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               I2NSF Registration Interface YANG Data Model
                 draft-ietf-i2nsf-registration-interface-dm-02

Abstract

   This document defines an information model and a YANG data model for
   Interface to Network Security Functions (I2NSF) Registration
   Interface between Security Controller and Developer's Management
   System (DMS). The objective of these information and data models is
   to support NSF capability registration and query via I2NSF
   Registration Interface.

Editorial Note (To be removed by RFC Editor)

   Please update these statements within the document with the RFC
   number to be assigned to this document:

      "This version of this YANG module is part of RFC XXXX;"

      "RFC XXXX: I2NSF Registration Interface YANG Data Model"

      "reference: RFC XXXX"

   Please update the "revision" date of the YANG module.

Status of This Memo

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

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   material or to cite them other than as "work in progress."

   This Internet-Draft will expire on September 12, 2019.

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1. Introduction

   A number of network security functions may exist in Interface to
   Network Security Functions (I2NSF) framework [RFC8329]. Since these
   NSFs likely have different security capabilities, it is important to
   register the security capabilities of each NSF into the security
   controller. In addition, it is required to search NSFs of some
   required security capabilities on demand. As an example, if
   additional security capabilities are required to serve some security
   service request(s) from an I2NSF user, the security controller should
   be able to request the DMS for NSFs that have the required security
   capabilities.

   This document describes an information model (see Section 5) and a
   YANG [RFC7950] data model (see Section 6) for the I2NSF Registration
   Interface [RFC8329] between the security controller and the
   developer's management system (DMS) to support NSF capability
   registration and query and NSF initiation request via the
   registration interface. It also describes the operations which
   should be performed by the security controller and the DMS via the
   Registration Interface using the defined model.

2. Requirements Language

   The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
   "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this
   document are to be interpreted as described in [RFC2119].

3. Terminology

   This document uses the following terms defined in
   [i2nsf-terminology], [capability-im], [RFC8329],
   [nsf-triggered-steering], [supa-policy-data-model], and
   [supa-policy-info-model]

o Network Security Function (NSF): A function that is responsible
   for specific treatment of received packets. A Network Security
   Function can act at various layers of a protocol stack (e.g., at
   the network layer or other OSI layers). Sample Network Security
   Service Functions are as follows: Firewall, Intrusion Prevention/
   Detection System (IPS/IDS), Deep Packet Inspection (DPI),
   Application Visibility and Control (AVC), network virus and
   malware scanning, sandbox, Data Loss Prevention (DLP), Distributed
   Denial of Service (DDoS) mitigation and TLS proxy.
   [nsf-triggered-steering]

o Data Model: A data model is a representation of concepts of
   interest to an environment in a form that is dependent on data
   repository, data definition language, query language,
   implementation language, and protocol. [supa-policy-info-model]

o Information Model: An information model is a representation of
   concepts of interest to an environment in a form that is
   independent of data repository, data definition language, query
   language, implementation language, and protocol.
   [supa-policy-info-model]

o YANG: This document follows the guidelines of [RFC6087], uses the
   common YANG types defined in [RFC6991], and adopts the Network
   Management Datastore Architecture (NMDA). The meaning of the
   symbols in tree diagrams is defined in [RFC8340].

4. Objectives

o Registering NSFs to I2NSF framework: Developer's Management System
   (DMS) in I2NSF framework is typically run by an NSF vendor, and
   uses Registration Interface to provide NSFs developed by the NSF
   vendor to Security Controller. DMS registers NSFs and their
   capabilities to I2NSF framework through Registration Interface.
   For the registered NSFs, Security Controller maintains a catalog
   of the capabilities of those NSFs.

o Updating the capabilities of registered NSFs: After an NSF is
   registered into Security Controller, some modifications on the
   capability of the NSF may be required later. In this case, DMS
   uses Registration Interface to update the capability of the NSF,
   and this update should be reflected on the catalog of NSFs.

o Querying DMS about some required capabilities: Security Controller
   may need some additional capabilities to serve the security
   service request from an I2NSF user, but none of the registered
   NSFs has the required capabilities. In this case, Security

Controller may query DMS about NSF(s) that can provide the
required capabilities via Registration Interface.

5. Information Model

The I2NSF registration interface is used by Security Controller and
Developer's Management System (DMS) in I2NSF framework. The
following summarizes the operations done through the registration
interface:

1) DMS registers NSFs and their capabilities to Security Controller
    via the registration interface. DMS also uses the registration
    interface to update the capabilities of the NSFs registered
    previously.

2) In case that Security Controller fails to find any registered NSF
    that can provide some required capabilities, Security Controller
    queries DMS about NSF(s) having the required capabilities via the
    registration interface.

Figure 1 shows the information model of the I2NSF registration
interface, which consists of three submodels: NSF capability
registration, and NSF capability query. Each submodel is used for
the operations listed above. The remainder of this section will
provide more in-depth explanations of each submodel.

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          I2NSF Registration Interface Information Model   |
|                                                          |
|         +-+-+-+-+-+-+-+-+-+-+   +-+-+-+-+-+-+-+-+-+-+      |
|         | NSF Capability   |   | NSF Capability   |      |
|         | Registration     |   | Query            |      |
|         +-+-+-+-+-+-+-+-+-+-+   +-+-+-+-+-+-+-+-+-+-+      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
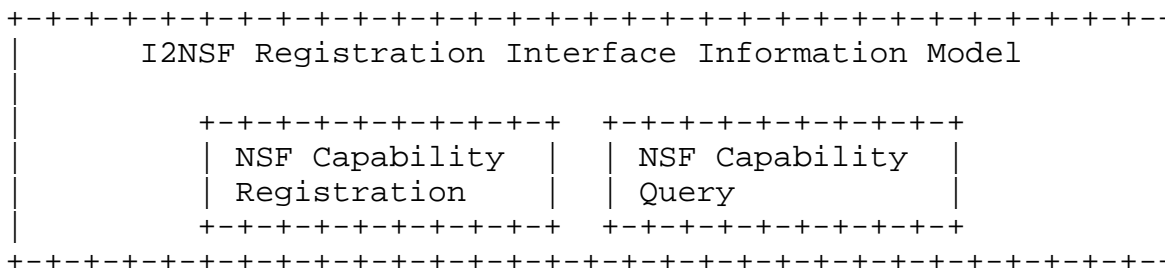
Figure 1: I2NSF Registration Interface Information Model

5.1. NSF Capability Registration

This submodel is used by DMS to register an NSF to Security
Controller. Figure 2 shows how this submodel is constructed. The
most important part in Figure 2 is the NSF capability, and this
specifies the set of capabilities that the NSF to be registered can
offer. The NSF Name contains a unique name of this NSF with the
specified set of capabilities. When registering the NSF, DMS
additionally includes the network access information of the NSF which
is required to enable network communications with the NSF.

The following will further explain the NSF capability information and
the NSF access information in more detail.

```
                        +-+-+-+-+-+-+-+-+-+
                        | NSF Capability  |
                        | Registration    |
                        +-+-+-+-^-+-+-+-+-+
                                |
            +-------------------+------------------+
            |                   |                  |
            |                   |                  |
    +-+-+-+-+-+-+-+     +-+-+-+-+-+-+-+-+-+    +-+-+-+-+-+-+-+-+
    |    NSF      |     | NSF Capability|    | NSF Access   |
    |    Name     |     | Information   |    | Information   |
    +-+-+-+-+-+-+-+     +-+-+-+-+-+-+-+-+-+    +-+-+-+-+-+-+-+-+
```
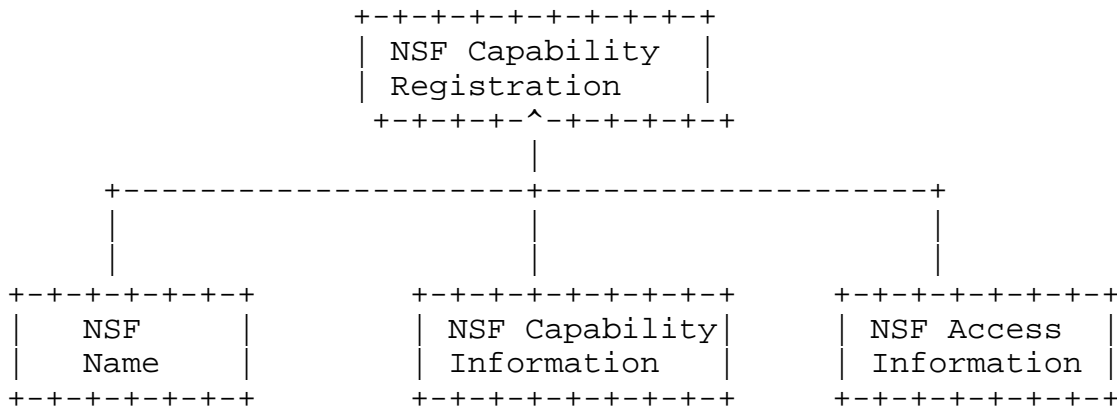
Figure 2: NSF Capability Registration Sub-Model

5.1.1. NSF Capability Information

   NSF Capability Information basically describes the security
   capabilities of an NSF. In Figure 3, we show capability objects of
   an NSF. Following the information model of NSF capabilities defiend
   in [capability-im], we share the same security capabilities: Network
   Security Capabilities, Content Security Capabilities, and Attack
   Mitigation Capabilities. Also, NSF Capability Information
   additionally contains the performance capabilities of an NSF as shown
   in Figure 3.

```
                    +-+-+-+-+-+-+-+-+-+
                    | NSF Capability  |
                    | Information     |
                    +-+-+-+-^-+-+-+-+-+
                            |
                            |
                 +----------------+-------+-------------+
                 |                        |             |
                 |                        |             |
         +-+-+-+-+-+-+-+-+-+      +-+-+-+-+-+-+-+-+-+    |
         |Network Security |      |Content Security |    |
         |   Capabilities  |      |   Capabilities  |    |
         +-+-+-+-+-+-+-+-+-+      +-+-+-+-+-+-+-+-+-+    |
                                                        |
                 +-----------------------+--------------+
                 |                       |
                 |                       |
         +-+-+-+-+-+-+-+-+-+      +-+-+-+-+-+-+-+-+-+
         |   Performance   |      |Attack Mitigation|
         |   Capabilities  |      |   Capabilities  |
         +-+-+-+-+-+-+-+-+-+      +-+-+-+-+-+-+-+-+-+
```
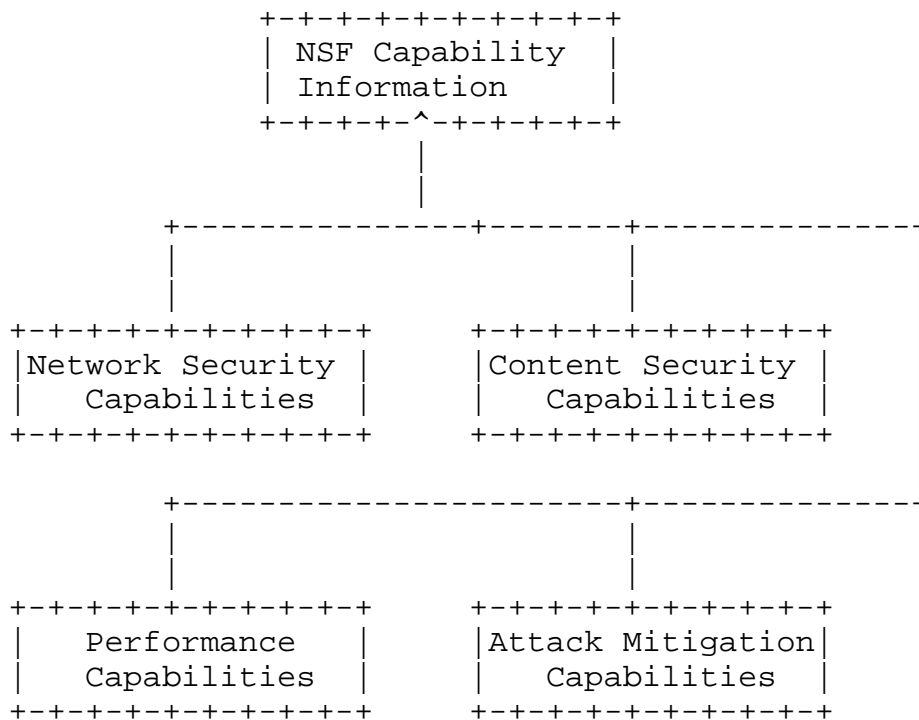
                  Figure 3: NSF Capability Information

5.1.1.1. Performance Capabilities

   This information represents the processing capability of an NSF.
   This information can be used to determine whether the NSF is in
   congestion by comparing this with the workload that the NSF currently
   undergoes. Moreover, this information can specify an available
   amount of each type of resources such as processing power which are
   available on the NSF. (The registration interface can control the
   usages and limitations of the created instance and make the
   appropriate request according to the status.) As illustrated in
   Figure 4, this information consists of two items: Processing and
   Bandwidth. Processing information describes the NSF's available
   processing power. Bandwidth describes the information about
   available network amount in two cases, outbound, inbound. This two
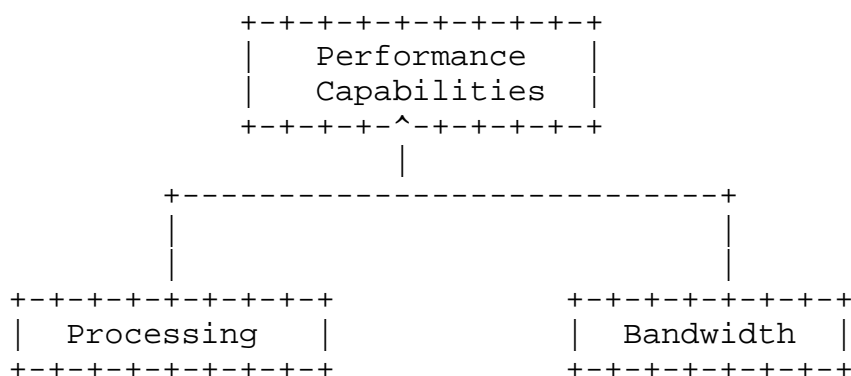   information can be used for the NSF's instance request.

```
                 +-+-+-+-+-+-+-+-+-+
                 |   Performance   |
                 |   Capabilities  |
                 +-+-+-+-^-+-+-+-+-+
                         |
            +----------------------------+
            |                            |
            |                            |
   +-+-+-+-+-+-+-+-+             +-+-+-+-+-+-+-+-+
   |  Processing   |             |   Bandwidth   |
   +-+-+-+-+-+-+-+-+             +-+-+-+-+-+-+-+-+
```

Figure 4: Performance Capability Overview

5.1.2. NSF Access Information

   NSF Access Information contains the followings that are required to
   communicate with an NSF: IPv4 address, IPv6 address, port number, and
   supported transport protocol(s) (e.g., Virtual Extensible LAN (VXLAN)
   [RFC 7348], Generic Protocol Extension for VXLAN (VXLAN-GPE)
   [draft-ietf-nvo3-vxlan-gpe], Generic Route Encapsulation (GRE),
   Ethernet etc.). In this document, NSF Access Information is used to
   identify a specific NSF instance (i.e. NSF Access Information is the
   signature(unique identifier) of an NSF instance in the overall
   system).

5.2. NSF Capability Query

   Security Controller may require some additional capabilities to serve
   the security service request from an I2NSF user, but none of the
   registered NSFs has the required capabilities. In this case,
   Security Controller makes a description of the required capabilities
   by using the NSF capability information sub-model in Section 5.1.1,
   and sends DMS a query about which NSF(s) can provide these
   capabilities.

6. Data Model

6.1. YANG Tree Diagram

   This section provides an overview of the YANG Tree diagram of the
   I2NSF registration interface.

6.1.1. Definition of Symbols in Tree Diagrams

   A simplified graphical representation of the data model is used in
   this section. The meaning of the symbols used in the following
   diagrams [RFC8431] is as follows:

      Brackets "[" and "]" enclose list keys.

      Abbreviations before data node names: "rw" means configuration
      (read-write) and "ro" state data (read-only).

      Symbols after data node names: "?" means an optional node and "*"
      denotes a "list" and "leaf-list".

      Parentheses enclose choice and case nodes, and case nodes are also
      marked with a colon (":").

      Ellipsis ("...") stands for contents of subtrees that are not
      shown.

6.1.2. I2NSF Registration Interface

```
        module : ietf-i2nsf-reg-interface
            +--rw nsf-capability-registration
            |  uses i2nsf-nsf-registrations

        rpcs :
            +---x nsf-capability-query
            |  uses i2nsf-nsf-capability-query
```

         Figure 5: YANG tree of I2NSF Registration Interface

   The I2NSF registration interface is used for the following purposes.
   Developer's Management System (DMS) registers NSFs and their
   capabilities into Security Controller via the registration interface.
   In case that Security Controller fails to find any NSF among the
   registered NSFs which can provide some required capabilities,
   Security Controller uses the registration interface to query DMS
   about NSF(s) having the required capabilities. The following
   sections describe the YANG data models to support these operations.

6.1.2.1. NSF Capability Registration

   This section expands the i2nsf-nsf-registrations in Figure 5.

```
       NSF Capability Registration
        +--rw i2nsf-nsf-registrations
           +--rw i2nsf-nsf-capability-registration*  [nsf-name]
              +--rw nsf-name                             string
              +--rw nsf-capability-info
              |  uses i2nsf-nsf-capability-info
              +--rw nsf-access-info
              |  uses i2nsf-nsf-access-info
```

Figure 6: YANG tree of NSF Capability Registration

When registering an NSF to Security Controller, DMS uses this module
to describe what capabilities the NSF can offer. DMS includes the
network access information of the NSF which is required to make a
network connection with the NSF as well as the capability description
of the NSF.

6.1.2.2. NSF Capability Query

This section expands the i2nsf-nsf-capability-query in Figure 5.

```
       NSF Capability Query
         +---x i2nsf-nsf-capability-query
            +---w input
            |  +---w query-i2nsf-capability-info
            |  |    uses ietf-i2nsf-capability
            +--ro output
               +--ro nsf-access-info
               |  uses i2nsf-nsf-access-info
```

Figure 7: YANG tree of NSF Capability Query

Security Controller may require some additional capabilities to
provide the security service requested by an I2NSF user, but none of
the registered NSFs has the required capabilities. In this case,
Security Controller makes a description of the required capabilities
using this module and then queries DMS about which NSF(s) can provide
these capabilities. Use NETCONF RPCs to send a NSF capability query.
Input data is query-i2nsf-capability-info and output data is nsf-
access-info. In Figure 7, the ietf-i2nsf-capability refers to the
module defined in [i2nsf-capability-dm].

6.1.3. NSF Capability Information

   This section expands the i2nsf-nsf-capability-info in Figure 6 and
   Figure 7.

```
        NSF Capability Information
          +--rw i2nsf-nsf-capability-info
            +--rw i2nsf-capability
            |   uses ietf-i2nsf-capability
            +--rw nsf-performance-capability
            |   uses i2nsf-nsf-performance-capability
```

        Figure 8: YANG tree of I2NSF NSF Capability Information

   In Figure 8, the ietf-i2nsf-capability refers to the module defined
   in [i2nsf-capability-dm]. The i2nsf-nsf-performance-capability is
   used to specify the performance capability of an NSF.

6.1.3.1. NSF Performance Capability

   This section expands the i2nsf-nsf-performance-capability in
   Figure 8.

```
        NSF Performance Capability
          +--rw i2nsf-nsf-performance-capability
           +--rw processing
           |    +--rw processing-average  uint16
           |    +--rw processing-peak     uint16
           +--rw bandwidth
           |    +--rw outbound
           |    |   +--rw outbound-average  uint16
           |    |   +--rw outbound-peak     uint16
           |    +--rw inbound
           |    |   +--rw inbound-average   uint16
           |    |   +--rw inbound-peak      uint16
```

        Figure 9: YANG tree of I2NSF NSF Performance Capability

   This module is used to specify the performance capabilities of an NSF
   when registering or initiating the NSF.

6.1.4. NSF Access Information

   This section expands the i2nsf-nsf-access-info in Figure 6.

```
        NSF Access Information
          +--rw i2nsf-nsf-access-info
            +--rw nsf-instance-name      string
            +--rw nsf-address            inet:ipv4-address
            +--rw nsf-port-number        inet:port-number
```

            Figure 10: YANG tree of I2NSF NSF Access Informantion

   This module contains the network access information of an NSF that is
   required to enable network communications with the NSF.

6.2. YANG Data Modules

   This section introduces a YANG data module for the information model
   of the required data for the registration interface between Security
   Controller and Developer's Management System, as defined in
   Section 5.

      <CODE BEGINS> file "ietf-i2nsf-reg-interface@2019-03-11.yang

```
   module ietf-i2nsf-reg-interface{
   yang-version 1.1;
   namespace
   "urn:ietf:params:xml:ns:yang:ietf-i2nsf-reg-interface";
   prefix "iiregi";

   import ietf-inet-types{
      prefix inet;
      reference "RFC 6991";
   }
   import ietf-i2nsf-capability{
     prefix capa;
     reference "draft-ietf-i2nsf-capability
             -data-model-02";
   }
   organization
     "IETF I2NSF (Interface to Network Security Functions)
     Working Group";

   contact
     "WG Web: <http://tools.ietf.org/wg/i2nsf>
     WG List: <mailto:i2nsf@ietf.org>

     WG Chair: Linda Dunbar
     <mailto:Linda.duhbar@huawei.com>

     Editor: Sangwon Hyun
     <mailto:swhyun77@skku.edu>
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      Editor: Jaehoon Paul Jeong
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      Editor: Taekyun Roh
      <mailto:tkroh0198@skku.edu>

      Editor: Sarang Wi
      <mailto:dnl9795@skku.edu>

      Editor: Jung-Soo Park
      <mailto:pjs@etri.re.kr>";

    description

     "It defines a YANG data model for Registration Interface.
     Copyright (c) 2018 IETF Trust and the persons identified as
     authors of the code. All rights reserved.

     Redistribution and use in source and binary forms, with or
     without modification, is permitted pursuant to, and subject
     to the license terms contained in, the Simplified BSD License
     set forth in Section 4.c of the IETF Trust's Legal Provisions
     Relating to IETF Documents
     (http://trustee.ietf.org/license-info).

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

    revision 2019-03-11 {
      description "The third revision";
      reference
        "RFC XXXX: I2NSF Registration Interface YANG Data Model";
    }
    rpc i2nsf-nsf-capability-query {
       description
         "Capability information that the
          Security Controller
          sends to the DMS";
       input{
          container query-i2nsf-capability-info {
            description
            "i2nsf capability information";
            uses "capa:nsf-capabilities";
            reference
              "draft-ietf-i2nsf-capability
                    -data-model-02";
            }

```
              }
          output{
              container nsf-access-info {
                description
                 "nsf access information";
                uses i2nsf-nsf-access-info;


              }
          }
      }
      container i2nsf-nsf-registrations{
      description
       "i2nsf-nsf-registrations";
       list i2nsf-nsf-capability-registration {
         key "nsf-name";
         description
          "Requeired information for registration";
          leaf nsf-name {
            type string;
            mandatory true;
            description
              "nsf-name";
          }
          container nsf-capability-info {
            description
              "nsf-capability-information";
              uses i2nsf-nsf-capability-info;
          }
          container nsf-access-info {
            description
              "nsf-access-info";
              uses i2nsf-nsf-access-info;
          }
       }
      }
      grouping i2nsf-nsf-performance-capability {
         description
          "NSF performance capailities";
         container processing{
           description
            "processing info";
           leaf processing-average{
            type uint16;
            description
              "processing-average";
           }
           leaf processing-peak{
            type uint16;
```

```
              description
                "processing peak";
            }
          }
        container bandwidth{
          description
            "bandwidth info";
          container outbound{
            description
                "outbound";
            leaf outbound-average{
                type uint16;
                description
                  "outbound-average";
            }
            leaf outbound-peak{
                type uint16;
                description
                  "outbound-peak";
            }
          }
            container inbound{
              description
                "inbound";
              leaf inbound-average{
                type uint16;
                description
                  "inbound-average";
              }
              leaf inbound-peak{
                type uint16;
                description
                  "inbound-peak";
              }
            }
          }
        }
      grouping i2nsf-nsf-capability-info {
        description
          "Detail information of an NSF";
        container i2nsf-capability {
          description
            "ietf i2nsf capability information";
          uses "capa:nsf-capabilities";
          reference "draft-ietf-i2nsf-capability
                -data-model-02";
          }
          container nsf-performance-capability {
```

```
          description
           "performance capability";
          uses i2nsf-nsf-performance-capability;
        }
      }

      grouping i2nsf-nsf-access-info {
        description
         "NSF access information";
        leaf nsf-instance-name {
          type string;
          description
            "nsf-instance-name";
        }
        leaf nsf-address {
          type inet:ipv4-address;
          mandatory true;
          description
            "nsf-address";
         }
        leaf nsf-port-address {
          type inet:port-number;
          description
            "nsf-port-address";
        }
      }
    }
```

            <CODE ENDS>

            Figure 11: Registration Interface YANG Data Model

7. IANA Considerations

   This document requests IANA to register the following URI in the
   "IETF XML Registry" [RFC3688]:

      URI: urn:ietf:params:xml:ns:yang:ietf-i2nsf-reg-interface
      Registrant Contact: The IESG.
      XML: N/A; the requested URI is an XML namespace.

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

         Name: ietf-i2nsf-reg-interface
         Namespace: urn:ietf:params:xml:ns:yang:ietf-i2nsf-reg-interface
         Prefix: iiregi
         Reference: RFC XXXX

8. Security Considerations

   This document introduces no additional security threats and SHOULD
   follow the security requirements as stated in [RFC8329].

9. References

9.1. Normative References

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             Abstractions (SUPA)", draft-ietf-supa-generic-policy-data-
             model-04 (work in progress), June 2017.

   [supa-policy-info-model]
             Strassner, J., Halpern, J., and S. van der Meer, "Generic
             Policy Information Model for Simplified Use of Policy
             Abstractions (SUPA)", draft-ietf-supa-generic-policy-info-
             model-03 (work in progress), May 2017.

Appendix A.   XML Example of Registration Interface Data Model

   This section describes XML examples of the I2NSF Registration
   Interface data model in five NSF Registration examples and one NSF
   Capability Query example.

A.1.   Example 1: Registration for Capabilities of General Firewall

   This section shows a configuration example for capabilities
   registration of general firewall.

```
        <i2nsf-nsf-registrations
          xmlns="urn:ietf:params:xml:ns:yang:ietf-i2nsf-reg-interface"
          xmlns:capa="urn:ietf:params:xml:ns:yang:ietf-i2nsf-capability">
           <i2nsf-nsf-capability-registration>
            <nsf-name>general_firewall_capability</nsf-name>
            <nsf-capability-info>
              <i2nsf-capability>
                <condition-capabilities>
                  <generic-nsf-capabilities>
                   <ipv4-capa>capa:ipv4-protocol</ipv4-capa>
                   <ipv4-capa>capa:exact-ipv4-address</ipv4-capa>
                   <ipv4-capa>capa:range-ipv4-address</ipv4-capa>
                   <tcp-capa>capa:exact-tcp-port-num</tcp-capa>
                   <tcp-capa>capa:range-tcp-port-num</tcp-capa>
                  </generic-nsf-capabilities>
                  </condition-capabilities>
                  <action-capabilities>
                    <ingress-action-capa>capa:pass</ingress-action-capa>
                    <ingress-action-capa>capa:drop</ingress-action-capa>
                    <ingress-action-capa>capa:alert</ingress-action-capa>
                    <egress-action-capa>capa:pass</egress-action-capa>
                    <egress-action-capa>capa:drop</egress-action-capa>
                    <egress-action-capa>capa:alert</egress-action-capa>
                  </action-capabilities>
              </i2nsf-capability>
              <nsf-performance-capability>
               <processing>
                <processing-average>1000</processing-average>
                <processing-peak>5000</processing-peak>
               </processing>
               <bandwidth>
                <outbound>
                   <outbound-average>1000</outbound-average>
                   <outbound-peak>5000</outbound-peak>
                </outbound>
                <inbound>
                   <inbound-average>1000</inbound-average>
```

```
                  <inbound-peak>5000</inbound-peak>
                </inbound>
              </bandwidth>
            </nsf-performance-capability>
          </nsf-capability-info>
          <nsf-access-info>
            <nsf-instance-name>general_firewall</nsf-instance-name>
            <nsf-address>221.159.112.100</nsf-address>
            <nsf-port-address>3000</nsf-port-address>
          </nsf-access-info>
        </i2nsf-nsf-capability-registration>
      </i2nsf-nsf-registrations>
```

Figure 12: Configuration XML for Registration of General Firewall

Figure 12 shows the configuration XML for registration of general firewall and its capabilities are as follows.

1. The instance name of the NSF is general_firewall.

2. The NSF can inspect protocol, exact IPv4 address, and range IPv4 address for IPv4 packets.

3. The NSF can inspect exact port number and range port number for tcp packets.

4. The NSF can control whether the packets are allowed to pass, drop, or alert.

5. The NSF can have processing power and bandwidth.

6. The location of the NSF is 221.159.112.100.

7. The port of the NSF is 3000.

A.2. Example 2: Registration for Capabilities of Time based Firewall

This section shows a configuration example for capabilities registration of time based firewall.

```
      <i2nsf-nsf-registrations
        xmlns="urn:ietf:params:xml:ns:yang:ietf-i2nsf-reg-interface"
        xmlns:capa="urn:ietf:params:xml:ns:yang:ietf-i2nsf-capability">
        <i2nsf-nsf-capability-registration>
          <nsf-name>time_based_firewall_capability</nsf-name>
          <nsf-capability-info>
            <i2nsf-capability>
```

```
            <time-capabilities>absolute-time</time-capabilities>
            <time-capabilities>periodic-time</time-capabilities>
            <condition-capabilities>
            <generic-nsf-capabilities>
               <ipv4-capa>capa:ipv4-protocol</ipv4-capa>
               <ipv4-capa>capa:exact-ipv4-address</ipv4-capa>
               <ipv4-capa>capa:range-ipv4-address</ipv4-capa>
            </generic-nsf-capabilities>
          </condition-capabilities>
          <action-capabilities>
             <ingress-action-capa>capa:pass</ingress-action-capa>
             <ingress-action-capa>capa:drop</ingress-action-capa>
             <ingress-action-capa>capa:alert</ingress-action-capa>
             <egress-action-capa>capa:pass</egress-action-capa>
             <egress-action-capa>capa:drop</egress-action-capa>
             <egress-action-capa>capa:alert</egress-action-capa>
          </action-capabilities>
        </i2nsf-capability>
        <nsf-performance-capability>
          <processing>
            <processing-average>1000</processing-average>
            <processing-peak>5000</processing-peak>
          </processing>
          <bandwidth>
            <outbound>
               <outbound-average>1000</outbound-average>
               <outbound-peak>5000</outbound-peak>
            </outbound>
            <inbound>
               <inbound-average>1000</inbound-average>
               <inbound-peak>5000</inbound-peak>
            </inbound>
          </bandwidth>
        </nsf-performance-capability>
      </nsf-capability-info>
      <nsf-access-info>
        <nsf-instance-name>time_based_firewall</nsf-instance-name>
        <nsf-address>221.159.112.110</nsf-address>
        <nsf-port-address>3000</nsf-port-address>
      </nsf-access-info>
    </i2nsf-nsf-capability-registration>
  </i2nsf-nsf-registrations>
```

   Figure 13: Configuration XML for Registration of Time based Firewall

   Figure 13 shows the configuration XML for registration of time based
   firewall and its capabilities are as follows.

1.   The instance name of the NSF is time_based_firewall.

2.   The NSF can execute the security policy rule according to
     absolute time and periodic time.

3.   The NSF can inspect protocol, exact IPv4 address, and range IPv4
     address for IPv4 packets.

4.   The NSF can control whether the packets are allowed to pass,
     drop, or alert.

5.   The NSF can have processing power and bandwidth.

6.   The location of the NSF is 221.159.112.110.

7.   The port of the NSF is 3000.

A.3. Example 3: Registration for Capabilities of Web Filter

   This section shows a configuration example for capabilities
   registration of web filter.

```
      <i2nsf-nsf-registrations
        xmlns="urn:ietf:params:xml:ns:yang:ietf-i2nsf-reg-interface"
        xmlns:capa="urn:ietf:params:xml:ns:yang:ietf-i2nsf-capability">
        <i2nsf-nsf-capability-registration>
          <nsf-name>web_filter_capability</nsf-name>
          <nsf-capability-info>
            <i2nsf-capability>
              <condition-capabilities>
                <advanced-nsf-capabilities>
                  <http-capa>capa:url</http-capa>
                </advanced-nsf-capabilities>
              </condition-capabilities>
              <action-capabilities>
                <ingress-action-capa>capa:pass</ingress-action-capa>
                <ingress-action-capa>capa:drop</ingress-action-capa>
                <ingress-action-capa>capa:alert</ingress-action-capa>
                <egress-action-capa>capa:pass</egress-action-capa>
                <egress-action-capa>capa:drop</egress-action-capa>
                <egress-action-capa>capa:alert</egress-action-capa>
              </action-capabilities>
            </i2nsf-capability>
            <nsf-performance-capability>
              <processing>
                <processing-average>1000</processing-average>
                <processing-peak>5000</processing-peak>
              </processing>
              <bandwidth>
                <outbound>
                  <outbound-average>1000</outbound-average>
                  <outbound-peak>5000</outbound-peak>
                </outbound>
                <inbound>
                  <inbound-average>1000</inbound-average>
                  <inbound-peak>5000</inbound-peak>
                </inbound>
              </bandwidth>
            </nsf-performance-capability>
          </nsf-capability-info>
          <nsf-access-info>
            <nsf-instance-name>web_filter</nsf-instance-name>
            <nsf-address>221.159.112.120</nsf-address>
            <nsf-port-address>3000</nsf-port-address>
          </nsf-access-info>
        </i2nsf-nsf-capability-registration>
      </i2nsf-nsf-registrations>
```

       Figure 14: Configuration XML for Registration of Web Filter

Figure 14 shows the configuration XML for registration of web filter and its capabilities are as follows.

1. The instance name of the NSF is web_filter.

2. The NSF can inspect url for http and https packets.

3. The NSF can control whether the packets are allowed to pass, drop, or alert.

4. The NSF can have processing power and bandwidth.

5. The location of the NSF is 221.159.112.120.

6. The port of the NSF is 3000.

A.4. Example 4: Registration for Capabilities of VoIP/VoLTE Filter

This section shows a configuration example for capabilities registration of VoIP/VoLTE filter.

```
<i2nsf-nsf-registrations
  xmlns="urn:ietf:params:xml:ns:yang:ietf-i2nsf-reg-interface"
    xmlns:capa="urn:ietf:params:xml:ns:yang:ietf-i2nsf-capability">
  <i2nsf-nsf-capability-registration>
    <nsf-name>voip_volte_filter_capability</nsf-name>
    <nsf-capability-info>
      <i2nsf-capability>
        <condition-capabilities>
          <advanced-nsf-capabilities>
            <voip-volte-capa>capa:voice-id</voip-volte-capa>
          </advanced-nsf-capabilities>
        </condition-capabilities>
        <action-capabilities>
          <ingress-action-capa>capa:pass</ingress-action-capa>
          <ingress-action-capa>capa:drop</ingress-action-capa>
          <ingress-action-capa>capa:alert</ingress-action-capa>
          <egress-action-capa>capa:pass</egress-action-capa>
          <egress-action-capa>capa:drop</egress-action-capa>
          <egress-action-capa>capa:alert</egress-action-capa>
        </action-capabilities>
      </i2nsf-capability>
      <nsf-performance-capability>
      <processing>
        <processing-average>1000</processing-average>
        <processing-peak>5000</processing-peak>
      </processing>
      <bandwidth>
        <outbound>
          <outbound-average>1000</outbound-average>
          <outbound-peak>5000</outbound-peak>
        </outbound>
        <inbound>
          <inbound-average>1000</inbound-average>
          <inbound-peak>5000</inbound-peak>
        </inbound>
      </bandwidth>
    </nsf-performance-capability>
  </nsf-capability-info>
  <nsf-access-info>
    <nsf-instance-name>voip_volte_filter</nsf-instance-name>
    <nsf-address>221.159.112.130</nsf-address>
    <nsf-port-address>3000</nsf-port-address>
  </nsf-access-info>
</i2nsf-nsf-capability-registration>
</i2nsf-nsf-registrations>
```

Figure 15: Configuration XML for Registration of VoIP/VoLTE Filter

Figure 15 shows the configuration XML for registration of VoIP/VoLTE filter and its capabilities are as follows.

1. The instance name of the NSF is voip_volte_filter.

2. The NSF can inspect voice id for VoIP/VoLTE packets.

3. The NSF can control whether the packets are allowed to pass, drop, or alert.

4. The NSF can have processing power and bandwidth.

5. The location of the NSF is 221.159.112.130.

6. The port of the NSF is 3000.

A.5. Example 5: Registration for Capabilities of HTTP and HTTPS Flood Mitigation

This section shows a configuration example for capabilities registration of http and https flood mitigation.

```
<i2nsf-nsf-registrations
  xmlns="urn:ietf:params:xml:ns:yang:ietf-i2nsf-reg-interface"
    xmlns:capa="urn:ietf:params:xml:ns:yang:ietf-i2nsf-capability">
  <i2nsf-nsf-capability-registration>
    <nsf-name>
      http_and_https_flood_mitigation_capability
    </nsf-name>
     <nsf-capability-info>
      <i2nsf-capability>
           <condition-capabilities>
             <advanced-nsf-capabilities>
               <antiddos-capa>capa:http-flood-action</antiddos-capa>
               <antiddos-capa>capa:https-flood-action</antiddos-capa>
             </advanced-nsf-capabilities>
           </condition-capabilities>
           <action-capabilities>
             <ingress-action-capa>capa:pass</ingress-action-capa>
             <ingress-action-capa>capa:drop</ingress-action-capa>
             <ingress-action-capa>capa:alert</ingress-action-capa>
             <egress-action-capa>capa:pass</egress-action-capa>
             <egress-action-capa>capa:drop</egress-action-capa>
             <egress-action-capa>capa:alert</egress-action-capa>
           </action-capabilities>
      </i2nsf-capability>
      <nsf-performance-capability>
        <processing>
```

```
                <processing-average>1000</processing-average>
                <processing-peak>5000</processing-peak>
              </processing>
              <bandwidth>
                <outbound>
                  <outbound-average>1000</outbound-average>
                  <outbound-peak>5000</outbound-peak>
                </outbound>
                <inbound>
                  <inbound-average>1000</inbound-average>
                  <inbound-peak>5000</inbound-peak>
                </inbound>
              </bandwidth>
            </nsf-performance-capability>
        </nsf-capability-info>
        <nsf-access-info>
          <nsf-instance-name>
            http_and_https_flood_mitigation
          </nsf-instance-name>
          <nsf-address>221.159.112.140</nsf-address>
          <nsf-port-address>3000</nsf-port-address>
        </nsf-access-info>
      </i2nsf-nsf-capability-registration>
    </i2nsf-nsf-registrations>
```

        Figure 16: Configuration XML for Registration of of HTTP and HTTPS
                            Flood Mitigation

   Figure 16 shows the configuration XML for registration of VoIP/VoLTE
   filter and its capabilities are as follows.

   1.   The instance name of the NSF is http_and_https_flood_mitigation.

   2.   The NSF can control the amount of packets for http and https
        packets.

   3.   The NSF can control whether the packets are allowed to pass,
        drop, or alert.

   4.   The NSF can have processing power and bandwidth.

   5.   The location of the NSF is 221.159.112.140.

   6.   The port of the NSF is 3000.

A.6. Example 6: Query for Capabilities of Time based Firewall

   This section shows a configuration example for capabilities query of
   Time based Firewall.

```
<rpc message-id="101"
  xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
  <i2nsf-nsf-capability-query
    xmlns="urn:ietf:params:xml:ns:yang:ietf-i2nsf-reg-interface"
     xmlns:capa="urn:ietf:params:xml:ns:yang:ietf-i2nsf-capability">
    <query-i2nsf-capability-info>
          <time-capabilities>absolute-time</time-capabilities>
          <time-capabilities>periodic-time</time-capabilities>
          <condition-capabilities>
            <generic-nsf-capabilities>
              <ipv4-capa>capa:ipv4-protocol</ipv4-capa>
              <ipv4-capa>capa:exact-ipv4-address</ipv4-capa>
              <ipv4-capa>capa:range-ipv4-address</ipv4-capa>
            </generic-nsf-capabilities>
          </condition-capabilities>
          <action-capabilities>
            <ingress-action-capa>capa:pass</ingress-action-capa>
            <ingress-action-capa>capa:drop</ingress-action-capa>
            <ingress-action-capa>capa:alert</ingress-action-capa>
            <egress-action-capa>capa:pass</egress-action-capa>
            <egress-action-capa>capa:drop</egress-action-capa>
            <egress-action-capa>capa:alert</egress-action-capa>
          </action-capabilities>
      </query-i2nsf-capability-info>
    </i2nsf-nsf-capability-query>
  </rpc>


<rpc-reply message-id="101"
  xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
  <nsf-access-info
    xmlns="urn:ietf:params:xml:ns:yang:ietf-i2nsf-reg-interface">
    <nsf-instance-name>time-based-firewall</nsf-instance-name>
    <nsf-address>221.159.223.250</nsf-address>
    <nsf-port-address>8080</nsf-port-address>
  </nsf-access-info>
</rpc-reply>
```

       Figure 17: Configuration XML for Query of Time based Firewall

Figure 17 shows the configuration of input data and output data XML for nsf capability query of time based firewall.

Appendix B. NSF Lifecycle Managmenet in NFV Environments

Network Functions Virtualization (NFV) can be used to implement I2NSF framework. In NFV environments, NSFs are deployed as virtual network functions (VNFs). Security Controller can be implemented as an Element Management (EM) of the NFV architecture, and is connected with the VNF Manager (VNFM) via the Ve-Vnfm interface [nfv-framework]. Security Controller can use this interface for the purpose of the lifecycle management of NSFs. If some NSFs need to be instantiated to enforce security policies in the I2NSF framework, Security Controller could request the VNFM to instantiate them through the Ve-Vnfm interface. Or if an NSF, running as a VNF, is not used by any traffic flows for a time period, Security Controller may request deinstantiating it through the interface for efficient resource utilization.

Appendix C. Changes from draft-ietf-i2nsf-registration-interface-dm-01

The following changes have been made from draft-ietf-i2nsf-registration-interface-dm-01:

o Section 4 has been revised to clarify major objectives of the I2NSF registration interface: NSF capability registration, NSF capability query.

o Section 5 has been revised to describe the above-mentioned major operations of the I2NSF registration interface. Section 5.1 describes the information model for registering NSFs and their capabilities. Section 5.2 describes the information model for querying NSFs based on a description of required capabilities.

o In section 6, the data model has been revised according to the revised information model.

o Appendix A. has been revised to describe the XML examples of the registration interface data model in five NSF Registration examples and one NSF Capability Query example.

Appendix D. Acknowledgments

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Appendix E. Contributors

   This document is made by the group effort of I2NSF working group.
   Many people actively contributed to this document. The following are
   considered co-authors:

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