of the RFC9543 Network Slice Services in IP/MPLS and Segment Routing (SR) networks.

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1. Introduction

[RFC9543] describes a framework for Network Slices in networks built from IETF technologies. As specified in Section 7.4 [RFC9543], an NRP is a collection of resources identified in the underlay network to support the RFC 9543 Network Slice Service to meet the slice Service Level Objectives (SLOs) and Service Level Expectations (SLEs) characteristics and network scalability. This document follows the Network Slice Service defined in [RFC9543], and all references to "Network Slice" refers to that same context.

Considering the NRPs realizations in IP/MPLS and Segment Routing (SR) networks, [I-D.ietf-teas-ns-ip-mpls] and [I-D.ietf-teas-nrp-scalability] describe NRP mechanisms of control plane, data plane, and management plane to provide specific forwarding treatment (scheduling, drop policy, resource usage) to the Slice Service packets associated with an NRP. Specifically, for instantiation of the device-specific and network wide NRPs, Section 3.5 of [I-D.ietf-teas-ns-ip-mpls] introduces the construct of NRP Policy.

Based on these descriptions of NRP, this document defines two YANG models: NRPs network model in Section 4 and NRPs device model in Section 5. The NRP network model can be used by an Network Slice Controller (NSC) (defined in Section 6.3 [RFC9543]) to manage NRP instances for Network Slice Service realizations, which is a network configuration model according to the YANG model classification of [RFC8309]. And the NRPs device model can be used by a network controller to set NRP parameters on an individual device, including device-specific configuration (e.g. interfaces), which is a device configuration model by the classification.

The NRPs models conforms to the Network Management Datastore Architecture (NMDA) [RFC8342].

2. Terminology

The following terms are defined in [RFC6241] and are used in this specification:

* configuration data

* state data

The following terms are defined in [RFC7950] and are used in this specification:

* augment

* data model

* data node

The terminology for describing YANG data models is found in [RFC7950].

The tree diagram used in this document follows the notation defined in [RFC8340].

3. NRP Data Models

3.1. Models Usage

As defined in Section 7.1 [RFC9543], the Network Slice Controller (NSC) can determine which specific connectivity constructs from one or more slices could be grouped together upon Slice Service requests. This could be based on a specific set of SLOs and SLEs, or on any administrative or operational policy. The NSC can further map these connectivity constructs onto an NRP. It also constructs and distributes the network wide consistent NRP model to the relevant controllers, and in turn the controllers distribute the NRP device model to the NRP-enabled devices in the underlay network. Figure 1 shows the interfaces to which the two models are applied.

```
   +------------------------------------------+
   | Customer higher-level operation system   |
   +------------------------------------------+
                       A
                       | Network Slice Service Interface
                       V
   +------------------------------------------+
   |    IETF Network Slice Controller (NSC)   |
   +------------------------------------------+
                       A
                       | Network Configuration Interface
                       |  (e.g.,NRP Model)
                       V
   +------------------------------------------+
   |           Network Controller(s)          |
   +------------------------------------------+
                       A
                       | Device Configuration Interface
                       |  (e.g.,NRP Device Model)
                       V
 +------------------------------------------------+
 |                Underlay Network                |
 +------------------------------------------------+
```

Figure 1

The general operations of NRPs are as follows:

* NRPs instantiation: Depending on the Slice Service types, network resources status, and also the operator’s policies, there can be at least two approaches. One method is to create an NRP instance before the network controller processes a Network Slice Service request. Another one is that the network controller may decide creating an NRP instance while implementing the Network Slice Service request.

* NRPs modification: When the capacity of an existing NPR link is close to maximum capacity, the bandwidth of the link could be increased. And when an NRP links or nodes resources are insufficient, new NRP links and nodes could be added.

* NRPs Deletion: If an NSC determines that no Slice Service is using an NRP, the NSC can delete the NRP instance. Another example is when it is necessary to merge NRPs.

* NRPs Monitoring: The NSC can use the NRPs model to track and monitor NRPs resource status and usage.

3.2. NRPs Instantiation

Section 3.5 of [I-D.ietf-teas-ns-ip-mpls] introduces the construct of NRP policy, which specifies the rules to trigger how an NRP can be realized in IP/MPLS/SR networks. These rules are generic and can be applied to both device and network-level configurations.

Section 5.1 of [I-D.ietf-teas-ns-ip-mpls] states the rules may include the following:

1. Topology customization policies: Determine the topology associated with the NRP, including policies of nodes, links, and functions membership that belong to the NRP.

2. Data plane specific policies: Include the NRP data plane identifier, QoS profiles, bandwidth reservations, etc., associated with the NRP.

3. Control plane specific policies: Include bandwidth reservation, resource sharing policy, reservation preferences, etc.

To further specify if the NRP realization involves the data plane or control plane, Section 4 of [I-D.ietf-teas-ns-ip-mpls] also defines three partition modes for an NRP policy:

a. Data plane only: This mode Indicates that the physical network resources (e.g., bandwidth) can be partitioned on network devices for the NRP. The devices need to enable NRP data plane mechanism to support the NRP data plane identification to ensure the proper forwarding treatment by applying a Per Hop forwarding Behavior (PHB) to the packets forwarded on the specific NRP.

b. Control plane only: This mode indicates the NRP state reservation for each NRP can be maintained at the some NRP aware Traffic Engineering (TE) network devices (e.g., RSVP-TE devices) or the network controllers. This mode provides no physical network resources isolation.

c. Both control and data planes: This mode indicates the network resources can be partitioned in both the control plane (TE or IGP) and data plane.

The NRP policy modes (a), (b) and (c), require the topology associated with the NRP to be specified.

The NRP policy modes (a) and (c) require the forwarding engine on each NRP-enabled device to identify the traffic belonging to a specific NRP and to apply the corresponding Per-Hop Behavior (PHB) or forwarding mechanism that determines the forwarding treatment of the packets belonging to the NRP. This NRP identification is referred to as the NRP selector identifier.

For some Traffic Engineering (TE) scenarios, the NRP policy modes (b) and (c) require the distributed and/or centralized resource reservation management for NRP stateful TE (Section 4.2 of [I-D.ietf-teas-ns-ip-mpls])). For better scalability scenarios defined in [I-D.ietf-teas-nrp-scalability], control plane of mode (c) also requires NRP aware IGP routing.

The high-level model structure of NRP policy as modeled in this document is shown in Figure 2:

```
module: ietf-nrp
  augment /nw:networks:
    +--rw nrp-policies
       +--rw policy-profiles
       |  +--rw phb-profile-identifier* [id]
       |        ...
       +--rw nrp-policy* [name]
          +--rw name                     string
          +--rw nrp-id?                  uint32
          +--rw mode?                    identityref
          +--rw resource-reservation
          |     ...
          +--rw selector-id
          |     ...
          +--rw phb-profile?             leafref
          +--rw topology
                ...
```

Figure 2: NRP Policy subtree high-level structure

The "networks" container from the "ietf-network" module [RFC8345] provides a placeholder for an inventory of nodes in the network. This container is augmented to include a set of NRP policies.

The "policy-profiles" container provides a list of policy profile entries. Each of these entries can be referenced by one or more NRPs. A "phb-profile-identifier" entry can have a reference to a standard PHB profile available on the device or the network controller.

The "nrp-policies" container includes a list of NRP policies. Each "nrp-policy" entry is identified by a name and holds the set of attributes needed to instantiate an NRP.

The description of the "nrp-policies" data nodes are as follows, and the other key elements of each nrp-policy entry are discussed in the following sub-sections.

* "nrp-id": Is an identifier that is used to uniquely identify an NRP instance within an NSC network scope, which is created by the enforcement of the "nrp-policy".

* "mode": Refers to control plane resource partition, data plane resource partition, or a combination of both types.

3.2.1. Resource Reservation

The "resource-reservation" container may include bandwidth reservation, resource sharing policy, protection policy, etc.

Bandwidth reservation specifies the bidirectiona bandwidth resource allocated to an NRP. This can be overridden by the configuration of the link specific "resource-reservation" of "nrp-topology" in Section 3.2.4.

```
+--rw resource-reservation
  +--rw (max-bw-type)?
     +--:(bw-value)
     |  +--rw maximum-bandwidth?           uint64
     +--:(bw-percentage)
        +--rw maximum-bandwidth-percent?   rt-types:percentage
```

Figure 3: NRP Resource Reservation YANG subtree structure

3.2.2. NRP Selector Identifier (NRP Selector ID)

NRP selector ID defines the data plane encapsulation types and values that are used to identify NRP-specific network resources. The configuration can be overridden by the link specific "selector-id" of "nrp-topology" in Section 3.2.4.

[I-D.ietf-teas-nrp-scalability] discusses several candidate NRP selector ID encapsulation schemes, including IP, MPLS, and SRv6, for example, the IPv6 Hop-by-Hop extension header defined in [I-D.ietf-6man-enhanced-vpn-vtn-id], or the SRv6 SID defined in [I-D.ietf-spring-sr-for-enhanced-vpn]. Since the MPLS encapsulation schemes are still under discussion, the model only provides a place holder for future updates. Additionally, the use of NRP-specific IP addresses to identify NRP resources, or the use of specific ACLs, are optional NRP selector ID mechanisms.

```
+--rw selector-id
|  +--rw ipv4-derived
|  |  +--rw destination-prefix*   inet:ipv4-prefix
|  +--rw ipv6
|  |  +--rw (selector-type)?
|  |     +--:(dedicated)
|  |     |  +--rw ipv6-hbh-eh?          uint32
|  |     +--:(srv6-sid-derived)
|  |     |  +--rw srv6-sid*             inet:ipv6-prefix
|  |     +--:(ipv6-destination-derived)
|  |        +--rw destination-prefix*   inet:ipv6-prefix
|  +--rw mpls
|  +--rw acl-ref*   nrp-acl-ref
```

Figure 4: NRP Selector ID YANG subtree structure

3.2.3. Per-Hop Behavior (PHB)

PHB and NRP selector are combined mechanisms. PHB is used to specify the forwarding treatment of packets belonging to a specific NRP selector ID, such as bandwidth control, congestion control (e.g., Section 3.4 [RFC3644]). The "phb-profile" can be overridden by the link specific "phb-profile" of "nrp-topology" in Section 3.2.4.

The "phb-profile" leaf refers to a standard profile defined. The exact definition of PHB is locally defined by the device or network controller managing the NRPs. Some examples of "phb-probile" may be standard PHBs, such as "Assured Forwarding (AF)", "Expedited Forwarding (EF)", or a customized local policies, such as "High", "Low", "Standard".

```
+--rw phb-profile?            leafref
```

Figure 5: PHB YANG subtree structure

3.2.4. NRP Topology

"nrp-topology" defines a customized NRP topology used for an NRP.

When an NRP support IGP routing, the topology of the NRP must be congruent with an IGP instance.The topology used for IGP route computation and forwarding can be derived using Multi-Topology Routing (MTR) [RFC4915], [RFC5120], and [I-D.ietf-lsr-isis-sr-vtn-mt] or Flex-algo [RFC9350].

Figure 6 shows an example of NRP-1 enabling "igp-congruent", which indicates that this NRP instance uses the same IGP topology with the specified "multi-topology-id" or "algo-id". NRP-1 has different link resource attributes from those of the IGP, but shares the same nodes and termination points (TPs) of the IGP topology.

```
                       # O #### O #### O
                     #  #      #      #
                    O   #      #      #
                     #  #      #      #
                      # O #### O #### O
                             NRP-1

                              ||
                              vv
                         O-----O-----O
                       / |     |     |
                      O  |     |     |
                       \ |     |     |
                         O-----O-----O
                     IGP Topology (MT or Flex-algo)
     Legend

     O     Virtual node
     ---   IGP links
     ###   Virtual links with a set of reserved resources
```

Figure 6: IGP Congruency Example

The "selection" container consists of a list of select subset of links of an underlay topology or a pre-built topology.

The "filter" container consists of a list of filters where each entry references a topology filter [I-D.ietf-teas-yang-topology-filter]. The topological elements that satisfy the membership criteria may override the default "resource-reservation" and "selector-id" specific nodes.

```
   +--rw topology
      +--rw igp-congruent!
      |  +--rw multi-topology-id?   uint32
      |  +--rw algo-id?             uint32
      |  +--rw sharing?             boolean
      +--rw (topology-type)?
         +--:(selection)
         |  +--rw select
         |     +--rw topology-group* [group-id]
         |        +--rw group-id                string
         |        +--rw base-topology-ref
         |        |     ...
         |        +--rw links* [link-ref]
         |        |     ...
         |        +--rw resource-reservation
         |        |     ...
         |        +--rw link-partition-type?
         |        |       identityref
         |        +--rw phb-profile?            leafref
         +--:(filter)
            +--rw filters
               +--rw filter* [filter-ref]
                  +--rw filter-ref
                  |       nrp-topo-filter-ref
                  +--rw resource-reservation
                  |     ...
                  +--rw selector-id
                  |     ...
                  +--rw phb-profile?            leafref
```

Figure 7: NRP Topology YANG subtree structure

3.3. NRPs Monitoring

The NRP model can be used to monitor the operational status and resource usage of NRPs.

```
     augment /nw:networks/nw:network/nw:network-types:
       +--rw nrp!
     augment /nw:networks/nw:network/nw:node:
       +--ro nrp-node-attributes
          +--ro selector-id
             +--ro srv6?   srv6-types:srv6-sid
     augment /nw:networks/nw:network/nt:link:
       +--ro nrp-link-attributes
          +--ro link-partition-type?   identityref
          +--ro bandwidth-value?       uint64
          +--ro selector-id
          |  +--ro srv6?   srv6-types:srv6-sid
          +--ro statistics
             +--ro status
             |     ...
             +--ro one-way-available-bandwidth?   uint64
             +--ro one-way-utilized-bandwidth?    uint64
             +--ro one-way-min-delay?             uint32
             +--ro one-way-max-delay?             uint32
             +--ro one-way-delay-variation?       uint32
             +--ro one-way-packet-loss?           decimal64
     augment /nw:networks/nw:network/nw:node:
       +--rw nrps-node-attributes
          +--ro nrp* [nrp-id]
             +--ro nrp-id                 uint32
             +--ro nrp-node-attributes
                   ...
     augment /nw:networks/nw:network/nt:link:
       +--ro nrps-link-attributes
          +--ro nrp* [nrp-id]
             +--ro nrp-id                 uint32
             +--ro nrp-link-attributes
                   ...
```

Figure 8: NRPs Monitoring YANG subtree structure

3.4. NRPs Device Model Description

The device-specific NRPs model is defined in module "ietf-nrp-device" as shown in Section 5.

The NRP device YANG data model is only applicable to device configuration and includes attributes such as QoS policies, resource reservations, and NRP selector IDs. Specifically, it adds interface-specific attributes for cases where the QoS policies, NRP resources, and NRP selector IDs of an interface differ from the global NRP attributes of the device.

Figure 9 shows the tree diagram of the device NRPs YANG model defined in modules "ietf-nrp-device.yang".

```
module: ietf-nrp-device
  +--rw nrp-policies
     +--rw qos-profiles
     |  +--rw phb-profile-identifier* [id]
     |     +--rw id    string
     +--rw nrp-policy* [name]
        +--rw name                    string
        +--rw nrp-id?                 uint32
        +--rw resource-reservation
        |  +--rw (max-bw-type)?
        |        ...
        +--rw selector-id
        |  +--rw ipv4-derived
        |  |     ...
        |  +--rw ipv6
        |  |     ...
        |  +--rw mpls
        |  +--rw acl-ref*        nrp-acl-ref
        +--rw phb-profile?            leafref
        +--rw igp-congruent!
        |  +--rw multi-topology-id?   uint32
        |  +--rw algo-id?             uint32
        |  +--rw sharing?             boolean
        +--rw interfaces
           +--rw interface* [interface]
                 ...
```

Figure 9: NRPs Device YANG subtree high-level structure

4. NRPs YANG Module

The "ietf-nrp" module uses types defined in [RFC8345], [RFC8294],[RFC8776], [RFC6991], [RFC8519], [I-D.ietf-spring-srv6-yang], and [I-D.ietf-teas-yang-topology-filter].

```
<CODE BEGINS> file "ietf-nrp@2025-03-02.yang"
module ietf-nrp {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-nrp";
  prefix nrp;

  import ietf-network {
    prefix nw;
    reference
```

```
           "RFC 8345: A YANG Data Model for Network Topologies,
                      Section 6.1";
       }
       import ietf-network-topology {
         prefix nt;
         reference
           "RFC 8345: A YANG Data Model for Network Topologies,
                      Section 6.2";
       }
       import ietf-routing-types {
         prefix rt-types;
         reference
           "RFC 8294: Common YANG Data Types for the Routing Area";
       }
       import ietf-vpn-common {
         prefix vpn-common;
         reference
           "RFC 9181: A Common YANG Data Model for Layer 2 and Layer 3
                      VPNs";
       }
       import ietf-te-packet-types {
         prefix te-packet-types;
         reference
           "RFC 8776: Traffic Engineering Common YANG Types";
       }
       import ietf-inet-types {
         prefix inet;
         reference
           "RFC 6991: Common YANG Data Types";
       }
       import ietf-access-control-list {
         prefix acl;
         reference
           "RFC 8519: YANG Data Model for Network Access Control Lists
                      (ACLs)";
       }
       import ietf-srv6-types {
         prefix srv6-types;
         reference
           "draft-ietf-spring-srv6-yang: YANG Data Model for SRv6 Base
            and Static";
       }
       import ietf-topology-filter {
         prefix topo-filt;
         reference
           "draft-bestbar-teas-yang-topology-filter: YANG Data Model
            for Topology Filter";
       }
```

```
     organization
       "IETF Traffic Engineering Architecture and Signaling (TEAS)
        Working Group";
     contact
       "WG Web:   <https://datatracker.ietf.org/wg/teas/>
        WG List:  <mailto:teas@ietf.org>

        Editor:   Bo Wu
               <mailto:lana.wubo@huawei.com>
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               <mailto:dhruv.ietf@gmail.com>

        Editor:   Vishnu Pavan Beeram
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        Editor:   Tarek Saad
                  <mailto:tsaad.net@gmail.com>

        Editor:   Shaofu Peng
                  <mailto:peng.shaofu@zte.com.cn>";
     description
       "This YANG module defines a data model for
        Network Resource Partitions (NRPs) management.

        Copyright (c) 2025 IETF Trust and the persons identified as
        authors of the code.  All rights reserved.

        Redistribution and use in source and binary forms, with or
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           (https://trustee.ietf.org/license-info).

        This version of this YANG module is part of RFC XXXX
        (https://www.rfc-editor.org/info/rfcXXXX); see the RFC itself
        for full legal notices.";

     revision 2025-03-02 {
       description
         "Initial revision.";
       reference
         "RFC XXXX: YANG Data Models for Network Resource
                    Partitions (NRPs)";
     }

     /*
      * I D E N T I T I E S
```

```
       */

      identity nrp-partition-mode {
        description
          "Base identity for NRP partition type.";
      }

      identity control-plane-partition {
        base nrp-partition-mode;
        description
          "NRP control plane partition.";
      }

      identity data-plane-partition {
        base nrp-partition-mode;
        description
          "NRP data plane partition.";
      }

      identity hybrid-plane-partition {
        base nrp-partition-mode;
        description
          "Both control and data planes partitions of NRP.";
      }

      identity nrp-link-partition-type {
        description
          "Base identity for NRP interface partition type.";
      }

      identity virtual-sub-interface-partition {
        base nrp-link-partition-type;
        description
          "Identity for NRP virtual interface or sub-interface partition,
           e.g., FlexE.";
      }

      identity queue-partition {
        base nrp-link-partition-type;
        description
          "Identity for NRP queue partition type.";
      }

      /*
       * T Y P E D E F S
       */

      typedef acl-ref {
```

```
       type leafref {
         path "/acl:acls/acl:acl/acl:name";
       }
       description
         "Used to reference an ACL.";
     }

     typedef topo-filter-ref {
       type leafref {
         path "/nw:networks/topo-filt:topology-filters/"
            + "topo-filt:topology-filter/topo-filt:name";
       }
       description
         "This type is used to reference a Topology Filter.";
       reference
         "draft-bestbar-teas-yang-topology-filter: YANG Data Model
          for Topology Filter";
     }

     /*
      * Grouping - NRP Resource Reservation
      */

     grouping resource-reservation {
       description
         "Grouping for NRP resource reservation.";
       container resource-reservation {
         description
           "Container for NRP resource reservation.";
         choice max-bw-type {
           description
             "Choice of maximum bandwidth specification.";
           case bw-value {
             leaf maximum-bandwidth {
               type uint64;
               units "bits/second";
               description
                 "The maximum bandwidth allocated to an NRP
                  - specified as absolute value.";
             }
           }
           case bw-percentage {
             leaf maximum-bandwidth-percent {
               type rt-types:percentage;
               description
                 "The maximum bandwidth allocated to an NRP
                  - specified as percentage of link
                  capacity.";
```

```
             }
           }
         }
       }
     }

     /*
      * Grouping - NRP Selector Identifier Configuration
      */

     grouping selector-id {
       description
         "Grouping for NRP selector identifier (NRP Selector ID)
          configuration.";
       container selector-id {
         description
           "Container for NRP selector ID.";
         container ipv4-derived {
           description
             "Container for IPv4 NRP selector ID.";
           leaf-list destination-prefix {
             type inet:ipv4-prefix;
             description
               "Any prefix from the specified set of IPv4
                destination prefixes can be the selector ID.";
           }
         }
         container ipv6 {
           description
             "Container for IPv6 NRP selector ID.";
           choice selector-type {
             description
               "Choices for IPv6 selector ID type.";
             case dedicated {
               leaf ipv6-hbh-eh {
                 type uint32;
                 description
                   "The selector ID carried in Hop-by-Hop option of
                    IPv6 extension header.";
                 reference
                   "draft-ietf-6man-enhanced-vpn-vtn-id: Carrying
                    Network Resource (NRP) related Information in IPv6
                    Extension Header";
               }
             }
             case srv6-sid-derived {
               leaf-list srv6-sid {
                 type srv6-types:srv6-sid;
```

```
                description
                  "Any SID from the specified set of SRv6 SID can
                   be the NRP selector ID.";
                reference
                  "draft-ietf-spring-sr-for-enhanced-vpn: Segment
                   Routing based Network Resource Partition (NRP) for
                   Enhanced VPN";
              }
            }
            case ipv6-destination-derived {
              leaf-list destination-prefix {
                type inet:ipv6-prefix;
                description
                  "Any prefix from the specified set of IPv6
                   destination prefixes can be the NRP selector ID.";
              }
            }
          }
        }
        container mpls {
          description
            "Container for MPLS NRP selector ID. This is a placeholder
             for future updates based on the MPLS solutions.";
        }
        leaf-list acl-ref {
          type acl-ref;
          description
            "NRP selection is done based on the specified list of
             ACLs.";
          reference
            "RFC 8519: YANG Data Model for Network Access Control Lists
                       (ACLs)";
        }
      }
    }

    /*
     * Grouping - NRP QoS Per-Hop Behavior (PHB) profiles
     */

    grouping qos-profiles {
      description
        "Grouping for NRP QoS profiles.";
      container qos-profiles {
        description
          "Container for profiles.";
        list phb-profile-identifier {
          key "id";
```

```
           description
             "List of PHB profiles.";
           leaf id {
             type string;
             description
               "Uniquely identifies the PHB.
                The profile only has significance within the service
                provider's administrative domain";
           }
         }
       }
     }

     /*
      * Grouping - NRP QoS Per-Hop Behavior (PHB) profile
      */

     grouping qos-phb-profile {
       description
         "Grouping for NRP QoS Per-Hop Behavior (PHB) profile.";
       leaf phb-profile {
         type leafref {
           path "/nw:networks/nrp-policies/"
              + "qos-profiles/phb-profile-identifier/id";
         }
         description
           "PHB profile identifier, specifying the forwarding treatment
            of packets belonging to a specific NRP selector ID, such as
            bandwidth control, congestion control
            (e.g., Section 3.4 of [RFC3644]).
            The PHB may be standard PHB, such as Assured Forwarding (AF),
            Expedited Forwarding (EF), or a customized local policy,
            such as 'High', 'Low', 'Standard'.";
       }
     }

     /*
      * Grouping - NRP IGP congruent
      */

     grouping igp-congruent {
       description
         "Grouping for NRP IGP congruent attributes.";
       container igp-congruent {
         presence "Indicates NRP IGP congruency.";
         description
           "The presence of the container node describes NRP IGP
            congruent, which indicates that the NRP instance uses the
```

```
            same IGP topology with the specified 'multi-topology-id'
            and 'algo-id'. That is, the nodes and termination point of
            the NRP topology and the IGP topology are the same, while
            the link attributes of the NRP are different from those of
            the IGP.";
         leaf multi-topology-id {
           type uint32;
           description
             "Indicates the MT-id of the NRP IGP instance.";
           reference
             "RFC 5120:  M-ISIS: Multi Topology (MT) Routing in
              Intermediate System to Intermediate Systems (IS-ISs)
              RFC 4915:  Multi-Topology (MT) Routing in OSPF";
         }
         leaf algo-id {
           type uint32;
           description
             "Indicates the algo-id of the NRP IGP instance.";
           reference
             "RFC 9350: IGP Flexible Algorithm";
         }
         leaf sharing {
           type boolean;
           description
             "'true' if the NRP IGP instance can be shared with
              other NRPs;
              'false' if the NRP IGP instance is dedicated
              to this NRP.";
         }
       }
     }

     /*
      * Grouping - NRP Topology Filter
      */

     grouping topology-filter {
       description
         "Grouping for NRP filter topology.";
       container filters {
         description
           "Container for filters.";
         list filter {
           key "filter-ref";
           description
             "List of filters.";
           leaf filter-ref {
             type topo-filter-ref;
```

```
             description
               "Reference to a specific topology filter from the
                list of global topology filters.";
           }
           uses resource-reservation;
           uses selector-id;
           uses qos-phb-profile;
         }
       }
     }

     /*
      * Grouping - NRP Select Topology
      */

     grouping select-topology {
       description
         "NRP topology specified by selection.";
       container select {
         description
           "The container of NRP select topology.";
         list topology-group {
           key "group-id";
           description
             "List of groups for NRP topology elements (node or links)
              that share common attributes.";
           leaf group-id {
             type string;
             description
               "The NRP topology group identifier.";
           }
           container base-topology-ref {
             description
               "Container for the base topology reference.";
             uses nw:network-ref;
           }
           list link {
             key "link-ref";
             description
               "A list of links with common attributes";
             leaf link-ref {
               type leafref {
                 path
                   "/nw:networks/nw:network[nw:network-id=current()"
                 + "/../../base-topology-ref/network-ref]"
                 + "/nt:link/nt:link-id";
               }
               description
```

```
                 "A reference to a link in the base topology.";
             }
           }
           uses resource-reservation;
           leaf link-partition-type {
             type identityref {
               base nrp-link-partition-type;
             }
             description
               "Indicates the resource reservation type of an NRP link.";
           }
           uses qos-phb-profile;
         }
       }
     }

     /*
      * Grouping - NRP Policy
      */

     grouping nrp-pol {
       description
         "Grouping for NRP policies.";
       container nrp-policies {
         description
           "Container for nrp policies.";
         uses qos-profiles;
         list nrp-policy {
           key "name";
           unique "nrp-id";
           description
             "List of NRP policies.";
           leaf name {
             type string;
             description
               "A string that uniquely identifies the NRP policy.";
           }
           leaf nrp-id {
             type uint32;
             description
               "A 32-bit ID that uniquely identifies the NRP
                created by the enforcement of this NRP policy.";
           }
           leaf mode {
             type identityref {
               base nrp-partition-mode;
             }
             description
```

```
                "Indicates the resource partition mode of the NRP, such
                 as control plane partition, data plane partition,
                 or hybrid partition.";
            }
            uses resource-reservation;
            uses selector-id;
            uses qos-phb-profile;
            container topology {
              description
                "Container for NRP topology.";
              uses igp-congruent;
              choice topology-type {
                description
                  "Choice of NRP topology type.";
                case selection {
                  uses select-topology;
                }
                case filter {
                  uses topology-filter;
                }
              }
            }
          }
        }
      }

      /*
       * Grouping - NRP Selector ID State
       */

      grouping selector-id-state {
        description
          "The grouping of NRP selector ID state.";
        container selector-id {
          config false;
          description
            "The container of NRP selector ID.";
          leaf srv6 {
            type srv6-types:srv6-sid;
            description
              "Indicates the SRv6 SID value as the NRP selector ID.";
          }
        }
      }

      // nrp-link-statistics

      grouping statistics-per-link {
```

```
       description
         "Statistics attributes per NRP link.";
       container statistics {
         config false;
         description
           "Statistics for NRP link.";
         uses vpn-common:service-status;
         uses nrp-bandwidth-metrics;
         uses te-packet-types:one-way-performance-metrics-packet;
       }
     }

     /*
      * Grouping - NRP node attributes
      */

     grouping nrp-node-attributes {
       description
         "NRP node scope attributes.";
       container nrp-node-attributes {
         config false;
         description
           "Containing NRP attributes.";
         uses selector-id-state;
       }
     }

     /*
      * Grouping - NRP Link Attributes
      */

     grouping nrp-link-attributes {
       description
         "NRP link scope attributes.";
       container nrp-link-attributes {
         config false;
         description
           "Contains NRP link attributes.";
         leaf link-partition-type {
           type identityref {
             base nrp-link-partition-type;
           }
           description
             "Indicates the resource partition type of an NRP link.";
         }
         leaf bandwidth-value {
           type uint64;
           units "bits/second";
```

```
           description
             "Bandwidth allocation for the NRP as absolute value.";
         }
         uses selector-id-state;
         uses statistics-per-link;
       }
     }

     /*
      * Grouping - NRP Bandwidth Metrics
      */

     grouping nrp-bandwidth-metrics {
       description
         "Grouping for NRP bandwidth metrics.";
       leaf one-way-available-bandwidth {
         type uint64;
         units "bits/second";
         description
           "Available bandwidth that is defined to be NRP link
            bandwidth minus bandwidth utilization.";
       }
       leaf one-way-utilized-bandwidth {
         type uint64;
         units "bits/second";
         description
           "Bandwidth utilization that represents the actual
            utilization of the link (i.e., as measured in the router).";
       }
     }

     /*
      * Grouping - NRPs Node Attributes
      */

     grouping nrps-node-attributes {
       description
         "Grouping for NRPs nodes attributes.";
       container nrps-node-attributes {
         description
           "Containing NRPs attributes.";
         list nrp {
           key "nrp-id";
           config false;
           description
             "List of NRPs.";
           leaf nrp-id {
             type uint32;
```

```
            description
              "NRP identifier";
          }
          uses nrp-node-attributes;
        }
      }
    }

    /*
     * Grouping - NRPs Link Attributes
     */

    grouping nrps-link-attributes {
      description
        "Grouping for NRPs link attributes.";
      container nrps-link-attributes {
        config false;
        description
          "Contains NRPs link attributes.";
        list nrp {
          key "nrp-id";
          config false;
          description
            "List of NRPs.";
          leaf nrp-id {
            type uint32;
            description
              "NRP identifier";
          }
          uses nrp-link-attributes;
        }
      }
    }

    // nrp-network-type

    grouping nrp-network-type {
      description
        "Identifies the network type to be NRP.";
      container nrp {
        presence "Indicates NRP network topology.";
        description
          "The presence of the container node indicates NRP network.";
      }
    }

    /*
     * Augment - Network Resource Partition Policies.
```

```
       */

      augment "/nw:networks" {
        description
          "Augments networks with NRP policies.";
        uses nrp-pol;
      }

      /*
       * Augment - NRP type.
       */

      augment "/nw:networks/nw:network/nw:network-types" {
        description
          "Indicates the network type of NRP";
        uses nrp-network-type;
      }

      /*
       * Augment - NRP node operational status.
       */

      augment "/nw:networks/nw:network/nw:node" {
        when '../nw:network-types/nrp:nrp' {
          description
            "Augments only for NRP network topology.";
        }
        description
          "Augments node with NRP state attributes.";
        uses nrp-node-attributes;
      }

      /*
       * Augment - NRP link operational status.
       */

      augment "/nw:networks/nw:network/nt:link" {
        when '../nw:network-types/nrp:nrp' {
          description
            "Augments only for NRP network topology.";
        }
        description
          "Augments link with NRP state attributes.";
        uses nrp-link-attributes;
      }

      /*
       * Augment - Native topology with NRPs node operational status.
```

```
     */

    augment "/nw:networks/nw:network/nw:node" {
      description
        "Augments node with NRP list state attributes.";
      uses nrps-node-attributes;
    }

    /*
     * Augment - Native topology with NRPs link operational status.
     */

    augment "/nw:networks/nw:network/nt:link" {
      description
        "Augments link with NRP list state attributes.";
      uses nrps-link-attributes;
    }
  }
  <CODE ENDS>
```

5. NRPs Device YANG Module

The NRP YANG module for devices ("ietf-nrp-device") reuses the qos policy, "resource-reservation", "selector-id" grouping defined in Section 4,and adds interface-specific NRP attributes.

The device NRPs YANG module also imports the following module(s): ietf-interfaces defined in [RFC8343].

```
<CODE BEGINS> file "ietf-nrp-device@2025-03-02.yang"
module ietf-nrp-device {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-nrp-device";
  prefix nrp-dev;

  /* Import IETF interface module */

  import ietf-interfaces {
    prefix if;
    reference
      "RFC8343: A YANG Data Model for Interface Management";
  }

  /* Import NRPs module */

  import ietf-nrp {
    prefix nrp;
    reference
```

```
         "RFCXXXX: YANG Data Models for Network Resource
                   Partitions (NRPs)";
     }

     organization
       "IETF Traffic Engineering Architecture and Signaling (TEAS)
        Working Group";
     contact
       "WG Web:   <https://datatracker.ietf.org/wg/teas/>
        WG List:  <mailto:teas@ietf.org>

        Editor:   Bo Wu
                  <mailto:lana.wubo@huawei.com>

        Editor:   Dhruv Dhody
                  <mailto:dhruv.ietf@gmail.com>

        Editor:   Vishnu Pavan Beeram
                  <mailto:vbeeram@juniper.net>

        Editor:   Tarek Saad
                  <mailto:tsaad.net@gmail.com>

        Editor:   Shaofu Peng
                  <mailto:peng.shaofu@zte.com.cn>";
     description
       "This YANG module defines a data model for Network Resource
        Partitions (NRPs) device configurations and states. The model
        fully conforms to the Network Management Datastore
        Architecture (NMDA).

        Copyright (c) 2025 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 Revised 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 XXXX
        (https://www.rfc-editor.org/info/rfcXXXX); see the RFC itself
        for full legal notices.";

     // 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 2025-03-02 {
     description
       "Initial revision.";
     reference
       "RFCXXXX: YANG Data Models for Network Resource
                 Partitions (NRPs)";
   }

   /*
    * Grouping - NRP QoS Per-Hop Behavior (PHB) profile
    */

   grouping qos-phb-profile {
     description
       "Grouping for NRP QoS Per-Hop Behavior (PHB) profile.";
     leaf phb-profile {
       type leafref {
         path
           "/nrp-policies/qos-profiles/phb-profile-identifier/id";
       }
       description
         "PHB profile identifier, specifying the forwarding treatment
          of packets belonging to a specific NRP selector identifier,
          such as bandwidth control, congestion control
          (e.g., Section 3.4 of [RFC3644]).
          The PHB may be standard PHB, such as Assured
          Forwarding (AF), Expedited Forwarding (EF), or
          a customized local policy, such as 'High', 'Low',
          'Standard'.";
     }
   }

   /* NRP device configuraiton */

   container nrp-policies {
     description
       "Container for nrp policies.";
     uses nrp:qos-profiles;
     list nrp-policy {
       key "name";
       unique "nrp-id";
       description
         "List of NRP policies.";
       leaf name {
         type string;
         description
```

```
            "A string that uniquely identifies the NRP policy.";
        }
        leaf nrp-id {
          type uint32;
          description
            "A 32-bit ID that uniquely identifies the NRP
             created by the enforcement of this NRP policy.";
        }
        uses nrp:resource-reservation;
        uses nrp:selector-id;
        uses qos-phb-profile;
        uses nrp:igp-congruent;
        /* NRP Interface Configuration Data */
        container interfaces {
          description
            "NRP interfaces global configuration.";
          list interface {
            key "interface";
            description
              "The list of interfaces enabled for NRP.";
            leaf interface {
              type if:interface-ref;
              description
                "NRP interface name.";
            }
            uses nrp:resource-reservation;
            uses nrp:selector-id;
            uses qos-phb-profile;
          }
        }
      }
    }
  }
<CODE ENDS>
```

6. Scalability Considerations

[I-D.ietf-teas-nrp-scalability] analyzes the scalability considerations of the control plane and data plane in the NRPs deployment. This section complements some scalability considerations with the model and the possible implications on deployment or implementation.

As discussed in Section 2 of [I-D.ietf-teas-nrp-scalability], the number of Network Resource Partitions (NRPs) required depends on the deployment scenario: multi-service networks typically need around ten NRPs, whereas industrial-vertical and cloud-network expansions can require hundreds to thousands of NRPs to support correspondingly large numbers of Network Slices. Compared to a single NRP, all these numbers of NRPs pose challenges for management and operations, including NRP planning, provisioning, monitoring, and Network Slice Service provisioning and assurance based on NRPs. Section 3 of [I-D.ietf-teas-ns-ip-mpls] describes the detailed realization process of multiple NRPs.

For better scalability, the NRP YANG model design considers the following aspects:

* Planning: A reusable "qos-profile" groups Service-Level Objectives (SLOs) once and applies them to any NRP, guaranteeing consistent QoS policy across the domain while eliminating per-NRP duplication. "filter/selection" enables multiple NRPs to share a common topology, confining per-NRP state to the differences rather than replicating the entire topology. Network operators should create new NRPs only when strict resource isolation is required, ensuring that network-wide resources remain efficiently utilized.

* Provisioning: The network controller, not the Network Slice Controller (NSC), is responsible for the actual resource allocation of NRPs on devices. It assigns NRPs to the relevant interfaces, reserve the bandwidth, and set data-plane selector IDs. NSC conveys the intent through the NRP network model, specifically via the "nrp-policy", and the network controller then realize the requested allocation. And for data-plane selector IDs, Section 5.2 of [I-D.ietf-teas-nrp-scalability] recommends selecting a data-plane mechanism that minimizes per-NRP configuration. A dedicated IPv6 selector identifier is one example that achieves this objective.

* Monitoring: The model supports two complementary monitoring approaches:

  Per-NRP view: Operational state scoped to a single "nrp-id", letting the controller present the logical network dedicated to that NRP.

  Network-wide view: An extension of the RFC 8345 topology model that exposes the mapping between the underlay network and all associated NRPs, including per-node and per-link NRP status.

7. Security Considerations

The YANG models defined in this document is designed to be accessed via network management protocols such as NETCONF [RFC6241] or RESTCONF [RFC8040]. The lowest NETCONF layer is the secure transport layer, and the mandatory-to-implement secure transport is Secure Shell (SSH) [RFC6242]. The lowest RESTCONF layer is HTTPS, and the mandatory-to-implement secure transport is TLS [RFC8446].

The NETCONF access control model [RFC8341] provides the means to restrict access for particular NETCONF or RESTCONF users to a preconfigured subset of all available NETCONF or RESTCONF protocol operations and content.

There are a number of data nodes defined in this YANG model that are writable/creatable/deletable (i.e., config true, which is the default). These data nodes may be considered sensitive or vulnerable in some network environments. Write operations (e.g., edit-config) to these data nodes without proper protection can have a negative effect on network operations.

nrp-link: A malicious client could attempt to remove a link from a topology, add a new link. In each case, the structure of the topology would be sabotaged, and this scenario could, for example, result in an NRP topology that is less than optimal.

The entries in the nodes above include the whole network configurations corresponding with the NRP, and indirectly create or modify the PE or P device configurations. Unexpected changes to these entries could lead to service disruption and/or network misbehavior.

8. IANA Considerations

This document registers a URI in the IETF XML registry [RFC3688]. Following the format in [RFC3688], the following registration is requested to be made:

    URI: urn:ietf:params:xml:ns:yang:ietf-nrp
    Registrant Contact: The IESG.
    XML: N/A, the requested URI is an XML namespace.

    URI: urn:ietf:params:xml:ns:yang:ietf-nrp-device
    Registrant Contact: The IESG.
    XML: N/A, the requested URI is an XML namespace.

This document requests to register a YANG module in the YANG Module Names registry [RFC7950].

Name: ietf-nrp
Namespace: urn:ietf:params:xml:ns:yang:ietf-nrp
Maintained by IANA: N
Prefix: nrp
Reference: RFC XXXX

Name: ietf-nrp-device
Namespace: urn:ietf:params:xml:ns:yang:ietf-nrp-device
Maintained by IANA: N
Prefix: nrp-dev
Reference: RFC XXXX

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10. Contributor

The following individuals, authors of [I-D.bestbar-teas-yang-nrp-policy] and [I-D.wd-teas-nrp-yang], contributed to this consolidated document:

Xufeng Liu
IBM Corporation
Email: xufeng.liu.ietf@gmail.com

Mohamed Boucadair
Orange
Email: mohamed.boucadair@orange.com

Daniele Ceccarelli

Bin Wen
Comcast
Email: Bin_Wen@cable.comcast.com

Ran Chen
ZTE Corporation
Email: chen.ran@zte.com.cn

Luis M. Contreras
Telefonica
Email: luismiguel.contrerasmurillo@telefonica.com

Ying Cheng
China Unicom
Email: chengying10@chinaunicom.cn

Liyan Gong
China Mobile
Email: gongliyan@chinamobile.com

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Appendix A. Open issues

This section lists the non-blocking issues raised during the Working Group adoption process. The issues listed below need to be fully resolved before publication

1. Raised by Tom Petch: Abstract lacks the reference to the NS framework that defines the NRP.

2. Raised by Adrain Farrel: 1) Avoid limiting IP/MPLS technology to realize NRPs, SR should be in scope; 2) Avoid the "IETF Network Slice" language, should use terms as "RFC 9543 Network Slice" and "RFC 9543 Network Slice Service" 3) It’s good to investigate any scaling issues with the model and any implications on deployments or implementations, just as draft-ietf-teas-nrp-scalability.

3. Raised by Med Boucadair: 1) Normative dependency on individual drafts, such as I-D.bestbar-teas-yang-topology-filter, suggesting to add it back when stable 2) The device model in the spec is not a device model as it augments a network model. 3) Some of the review provided in https://github.com/boucadair/IETF-Drafts-Reviews/blob/master/2024/draft-ahuang-netconf-udp-client-server-01-rev%20Med.pdf

4. Raised by Lius Contreras: 1) Clarify the NRP model usage in NSC, network controllers, and devices; 2) Rename Section 3.1.1 title to bandwidth reservation; 3) Add the references of "NRP capable node"; 4) In Section 3.1.3, better to clarify single PHB or multiple PHB per NRP and Whether the PHB management scope is in the NSC or network controller; 5) Section 3.1 adds description of NRP policy modes (b) and (c).

5. Raised by Xuesong: 1) Clarify the considerations for defining the NRP policy; 2) Distinguish NRP model operation and NRP mode (CP,DP, and hybrid); 3) Clarify the relationship and design consideration of NRPs network and device models.

6. Raised by Italo: 1) Clarify the models are technology-agnostic NRPs model or IP technology-specific NRPs model; 2) Updates the abstract/introduction to clarify that this model applies on devices and on controllers.

Appendix B. An Example

This section contains an example of an instance data tree in JSON encoding [RFC7951]. The example below instantiates an NRP for the topology that is depicted in the following diagram. There are three nodes, D1, D2, and D3. D1 has three termination points, 1-0-1, 1-2-1, and 1-3-1. D2 has three termination points as well, 2-1-1, 2-0-1, and 2-3-1. D3 has two termination points, 3-1-1 and 3-2-1. In addition there are six links, two between each pair of nodes with one going in each direction.

```
 +------------+                  +------------+
 |     D1     |                  |     D2     |
/-\          /-\                /-\          /-\
| | 1-0-1    | |--------------->| | 2-1-1    | |
| |    1-2-1 | |<---------------| |    2-0-1 | |
\-/  1-3-1   \-/                \-/  2-3-1   \-/
 |   /----\   |                  |   /----\   |
 +---|    |---+                  +---|    |---+
     \----/                          \----/
      |  |                            |  |
      |  |                            |  |
      |  |                            |  |
      |  |        +------------+      |  |
      |  |        |     D3     |      |  |
      |  |       /-\          /-\     |  |
      |  +----->| | 3-1-1    | |-------+  |
      +---------| |    3-2-1 | |<---------+
                 \-/          \-/
                  |            |
                  +------------+
```

Figure 10: An NRP Instance Example

An corresponding IGP congruent NRP instance data tree is depicted below:


```
============== NOTE: '\' line wrapping per RFC 8792 ===============
{
  "ietf-network:networks": {
    "ietf-nrp:nrp-policies": {
      "nrp-policy": [
        {
          "name": "NRP1",
          "nrp-id": "example:nrp-example1",
          "mode": "ietf-nrp:hybrid-plane-partition",
          "resource-reservation": {
            "bw-value": "10000"
          },
          "selector-id": {
            "ipv6": {
              "ipv6-hbh-eh:": "100"
            }
          },
          "phb-profile:": "High",
          "topology": {
            "igp-congruent": {
              "multi-topology-id": "2"
            },
```

```
              "select": {
                "topology-group": [
                  {
                    "group-id": "access-group",
                    "base-topology-ref": {
                      "network-ref": "native-topology"
                    },
                    "link": [
                      {
                        "link-ref": "example:D1,example:1-2-1,\
                                     example:D2,example:2-1-1"
                      },
                      {
                        "link-ref": "example:D2,example:2-1-1,\
                                     example:D1,example:1-2-1"
                      },
                      {
                        "link-ref": "example:D1,example:1-3-1,\
                                     example:D3,example:3-1-1"
                      },
                      {
                        "link-ref": "example:D3,example:3-1-1,\
                                     example:D1,example:1-3-1"
                      },
                      {
                        "link-ref": "example:D2,example:2-3-1,\
                                     example:D3,example:3-2-1"
                      },
                      {
                        "link-ref": "example:D3,example:3-2-1,\
                                     example:D2,example:2-3-1"
                      }
                    ],
                    "link-partition-type": "virtual-sub-interface-\
                                                     partition"
                  }
                ]
              }
            }
          }
        ]
      }
    }
  }
```


Figure 11: Instance data tree

In addition, an example of an NRP that supports the control plane partition mode is shown in the following figure.


```
{
  "ietf-network:networks": {
    "ietf-nrp:nrp-policies": {
      "nrp-policy": [
        {
          "name": "NRP2",
          "nrp-id": "example:nrp-example2",
          "mode": "control-plane-partition",
          "resource-reservation": {
            "bw-value": "10000"
          },
          "phb-profile:": "EF",
          "topology": {
            "filters": {
              "filter": [
                {
                  "filter-ref": "te-topology-filter1"
                }
              ]
            }
          }
        }
      ]
    }
  }
}
```


Appendix C. NRPs YANG Module Tree

Figure 12 shows the full tree diagram of the NRPs YANG model defined in module "ietf-nrp.yang".

```
module: ietf-nrp
  augment /nw:networks:
    +--rw nrp-policies
       +--rw qos-profiles
       |  +--rw phb-profile-identifier* [id]
       |     +--rw id    string
       +--rw nrp-policy* [name]
          +--rw name                      string
          +--rw nrp-id?                   uint32
          +--rw mode?                     identityref
          +--rw resource-reservation
          |  +--rw (max-bw-type)?
          |     +--:(bw-value)
```

```
           |     |  +--rw maximum-bandwidth?           uint64
           |     +--:(bw-percentage)
           |        +--rw maximum-bandwidth-percent?
           |                rt-types:percentage
           +--rw selector-id
           |  +--rw ipv4-derived
           |  |  +--rw destination-prefix*   inet:ipv4-prefix
           |  +--rw ipv6
           |  |  +--rw (selector-type)?
           |  |     +--:(dedicated)
           |  |     |  +--rw ipv6-hbh-eh?          uint32
           |  |     +--:(srv6-sid-derived)
           |  |     |  +--rw srv6-sid*             srv6-types:srv6-sid
           |  |     +--:(ipv6-destination-derived)
           |  |        +--rw destination-prefix*   inet:ipv6-prefix
           |  +--rw mpls
           |  +--rw acl-ref*        acl-ref
           +--rw phb-profile?            leafref
           +--rw topology
              +--rw igp-congruent!
              |  +--rw multi-topology-id?   uint32
              |  +--rw algo-id?             uint32
              |  +--rw sharing?             boolean
              +--rw (topology-type)?
                 +--:(selection)
                 |  +--rw select
                 |     +--rw topology-group* [group-id]
                 |        +--rw group-id                string
                 |        +--rw base-topology-ref
                 |        |  +--rw network-ref?
                 |        |          -> /nw:networks/network/network-id
                 |        +--rw link* [link-ref]
                 |        |  +--rw link-ref    leafref
                 |        +--rw resource-reservation
                 |        |  +--rw (max-bw-type)?
                 |        |     +--:(bw-value)
                 |        |     |  +--rw maximum-bandwidth?
                 |        |     |          uint64
                 |        |     +--:(bw-percentage)
                 |        |        +--rw maximum-bandwidth-percent?
                 |        |                rt-types:percentage
                 |        +--rw link-partition-type?    identityref
                 |        +--rw phb-profile?            leafref
                 +--:(filter)
                    +--rw filters
                       +--rw filter* [filter-ref]
                          +--rw filter-ref
                          |       topo-filter-ref
```

```
                           +--rw resource-reservation
                           |  +--rw (max-bw-type)?
                           |     +--:(bw-value)
                           |     |  +--rw maximum-bandwidth?
                           |     |          uint64
                           |     +--:(bw-percentage)
                           |        +--rw maximum-bandwidth-percent?
                           |                rt-types:percentage
                           +--rw selector-id
                           |  +--rw ipv4-derived
                           |  |  +--rw destination-prefix*
                           |  |          inet:ipv4-prefix
                           |  +--rw ipv6
                           |  |  +--rw (selector-type)?
                           |  |     +--:(dedicated)
                           |  |     |  +--rw ipv6-hbh-eh?
                           |  |     |          uint32
                           |  |     +--:(srv6-sid-derived)
                           |  |     |  +--rw srv6-sid*
                           |  |     |          srv6-types:srv6-sid
                           |  |     +--:(ipv6-destination-derived)
                           |  |        +--rw destination-prefix*
                           |  |                inet:ipv6-prefix
                           |  +--rw mpls
                           |  +--rw acl-ref*        acl-ref
                           +--rw phb-profile?            leafref
    augment /nw:networks/nw:network/nw:network-types:
      +--rw nrp!
    augment /nw:networks/nw:network/nw:node:
      +--ro nrp-node-attributes
         +--ro selector-id
            +--ro srv6?   srv6-types:srv6-sid
    augment /nw:networks/nw:network/nt:link:
      +--ro nrp-link-attributes
         +--ro link-partition-type?   identityref
         +--ro bandwidth-value?       uint64
         +--ro selector-id
         |  +--ro srv6?   srv6-types:srv6-sid
         +--ro statistics
            +--ro status
            |  +--ro admin-status
            |  |  +--ro status?        identityref
            |  |  +--ro last-change?   yang:date-and-time
            |  +--ro oper-status
            |     +--ro status?        identityref
            |     +--ro last-change?   yang:date-and-time
            +--ro one-way-available-bandwidth?   uint64
            +--ro one-way-utilized-bandwidth?    uint64
```

```
            +--ro one-way-min-delay?             uint32
            +--ro one-way-max-delay?             uint32
            +--ro one-way-delay-variation?       uint32
            +--ro one-way-packet-loss?           decimal64
    augment /nw:networks/nw:network/nw:node:
      +--rw nrps-node-attributes
         +--ro nrp* [nrp-id]
            +--ro nrp-id                 uint32
            +--ro nrp-node-attributes
               +--ro selector-id
                  +--ro srv6?   srv6-types:srv6-sid
    augment /nw:networks/nw:network/nt:link:
      +--ro nrps-link-attributes
         +--ro nrp* [nrp-id]
            +--ro nrp-id                 uint32
            +--ro nrp-link-attributes
               +--ro link-partition-type?   identityref
               +--ro bandwidth-value?       uint64
               +--ro selector-id
               |  +--ro srv6?   srv6-types:srv6-sid
               +--ro statistics
                  +--ro status
                  |  +--ro admin-status
                  |  |  +--ro status?        identityref
                  |  |  +--ro last-change?   yang:date-and-time
                  |  +--ro oper-status
                  |     +--ro status?        identityref
                  |     +--ro last-change?   yang:date-and-time
                  +--ro one-way-available-bandwidth?   uint64
                  +--ro one-way-utilized-bandwidth?    uint64
                  +--ro one-way-min-delay?             uint32
                  +--ro one-way-max-delay?             uint32
                  +--ro one-way-delay-variation?       uint32
                  +--ro one-way-packet-loss?           decimal64
```

Figure 12

Appendix D. NRPs Device YANG Module Tree

Figure 13 shows the full tree diagram of the NRPs device YANG model defined in module "ietf-nrp-device.yang".

```
   module: ietf-nrp-device
     +--rw nrp-policies
        +--rw qos-profiles
        |  +--rw phb-profile-identifier* [id]
        |     +--rw id    string
        +--rw nrp-policy* [name]
```

```
           +--rw name                   string
           +--rw nrp-id?                uint32
           +--rw resource-reservation
           |  +--rw (max-bw-type)?
           |     +--:(bw-value)
           |     |  +--rw maximum-bandwidth?           uint64
           |     +--:(bw-percentage)
           |        +--rw maximum-bandwidth-percent?
           |                rt-types:percentage
           +--rw selector-id
           |  +--rw ipv4-derived
           |  |  +--rw destination-prefix*   inet:ipv4-prefix
           |  +--rw ipv6
           |  |  +--rw (selector-type)?
           |  |     +--:(dedicated)
           |  |     |  +--rw ipv6-hbh-eh?          uint32
           |  |     +--:(srv6-sid-derived)
           |  |     |  +--rw srv6-sid*             srv6-types:srv6-sid
           |  |     +--:(ipv6-destination-derived)
           |  |        +--rw destination-prefix*   inet:ipv6-prefix
           |  +--rw mpls
           |  +--rw acl-ref*        acl-ref
           +--rw phb-profile?           leafref
           +--rw igp-congruent!
           |  +--rw multi-topology-id?   uint32
           |  +--rw algo-id?             uint32
           |  +--rw sharing?             boolean
           +--rw interfaces
              +--rw interface* [interface]
                 +--rw interface               if:interface-ref
                 +--rw resource-reservation
                 |  +--rw (max-bw-type)?
                 |     +--:(bw-value)
                 |     |  +--rw maximum-bandwidth?           uint64
                 |     +--:(bw-percentage)
                 |        +--rw maximum-bandwidth-percent?
                 |                rt-types:percentage
                 +--rw selector-id
                 |  +--rw ipv4-derived
                 |  |  +--rw destination-prefix*   inet:ipv4-prefix
                 |  +--rw ipv6
                 |  |  +--rw (selector-type)?
                 |  |     +--:(dedicated)
                 |  |     |  +--rw ipv6-hbh-eh?          uint32
                 |  |     +--:(srv6-sid-derived)
                 |  |     |  +--rw srv6-sid*
                 |  |     |          srv6-types:srv6-sid
                 |  |     +--:(ipv6-destination-derived)
```

```
                 |  |        +--rw destination-prefix*
                 |  |                inet:ipv6-prefix
                 |  +--rw mpls
                 |  +--rw acl-ref*        acl-ref
                 +--rw phb-profile?            leafref
```

Figure 13

Authors’ Addresses

Bo Wu
Huawei Technologies
101 Software Avenue, Yuhua District
Nanjing
Jiangsu, 210012
China
Email: lana.wubo@huawei.com

Dhruv Dhody
Huawei Technologies
Divyashree Techno Park
Bangalore 560066
Karnataka
India
Email: dhruv.ietf@gmail.com

Vishnu Pavan Beeram
Juniper Networks
Email: vbeeram@juniper.net

Tarek Saad
Cisco Systems
Email: tsaad.net@gmail.com

Shaofu Peng
ZTE Corporation
Email: peng.shaofu@zte.com.cn