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I2NSF Application Interface YANG Data Model
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Abstract

This document describes an information model and a YANG data model for the Application Interface between an Interface to Network Security Functions (I2NSF) Analyzer and a Security Controller in an I2NSF system in a Network Functions Virtualization (NFV) environment. The YANG data model described in this document is based on the I2NSF NSF-Facing Interface and the I2NSF Monitoring Interface for enabling feedback delivery based on the information received from a Network Security Function (NSF).

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[1.](#) Introduction

In Interface to Network Security Functions (I2NSF) [[RFC8329](#)], the Monitoring Interface [[I-D.ietf-i2nsf-nsf-monitoring-data-model](#)] is defined as an interface to collect information (e.g., network statistics, resources) from NSF(s). The information can be received by a query or a report. In a query-based, the information is obtained by a request from a client (I2NSF Analyzer). But in a report-based, the information is provided by a server (NSFs) when the notification or alarm is triggered by an event. In this model, the report-based collection information is used for realizing the Security Management Automation (SMA) in cloud-based security services [[I-D.jeong-i2nsf-security-management-automation](#)]. as the information is sent automatically by the NSFs. Figure 1 shows the I2NSF

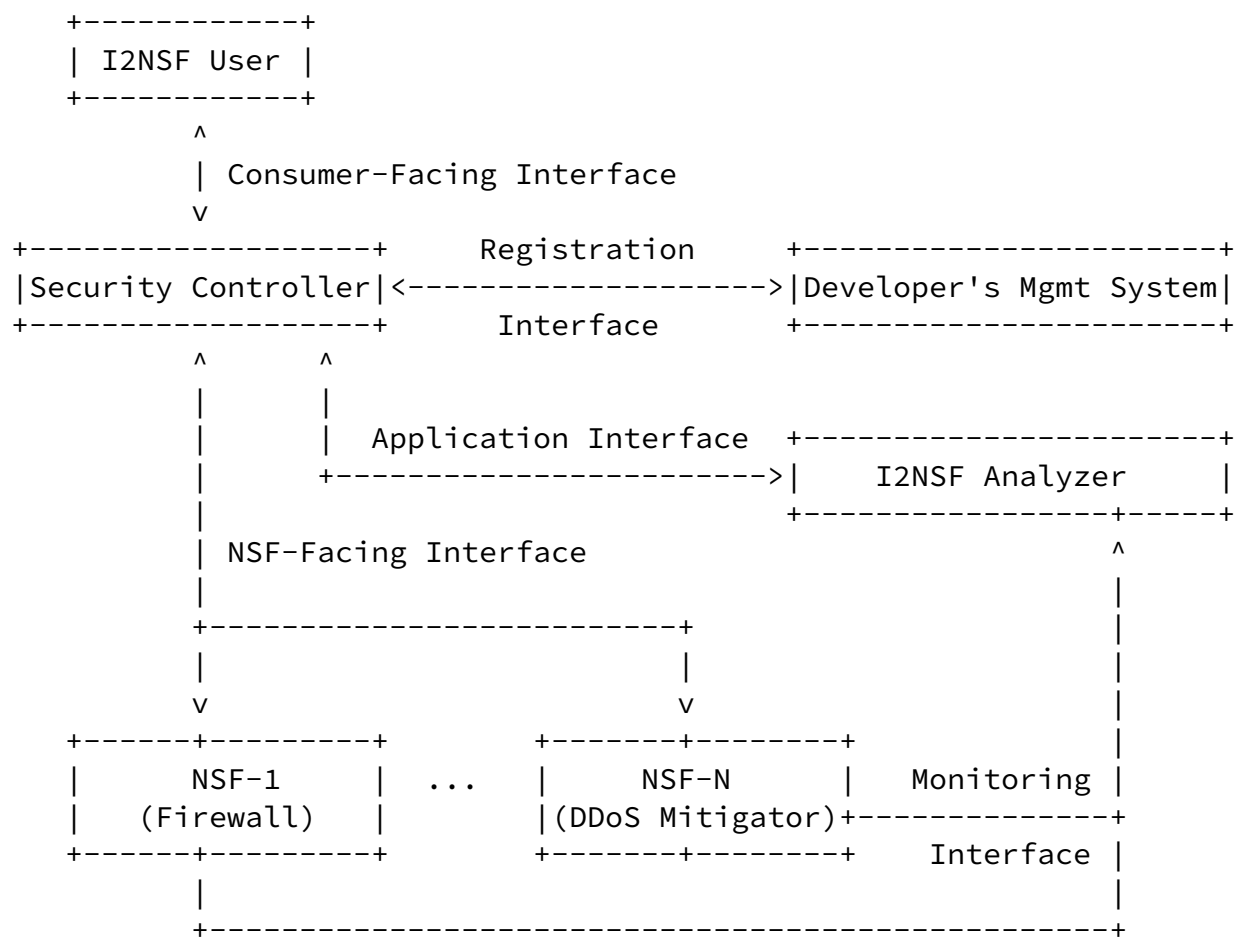


Figure 1: I2NSF Framework for Security Management Automation

The automatic reports by the NSFs are collected in a single instance (i.e., I2NSF Analyzer) to be analyzed. By analyzing the information, a new security policy can be produced to further enhance the security of the network. To create the automated system, the analyzer should be done automatically with the help of machine learning. The automated analyzer is not in the scope of this document.

The new security policy needs to be delivered from the I2NSF Analyzer to the Security Controller so the new policy can be listed and monitored properly. For that purpose, this document introduces the Application Interface as the intermediary between the I2NSF Analyzer and the Security Controller. Then the policy should be delivered directly to the NSFs by the Security Controller via the NSF-Facing Interface [[I-D.ietf-i2nsf-nsf-facing-interface-dm](#)].

The purpose of this document is to provide a standard for a feedback interface in an I2NSF Framework called Application Interface. With the provided Application Interface, the realization of Security Management Automation (SMA) should be possible.

[2.](#) Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [BCP 14](#) [[RFC2119](#)] [[RFC8174](#)] when, and only when, they appear in all capitals, as shown here.

This document uses the terminology described in [[RFC8329](#)].

This document follows the guidelines of [[RFC8407](#)] and adopts the Network Management Datastore Architecture (NMDA). The meaning of the symbols in tree diagrams is defined in [[RFC8340](#)].

[3.](#) Information Model for Application Interface

This document introduces Application Interface as an interface to deliver a report of the augmentation or generation of security policy rules created by I2NSF Analyzer to Security Controller [[I-D.jeong-i2nsf-security-management-automation](#)]. This allows Security Controller to actively reinforce the network with its security policy management. Figure 2 shows the high-level concept of Application Interface such as Policy Reconfiguration and Feedback Information.

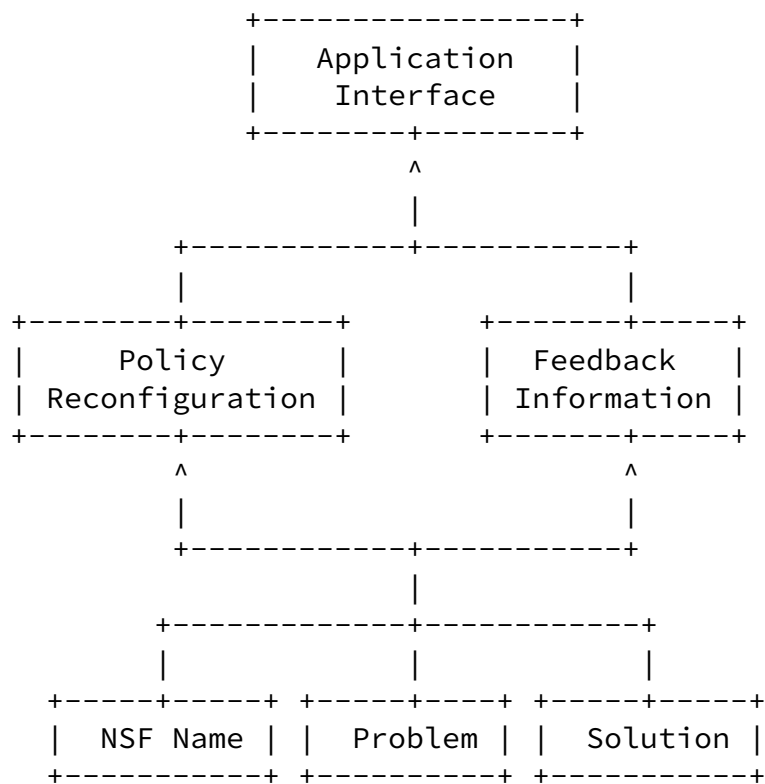


Figure 2: Diagram for Application Interface

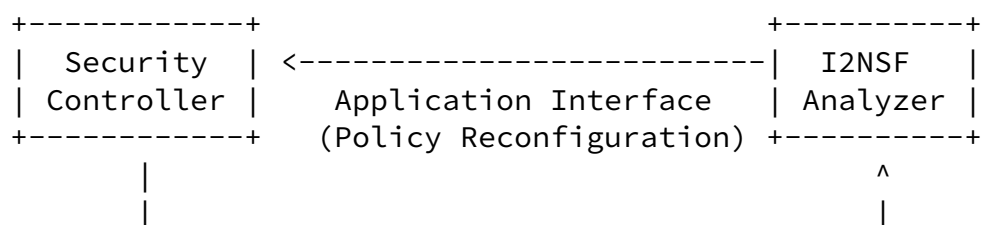
Both policy reconfiguration and feedback information provide the following high-level abstraction:

- * NSF Name: It is the name or IP address of the NSF for identifying the NSF with problem. The name is a unique string to identify an NSF, including a Fully Qualified Domain Name (FQDN).
- * Problem: It describes the issue(s) in the NSF that needs to be handled.
- * Solution: It specifies the possible solution(s) for the problem.

3.1. Information Model for Policy Reconfiguration

Policy reconfiguration is the rearrangement of a security policy in a different form or combination of the existing security policy to enhance the security service in the network. A policy reconfiguration is generated by the I2NSF Analyzer after receiving and analyzing monitoring information of NSF Events from an NSF [[I-D.ietf-i2nsf-nsf-monitoring-data-model](#)].

Policy reconfiguration works together with the three I2NSF interfaces defined for the I2NSF Framework, i.e., NSF-Facing Interface [[I-D.ietf-i2nsf-nsf-facing-interface-dm](#)], NSF Monitoring Interface [[I-D.ietf-i2nsf-nsf-monitoring-data-model](#)], and Application Interface, to create a closed-loop system for reinforcing the network security. Figure 3 shows an illustration of the closed-loop system for the I2NSF Framework.



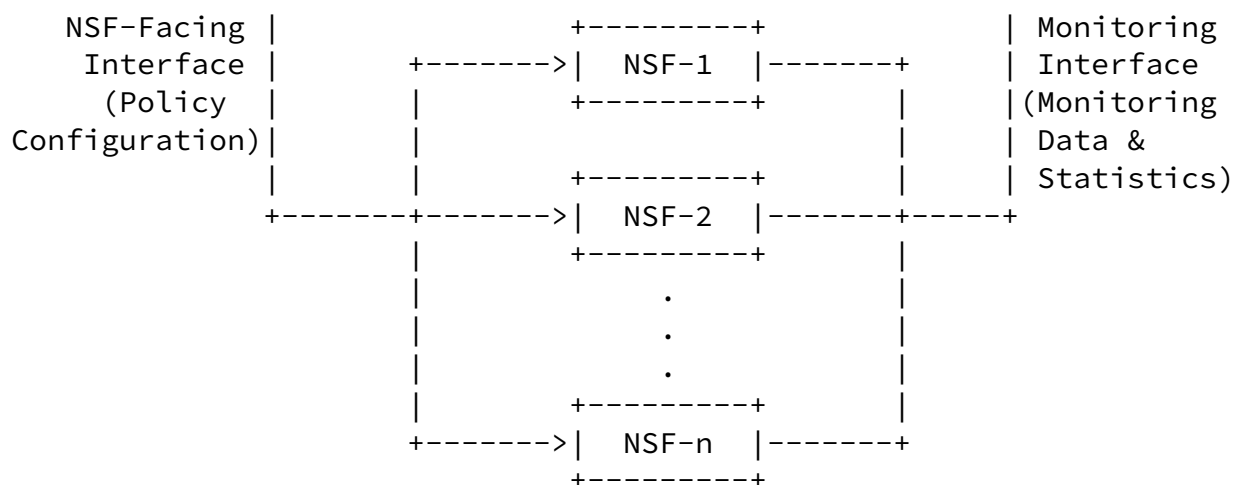


Figure 3: A Closed-Loop Architecture for Security Management Automation (SMA)

Figure 3 shows a closed-loop system between Security Controller, NSF, and I2NSF Analyzer. The Security Controller delivers a security policy to an appropriate NSF via the NSF-Facing Interface [\[I-D.ietf-i2nsf-nsf-facing-interface-dm\]](#). The NSF will prepare for a security service according to the given configuration and provide a security service for the network. The NSF SHOULD also provide monitoring information (e.g., NSF Events and System Alarms) to be analyzed. This monitoring information can be delivered from the NSF to an I2NSF Analyzer via the Monitoring Interface [\[I-D.ietf-i2nsf-nsf-monitoring-data-model\]](#). Then the I2NSF Analyzer analyzes the monitoring information for the reconfiguration of an existing security policy, the generation of a new security policy, and the feedback for security system management (e.g., the scaling-up or scaling-down of resources related to NSFs). To fully automate the closed-loop system, the I2NSF Analyzer should analyze the monitoring

information automatically using machine learning techniques (e.g., Deep Learning [\[Deep-Learning\]](#)). The results of the analysis may trigger the reconfiguration of an existing security policy or the generation of a new security policy to strengthen the network security. The reconfiguration or configuration request will be delivered from the I2NSF Analyzer to the Security Controller via the Application Interface.

To realize the closed-loop system, the Application Interface needs to properly follow the similar guidelines for the I2NSF Framework [RFC8329]. The Application Interface follows [I-D.ietf-i2nsf-nsf-facing-interface-dm] to create a security policy to reconfigure an existing security policy of NSF(s) or to generate a new security policy.

Application Interface holds a list of security policies so that the (re)configuration of a security policy and the feedback information can be provided to the Security Controller. Each policy consists of a list of rule to be enhanced on the NSF. Note that the synchronization of the list of security policies should be done between the Security Controller and the I2NSF Analyzer and the specific mechanism is out of the scope of this document. A (re)configured security policy rule should be able to cope with attacks or failures that can happen to the network in near future. Such a rule is reconfigured or generated by the I2NSF Analyzer to tackle a detected problem in the network. It uses the Event-Condition-Action (ECA) model as the basis for the design of I2NSF Policy (Re)configuration as described in [RFC8329] and [I-D.ietf-i2nsf-capability-data-model].

An example of Policy (Re)configuration is a DDoS Attack that is detected by a DDoS Mitigator. The DDoS Mitigator creates monitoring information and delivers it to the I2NSF Analyzer. The I2NSF Analyzer analyzes the information and generates a new policy to handle the DDoS Attack, such as a firewall rule to drop all packets from the source of the DDoS Attack.

3.2. YANG Tree Structure for Policy Reconfiguration

The YANG tree structure for policy reconfiguration is provided through the augmentation of the NSF-Facing Interface YANG Module [I-D.ietf-i2nsf-nsf-facing-interface-dm] as follows:

```
augment /nsfintf:i2nsf-security-policy:
```



```

+--rw nsf-name?    union
+--rw problem
  +--rw (attack-detection)?
    +--:(ddos-detected)
      | +--rw ddos-detected
      |   +--rw attack-src-ip*    inet:ip-address-no-zone
      |   +--rw attack-dst-ip*    inet:ip-address-no-zone
      |   +--rw attack-src-port*  inet:port-number
      |   +--rw attack-dst-port*  inet:port-number
    +--:(virus-detected)
      | +--rw virus-detected
      |   +--rw virus-name?      string
      |   +--rw virus-type?      identityref
      |   +--rw host?            union
      |   +--rw file-type?       string
      |   +--rw file-name?       string
      |   +--rw os?              string
    +--:(intrusion-detected)
      | +--rw intrusion-detected
      |   +--rw protocol?        identityref
      |   +--rw app?             identityref
      |   +--rw attack-type?     identityref
    +--:(web-attack-detected)
      | +--rw web-attack-detected
      |   +--rw attack-type?     identityref
      |   +--rw req-method?      identityref
      |   +--rw req-uri?         string
      |   +--rw req-user-agent?  string
      |   +--rw cookies?         string
      |   +--rw req-host?        string
      |   +--rw response-code?   string
    +--:(voip-vocn-detected)
      | +--rw voip-vocn-detected
      |   +--rw source-voice-id*  string
      |   +--rw destination-voice-id*  string
      |   +--rw user-agent*       string

```

Figure 4: YANG Tree Structure of Policy Reconfiguration

The policy reconfiguration must include the following information:

NSF Name: The name or IP address (IPv4 or IPv6) of the NSF to be configured. If the given nsf-name is not IP address, the name can be an arbitrary string including FQDN (Fully Qualified Domain Name).

Problem: The issue that is emitted by an NSF via the I2NSF Monitoring Interface. The problem for policy configuration includes the NSF Events described in NSF Monitoring Interface YANG Data Model [[I-D.ietf-i2nsf-nsf-monitoring-data-model](#)], such as DDoS detection, Virus detection, Intrusion detection, Web-attack detection, and Voice over Internet Protocol (VoIP) or Voice over Cellular Network (VoCN) violation detection.

Solution: The solution for policy (re)configuration is the security policy that is reconfigured or generated to solve a detected attack. The security policy can be configured using the NSF-Facing Interface YANG data model [[I-D.ietf-i2nsf-nsf-facing-interface-dm](#)].

3.3. Information Model for Feedback Information

Feedback information is information about problem(s) of an NSF for a security service such as system resource over-usage or malfunction. This problem cannot be handled by creating a new policy. In the similar way with policy reconfiguration, the feedback information should be delivered from the I2NSF Analyzer to the Security Controller that will be able to handle the reported problem(s).

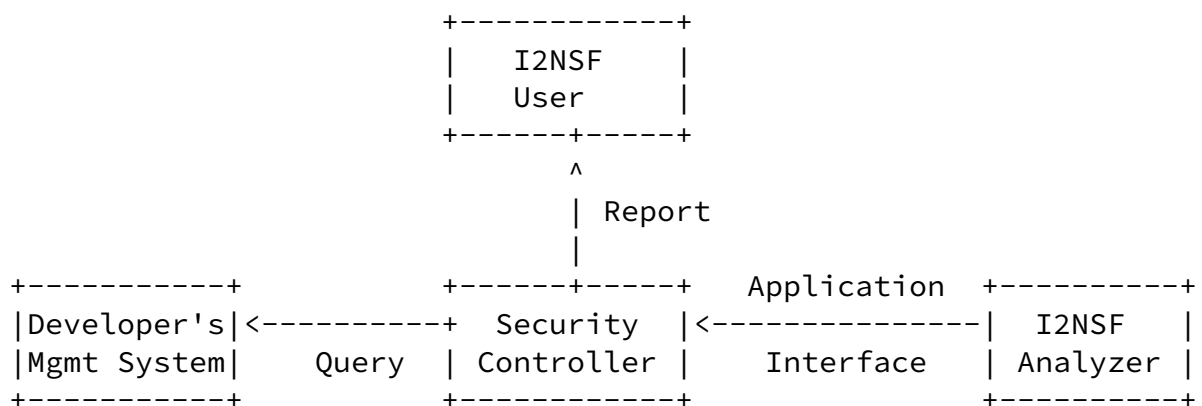


Figure 5: Handling of Feedback Information

Figure 5 shows the handling of feedback information. For feedback information, the given feedback is not a security policy, hence the Security Controller needs to take an action to handle the reported problem(s). The action includes the report to the I2NSF User and the query of the system resource management of the relevant NSF(s) to the Developer's Management System (DMS). DMS will communicate with the Management and Orchestration (MANO) Unit in the Network Functions Virtualization (NFV) Framework to deal with the system management issue(s) of the relevant NSFs [[I-D.ietf-i2nsf-applicability](#)]. The details of the handling process are out of the scope of this document.

[3.4.](#) YANG Tree Structure for Feedback Information

The YANG tree structure for feedback information is provided with the use of the NSF Monitoring Interface YANG Module [[I-D.ietf-i2nsf-nsf-monitoring-data-model](#)] as follows:

```
module: ietf-i2nsf-feedback-policy
  +---rw i2nsf-feedback-information* [nsf-name time]
    +---rw nsf-name      union
    +---rw time          yang:date-and-time
    +---rw language?    string
    +---rw problem
      | +---rw (alarm-type)?
      |   +---:(memory-alarm)
      |     | +---rw memory-alarm
      |     |   +---rw usage?      uint8
      |     |   +---rw message?    string
      |     |   +---rw duration?   uint32
      |   +---:(cpu-alarm)
      |     | +---rw cpu-alarm
      |     |   +---rw usage?      uint8
      |     |   +---rw message?    string
      |     |   +---rw duration?   uint32
      |   +---:(disk-alarm)
      |     | +---rw disk-alarm
      |     |   +---rw disk-id?    string
      |     |   +---rw usage?      uint8
      |     |   +---rw message?    string
      |     |   +---rw duration?   uint32
      |   +---:(hardware-alarm)
      |     | +---rw hardware-alarm
      |     |   +---rw component-name? string
      |     |   +---rw message?      string
      |     |   +---rw duration?     uint32
      |   +---:(interface-alarm)
      |     | +---rw interface-alarm
      |     |   +---rw interface-id?  string
      |     |   +---rw interface-state? enumeration
```

```

|           +---rw message?           string
|           +---rw duration?          uint32
+---rw solution*   string

```

Figure 6: YANG Tree Structure of Feedback Information

Figure 6 shows the high-level abstraction of Feedback Information. The feedback information should include:

- * NSF Name: The name or IP address (IPv4 or IPv6) of the NSF that detected the problem. If the given nsf-name is not IP address, the name can be an arbitrary string including FQDN.
- * Time: The time of the delivery of the feedback information.

- * Language: The language tag that is used for the natural language text that is included in the "message" and "solution" attributes. The language field is encoded following the rules in [Section 2.1 of \[RFC5646\]](#). The default language tag is "en-US".
- * Problem: The issue that is emitted by an NSF via the I2NSF Monitoring Interface. The problem for feedback information includes the system alarms described in NSF Monitoring Interface YANG Data Model [[I-D.ietf-i2nsf-nsf-monitoring-data-model](#)], such as Memory alarm, CPU alarm, Disk alarm, Hardware alarm, and Interface alarm.
- * Solution: A possible solution given as feedback is in the form of a free-form string (as a high-level instruction).

[4.](#) YANG Data Model of Application Interface

This section shows the YANG module of Application Interface. The YANG module in this document is referencing to [[RFC6991](#)] [[I-D.ietf-i2nsf-nsf-facing-interface-dm](#)] [[I-D.ietf-i2nsf-nsf-monitoring-data-model](#)].

The YANG module makes references to [[RFC5646](#)] [[RFC6265](#)] [[RFC8343](#)] [[I-D.ietf-httpbis-semantics](#)]

```

<CODE BEGINS> file "ietf-i2nsf-feedback-policy@2022-04-28.yang"
module ietf-i2nsf-feedback-policy {
  yang-version 1.1;
  namespace
    "urn:ietf:params:xml:ns:yang:ietf-i2nsf-feedback-policy";
  prefix nsffbck;

  import ietf-inet-types{
    prefix inet;
    reference "RFC 6991";
  }

  import ietf-yang-types{
    prefix yang;
    reference "RFC 6991";
  }

  import ietf-i2nsf-policy-rule-for-nsf {
    prefix nsfintf;
    reference
      "Section 4.1 of draft-ietf-i2nsf-nsf-facing-interface-dm-21";
  }

```

```

import ietf-i2nsf-nsf-monitoring {
  prefix nsfmi;
  reference
    "Section 7 of draft-ietf-i2nsf-nsf-monitoring-data-model-15";
}

organization
  "IETF I2NSF (Interface to Network Security Functions)
  Working Group";

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```

<mailto:pauljeong@skku.edu>;

description

"This module is a YANG module for Application Interface.

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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 an actual RFC number and remove
// this note.

revision "2022-04-28" {
 description "Initial revision.";
 reference

"RFC XXXX: I2NSF Application Interface YANG Data Model";

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

}

```
augment "/nsfintf:i2nsf-security-policy" {  
  description  
    "Augment the NSF-Facing Interface Data Model for the policy  
    reconfiguration";  
  leaf nsf-name {  
    type union {  
      type string;  
      type inet:ip-address;  
    }  
    description  
      "The name or IP address (IPv4 or IPv6) of the NSF to be
```

```

        configured. If the given nsf-name is not IP address, the
        name can be an arbitrary string including FQDN (Fully
        Qualified Domain Name).";
    }

    container problem {
        description
            "Problem: The issue that is emitted by an NSF via the
            I2NSF Monitoring Interface such as DDoS detection, Virus
            detection, Intrusion detection, Web-attack detection, and
            VoIP/VoCN violation detection.";
        choice attack-detection {
            description
                "The detected attack type";
            case ddos-detected {
                container ddos-detected {
                    leaf-list attack-src-ip {
                        type inet:ip-address-no-zone;
                        description
                            "The source IPv4 or IPv6 addresses of attack
                            traffic. It can hold multiple IPv4 or IPv6
                            addresses. Note that all IP addresses should not be
                            included, but only limited IP addresses are included
                            to conserve the server resources. The listed attacking
                            IP addresses can be an arbitrary sampling of the
                            'top talkers', i.e., the attackers that send the
                            highest amount of traffic.";
                    }
                    leaf-list attack-dst-ip {
                        type inet:ip-address-no-zone;
                        description
                            "The destination IPv4 or IPv6 addresses of attack
                            traffic. It can hold multiple IPv4 or IPv6
                            addresses.";
                    }
                    leaf-list attack-src-port {
                        type inet:port-number;

```

```

        description
            "The transport-layer source ports of the DDoS attack.
            Note that not all ports will have been seen on all the
            corresponding source IP addresses.";

```



```

    }
    leaf-list attack-dst-port {
        type inet:port-number;
        description
            "The transport-layer destination ports of the DDoS
            attack. Note that not all ports will have been seen
            on all the corresponding destination IP addresses.";
    }
    description
        "A container for DDoS Attack";
}
description
    "A DDoS Attack is detected";
}
case virus-detected {
    container virus-detected {
        leaf virus-name {
            type string;
            description
                "The name of the detected virus";
        }
        leaf virus-type {
            type identityref {
                base nsfmi:virus-type;
            }
            description
                "The virus type of the detected virus";
        }
        leaf host {
            type union {
                type string;
                type inet:ip-address-no-zone;
            }
            description
                "The name or IP address of the host/device. This is
                used to identify the host/device that is infected by
                the virus. If the given name is not an IP address, the
                name can be an arbitrary string including a FQDN
                (Fully Qualified Domain Name). The name MUST be unique
                in the scope of management domain for identifying the
                device that has been infected with a virus.";
        }
        leaf file-type {
            type string;
        }
    }
}

```

```
        description
            "The type of a file (indicated by the file's suffix,
             e.g., .exe) where virus code is found (if
             applicable).";
    }
    leaf file-name {
        type string;
        description
            "The name of file virus code is found in (if
             applicable).";
    }
    leaf os {
        type string;
        description
            "The operating system of the device.";
    }
    description
        "A Virus Attack is detected";
}
description
    "A virus is detected";
}
case intrusion-detected {
    container intrusion-detected {
        leaf protocol {
            type identityref {
                base nsfmi:transport-protocol;
            }
            description
                "The transport protocol type for
                 nsf-detection-intrusion notification";
        }
        leaf app {
            type identityref {
                base nsfmi:application-protocol;
            }
            description
                "The employed application layer protocol";
        }
        leaf attack-type {
            type identityref {
                base nsfmi:intrusion-attack-type;
            }
            description
                "The sub attack type for intrusion attack";
        }
    }
    description
```

"An intrusion is detected";

```
    }
  }
  case web-attack-detected {
    container web-attack-detected {
      leaf attack-type {
        type identityref {
          base nsfmi:web-attack-type;
        }
        description
          "Concrete web attack type, e.g., SQL injection,
            command injection, XSS, and CSRF.";
      }
      leaf req-method {
        type identityref {
          base nsfmi:req-method;
        }
        description
          "The HTTP request method, e.g., PUT or GET.";
        reference
          "draft-ietf-httpbis-semantics-19: HTTP Semantics -
            Request Methods";
      }
      leaf req-uri {
        type string;
        description
          "The Requested URI";
      }
      leaf req-user-agent {
        type string;
        description
          "The request user agent";
      }
      leaf cookies {
        type string;
        description
          "The HTTP Cookies header field of the request from
            the user agent. The cookie information needs to be
            kept confidential and is NOT RECOMMENDED to be
            included in the monitoring data unless the information
            is absolutely necessary to help to enhance the
```

```

        security of the network.";
    reference
        "RFC 6265: HTTP State Management Mechanism - Cookie";
}
leaf req-host {
    type string;
    description
        "The domain name of the requested host";
}

```

```

}
leaf response-code {
    type string;
    description
        "The HTTP Response code";
    reference
        "IANA Website: Hypertext Transfer Protocol (HTTP)
        Status Code Registry";
}
description
    "A web attack is detected";
}
description
    "A web attack is detected";
}
case voip-vocn-detected {
    container voip-vocn-detected {
        leaf-list source-voice-id {
            type string;
            description
                "The detected source voice ID for Voice over Internet
                Protocol (VoIP) and Voice over Cellular Network
                (VoCN) that violates the security policy.";
        }
        leaf-list destination-voice-id {
            type string;
            description
                "The detected destination voice ID for Voice over
                Internet Protocol (VoIP) and Voice over Cellular
                Network (VoCN) that violates the security policy.";
        }
        leaf-list user-agent {
            type string;
        }
    }
}

```

```

        description
            "The detected user-agent for VoIP and VoCN that
            violates the security policy.";
    }
    description
        "A violation of VoIP/VoCN is detected";
    }
    description
        "A violation of VoIP/VoCN is detected";
    }
}
}
}
}

```

```
list i2nsf-feedback-information {
```

```

    key "nsf-name time";

    description
        "Feedback information is information about problem(s) of an
        NSF for a security service such as system resource over-usage
        or malfunction. ";

    leaf nsf-name {
        type union {
            type string;
            type inet:ip-address;
        }
        description
            "The name or IP address (IPv4 or IPv6) of the NSF to be
            configured. If the given nsf-name is not IP address, the
            name can be an arbitrary string including FQDN (Fully
            Qualified Domain Name).";
    }

    leaf time {
        type yang:date-and-time;
        description
            "The time of the feedback information delivered";
    }

    leaf language {

```

```

type string {
  pattern '([A-Za-z]{2,3}(-[A-Za-z]{3}(-[A-Za-z]{3})'
    + '{0,2})?|[A-Za-z]{4}|[A-Za-z]{5,8})(-[A-Za-z]{4})?'
    + '(-([A-Za-z]{2}|[0-9]{3}))?(-([A-Za-z0-9]{5,8}'
    + '|([0-9][A-Za-z0-9]{3})))*(-([0-9A-WY-Za-wy-z]'
    + '(-([A-Za-z0-9]{2,8})))*(-[Xx](-([A-Za-z0-9]'
    + '{1,8})))+)?|[Xx](-([A-Za-z0-9]{1,8}))+'
    + '([Ee][Nn]-[Gg][Bb]-[Oo][Ee][Dd]|[Ii]-'
    + '[Aa][Mm][Ii]|[Ii]-[Bb][Nn][Nn]|[Ii]-'
    + '[Dd][Ee][Ff][Aa][Uu][Ll][Tt]|[Ii]-'
    + '[Ee][Nn][Oo][Cc][Hh][Ii][Aa][Nn]'
    + '|[Ii]-[Hh][Aa][Kk]|'
    + '[Ii]-[Kk][Ll][Ii][Nn][Gg][Oo][Nn]|'
    + '[Ii]-[Ll][Uu][Xx]|[Ii]-[Mm][Ii][Nn][Gg][Oo]|'
    + '[Ii]-[Nn][Aa][Vv][Aa][Jj][Oo]|[Ii]-[Pp][Ww][Nn]|'
    + '[Ii]-[Tt][Aa][Oo]|[Ii]-[Tt][Aa][Yy]|'
    + '[Ii]-[Tt][Ss][Uu]|[Ss][Gg][Nn]-[Bb][Ee]-[Ff][Rr]|'
    + '[Ss][Gg][Nn]-[Bb][Ee]-[Nn][Ll]|[Ss][Gg][Nn]-'
    + '[Cc][Hh]-[Dd][Ee])|([Aa][Rr][Tt]-'
    + '[Ll][Oo][Jj][Bb][Aa][Nn]|[Cc][Ee][Ll]-'
    + '[Gg][Aa][Uu][Ll][Ii][Ss][Hh]|'
    + '[Nn][Oo]-[Bb][Oo][Kk]|[Nn][Oo]-'

```

```

    + '[Nn][Yy][Nn]|[Zz][Hh]-[Gg][Uu][Oo][Yy][Uu]|'
    + '[Zz][Hh]-[Hh][Aa][Kk][Kk][Aa]|[Zz][Hh]-'
    + '[Mm][Ii][Nn]|[Zz][Hh]-[Mm][Ii][Nn]-'
    + '[Nn][Aa][Nn]|[Zz][Hh]-[Xx][Ii][Aa][Nn][Gg]))));';
}
default "en-US";
description
  "The value in this field indicates the language tag
  used for all of the text in the module
  (i.e., 'leaf message' and 'leaf-list solution').

  The attribute is encoded following the rules in Section 2.1
  in RFC 5646. The default language tag is 'en-US'";
reference
  "RFC 5646: Tags for Identifying Languages";
}

container problem {
  description

```

```

    "The issue that is emitted by an NSF via the I2NSF Monitoring
    Interface. The problem for feedback information includes the
    system alarms, such as Memory alarm, CPU alarm, Disk alarm,
    Hardware alarm, and Interface alarm.";
choice alarm-type {
  description
    "The detected alarm type";
  case memory-alarm {
    container memory-alarm {
      leaf usage {
        type uint8 {
          range "0..100";
        }
        units "percent";
        description
          "The average usage for the duration of the alarm.";
      }
      leaf message {
        type string;
        description
          "A message explaining the problem.";
      }
      leaf duration {
        type uint32;
        description
          "Specify the duration of the first alarm triggered
          until the feedback information is created.";
      }
    }
  }
  description

```

```

    "The container for memory-alarm";
  }
  description
    "The detected alarm type is memory-alarm";
}
case cpu-alarm {
  container cpu-alarm {
    leaf usage {
      type uint8 {
        range "0..100";
      }
      units "percent";
    }
  }
}

```

```

        description
            "The average usage for the duration of the alarm.";
    }
    leaf message {
        type string;
        description
            "A message explaining the problem.";
    }
    leaf duration {
        type uint32;
        description
            "Specify the duration of the first alarm triggered
            until the feedback information is created.";
    }
    description
        "The container for cpu-alarm";
}
description
    "The detected alarm type is cpu-alarm";
}
case disk-alarm {
    container disk-alarm {
        leaf disk-id {
            type string;
            description
                "The ID of the storage disk. It is a free form
                identifier to identify the storage disk.";
        }
        leaf usage {
            type uint8 {
                range "0..100";
            }
            units "percent";
            description
                "The average usage for the duration of the alarm.";
        }
    }
}

```

```

    leaf message {
        type string;
        description
            "A message explaining the problem.";
    }
}

```



```

    leaf duration {
        type uint32;
        description
            "Specify the duration of the first alarm triggered
            until the feedback information is created.";
    }
    description
        "The container for disk-alarm";
}
description
    "The detected alarm type is disk-alarm";
}
case hardware-alarm {
    container hardware-alarm {
        leaf component-name {
            type string;
            description
                "The hardware component responsible for generating
                the message. Applicable for Hardware Failure
                Alarm.";
        }
        leaf message {
            type string;
            description
                "A message explaining the problem.";
        }
        leaf duration {
            type uint32;
            description
                "Specify the duration of the first alarm triggered
                until the feedback information is created.";
        }
        description
            "The container for hardware-alarm";
    }
    description
        "The detected alarm type is hardware-alarm";
}
case interface-alarm {
    container interface-alarm {
        leaf interface-id {
            type string;
            description

```

```

        "The interface ID responsible for generating
        the message.";
    }
    leaf interface-state {
        type enumeration {
            enum up {
                value 1;
                description
                    "The interface state is up and not congested.
                    The interface is ready to pass packets.";
            }
            enum down {
                value 2;
                description
                    "The interface state is down, i.e., does not pass
                    any packets.";
            }
            enum congested {
                value 3;
                description
                    "The interface state is up but congested.";
            }
            enum testing {
                value 4;
                description
                    "In some test mode. No operational packets can
                    be passed.";
            }
            enum unknown {
                value 5;
                description
                    "Status cannot be determined for some reason.";
            }
            enum dormant {
                value 6;
                description
                    "Waiting for some external event.";
            }
            enum not-present {
                value 7;
                description
                    "Some component (typically hardware) is
                    missing.";
            }
            enum lower-layer-down {
                value 8;
                description
                    "Down due to state of lower-layer interface(s).";
            }
        }
    }

```

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```
    }
  }
  description
    "The state of the interface. Applicable for Network
    Interface Failure Alarm.";
  reference
    "RFC 8343: A YANG Data Model for Interface Management
    - Operational States";
}
leaf message {
  type string;
  description
    "A message explaining the problem.";
}
leaf duration {
  type uint32;
  description
    "Specify the duration of the first alarm triggered
    until the feedback information is created.";
}
description
  "The container for interface-alarm";
}
description
  "The detected alarm type is interface-alarm";
}
}
}

leaf-list solution {
  type string;
  description
    "A possible solution given as feedback is in the form of
    a free-form string (as a high-level instruction).";
}
}
}
}
<CODE ENDS>
```

Figure 7: YANG for Application Interface

5. 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-feedback-policy
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](#)][RFC8525]:

name: ietf-i2nsf-feedback-policy
namespace: urn:ietf:params:xml:ns:yang:ietf-i2nsf-feedback-policy
prefix: nsffb
reference: RFC XXXX

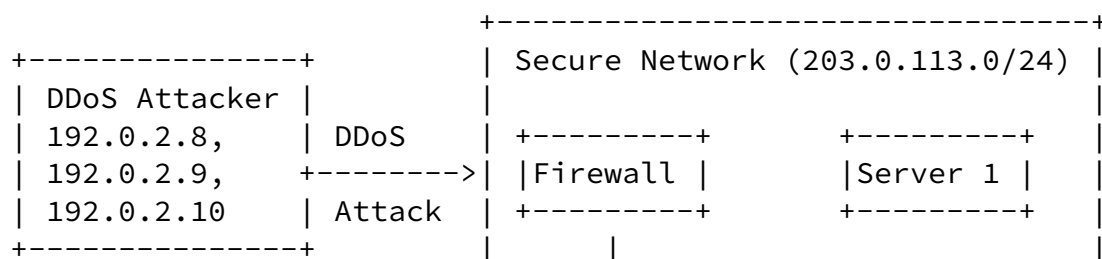
// RFC Ed.: replace XXXX with an actual RFC number and remove
// this note.

[6.](#) XML Configuration Examples of Feedback Policy

This section shows XML configuration examples of feedback policy rules that are delivered from the I2NSF Analyzer to the Security Controller over the Application Interface after the I2NSF Analyzer analyzes the Monitoring Information.

[6.1.](#) Feedback Policy for DDoS Detection

In this example, the scenario can be seen in Figure 8.



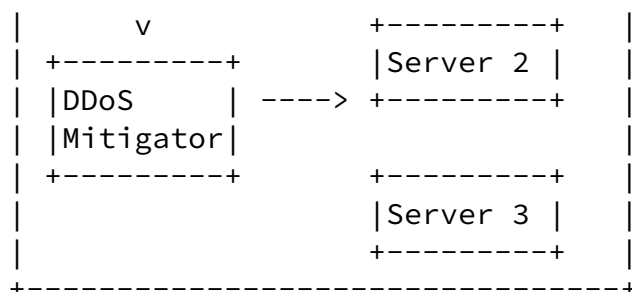


Figure 8: A Scenario Example of DDoS Attack

In this scenario, a DDoS Mitigator detects a DDoS Attack and sends a notification to the I2NSF Analyzer as shown in Figure 9.

```

<?xml version="1.0" encoding="UTF-8"?>
<notification
  xmlns="urn:ietf:params:xml:ns:netconf:notification:1.0">
  <eventTime>2021-08-27T09:00:01.00Z</eventTime>
  <i2nsf-nsf-event
    xmlns="urn:ietf:params:xml:ns:yang:ietf-i2nsf-nsf-monitoring">
    <acquisition-method>subscription</acquisition-method>
    <emission-type>on-change</emission-type>
    <dampening-type>on-repetition</dampening-type>
    <i2nsf-nsf-detection-ddos>
      <attack-type>nsfmi:syn-flood</attack-type>
      <start-time>2021-08-27T09:00:00.00Z</start-time>
      <attack-src-ip>192.0.2.8</attack-src-ip>
      <attack-src-ip>192.0.2.9</attack-src-ip>
      <attack-src-ip>192.0.2.10</attack-src-ip>
      <attack-dst-ip>203.0.113.0/24</attack-dst-ip>
      <attack-rate>100</attack-rate>
      <message>A DDoS Attack is detected</message>
      <nsf-name>DDoS_mitigator</nsf-name>
    </i2nsf-nsf-detection-ddos>
  </i2nsf-nsf-event>
</notification>

```

Figure 9: A Detected DDoS Attack by DDoS Mitigator

In the scenario shown in Figure 9, the description of the XML example is as follows:

1. The DDoS attack is detected at 9 am on August 27 in 2021.
2. The sources of the attack are 192.0.2.8, 192.0.2.9, and 192.0.2.10.
3. The destination of the attack is 203.0.113.0/24.

After receiving the information, the I2NSF Analyzer analyzes the data and creates a new feedback policy to enforce the security of the network. The I2NSF Analyzer delivers a feedback policy to the Security Controller as shown in Figure 10.

```
<?xml version="1.0" encoding="UTF-8" ?>
<i2nsf-security-policy
  xmlns="urn:ietf:params:xml:ns:yang:ietf-i2nsf-feedback-policy">
  <system-policy-name>
    feedback_policy_for_ddos_attack
  </system-policy-name>
  <rules>
    <rule-name>deny_ddos_attack</rule-name>
    <condition>
      <ipv4>
        <source-ipv4-range>
          <start>192.0.2.8</start>
          <end>192.0.2.10</end>
        </source-ipv4-range>
      </ipv4>
      <context>
        <time>
          <start-date-time>2021-08-27T09:00:00.00Z</start-date-time>
        </time>
      </context>
    </condition>
  </rules>
</i2nsf-security-policy>
```

```

    <actions>
      <packet-action>
        <ingress-action>drop</ingress-action>
      </packet-action>
    </actions>
  </rules>
</nsf-name>Firewall</nsf-name>
<problem>
  <ddos-detected>
    <attack-src-ip>192.0.2.8</attack-src-ip>
    <attack-src-ip>192.0.2.9</attack-src-ip>
    <attack-src-ip>192.0.2.10</attack-src-ip>
    <attack-dst-ip>203.0.113.0/24</attack-dst-ip>
  </ddos-detected>
</problem>
</i2nsf-security-policy>

```

Figure 10: Policy Reconfiguration for a Detected DDoS Attack

The policy reconfiguration in Figure 10 means the following:

1. The feedback policy is named as "feedback_policy_for_ddos_attack".
2. The rule is named as "deny_ddos_attack".

3. The rule starts from 09:00 am on August 24 in 2021. The condition of the rule is from the sources of the IP addresses 192.0.2.8, 192.0.2.9, and 192.0.2.10.
4. The action required is to "drop" any access from the the IP addresses have been identified as malicious.
5. The NSF to be configured is named "Firewall".
6. The problem that triggered the generation of the feedback is a DDoS attack from the sources of the IP addresses 192.0.2.8, 192.0.2.9, and 192.0.2.10 to the protected network of 203.0.113.0/24.

6.2. Feedback Information for Overloaded NSF

In this scenario, an NSF is overloaded and sends a notification to the I2NSF Analyzer as shown in Figure 11.

```
<?xml version="1.0" encoding="UTF-8"?>
<notification
  xmlns="urn:ietf:params:xml:ns:netconf:notification:1.0">
  <eventTime>2021-08-27T07:43:52.181088+00:00</eventTime>
  <i2nsf-event
    xmlns="urn:ietf:params:xml:ns:yang:ietf-i2nsf-nsf-monitoring">
    <acquisition-method>subscription</acquisition-method>
    <emission-type>on-change</emission-type>
    <dampening-type>on-repetition</dampening-type>
    <language>en-US</language>
    <i2nsf-system-detection-alarm>
      <alarm-category>memory-alarm</alarm-category>
      <usage>91</usage>
      <threshold>90</threshold>
      <message>Memory Usage Exceeded the Threshold</message>
      <nsf-name>time_based_firewall</nsf-name>
      <severity>high</severity>
    </i2nsf-system-detection-alarm>
  </i2nsf-event>
</notification>
```

Figure 11: The Monitoring of an Overloaded NSF

In the scenario shown in Figure 11, the description of the XML example is as follows:

1. The NSF that sends the information is named "firewall".

2. The memory usage of the NSF triggered the alarm.
3. The memory usage of the NSF is 98 percent.
4. The memory threshold to trigger the alarm is 80 percent.
5. The event is delivered at 2021-08-27T07:43:52.181088+00:00.

After receiving the information, the I2NSF Analyzer analyzes the data and creates a new feedback policy to solve the problem that is detected in the NSF. The I2NSF Analyzer delivers a feedback information to the Security Controller as shown in Figure 12.

```
<?xml version="1.0" encoding="UTF-8" ?>
<i2nsf-feedback-information
  xmlns="urn:ietf:params:xml:ns:yang:ietf-i2nsf-feedback-policy">
  <time>2021-08-27T08:43:52.000000+00:00</time>
  <nsf-name>Firewall</nsf-name>
  <language>en-US</language>
  <problem>
    <memory-alarm>
      <usage>95</usage>
      <message>Memory Usage Exceeded the Threshold</message>
      <duration>3600</duration>
    </memory-alarm>
  </problem>
  <solution>
    Add more memory capacity to the NSF
  </solution>
  <solution>
    Create a new NSF with the same security service
  </solution>
</i2nsf-feedback-information>
```

Figure 12: Feedback Information for the Overloaded NSF

The feedback information in Figure 12 means the following:

1. The name of the NSF that needs to be handled is called "Firewall".
2. The feedback information is delivered at 2021-08-27T08:43:52.000000+00:00.
3. The problem is that the Memory Usage Exceeded the Threshold with the average usage of memory as 95.

4. The problem persists for 3,600 seconds (1 hour) without any fix.
5. The proposed solution to the problem is to add more memory capacity in hardware to the NSF or to create a new NSF with the same security service.

7. Security Considerations

The YANG module specified in this document defines a data schema designed to be accessed through network management protocols such as NETCONF [[RFC6241](#)] or RESTCONF [[RFC8040](#)]. The lowest NETCONF layer is the secure transport layer, and the required secure transport is Secure Shell (SSH) [[RFC6242](#)]. The lowest RESTCONF layer is HTTPS, and the required secure transport is TLS [[RFC8446](#)].

The NETCONF access control model [[RFC8341](#)] provides a means of restricting access to specific 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 module 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. And the data model in this document uses the data model from NSF-Facing Interface data model, it MUST follow the Security Considerations mentioned in the [[I-D.ietf-i2nsf-nsf-facing-interface-dm](#)].

Some of the readable data nodes in this YANG module may be considered sensitive or vulnerable in some network environments. It is thus important to control read access (e.g., via get, get-config, or notification) to these data nodes. This document also MUST follow the Security Considerations about the readable data nodes mentioned in the [[I-D.ietf-i2nsf-nsf-facing-interface-dm](#)].

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[Appendix A.](#) Acknowledgments

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[Appendix C.](#) Changes from [draft-lingga-i2nsf-application-interface-dm-02](#)

The following changes are made from [draft-lingga-i2nsf-application-interface-dm-02](#):

* This version has been updated to follow the latest versions of the

NSF-Facing Interface YANG Data Model
[[I-D.ietf-i2nsf-nsf-facing-interface-dm](#)] and the NSF Monitoring
Interface YANG Data Model
[[I-D.ietf-i2nsf-nsf-monitoring-data-model](#)].

- * Especially, the XML examples are updated to follow the latest versions of both the YANG data models.

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