

This document is subject to BCP 78 and the IETF Trust's Legal Provisions Relating to IETF Documents (<https://trustee.ietf.org/license-info>) in effect on the date of publication of this document. Please review these documents carefully, as they describe your rights and restrictions with respect to this document. Code Components extracted from this document must include Revised BSD License text as described in Section 4.e of the Trust Legal Provisions and are provided without warranty as described in the Revised BSD License.

Table of Contents

- [1. Introduction](#)
- [2. Terminology](#)
 - [2.1. Tree Diagrams](#)
- [3. NRP Modelling Requirements](#)
- [4. NRP Modelling Considerations](#)
 - [4.1. NRP Model Usage](#)
 - [4.2. NRP Modeling Design](#)
- [5. Description of NRP YANG Module](#)
- [6. NRP YANG Module Tree](#)
- [7. NRP Yang Module](#)
- [8. Security Considerations](#)
- [9. IANA Considerations](#)
- [10. Contributor](#)
- [11. References](#)
 - [11.1. Normative References](#)
 - [11.2. Informative References](#)
- [Appendix A. An Example](#)
- [Authors' Addresses](#)

1. Introduction

[[I-D.ietf-teas-ietf-network-slices](#)] defines IETF Network Slice services that provide connectivity coupled with network resources commitment between a number of Service Demarcation Points (SDPs) over a shared network infrastructure and, for scalability and agility concerns, defines Network Resource Partition (NRP) to host one or a group of network slice services according to characteristics including Service Level Objectives (SLOs) and Service Level Expectations (SLEs). [[I-D.ietf-teas-nrp-scalability](#)] analyzes the scalability issues of network slice services in detail and suggests candidate technologies of control and forwarding planes of the NRP.

This document defines a YANG module of NRP that the IETF NSC (Network Slice controller) can use to manage NRP instances to realize the network slicing services. According to the YANG model classification of [[RFC8309](#)], the NRP model is a network configuration model.

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](#)].

2.1. Tree Diagrams

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

3. NRP Modelling Requirements

[[I-D.ietf-teas-ietf-network-slices](#)] section 6.1 introduces the concept of NRP, which is a collection of resources (bufferage, queuing, scheduling, etc.) in the underlay network to provide specific SLOs and SLEs for connectivity constructs of IETF Network Slice services. [[I-D.ietf-teas-ns-ip-mpls](#)] provides some solutions to realize network slicing in IP/MPLS networks. Additionally [[I-D.ietf-teas-nrp-scalability](#)] provides analysis and possible optimizations of the control plane and data plane of NRP in IP/MPLS networks for better scalability. The following are some common NRP attributes for NRP management identified based on the analysis:

*NRP instantiation

- NRP partition type: Refers to various NRP resource partition methods, such as control plane partition, data plane partition, or hybrid partition, etc.
- NRP topology generation method: Topologies can be created using multiple methods. For example, NRP links can be all links in the underlay topology, or explicitly selected links from the topology or implicitly selected from the various existing topologies.
- NRP resource reservation: Reserves link resources for the NRP, including bandwidth, queuing, and other resource partitioning.
- NRP control plane: Mechanisms that provide routing and forwarding to one or a group of network slice traffic to ensure the corresponding SLO and SLE through NRP link resources, e.g. distributed control plane described in [[I-](#)

[D.ietf-teas-nrp-scalability](#)], or NRP aware TE (NRP-TE) described in [[I-D.ietf-teas-ns-ip-mpls](#)].

- NRP data plane: Dataplane identifier carried in a data packet, which is used to mark the link resources and behaviors allocated to the NRP.

- NRP steering policy: Policies for steering slice traffic to the NRP.

- *NRP modification or updates: Modifications or additions to existing NRP-allocated resources, e.g. some congested links need to be expanded.

- *NRP monitoring: NRP-allocated resources, including NRP-specific link or node SID, link bandwidth usage, link delay, and packet loss status, etc.

4. NRP Modelling Considerations

An NRP is a subset, or all, of resources allocated from a physical network or logical network. Depending on the SLO and SLE requirements of the slicing service and also the available resources of the operator's network, there are several options of creating an NRP. One option is that each physical link is allocated to only one specific NRP, and different NRPs do not share any physical link. One more typical option is that multiple NRPs share the same physical links, and each NRP is built with virtual links with a certain subset of the bandwidth available on the physical links to provide network resource isolation.

In addition to specifying resource allocation from the underlay network, an NRP also needs to have associated control plane and forwarding plane technologies, which can provide specific routing and forwarding so that the traffic received from NRP edge nodes that is characterized to match the NRP traffic classification rule is constrained to the NRP exclusive topology and resource allocation. The NRP allows network operators to manage the resources of IETF Network Slices which are used to provide network slice service traffic with specific SLOs and SLEs.

As defined in [[I-D.ietf-teas-nrp-scalability](#)], the draft discusses NRP control plane and data plane requirements in different provisioning scenarios, and describes that the NRP control plane is used to exchange network resource attributes and associated logical topology information between nodes of the NRP so that NRP-specific routing and forwarding tables could be generated. For the NRP control plane, distributed control plane mechanism, such as Multi-topology, Flex-Algo or centralized SDN or hybrid combination could be defined. To help with forwarding entries, several data-plane

encapsulation options are also discussed to carry NRP information in the NRP traffic packets. The example NRP data plane identifier could be the IPv6 addresses or the MPLS forwarding labels or dedicated NRP data-plane identifiers.

An example of NRP instances and a physical network is illustrated in [Figure 1](#). In the example, each NRP instance has a customized network topology comprised of a set of links and nodes in the physical network. In control plane, each NRP could be associated with a multi-topology or a Flex-Algo. And it also has its own forwarding plane resources and identifiers which provide NRP-specific packet forwarding.

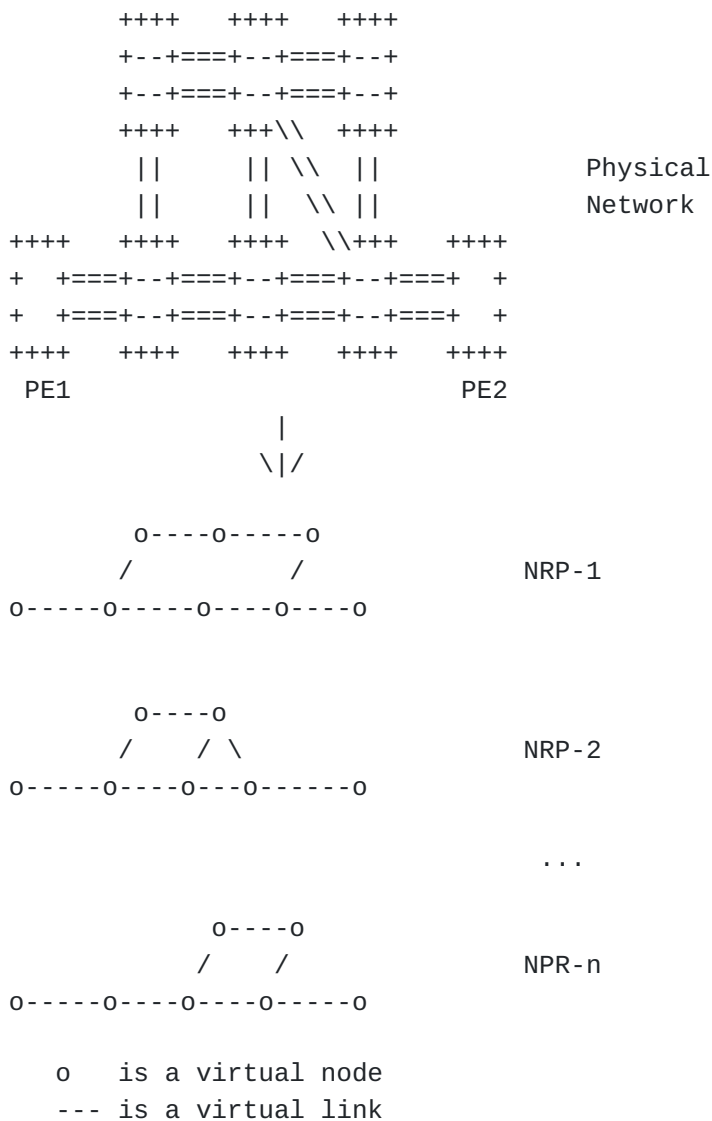


Figure 1: An NRP Example

[[I-D.ietf-teas-ietf-network-slices](#)] also describes the management of the NRP. After an NRP created, the NRP may need to be refined and

modified as the network status and slice services change, and could be extended if necessary to meet the customers' demands. In addition to configuration management, the NRP should also provide detailed monitoring information about underlying resources to further provide monitoring for the hosted slice services.

4.1. NRP Model Usage

One major application of network slices is 5G services. [Figure 2](#) shows the use of the NRP model to realize the IETF Network Slice for the 5G use case, based on the reference framework defined in [[I-D.ietf-teas-ietf-network-slices](#)]. The figure shows that the NSC uses the L3VPN network model (L3NM) [[RFC9182](#)] and the NRP model to map to an IETF Network Slice service. One possible method is to set the "underlay-transport" of the L3NM as an NRP instance, which is used to specify the NRP to carry the VPN traffic. In this way, the NRP-specific resources, together with NRP control plane and forwarding plane technologies are used to ensure the SLO and SLE required by the traffic. Similarly, the L2NM [[RFC9291](#)] can also be used to map an IETF Network Slice service to an underlying network.

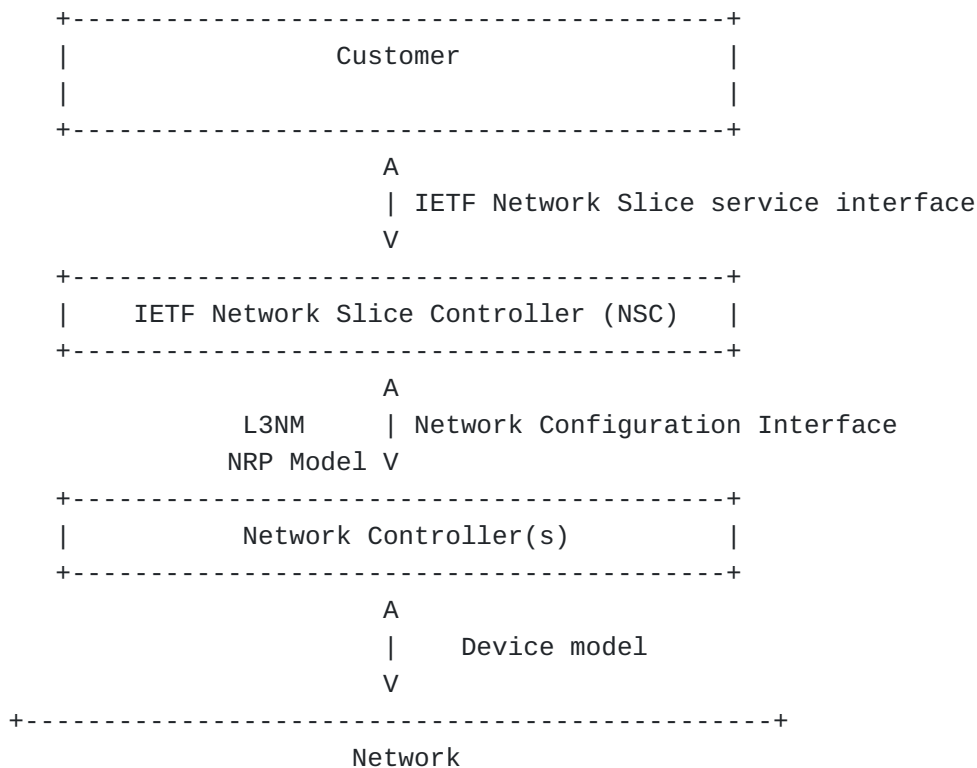


Figure 2: Reference Module Use Case

In the process of realizing an IETF Network Slice service, the NSC can use a pre-built NRP instance or dynamically create one as one or a group of VPNs underlay construct. Compared with current VPN

underlay transport mechanisms, the NRP could provide resource isolation, topology constraints, and distributed and/ or centralized traffic engineering (TE). For example, an NRP can use SR policies mechanisms, such as [\[I-D.dong-idr-sr-policy-nrp\]](#) to optimize the specific VPN traffic in the NRP topology while providing NRP shortest path forwarding for other VPN traffic.

4.2. NRP Modeling Design

As defined in [\[I-D.ietf-teas-ietf-network-slices\]](#), a network resource partition (NRP) is a collection of resources in the underlay network. An NRP can have a dedicated topology or can use a shared topology with other NRPs.

Therefore, an NRP is modeled as network topology defined in [\[RFC8345\]](#) with augmentations. A new network type "nrp" is defined. A network topology data instance containing the nrp network type, indicates an NRP instance. The [Figure 3](#) shows the relationship between this model and other topology models.

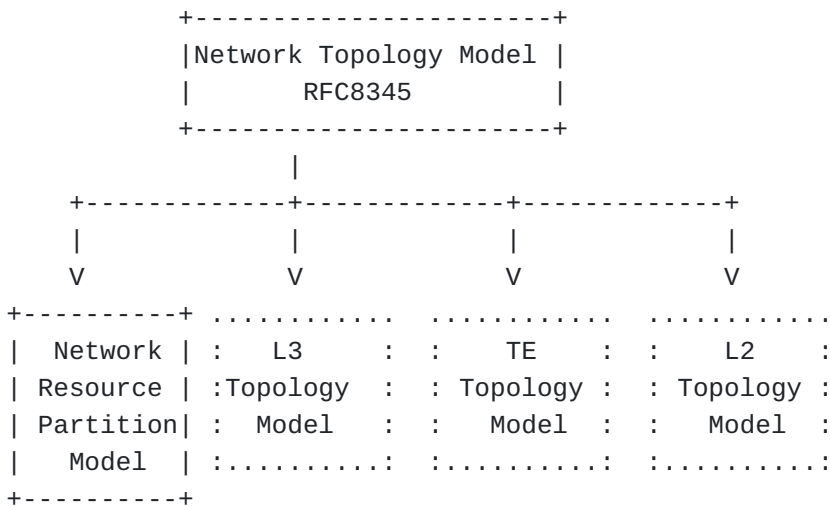


Figure 3: NRP Model Relationship

The container "nrp" under 'network' of [\[RFC8345\]](#) defines global parameters for an NRP, which defines NRP partition type, NRP topology generation method, and the specific control plane and data plane mechanisms of an NRP. And also, the traffic steering policy of the NRP may include a dynamic color based policies or an ACL-based static ones.

The NRP partition type is used to describe multiple NRP resource partition methods, for example, no partition, control plane resource partition, data plane resource partition, or a combination of two types.

As an NRP may consist of the entire or a subset of links in the underlay network, there are various methods to generate NRP topology, which include:

The NRP with a subset of links in the underlay network, which has the same topology as the pre-built L3 topology, MT topology, flexalgo, or TE topology, and also has the same resource reservation requirements. The topology definition may come directly from the topology defined by "control plane".

For other NRPs that require a dedicated topology, "nrp-topology-group" is used to configure the selected links from the base topology. Generally, the base topology refers to the underlay network topology. An NRP can be configured with one or more "nrp-topology-group" to create topology resources required by the NRP. For example, if an NRP needs to reserve the same bandwidth for a groups of links, the same "group-id" can be assigned to the links and "bandwidth-reservation" is specified, such as access network link group, aggregation network link group, etc. If some inter-domain links, have multiple bandwidth reservation requirements, they can also be classified into a group. Then, each link can override the bandwidth reservation of the group bandwidth reservation.

As discussed in [[I-D.ietf-teas-nrp-scalability](#)], an NRP could have multiple control plane implementation options. For a better network scalability, an NRP does not require an independent distributed control protocol instance or a independent centralized control plane instance, that is, multiple NRPs can share a same control plane instance. Thus, an NRP can use a predefined native or abstract TE topology by referring to a TE network instance or a predefined control protocol instance by referring to Layer3 network instance.

In addition to global NRP parameters, each NRP instance also consists of a set of nodes and a set of links, which have different attributes that represent the allocated resources or the operational status of the NRP. An NRP could support several data plane resource partition methods, which are defined by 'link-partition-type' under an NRP link, which can further be supported by FlexE or independent queue techniques.

There are multiple modes of NRP operations to be supported as follows:

*NRP instantiation: Depending on the slice services types and also network status, there can be two types of approaches. One method is to create an NRP instance before the network controller processes the IETF Network Slice service request. Another one is

that the network controller may start creating an NRP instance while configuring the IETF Network Slice service request.

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

*NRP Deletion: If the NSC determines that no slice service is using an NRP, the NSC can delete the NRP instance.

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

5. Description of NRP YANG Module

The description of the NRP data nodes are as follows:

*"nrp-id": Is an identifier that is used to uniquely identify an NRP instance within the network scope.

*NRP partition type: Refers to control plane resource partition, data plane resource partition, or a combination of two types.

*NRP resources reservation: The nodes and links represent the network resource allocated for an NRP instance. 'bandwidth-reservation' specifies the bandwidth allocated to an NRP instance, or is overridden by the configuration of the NRP link. 'link-partition-type' specifies the resource partition types of the physical interfaces associated with an NRP link.

*NRP control plane: An NRP can use Multi-Topology Routing (MTR) or Flex-algo to refer to the IGP instance to generate its own NRP-specific forwarding tables. Multi-Topology Routing (MTR) is defined in [[RFC4915](#)], [[RFC5120](#)], and [[I-D.ietf-lsr-isis-sr-vtn-mt](#)] or Flex-algo is defined in [[I-D.ietf-lsr-flex-algo](#)].

*NRP data plane: Defines the data plane mechanism and the NRP identifier of the network domain managed by the network controller. The data plane mechanism could be based on MPLS or IPv6 forwarding. The container "data plane" is used to specify the NRP data plane encapsulation types and values that are used to identify NRP-specific network resources. The NRP data plane identifier is defined, e.g., in [[I-D.ietf-spring-sr-for-enhanced-vpn](#)] and [[I-D.dong-6man-enhanced-vpn-vtn-id](#)].

*NRP steering policy: The leaf-list "color-id" is used for dynamic traffic steering based on SR policy of an NRP and The leaf-list "acl-ref" is used for common traffic steering.

*NRP topology group: The list "nrp-topology-group" is used to explicitly select subset of links of a underlay topology.

6. NRP YANG Module Tree

```

module: ietf-nrp
augment /nw:networks/nw:network/nw:network-types:
  +--rw nrp!
augment /nw:networks/nw:network:
  +--rw nrp
    +--rw nrp-id?          uint32
    +--rw nrp-name?        string
    +--rw partition-type?  identityref
    +--rw resource-reservation
      | +--rw link-partition-type?  identityref
      | +--rw bandwidth-reservation
      |   +--rw (bandwidth-type)?
      |     +--:(bandwidth-value)
      |       | +--rw bandwidth-value?    uint64
      |       +--:(bandwidth-percentage)
      |         +--rw bandwidth-percent?  rt-types:percentage
    +--rw control-plane
      | +--rw multi-topology-id?    uint32
      | +--rw algo-id?              uint32
      | +--rw sharing?              boolean
      | +--rw topology-change-is-allowed?  boolean
    +--rw data-plane
      | +--rw global-resource-identifier
      | | +--rw ipv6
      | | | +--rw value?    inet:ipv6-address
      | | +--rw mpls
      | |   +--rw label?    uint32
      | +--rw nrp-aware
      |   +--rw srv6!
      |   +--rw sr-mpls!
    +--rw steering-policy
      | +--rw color-id*    uint32
      | +--rw acl-ref*     -> /acl:acls/acl/name
    +--rw topology-group* [group-id]
      +--rw group-id          string
      +--rw base-topology-ref
      | +--rw network-ref?
      |   -> /nw:networks/network/network-id
    +--rw links* [link-ref]
      | +--rw link-ref    leafref
    +--rw resource-reservation
      +--rw link-partition-type?  identityref
      +--rw bandwidth-reservation
        +--rw (bandwidth-type)?
          +--:(bandwidth-value)
            | +--rw bandwidth-value?    uint64
          +--:(bandwidth-percentage)
            +--rw bandwidth-percent?
              rt-types:percentage

```

```

augment /nw:networks/nw:network/nw:node:
  +--ro nrp
    +--ro data-plane-id
      +--ro ipv6?      srv6-sid
      +--ro sr-mpls?   rt-types:mpls-label
augment /nw:networks/nw:network/nt:link:
  +--rw nrp
    +--rw bandwidth-value?      uint64
    +--ro link-partition-type?  identityref
    +--ro data-plane-id
      | +--ro ipv6?      srv6-sid
      | +--ro sr-mpls?   rt-types:mpls-label
    +--ro statistics
      +--ro admin-status?
        |      te-types:te-admin-status
      +--ro oper-status?
        |      te-types:te-oper-status
      +--ro one-way-available-bandwidth?
        |      rt-types:bandwidth-ieee-float32
      +--ro one-way-utilized-bandwidth?
        |      rt-types:bandwidth-ieee-float32
      +--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* [nrp-id]
    +--rw nrp-id      uint32
    +--ro nrp
      +--ro data-plane-id
        +--ro ipv6?      srv6-sid
        +--ro sr-mpls?   rt-types:mpls-label
augment /nw:networks/nw:network/nt:link:
  +--rw nrps* [nrp-id]
    +--rw nrp-id      uint32
    +--ro link-partition-type?  identityref
    +--ro data-plane-id
      | +--ro ipv6?      srv6-sid
      | +--ro sr-mpls?   rt-types:mpls-label
    +--ro statistics
      +--ro admin-status?
        |      te-types:te-admin-status
      +--ro oper-status?
        |      te-types:te-oper-status
      +--ro one-way-available-bandwidth?
        |      rt-types:bandwidth-ieee-float32
      +--ro one-way-utilized-bandwidth?
        |      rt-types:bandwidth-ieee-float32
      +--ro one-way-min-delay?      uint32

```

+-ro one-way-max-delay?	uint32
+-ro one-way-delay-variation?	uint32
+-ro one-way-packet-loss?	decimal64

7. NRP Yang Module

```
<CODE BEGINS> file "ietf-nrp@2022-09-26.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";
  }
  import ietf-network-topology {
    prefix nt;
    reference
      "RFC 8345: A YANG Data Model for Network Topologies";
  }
  import ietf-routing-types {
    prefix rt-types;
    reference
      "RFC 8294: Common YANG Data Types for the Routing Area";
  }
  import ietf-te-types {
    prefix te-types;
    reference
      "RFC 8776: Traffic Engineering Common YANG Types";
  }
  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)";
  }

  organization
    "IETF TEAS Working Group";
  contact
    "
      WG Web: <http://tools.ietf.org/wg/teas/>
      WG List:<mailto:teas@ietf.org>
    "

```



```

    Editor: Bo Wu <lane.wubo@huawei.com>
           : Dhruv Dhody <dhruv.ietf@gmail.com>;
description
    "This YANG module defines a network data module for
    NRP(Network Resource Partition).

    Copyright (c) 2022 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.";

revision 2022-09-26 {
    description
        "This is the initial version of NRP YANG model.";
    reference
        "RFC XXX: A YANG Data Model for Network Resource Partition";
}

typedef srv6-sid {
    type inet:ipv6-prefix;
    description
        "Defines an SRv6 Segment ID (SID). That is,
        an IPv6 address explicitly associated with the segment.";
    reference
        "RFC 8402: Segment Routing Architecture";
}

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

identity nrp-control-plane-partition {
    base nrp-partition-type;
    description
        "Identity for control plane partition.";
}

identity nrp-data-plane-partition {
    base nrp-partition-type;
    description

```

```

    "Identity for data plane partition.";
}

identity nrp-hybrid-plane-partition {
    base nrp-partition-type;
    description
        "Identity for both planes partition.";
}

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

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

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

/*
 * Groupings
 */

grouping nrp-resource-reservation {
    description
        "Grouping for NRP resource reservation.";
    container resource-reservation {
        description
            "Container for NRP resource reservation.";
        leaf link-partition-type {
            type identityref {
                base nrp-link-partition-type;
            }
            description
                "Indicates the resource reservation type of an NRP link.";
        }
        container bandwidth-reservation {
            description
                "Container for NRP bandwidth reservation.";
            choice bandwidth-type {
                description
                    "Choice of bandwidth reservation type.";
            }
        }
    }
}

```

```

    case bandwidth-value {
      leaf bandwidth-value {
        type uint64;
        units "bps";
        description
          "Bandwidth allocation for the NRP as absolute value.";
      }
    }
    case bandwidth-percentage {
      leaf bandwidth-percent {
        type rt-types:percentage;
        description
          "Bandwidth allocation for the NRP as a percentage
            of a link.";
      }
    }
  }
}
}

grouping nrp-control-plane-attributes {
  description
    "Grouping for NRP control plane attributes.";
  container control-plane {
    description
      "The container of NRP control plane mechanisms.";
    leaf multi-topology-id {
      type uint32;
      description
        "Indicates the MT-id of the NRP distributed control plane.";
    }
    leaf algo-id {
      type uint32;
      description
        "Indicates the algo-id of the NRP distributed control plane.";
    }
    leaf sharing {
      type boolean;
      default "true";
      description
        "'true' if the the NRP distributed control plane
          can be shared with other NRPs;
          'false' if the the NRP distributed control plane
          is dedicated to this NRP.";
    }
    leaf topology-change-is-allowed {
      type boolean;
      description

```

```

        "true - topology change is allowed,
        false - topology change is disallowed.";
    }
}
}

grouping nrp-data-plane-attributes {
    description
        "Grouping for NRP data plane attributes.";
    container data-plane {
        description
            "The data plane mechanisms of an NRP. The forwarding plane
            could be MPLS, IPv6, SRv6, or SR-MPLS.";
        container global-resource-identifier {
            description
                "The container of global NRP data-plane ID.";
            container ipv6 {
                description
                    "The container of IPv6 based NRP data-plane identifier.";
                leaf value {
                    type inet:ipv6-address;
                    description
                        "Indicates the IPv6 NRP data-plane identifier.";
                }
            }
        }
        container mpls {
            description
                "The container of MPLS based NRP data-plane identifier.";
            leaf label {
                type uint32;
                description
                    "Indicates MPLS metadata values to identify MPLS NRP
                    data plane identifier, e.g. Ancillary data.";
            }
        }
    }
}
container nrp-aware {
    description
        "The container of SR based NRP data-plane identifier.";
    container srv6 {
        presence "Enables SRv6 data plane type.";
        description
            "The container of SRv6 based NRP data-plane identifier.";
    }
    container sr-mpls {
        presence "Enables SR MPLS data plane type.";
        description
            "The container of SR MPLS based NRP data-plane identifier.";
    }
}

```

```

    }
  }
}

grouping nrp-traffic-steering-policy {
  description
    "The grouping of the NRP traffic steering policy.";
  container steering-policy {
    description
      "The container of a policy set
        matching an NRP traffic classifier.";
    leaf-list color-id {
      type uint32;
      description
        "A list of color ID for NRP traffic steering based on
          SR policy.";
    }
    leaf-list acl-ref {
      type leafref {
        path "/acl:acls/acl:acl/acl:name";
      }
      description
        "A list of ACL for NRP traffic classification.";
    }
  }
}

grouping nrp-aware-id {
  description
    "The grouping of NRP aware dataplane ID.";
  container data-plane-id {
    config false;
    description
      "The container of NRP data plane identifier.";
    leaf ipv6 {
      type srv6-sid;
      description
        "Indicates the SRv6 SID value as the NRP data plane
          identifier.";
    }
    leaf sr-mpls {
      type rt-types:mpls-label;
      description
        "Indicates the SR MPLS ID value as the NRP data plane
          identifier.";
    }
  }
}

```

```

grouping nrp-topology {
  description
    "Grouping for NRP 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 links {
      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 nrp-resource-reservation;
  }
}

```

```

grouping nrp-topology-attributes {
  description
    "NRP global attributes.";
  container nrp {
    description
      "Containing NRP topology attributes.";
    leaf nrp-id {
      type uint32;
      description
        "NRP identifier.";
    }
    leaf nrp-name {

```

```

        type string;
        description
            "NRP Name.";
    }
    leaf partition-type {
        type identityref {
            base nrp-partition-type;
        }
        description
            "Indicates the resource partition type of the NRP, such as
            control plane partition, data plane partition,
            or no partition.";
    }
    uses nrp-resource-reservation;
    uses nrp-control-plane-attributes;
    uses nrp-data-plane-attributes;
    uses nrp-traffic-steering-policy;
    uses nrp-topology;
}
// nrp
}

// nrp-node-attributes

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

// nrp-node-attributes

grouping nrp-link-states {
    description
        "NRP link scope states.";
    leaf link-partition-type {
        type identityref {
            base nrp-link-partition-type;
        }
        config false;
        description
            "Indicates the resource partition type of an NRP link.";
    }
    uses nrp-aware-id;
}

```

```

    uses nrp-statistics-per-link;
}

// one-way-performance-metrics

grouping one-way-performance-bandwidth {
    description
        "Grouping for one-way performance bandwidth.";
    leaf one-way-available-bandwidth {
        type rt-types:bandwidth-ieee-float32;
        units "bytes per second";
        default "0x0p0";
        description
            "Available bandwidth that is defined to be NRP link
            bandwidth minus bandwidth utilization. For a
            bundled link, available bandwidth is defined to be the
            sum of the component link available bandwidths.";
    }
    leaf one-way-utilized-bandwidth {
        type rt-types:bandwidth-ieee-float32;
        units "bytes per second";
        default "0x0p0";
        description
            "Bandwidth utilization that represents the actual
            utilization of the link (i.e. as measured in the router).
            For a bundled link, bandwidth utilization is defined to
            be the sum of the component link bandwidth
            utilizations.";
    }
}

// nrp-link-statistics

grouping nrp-statistics-per-link {
    description
        "Statistics attributes per NRP link.";
    container statistics {
        config false;
        description
            "Statistics for NRP link.";
        leaf admin-status {
            type te-types:te-admin-status;
            description
                "The administrative state of the link.";
        }
        leaf oper-status {
            type te-types:te-oper-status;
            description
                "The current operational state of the link.";
        }
    }
}

```



```

    }
    uses one-way-performance-bandwidth;
    uses te-packet-types:one-way-performance-metrics-packet;
  }
}

grouping nrp-augment {
  description
    "Augmentation for NRPs.";
  container nrp {
    presence "NRP support";
    description
      "Indicates NRP support.";
  }
  // nrp
}

// nrp-augment

augment "/nw:networks/nw:network/nw:network-types" {
  description
    "Defines the NRP topology type.";
  container nrp {
    presence "Indicates NRP topology";
    description
      "The presence identifies the NRP type.";
  }
}

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

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

```

```

augment "/nw:networks/nw:network/nt:link" {
  when '../nw:network-types/nrp:nrp' {
    description
      "Augment only for NRP topology.";
  }
  description
    "Augment link configuration and state.";
  container nrp {
    description
      "Containing NRP attributes.";
    leaf bandwidth-value {
      type uint64;
      units "bps";
      description
        "Bandwidth allocation for the NRP as absolute value.";
    }
    uses nrp-link-states;
  }
}

```

```

augment "/nw:networks/nw:network/nw:node" {
  description
    "Augment node with NRP aware attributes.";
  list nrps {
    key "nrp-id";
    description
      "List of NRPs.";
    leaf nrp-id {
      type uint32;
      description
        "NRP identifier";
    }
    uses nrp-node-attributes;
  }
}

```

```

augment "/nw:networks/nw:network/nt:link" {
  description
    "Augment link with NRP aware attributes.";
  list nrps {
    key "nrp-id";
    description
      "List of NRPs.";
    leaf nrp-id {
      type uint32;
      description
        "NRP identifier";
    }
    uses nrp-link-states;
  }
}

```

}
}
}

<CODE ENDS>

8. Security Considerations

The YANG model 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.

9. 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.

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
Prefix: nrp
Reference: RFC XXXX

10. Contributor

Zhenbin Li
Huawei

Email: lizhenbin@huawei.com

Jie Dong
Huawei

Email: jie.dong@huawei.com

11. References

11.1. Normative References

- [RFC3688] Mealling, M., "The IETF XML Registry", BCP 81, RFC 3688, DOI 10.17487/RFC3688, January 2004, <<https://www.rfc-editor.org/info/rfc3688>>.
- [RFC4915] Psenak, P., Mirtorabi, S., Roy, A., Nguyen, L., and P. Pillay-Esnault, "Multi-Topology (MT) Routing in OSPF", RFC 4915, DOI 10.17487/RFC4915, June 2007, <<https://www.rfc-editor.org/info/rfc4915>>.
- [RFC5120] Przygienda, T., Shen, N., and N. Sheth, "M-ISIS: Multi Topology (MT) Routing in Intermediate System to Intermediate Systems (IS-ISs)", RFC 5120, DOI 10.17487/RFC5120, February 2008, <<https://www.rfc-editor.org/info/rfc5120>>.
- [RFC6241] Enns, R., Ed., Bjorklund, M., Ed., Schoenwaelder, J., Ed., and A. Bierman, Ed., "Network Configuration Protocol (NETCONF)", RFC 6241, DOI 10.17487/RFC6241, June 2011, <<https://www.rfc-editor.org/info/rfc6241>>.
- [RFC6242] Wasserman, M., "Using the NETCONF Protocol over Secure Shell (SSH)", RFC 6242, DOI 10.17487/RFC6242, June 2011, <<https://www.rfc-editor.org/info/rfc6242>>.
- [RFC7950] Bjorklund, M., Ed., "The YANG 1.1 Data Modeling Language", RFC 7950, DOI 10.17487/RFC7950, August 2016, <<https://www.rfc-editor.org/info/rfc7950>>.

[RFC7951]

Lhotka, L., "JSON Encoding of Data Modeled with YANG", RFC 7951, DOI 10.17487/RFC7951, August 2016, <<https://www.rfc-editor.org/info/rfc7951>>.

[RFC8040]

Bierman, A., Bjorklund, M., and K. Watsen, "RESTCONF Protocol", RFC 8040, DOI 10.17487/RFC8040, January 2017, <<https://www.rfc-editor.org/info/rfc8040>>.

[RFC8340]

Bjorklund, M. and L. Berger, Ed., "YANG Tree Diagrams", BCP 215, RFC 8340, DOI 10.17487/RFC8340, March 2018, <<https://www.rfc-editor.org/info/rfc8340>>.

[RFC8341]

Bierman, A. and M. Bjorklund, "Network Configuration Access Control Model", STD 91, RFC 8341, DOI 10.17487/RFC8341, March 2018, <<https://www.rfc-editor.org/info/rfc8341>>.

[RFC8345]

Clemm, A., Medved, J., Varga, R., Bahadur, N., Ananthakrishnan, H., and X. Liu, "A YANG Data Model for Network Topologies", RFC 8345, DOI 10.17487/RFC8345, March 2018, <<https://www.rfc-editor.org/info/rfc8345>>.

[RFC8446]

Rescorla, E., "The Transport Layer Security (TLS) Protocol Version 1.3", RFC 8446, DOI 10.17487/RFC8446, August 2018, <<https://www.rfc-editor.org/info/rfc8446>>.

11.2. Informative References

[I-D.dong-6man-enhanced-vpn-vtn-id]

Dong, J., Li, Z., Xie, C., Ma, C., and G. Mishra, "Carrying Virtual Transport Network (VTN) Identifier in IPv6 Extension Header", Work in Progress, Internet-Draft, draft-dong-6man-enhanced-vpn-vtn-id-06, 24 October 2021, <<https://www.ietf.org/archive/id/draft-dong-6man-enhanced-vpn-vtn-id-06.txt>>.

[I-D.dong-idr-sr-policy-nrp]

Dong, J., Hu, Z., and R. Pang, "BGP SR Policy Extensions for Network Resource Partition", Work in Progress, Internet-Draft, draft-dong-idr-sr-policy-nrp-01, 11 July 2022, <<https://www.ietf.org/archive/id/draft-dong-idr-sr-policy-nrp-01.txt>>.

[I-D.ietf-lsr-flex-algo]

Psenak, P., Hegde, S., Filsfils, C., Talaulikar, K., and A. Gulko, "IGP Flexible Algorithm", Work in Progress, Internet-Draft, draft-ietf-lsr-flex-algo-23, 19 September 2022, <<https://www.ietf.org/archive/id/draft-ietf-lsr-flex-algo-23.txt>>.

[I-D.ietf-lsr-isis-sr-vtn-mt]

Xie, C., Ma, C., Dong, J., and Z. Li, "Using IS-IS Multi-Topology (MT) for Segment Routing

based Virtual Transport Network", Work in Progress, Internet-Draft, draft-ietf-lsr-isis-sr-vtn-mt-03, 10 July 2022, <<https://www.ietf.org/archive/id/draft-ietf-lsr-isis-sr-vtn-mt-03.txt>>.

[I-D.ietf-spring-sr-for-enhanced-vpn]

Dong, J., Bryant, S., Miyasaka, T., Zhu, Y., Qin, F., Li, Z., and F. Clad, "Segment Routing based Virtual Transport Network (VTN) for Enhanced VPN", Work in Progress, Internet-Draft, draft-ietf-spring-sr-for-enhanced-vpn-03, 8 September 2022, <<https://www.ietf.org/archive/id/draft-ietf-spring-sr-for-enhanced-vpn-03.txt>>.

[I-D.ietf-teas-ietf-network-slices]

Farrel, A., Drake, J., Rokui, R., Homma, S., Makhijani, K., Contreras, L. M., and J. Tantsura, "Framework for IETF Network Slices", Work in Progress, Internet-Draft, draft-ietf-teas-ietf-network-slices-14, 3 August 2022, <<https://www.ietf.org/archive/id/draft-ietf-teas-ietf-network-slices-14.txt>>.

[I-D.ietf-teas-nrp-scalability]

Dong, J., Li, Z., Gong, L., Yang, G., Guichard, J. N., Mishra, G., Qin, F., Saad, T., and V. P. Beeram, "Scalability Considerations for Network Resource Partition", Work in Progress, Internet-Draft, draft-ietf-teas-nrp-scalability-00, 11 July 2022, <<https://www.ietf.org/archive/id/draft-ietf-teas-nrp-scalability-00.txt>>.

[I-D.ietf-teas-ns-ip-mpls]

Saad, T., Beeram, V. P., Dong, J., Wen, B., Ceccarelli, D., Halpern, J., Peng, S., Chen, R., Liu, X., Contreras, L. M., Rokui, R., and L. Jalil, "Realizing Network Slices in IP/MPLS Networks", Work in Progress, Internet-Draft, draft-ietf-teas-ns-ip-mpls-00, 16 June 2022, <<https://www.ietf.org/archive/id/draft-ietf-teas-ns-ip-mpls-00.txt>>.

[RFC8309] Wu, Q., Liu, W., and A. Farrel, "Service Models Explained", RFC 8309, DOI 10.17487/RFC8309, January 2018, <<https://www.rfc-editor.org/info/rfc8309>>.

[RFC9182] Barguil, S., Gonzalez de Dios, O., Ed., Boucadair, M., Ed., Munoz, L., and A. Aguado, "A YANG Network Data Model

for Layer 3 VPNs", RFC 9182, DOI 10.17487/RFC9182,
February 2022, <<https://www.rfc-editor.org/info/rfc9182>>.

[RFC9291] Boucadair, M., Ed., Gonzalez de Dios, O., Ed., Barguil, S., and L. Munoz, "A YANG Network Data Model for Layer 2 VPNs", RFC 9291, DOI 10.17487/RFC9291, September 2022, <<https://www.rfc-editor.org/info/rfc9291>>.

Appendix A. An Example

This section contains an example of an instance data tree in JSON encoding [RFC7951]. The example instantiates ietf-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.

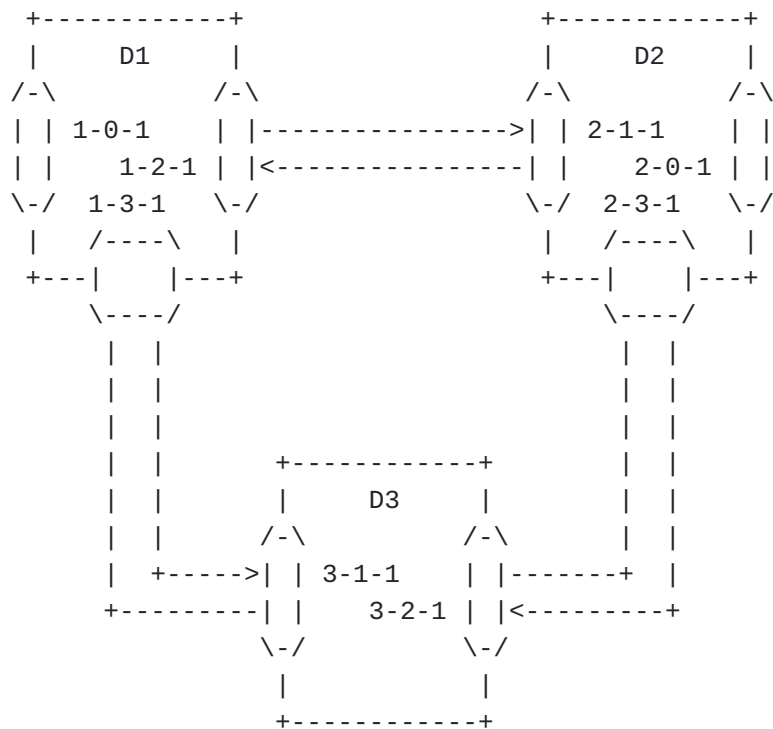


Figure 4: An NRP Instance Example

The corresponding NRP instance data tree is depicted below:


```

{
  "ietf-network:networks": {
    "network": [
      {
        "network-types": {
          "ietf-nrp:nrp": {}
        },
        "network-id": "foo:nrp-example",
        "ietf-nrp:nrp": {
          "nrp-id": "1",
          "nrp-name": "NRP1",
          "partition-type": "nrp-hybrid-plane-partition",
          "resource-reservation": {
            "link-partition-type": "virtual-sub-interface-partition",
            "bandwidth-reservation": {
              "bandwidth-value": "10000"
            }
          },
        },
        "control-plane": {
          "distributed-control": {}
        },
        "data-plane": {
          "global-resource-identifier": {
            "nrp-dataplane-ipv6-type": {
              "nrp-dp-value": "100"
            }
          }
        },
        "steering-policy": {
          "color-id": "100"
        },
        "nrp-topology-group": [
          {
            "group-id": "access-group",
            "base-topology-ref": {
              "network-ref": "native-topology"
            },
            "link": [
              {
                "link-ref": "D1,1-2-1,D2,2-1-1"
              },
              {
                "link-ref": "D2,2-1-1,D1,1-2-1"
              },
              {
                "link-ref": "D1,1-3-1,D3,3-1-1"
              },
              {
                "link-ref": "D3,3-1-1,D1,1-3-1"
              }
            ]
          }
        ]
      }
    ]
  }
}

```

```
    },
    {
      "link-ref": "D2,2-3-1,D3,3-2-1"
    },
    {
      "link-ref": "D3,3-2-1,D2,2-3-1"
    }
  ]
}
]
}
]
}
]
}
]
}
```

Figure 5: Instance data tree

Authors' Addresses

Bo Wu
Huawei Technologies
101 Software Avenue, Yuhua District
Nanjing
Jiangsu, 210012
China

Email: lane.wubo@huawei.com

Dhruv Dhody
Huawei Technologies
Divyashree Techno Park
Bangalore 560066
Karnataka
India

Email: dhruv.ietf@gmail.com

Mohamed Boucadair
Orange
Rennes 35000
France

Email: mohamed.boucadair@orange.com

Ying Cheng
China Unicom
Beijing
China

Email: chengying10@chinaunicom.cn

Liyan Gong
China Mobile
Beijing
China

Email: gongliyan@chinamobile.com