I2NSF Working Group
Internet-Draft
Intended status: Standards Track
Expires: January 14, 2021

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July 13, 2020

I2NSF Capability YANG Data Model
draft-ietf-i2nsf-capability-data-model-06

Abstract

This document defines a YANG data model for the capabilities of various Network Security Functions (NSFs) in the Interface to Network Security Functions (I2NSF) framework to centrally manage the capabilities of the various NSFs.

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1. Introduction

As the industry becomes more sophisticated and network devices (e.g., Internet of Things, Self-driving vehicles, and VoIP/VoLTE smartphones), service providers have a lot of problems described in [RFC8192]. To resolve these problems, [draft-ietf-i2nsf-capability] specifies the information model of the capabilities of Network Security Functions (NSFs).

This document provides a YANG data model [RFC6020][RFC7950] that defines the capabilities of NSFs to centrally manage the capabilities of those security devices. The security devices can register their own capabilities into a Network Operator Management (Mgmt) System (i.e., Security Controller) with this YANG data model through the registration interface [RFC8329]. With the capabilities of those security devices maintained centrally, those security devices can be more easily managed [RFC8329]. This YANG data model is based on the information model for I2NSF NSF capabilities [draft-ietf-i2nsf-capability].

This YANG data model uses an "Event-Condition-Action" (ECA) policy model that is used as the basis for the design of I2NSF Policy as described in [RFC8329] and [draft-ietf-i2nsf-capability]. The "ietf-i2nsf-capability" YANG module defined in this document provides the following features:

- Definition for general capabilities of network security functions.
- Definition for event capabilities of generic network security functions.
- Definition for condition capabilities of generic network security functions.
- Definition for condition capabilities of advanced network security functions.
- Definition for action capabilities of generic network security functions.
- Definition for resolution strategy capabilities of generic network security functions.
- Definition for default action capabilities of generic network security functions.

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][RFC8174].

3. Terminology

This document uses the terminology described in [draft-ietf-i2nsf-capability][RFC8431]. Especially, the following terms are from [RFC3444]:

- 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.

- 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.

3.1. Tree Diagrams

A simplified graphical representation of the data model is used in this document. The meaning of the symbols in these diagrams is referred from [RFC8340].

4. Overview

This section provides as overview of how the YANG data model can be used in the I2NSF framework described in [RFC8329]. Figure 1 shows the capabilities (e.g., firewall and web filter) of NSFs in the I2NSF Framework. As shown in this figure, an NSF Developer's Management System can register NSFs and the capabilities that the network security device can support. To register NSFs in this way, the Developer's Management System utilizes this standardized capability YANG data model through the I2NSF Registration Interface [draft-ietf-i2nsf-registration-interface-dm]. That is, this Registration Interface uses the YANG module described in this document to describe the capability of a network security function that is registered with the Security Controller. With the capabilities of those network security devices maintained centrally, those security devices can be more easily managed, which can resolve many of the problems described in [RFC8192].

In Figure 1, a new NSF at a Developer's Management Systems has capabilities of Firewall (FW) and Web Filter (WF), which are denoted as (Cap = {FW, WF}), to support Event-Condition-Action (ECA) policy rules where 'E', 'C', and 'A' mean "Event", "Condition", and "Action", respectively. The condition involves IPv4 or IPv6 datagrams, and the action includes "Allow" and "Deny" for those datagrams.

Note that the NSF-Facing Interface is used to configure the security policy rules of the generic network security functions [draft-ietf-i2nsf-nsf-facing-interface-dm], and The configuration of advanced security functions over the NSF-Facing Interface is used to configure the security policy rules of advanced network security functions (e.g., anti-virus and anti-DDoS attack)

[draft-dong-i2nsf-asf-config], respectively, according to the capabilities of NSFs registered with the I2NSF Framework.

```
      +-------------------------------------------------------+
      |  I2NSF User (e.g., Overlay Network Mgmt, Enterprise  |
      |  Network Mgmt, another network domain's mgmt, etc.)  |
      +--------------------+----------------------------------+
          I2NSF            ^
 Consumer-Facing Interface |
                           |
                           v                  I2NSF
         +-----------------+------------+  Registration  +-------------+
         | Network Operator Mgmt System |   Interface    | Developer's |
         | (i.e., Security Controller)  |<-------------->| Mgmt System |
         +-----------------+------------+                +-------------+
                           ^                                New NSF
                           |                            Cap = {FW, WF}
             I2NSF         |                            E = {}
      NSF-Facing Interface |                            C = {IPv4, IPv6}
                           |                            A = {Allow, Deny}
                           v
      +---------------+----+------------+-----------------+
      |               |                 |                 |
  +---+---+       +---+---+         +---+---+         +---+---+
  | NSF-1 |  ...  | NSF-m |         | NSF-1 |   ...   | NSF-n |  ...
  +-------+       +-------+         +-------+         +-------+
    NSF-1           NSF-m             NSF-1             NSF-n
Cap = {FW, WF}    Cap = {FW, WF}    Cap = {FW, WF}    Cap = {FW, WF}
E = {}            E = {user}        E = {dev}         E = {time}
C = {IPv4}        C = {IPv6}        C = {IPv4, IPv6}  C = {IPv4}
A = {Allow, Deny} A = {Allow, Deny} A = {Allow, Deny} A = {Allow, Deny}

  Developer's Mgmt System A          Developer's Mgmt System B
```

Figure 1: Capabilities of NSFs in I2NSF Framework

A use case of an NSF with the capabilities of firewall and web filter is described as follows.

- o If a network manager wants to apply security policy rules to block malicious users with firewall and web filter, it is a tremendous burden for a network administrator to apply all of the needed rules to NSFs one by one. This problem can be resolved by managing the capabilities of NSFs in this document.

- o If a network administrator wants to block malicious users for IPv6 traffic, he sends a security policy rule to block the users to the

Network Operator Management System using the I2NSF User (i.e., web application).

- o When the Network Operator Management System receives the security policy rule, it automatically sends that security policy rules to appropriate NSFs (i.e., NSF-m in Developer's Management System A and NSF-1 in Developer's Management System B) which can support the capabilities (i.e., IPv6). This lets an I2NSF User not consider NSFs where the rule is applied.

- o If NSFs encounter the suspicious IPv6 packets of malicious users, they can filter the packets out according to the configured security policy rule. Therefore, the security policy rule against the malicious users' packets can be automatically applied to appropriate NSFs without human intervention.

5. YANG Tree Diagram

This section shows a YANG tree diagram of capabilities of network security functions, as defined in the [draft-ietf-i2nsf-capability].

5.1. Network Security Function (NSF) Capabilities

This section explains a YANG tree diagram of NSF capabilities and its features. Figure 2 shows a YANG tree diagram of NSF capabilities. The NSF capabilities in the tree include time capabilities, event capabilities, condition capabilities, action capabilities, resolution strategy capabilities, and default action capabilities. Those capabilities can be tailored or extended according to a vendor's specific requirements. Refer to the NSF capabilities information model for detailed discussion [draft-ietf-i2nsf-capability].

```
module: ietf-i2nsf-capability
  +--rw nsf* [nsf-name]
     +--rw nsf-name            string
     +--rw time-capabilities*                  enumeration
     +--rw event-capabilities
     |  +--rw system-event-capability*   identityref
     |  +--rw system-alarm-capability*   identityref
     +--rw condition-capabilities
     |  +--rw generic-nsf-capabilities
     |  |  +--rw ipv4-capability*   identityref
     |  |  +--rw icmp-capability*   identityref
     |  |  +--rw ipv6-capability*   identityref
     |  |  +--rw icmpv6-capability*   identityref
     |  |  +--rw tcp-capability*    identityref
     |  |  +--rw udp-capability*    identityref
     |  +--rw advanced-nsf-capabilities
     |  |  +--rw anti-virus-capability*    identityref
     |  |  +--rw anti-ddos-capability*     identityref
     |  |  +--rw ips-capability*          identityref
     |  |  +--rw url-capability*          identityref
     |  |  +--rw voip-volte-capability*   identityref
     |  +--rw context-capabilities*        identityref
     +--rw action-capabilities
     |  +--rw ingress-action-capability*   identityref
     |  +--rw egress-action-capability*    identityref
     |  +--rw log-action-capability*       identityref
     +--rw resolution-strategy-capabilities*   identityref
     +--rw default-action-capabilities*        identityref
     +--rw ipsec-method*                       identityref
```

Figure 2: YANG Tree Diagram of Capabilities of Network Security Functions

Time capabilities are used to specify the capabilities which describe when to execute the I2NSF policy rule. The time capabilities are defined in terms of absolute time and periodic time. The absolute time means the exact time to start or end. The periodic time means repeated time like day, week, or month. See Section 3.4.6 (Capability Algebra) in [draft-ietf-i2nsf-capability] for more information about the time-based condition (e.g., time period) in the capability algebra.

Event capabilities are used to specify the capabilities that describe the event that would trigger the evaluation of the condition clause of the I2NSF Policy Rule. The defined event capabilities are system event and system alarm. See Section 3.1 (Design Principles and ECA

Policy Model Overview) in [draft-ietf-i2nsf-capability] for more information about the event in the ECA policy model.

Condition capabilities are used to specify capabilities of a set of attributes, features, and/or values that are to be compared with a set of known attributes, features, and/or values in order to determine whether or not the set of actions in that (imperative) I2NSF policy rule can be executed. The condition capabilities are classified in terms of generic network security functions and advanced network security functions. The condition capabilities of generic network security functions are defined as IPv4 capability, IPv6 capability, TCP capability, UDP capability, and ICMP capability. The condition capabilities of advanced network security functions are defined as anti-virus capability, anti-DDoS capability, IPS capability, HTTP capability, and VoIP/VoLTE capability. See Section 3.1 (Design Principles and ECA Policy Model Overview) in [draft-ietf-i2nsf-capability] for more information about the condition in the ECA policy model. Also, see Section 3.4.3 (I2NSF Condition Clause Operator Types) in [draft-ietf-i2nsf-capability] for more information about the operator types in an I2NSF condition clause.

Action capabilities are used to specify the capabilities that describe the control and monitoring aspects of flow-based NSFs when the event and condition clauses are satisfied. The action capabilities are defined as ingress-action capability, egress-action capability, and log-action capability. See Section 3.1 (Design Principles and ECA Policy Model Overview) in [draft-ietf-i2nsf-capability] for more information about the action in the ECA policy model. Also, see Section 7.2 (NSF-Facing Flow Security Policy Structure) in [RFC8329] for more information about the ingress and egress actions. In addition, see Section 9.1 (Flow-Based NSF Capability Characterization) for more information about logging at NSFs.

Resolution strategy capabilities are used to specify the capabilities that describe conflicts that occur between the actions of the same or different policy rules that are matched and contained in this particular NSF. The resolution strategy capabilities are defined as First Matching Rule (FMR), Last Matching Rule (LMR), Prioritized Matching Rule (PMR), Prioritized Matching Rule with Errors (PMRE), and Prioritized Matching Rule with No Errors (PMRN). See Section 3.4.2 (Conflict, Resolution Strategy and Default Action) in [draft-ietf-i2nsf-capability] for more information about the resolution strategy.

Default action capabilities are used to specify the capabilities that describe how to execute I2NSF policy rules when no rule matches a

packet. The default action capabilities are defined as pass, drop, alert, and mirror. See Section 3.4.2 (Conflict, Resolution Strategy and Default Action) in [draft-ietf-i2nsf-capability] for more information about the default action.

IPsec method capabilities are used to specify capabilities of how to support an Internet Key Exchange (IKE) for the security communication. The default action capabilities are defined as IKE or IKE-less. See [draft-ietf-i2nsf-sdn-ipsec-flow-protection] for more information about the SDN-based IPsec flow protection in I2NSF.

6. YANG Data Modules

6.1. I2NSF Capability YANG Data Module

This section introduces a YANG data module for network security functions capabilities, as defined in the [draft-ietf-i2nsf-capability].

```
<CODE BEGINS> file "ietf-i2nsf-capability@2020-07-13.yang"

module ietf-i2nsf-capability {
  yang-version 1.1;
  namespace
    "urn:ietf:params:xml:ns:yang:ietf-i2nsf-capability";
  prefix
    nsfcap;


  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>

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     <mailto:pauljeong@skku.edu>
```

```
     Editor: Jinyong Tim Kim
     <mailto:timkim@skku.edu>";

  description
    "This module describes a capability model for I2NSF devices.

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    authors of the code.  All rights reserved.

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    without modification, is permitted pursuant to, and subject
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    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 8341; see
    the RFC itself for full legal notices.";

  revision "2020-07-13"{
    description "Initial revision.";
    reference
      "RFC XXXX: I2NSF Capability YANG Data Model";
  }

  /*
   * Identities
   */

  identity event {
    description
      "Base identity for I2NSF policy events.";
    reference
      "draft-ietf-i2nsf-nsf-monitoring-data-model-03
       - Event";
  }

  identity system-event-capability {
    base event;
    description
      "Identity for system events";
    reference
      "draft-ietf-i2nsf-nsf-monitoring-data-model-03
       - System alarm";
  }

  identity system-alarm-capability {
    base event;
```

```
    description
      "Identity for system alarms";
    reference
      "draft-ietf-i2nsf-nsf-monitoring-data-model-03
       - System alarm";
  }

  identity access-violation {
    base system-event-capability;
    description
      "Identity for access violation events";
    reference
      "draft-ietf-i2nsf-nsf-monitoring-data-model-03
       - System event";
  }

  identity configuration-change {
    base system-event-capability;
    description
      "Identity for configuration change events";
    reference
      "draft-ietf-i2nsf-nsf-monitoring-data-model-03
       - System event";
  }

  identity memory-alarm {
    base system-alarm-capability;
    description
      "Identity for memory alarm events";
    reference
      "draft-ietf-i2nsf-nsf-monitoring-data-model-03
       - System alarm";
  }

  identity cpu-alarm {
    base system-alarm-capability;
    description
      "Identity for CPU alarm events";
    reference
      "draft-ietf-i2nsf-nsf-monitoring-data-model-03
       - System alarm";
  }

  identity disk-alarm {
    base system-alarm-capability;
    description
      "Identity for disk alarm events";
    reference
```

```
      "draft-ietf-i2nsf-nsf-monitoring-data-model-03
       - System alarm";
  }

  identity hardware-alarm {
    base system-alarm-capability;
    description
      "Identity for hardware alarm events";
    reference
      "draft-ietf-i2nsf-nsf-monitoring-data-model-03
       - System alarm";
  }

  identity interface-alarm {
    base system-alarm-capability;
    description
      "Identity for interface alarm events";
    reference
      "draft-ietf-i2nsf-nsf-monitoring-data-model-03
       - System alarm";
  }

  identity condition {
    description
      "Base identity for policy conditions";
  }

  identity context-capability {
    base condition;
    description
      "Identity for context condition capabilities";
  }

  identity acl-number {
    base context-capability;
    description
      "Identity for ACL number condition capability";
  }

  identity application {
    base context-capability;
    description
      "Identity for application condition capability";
  }

  identity target {
    base context-capability;
    description
```

```
      "Identity for target condition capability";
  }

  identity user {
    base context-capability;
    description
      "Identity for user condition capability";
  }

  identity group {
    base context-capability;
    description
      "Identity for group condition capability";
  }

  identity geography {
    base context-capability;
    description
      "Identity for geography condition capability";
  }

  identity ipv4-capability {
    base condition;
    description
      "Identity for IPv4 condition capabilities";
    reference
      "RFC 791: Internet Protocol";
  }

  identity exact-ipv4-header-length {
    base ipv4-capability;
    description
      "Identity for exact-match IPv4 header-length
      condition capability";
    reference
      "RFC 791: Internet Protocol - Header Length";
  }

  identity range-ipv4-header-length {
    base ipv4-capability;
    description
      "Identity for range-match IPv4 header-length
      condition capability";
    reference
      "RFC 791: Internet Protocol - Header Length";
  }

  identity ipv4-tos {
```

```
    base ipv4-capability;
    description
      "Identity for IPv4 Type-Of-Service (TOS)
      condition capability";
    reference
      "RFC 791: Internet Protocol - Type of Service";
  }

  identity exact-ipv4-total-length {
    base ipv4-capability;
    description
      "Identity for exact-match IPv4 total length
      condition capability";
    reference
      "RFC 791: Internet Protocol - Total Length";
  }

  identity range-ipv4-total-length {
    base ipv4-capability;
    description
      "Identity for range-match IPv4 total length
      condition capability";
    reference
      "RFC 791: Internet Protocol - Total Length";
  }

  identity ipv4-id {
    base ipv4-capability;
    description
      "Identity for identification condition capability";
    reference
      "RFC 791: Internet Protocol - Identification";
  }

  identity ipv4-fragment-flags {
    base ipv4-capability;
    description
      "Identity for IPv4 fragment flags condition capability";
    reference
      "RFC 791: Internet Protocol - Fragmentation Flags";
  }

  identity exact-ipv4-fragment-offset {
    base ipv4-capability;
    description
      "Identity for exact-match IPv4 fragment offset
      condition capability";
    reference
```

```
      "RFC 791: Internet Protocol - Fragmentation Offset";
  }

  identity range-ipv4-fragment-offset {
    base ipv4-capability;
    description
      "Identity for range-match IPv4 fragment offset
      condition capability";
    reference
      "RFC 791: Internet Protocol - Fragmentation Offset";
  }

  identity exact-ipv4-ttl {
    base ipv4-capability;
    description
      "Identity for exact-match IPv4 Time-To-Live (TTL)
      condition capability";
    reference
      "RFC 791: Internet Protocol - Time To Live (TTL)";
  }

  identity range-ipv4-ttl {
    base ipv4-capability;
    description
      "Identity for range-match IPv4 Time-To-Live (TTL)
      condition capability";
    reference
      "RFC 791: Internet Protocol - Time To Live (TTL)";
  }

  identity ipv4-protocol {
    base ipv4-capability;
    description
      "Identity for IPv4 protocol condition capability";
    reference
      "RFC 790: Assigned numbers - Assigned Internet
       Protocol Number
       RFC 791: Internet Protocol - Protocol";
  }

  identity exact-ipv4-address {
    base ipv4-capability;
    description
      "Identity for exact-match IPv4 address
      condition capability";
    reference
      "RFC 791: Internet Protocol - Address";
  }
```

```
  identity range-ipv4-address {
    base ipv4-capability;
    description
      "Identity for range-match IPv4 address condition
       capability";
    reference
      "RFC 791: Internet Protocol - Address";
  }

  identity ipv4-ip-opts {
    base ipv4-capability;
    description
      "Identity for IPv4 option condition capability";
    reference
      "RFC 791: Internet Protocol - Options";
  }

  identity ipv4-geo-ip {
    base ipv4-capability;
    description
      "Identity for geography condition capability";
    reference
      "draft-ietf-i2nsf-capability-05: Information Model
       of NSFs Capabilities - Geo-IP";
  }

  identity ipv6-capability {
    base condition;
    description
      "Identity for IPv6 condition capabilities";
    reference
      "RFC 8200: Internet Protocol, Version 6 (IPv6)
      Specification";
  }

  identity ipv6-traffic-class {
    base ipv6-capability;
    description
      "Identity for IPv6 traffic class
      condition capability";
    reference
      "RFC 8200: Internet Protocol, Version 6 (IPv6)
      Specification - Traffic Class";
  }

  identity exact-ipv6-flow-label {
    base ipv6-capability;
    description
```

```
      "Identity for exact-match IPv6 flow label
      condition capability";
    reference
      "RFC 8200: Internet Protocol, Version 6 (IPv6)
      Specification - Flow Label";
  }

  identity range-ipv6-flow-label {
    base ipv6-capability;
    description
      "Identity for range-match IPv6 flow label
      condition capability";
    reference
      "RFC 8200: Internet Protocol, Version 6 (IPv6)
      Specification - Flow Label";
  }

  identity exact-ipv6-payload-length {
    base ipv6-capability;
    description
      "Identity for exact-match IPv6 payload length
      condition capability";
    reference
      "RFC 8200: Internet Protocol, Version 6 (IPv6)
      Specification - Payload Length";
  }

  identity range-ipv6-payload-length {
    base ipv6-capability;
    description
      "Identity for range-match IPv6 payload length
      condition capability";
    reference
      "RFC 8200: Internet Protocol, Version 6 (IPv6)
      Specification - Payload Length";
  }

  identity ipv6-next-header {
    base ipv6-capability;
    description
      "Identity for IPv6 next header condition capability";
    reference
      "RFC 8200: Internet Protocol, Version 6 (IPv6)
      Specification - Next Header";
  }

  identity exact-ipv6-hop-limit {
    base ipv6-capability;
```

```
    description
      "Identity for exact-match IPv6 hop limit condition
      capability";
    reference
      "RFC 8200: Internet Protocol, Version 6 (IPv6)
      Specification - Hop Limit";
  }

  identity range-ipv6-hop-limit {
    base ipv6-capability;
    description
      "Identity for range-match IPv6 hop limit condition
      capability";
    reference
      "RFC 8200: Internet Protocol, Version 6 (IPv6)
      Specification - Hop Limit";
  }

  identity exact-ipv6-address {
    base ipv6-capability;
    description
      "Identity for exact-match IPv6 address condition
       capability";
    reference
      "RFC 8200: Internet Protocol, Version 6 (IPv6)
      Specification - Address";
  }

  identity range-ipv6-address {
    base ipv6-capability;
    description
      "Identity for range-match IPv6 address condition
      capability";
    reference
      "RFC 8200: Internet Protocol, Version 6 (IPv6)
      Specification - Address";
  }

  identity tcp-capability {
    base condition;
    description
      "Identity for TCP condition capabilities";
    reference
      "RFC 793: Transmission Control Protocol";
  }

  identity exact-tcp-port-num {
    base tcp-capability;
```

```
    description
      "Identity for exact-match TCP port number condition
       capability";
    reference
      "RFC 793: Transmission Control Protocol - Port Number";
  }

  identity range-tcp-port-num {
    base tcp-capability;
    description
      "Identity for range-match TCP port number condition
       capability";
    reference
      "RFC 793: Transmission Control Protocol - Port Number";
  }

  identity exact-tcp-seq-num {
    base tcp-capability;
    description
      "Identity for exact-match TCP sequence number condition
      capability";
    reference
      "RFC 793: Transmission Control Protocol - Sequence Number";
  }

  identity range-tcp-seq-num {
    base tcp-capability;
    description
      "Identity for range-match TCP sequence number condition
       capability";
    reference
      "RFC 793: Transmission Control Protocol - Sequence Number";
  }

  identity exact-tcp-ack-num {
    base tcp-capability;
    description
      "Identity for exact-match TCP acknowledgement number condition
       capability";
    reference
      "RFC 793: Transmission Control Protocol - Acknowledgement Number";
  }

  identity range-tcp-ack-num {
    base tcp-capability;
    description
      "Identity for range-match TCP acknowledgement number condition
       capability";
```

```
    reference
      "RFC 793: Transmission Control Protocol - Acknowledgement Number";
  }

  identity exact-tcp-window-size {
    base tcp-capability;
    description
      "Identity for exact-match TCP window size condition capability";
    reference
      "RFC 793: Transmission Control Protocol - Window Size";
  }

  identity range-tcp-window-size {
    base tcp-capability;
    description
      "Identity for range-match TCP window size condition capability";
    reference
      "RFC 793: Transmission Control Protocol - Window Size";
  }

  identity tcp-flags {
    base tcp-capability;
    description
      "Identity for TCP flags condition capability";
    reference
      "RFC 793: Transmission Control Protocol - Flags";
  }

  identity udp-capability {
    base condition;
    description
      "Identity for UDP condition capabilities";
    reference
      "RFC 768: User Datagram Protocol";
  }

  identity exact-udp-port-num {
    base udp-capability;
    description
      "Identity for exact-match UDP port number condition capability";
    reference
      "RFC 768: User Datagram Protocol - Port Number";
  }

  identity range-udp-port-num {
    base udp-capability;
    description
      "Identity for range-match UDP port number condition capability";
```

```
    reference
      "RFC 768: User Datagram Protocol - Port Number";
  }

  identity exact-udp-total-length {
    base udp-capability;
    description
      "Identity for exact-match UDP total-length condition capability";
    reference
      "RFC 768: User Datagram Protocol - Total Length";
  }

  identity range-udp-total-length {
    base udp-capability;
    description
      "Identity for range-match UDP total-length condition capability";
    reference
      "RFC 768: User Datagram Protocol - Total Length";
  }

  identity icmp-capability {
    base condition;
    description
      "Identity for ICMP condition capabilities";
    reference
      "RFC 792: Internet Control Message Protocol";
  }

  identity icmp-type {
    base icmp-capability;
    description
      "Identity for ICMP type condition capability";
    reference
      "RFC 792: Internet Control Message Protocol";
  }

  identity icmpv6-capability {
    base condition;
    description
      "Identity for ICMPv6 condition capabilities";
    reference
      "RFC 4443: Internet Control Message Protocol (ICMPv6)
       for the Internet Protocol Version 6 (IPv6) Specification
       - ICMPv6";
  }

  identity icmpv6-type {
    base icmpv6-capability;
```

```
    description
      "Identity for ICMPv6 type condition capability";
    reference
      "RFC 4443: Internet Control Message Protocol (ICMPv6)
       for the Internet Protocol Version 6 (IPv6) Specification
       - ICMPv6";
  }

  identity url-capability {
    base condition;
    description
      "Identity for URL condition capabilities";
  }

  identity pre-defined {
    base url-capability;
    description
      "Identity for URL pre-defined condition capabilities";
  }

  identity user-defined {
    base url-capability;
    description
      "Identity for URL user-defined condition capabilities";
  }

  identity log-action-capability {
    description
      "Identity for log-action capabilities";
  }

  identity rule-log {
    base log-action-capability;
    description
      "Identity for rule log log-action capability";
  }

  identity session-log {
    base log-action-capability;
    description
      "Identity for session log log-action capability";
  }

  identity ingress-action-capability {
    description
      "Identity for ingress-action capabilities";
    reference
      "RFC 8329: Framework for Interface to Network Security
```

```
       Functions - Ingress action";
  }

  identity egress-action-capability {
    description
      "Base identity for egress-action capabilities";
    reference
      "RFC 8329: Framework for Interface to Network Security
       Functions - Egress action";
  }

  identity default-action-capability {
    description
      "Identity for default-action capabilities";
    reference
      "draft-ietf-i2nsf-capability-05: Information Model of
       NSFs Capabilities - Default action";
  }

  identity pass {
    base ingress-action-capability;
    base egress-action-capability;
    base default-action-capability;
    description
      "Identity for pass action capability";
    reference
      "RFC 8329: Framework for Interface to Network Security
       Functions - Ingress, egress, and pass actions
           draft-ietf-i2nsf-capability-05: Information Model of
       NSFs Capabilities - Actions and default action";
  }

  identity drop {
    base ingress-action-capability;
    base egress-action-capability;
    base default-action-capability;
    description
      "Identity for drop action capability";
    reference
      "RFC 8329: Framework for Interface to Network Security
       Functions - Ingress, egress, and drop actions
       draft-ietf-i2nsf-capability-05: Information Model of
       NSFs Capabilities - Actions and default action";
  }

  identity alert {
    base ingress-action-capability;
    base egress-action-capability;
```

```
    base default-action-capability;
    description
      "Identity for alert action capability";
    reference
      "RFC 8329: Framework for Interface to Network Security
       Functions - Ingress, egress, and alert actions
       draft-ietf-i2nsf-nsf-monitoring-data-model-03: I2NSF
       NSF Monitoring YANG Data Model - Alarm (i.e., alert)
       draft-ietf-i2nsf-capability-05: Information Model of
       NSFs Capabilities - Actions and default action";
  }

  identity mirror {
    base ingress-action-capability;
    base egress-action-capability;
    base default-action-capability;
    description
      "Identity for mirror action capability";
    reference
      "RFC 8329: Framework for Interface to Network Security
       Functions - Ingress, egress, and mirror actions
       draft-ietf-i2nsf-capability-05: Information Model of
       NSFs Capabilities - Actions and default action";
  }

  identity invoke-signaling {
    base egress-action-capability;
    description
      "Identity for invoke signaling action capability";
    reference
      "RFC 8329: Framework for Interface to Network Security
       Functions - Invoke-signaling action";
  }

  identity tunnel-encapsulation {
    base egress-action-capability;
    description
      "Identity for tunnel encapsulation action capability";
    reference
      "RFC 8329: Framework for Interface to Network Security
       Functions - Tunnel-encapsulation action";
  }

  identity forwarding {
    base egress-action-capability;
    description
      "Identity for forwarding action capability";
    reference
```

```
      "RFC 8329: Framework for Interface to Network Security
       Functions - Forwarding action";
  }

  identity redirection {
    base egress-action-capability;
    description
      "Identity for redirection action capability";
    reference
      "RFC 8329: Framework for Interface to Network Security
       Functions - Redirection action";
  }

  identity resolution-strategy-capability {
    description
      "Base identity for resolution strategy capability";
    reference
      "draft-ietf-i2nsf-capability-05: Information Model of
       NSFs Capabilities - Resolution Strategy";
  }

  identity fmr {
    base resolution-strategy-capability;
    description
      "Identity for First Matching Rule (FMR) resolution
       strategy capability";
    reference
      "draft-ietf-i2nsf-capability-05: Information Model of
       NSFs Capabilities - Resolution Strategy";
  }

  identity lmr {
    base resolution-strategy-capability;
    description
      "Identity for Last Matching Rule (LMR) resolution
       strategy capability";
    reference
      "draft-ietf-i2nsf-capability-05: Information Model of
       NSFs Capabilities - Resolution Strategy";
  }

  identity pmr {
    base resolution-strategy-capability;
    description
      "Identity for Prioritized Matching Rule (PMR) resolution
       strategy capability";
    reference
      "draft-ietf-i2nsf-capability-05: Information Model of
```

```
       NSFs Capabilities - Resolution Strategy";
  }

  identity pmre {
    base resolution-strategy-capability;
    description
      "Identity for Prioritized Matching Rule with Errors (PMRE)
       resolution strategy capability";
    reference
      "draft-ietf-i2nsf-capability-05: Information Model of NSFs
      Capabilities - Resolution Strategy";
  }

  identity pmrn {
    base resolution-strategy-capability;
    description
      "Identity for Prioritized Matching Rule with No Errors (PMRN)
       resolution strategy capability";
    reference
      "draft-ietf-i2nsf-capability-05: Information Model of NSFs
       Capabilities - Resolution Strategy";
  }

  identity advanced-nsf-capability {
    description
      "Base identity for advanced network security function (NSF)
       capabilities";
    reference
      "RFC 8329: Framework for Interface to Network Security
       Functions - Differences from ACL Data Models
       draft-dong-i2nsf-asf-config-01: Configuration of Advanced
       Security Functions with I2NSF Security Controller -
       Advanced NSF Capability";
  }

  identity anti-virus-capability {
    base advanced-nsf-capability;
    description
      "Identity for advanced NSF anti-virus capabilities";
       reference
      "RFC 8329: Framework for Interface to Network Security
       Functions - Differences from ACL Data Models
       draft-dong-i2nsf-asf-config-01: Configuration of Advanced
       Security Functions with I2NSF Security Controller -
       Anti-Virus";
  }

  identity anti-ddos-capability {
```

```
    base advanced-nsf-capability;
    description
      "Identity for advanced NSF anti-ddos capabilities";
    reference
      "RFC 8329: Framework for Interface to Network Security
       Functions - Differences from ACL Data Models
       draft-dong-i2nsf-asf-config-01: Configuration of Advanced
       Security Functions with I2NSF Security Controller -
       Anti-DDoS";
  }

  identity ips-capability {
    base advanced-nsf-capability;
    description
      "Identity for advanced NSF Intrusion Prevention System
      (IPS) capabilities";
    reference
      "RFC 8329: Framework for Interface to Network Security
       Functions - Differences from ACL Data Models
       draft-dong-i2nsf-asf-config-01: Configuration of Advanced
       Security Functions with I2NSF Security Controller -
       Intrusion Prevention System";
  }

  identity voip-volte-capability {
    base advanced-nsf-capability;
    description
      "Identity for advanced NSF VoIP/VoLTE capabilities";
    reference
      "RFC 3261: SIP: Session Initiation Protocol
       RFC 8329: Framework for Interface to Network Security
       Functions - Differences from ACL Data Models
       draft-dong-i2nsf-asf-config-01: Configuration of Advanced
       Security Functions with I2NSF Security Controller";
  }

  identity detect {
    base anti-virus-capability;
    description
      "Identity for advanced NSF Anti-Virus detection capability";
    reference
      "draft-dong-i2nsf-asf-config-01: Configuration of Advanced
       Security Functions with I2NSF Security Controller -
       Anti-Virus";
  }

  identity exception-application {
    base anti-virus-capability;
```

```
    description
      "Identity for advanced NSF Anti-Virus exception application
       capability";
    reference
      "draft-dong-i2nsf-asf-config-01: Configuration of Advanced
       Security Functions with I2NSF Security Controller -
       Anti-Virus";
  }

  identity exception-signature {
    base anti-virus-capability;
    description
      "Identity for advanced NSF Anti-Virus exception signature
       capability";
    reference
      "draft-dong-i2nsf-asf-config-01: Configuration of Advanced
       Security Functions with I2NSF Security Controller -
       Anti-Virus";
  }

  identity whitelists {
    base anti-virus-capability;
    description
      "Identity for advanced NSF Anti-Virus whitelists capability";
    reference
      "draft-dong-i2nsf-asf-config-01: Configuration of Advanced
       Security Functions with I2NSF Security Controller -
       Anti-virus";
  }

  identity syn-flood-action {
    base anti-ddos-capability;
    description
      "Identity for advanced NSF Anti-DDoS syn flood action
       capability";
    reference
      "draft-dong-i2nsf-asf-config-01: Configuration of Advanced
       Security Functions with I2NSF Security Controller -
       Anti-DDoS";
  }

  identity udp-flood-action {
    base anti-ddos-capability;
    description
      "Identity for advanced NSF anti-DDoS UDP flood action
       capability";
    reference
      "draft-dong-i2nsf-asf-config-01: Configuration of Advanced
```

```
       Security Functions with I2NSF Security Controller -
       Anti-DDoS";
  }

  identity http-flood-action {
    base anti-ddos-capability;
    description
      "Identity for advanced NSF anti-DDoS http flood action
       capability";
    reference
      "draft-dong-i2nsf-asf-config-01: Configuration of Advanced
       Security Functions with I2NSF Security Controller -
       Anti-DDoS";
  }

  identity https-flood-action {
    base anti-ddos-capability;
    description
      "Identity for advanced NSF Anti-DDoS https flood action
       capability";
    reference
      "draft-dong-i2nsf-asf-config-01: Configuration of Advanced
       Security Functions with I2NSF Security Controller -
       Anti-DDoS";
  }

  identity dns-request-flood-action {
    base anti-ddos-capability;
    description
      "Identity for advanced NSF anti-DDoS dns request
      flood action capability";
    reference
      "draft-dong-i2nsf-asf-config-01: Configuration of Advanced
       Security Functions with I2NSF Security Controller -
       Anti-DDoS";
  }

  identity dns-reply-flood-action {
    base anti-ddos-capability;
    description
      "Identity for advanced NSF Anti-DDoS DNS reply flood action
       capability";
    reference
      "draft-dong-i2nsf-asf-config-01: Configuration of Advanced
       Security Functions with I2NSF Security Controller -
       Anti-DDoS";
  }
```

```
  identity icmp-flood-action {
    base anti-ddos-capability;
    description
      "Identity for advanced NSF Anti-DDoS ICMP flood action
       capability";
    reference
      "draft-dong-i2nsf-asf-config-01: Configuration of Advanced
       Security Functions with I2NSF Security Controller -
       Anti-DDoS";
  }

  identity icmpv6-flood-action {
    base anti-ddos-capability;
    description
      "Identity for advanced NSF Anti-DDoS ICMPv6 flood action
       capability";
    reference
      "draft-dong-i2nsf-asf-config-01: Configuration of Advanced
       Security Functions with I2NSF Security Controller -
       Anti-DDoS";
  }

  identity sip-flood-action {
    base anti-ddos-capability;
    description
      "Identity for advanced NSF Anti-DDoS SIP flood action
       capability";
    reference
      "draft-dong-i2nsf-asf-config-01: Configuration of Advanced
       Security Functions with I2NSF Security Controller -
       Anti-DDoS";
  }

  identity detect-mode {
    base anti-ddos-capability;
    description
      "Identity for advanced NSF Anti-DDoS detection mode
       capability";
    reference
      "draft-dong-i2nsf-asf-config-01: Configuration of Advanced
       Security Functions with I2NSF Security Controller -
       Anti-DDoS";
  }

  identity baseline-learning {
    base anti-ddos-capability;
    description
      "Identity for advanced NSF Anti-DDoS baseline learning
```

```
      capability";
    reference
      "draft-dong-i2nsf-asf-config-01: Configuration of Advanced
       Security Functions with I2NSF Security Controller -
       Anti-DDoS";
  }

  identity signature-set {
    base ips-capability;
    description
      "Identity for advanced NSF IPS signature set capability";
    reference
      "draft-dong-i2nsf-asf-config-01: Configuration of Advanced
       Security Functions with I2NSF Security Controller -
       Intrusion Prevention System";
  }

  identity ips-exception-signature {
    base ips-capability;
    description
      "Identity for advanced NSF IPS exception signature
       capability";
    reference
      "draft-dong-i2nsf-asf-config-01: Configuration of Advanced
       Security Functions with I2NSF Security Controller -
       Intrusion Prevention System";
  }

  identity voice-id {
    base voip-volte-capability;
    description
      "Identity for advanced NSF VoIP/VoLTE voice-id capability";
    reference
      "RFC 3261: SIP: Session Initiation Protocol";
  }

  identity user-agent {
    base voip-volte-capability;
    description
      "Identity for advanced NSF VoIP/VoLTE user agent capability";
    reference
      "RFC 3261: SIP: Session Initiation Protocol";
  }

  identity ipsec-capability {
    description
      "Base identity for an IPsec capabilities";
  }
```

```
  identity ike {
    base ipsec-capability;
    description
      "Identity for an IPSec Internet Key Exchange (IKE)
      capability";
  }

  identity ikeless {
    base ipsec-capability;
    description
      "Identity for an IPSec without Internet Key Exchange (IKE)
      capability";
  }

  /*
   *  Grouping
   */

  grouping nsf-capabilities {
    description
      "Network Security Function (NSF) Capabilities";
    reference
      "RFC 8329: Framework for Interface to Network Security
       Functions - I2NSF Flow Security Policy Structure
       draft-ietf-i2nsf-capability-05: Information Model of
       NSFs Capabilities - Capability Information Model Design";

    leaf-list time-capabilities {
      type enumeration {
        enum absolute-time {
          description
            "absolute time capabilities.
             If a network security function has the absolute time
             capability, the network security function supports
             rule execution according to absolute time.";
        }
        enum periodic-time {
          description
            "periodic time capabilities.
             If a network security function has the periodic time
             capability, the network security function supports
             rule execution according to periodic time.";
        }
      }
      description
        "Time capabilities";
    }
```

```
    container event-capabilities {
      description
        "Capabilities of events.
         If a network security function has the event capabilities,
         the network security function supports rule execution
         according to system event and system alarm.";

      reference
        "RFC 8329: Framework for Interface to Network Security
         Functions - I2NSF Flow Security Policy Structure
         draft-ietf-i2nsf-capability-05: Information Model of
         NSFs Capabilities - Design Principles and ECA Policy
         Model Overview
         draft-ietf-i2nsf-nsf-monitoring-data-model-03: I2NSF
         NSF Monitoring YANG Data Model - System Alarm and
         System Events";

      leaf-list system-event-capability {
        type identityref {
          base system-event-capability;
        }
        description
          "System event capabilities";
      }

      leaf-list system-alarm-capability {
        type identityref {
          base system-alarm-capability;
        }
        description
          "System alarm Capabilities";
      }
    }

    container condition-capabilities {
      description
        "Conditions capabilities.";

      container generic-nsf-capabilities {
        description
          "Conditions capabilities.
           If a network security function has the condition
           capabilities, the network security function
           supports rule execution according to conditions of
           IPv4, IPv6, TCP, UDP, ICMP, ICMPv6, and payload.";
        reference
          "RFC 791: Internet Protocol - IPv4
           RFC 792: Internet Control Message Protocol - ICMP
```

```
           RFC 793: Transmission Control Protocol - TCP
           RFC 768: User Datagram Protocol - UDP
           RFC 8200: Internet Protocol, Version 6 (IPv6)
           Specification - IPv6
           RFC 4443: Internet Control Message Protocol (ICMPv6)
           for the Internet Protocol Version 6 (IPv6) Specification
           - ICMPv6
           RFC 8329: Framework for Interface to Network Security
           Functions - I2NSF Flow Security Policy Structure
           draft-ietf-i2nsf-capability-05: Information Model of
           NSFs Capabilities - Design Principles and ECA Policy
           Model Overview";

        leaf-list ipv4-capability {
          type identityref {
            base ipv4-capability;
          }
          description
            "IPv4 packet capabilities";
          reference
            "RFC 791: Internet Protocol";
        }

        leaf-list icmp-capability {
          type identityref {
            base icmp-capability;
          }
          description
            "ICMP packet capabilities";
          reference
            "RFC 792: Internet Control Message Protocol - ICMP";
        }

        leaf-list ipv6-capability {
          type identityref {
            base ipv6-capability;
          }
          description
            "IPv6 packet capabilities";
          reference
            "RFC 8200: Internet Protocol, Version 6 (IPv6)
             Specification - IPv6";
        }

        leaf-list icmpv6-capability {
          type identityref {
            base icmpv6-capability;
          }
```

```
          description
            "ICMPv6 packet capabilities";
          reference
            "RFC 4443: Internet Control Message Protocol (ICMPv6)
             for the Internet Protocol Version 6 (IPv6) Specification
             - ICMPv6";
        }

        leaf-list tcp-capability {
          type identityref {
            base tcp-capability;
          }
          description
            "TCP packet capabilities";
          reference
            "RFC 793: Transmission Control Protocol - TCP";
        }

        leaf-list udp-capability {
          type identityref {
            base udp-capability;
          }
          description
            "UDP packet capabilities";
          reference
            "RFC 768: User Datagram Protocol - UDP";
        }
      }

      container advanced-nsf-capabilities {
        description
          "Advanced Network Security Function (NSF) capabilities,
           such as Anti-Virus, Anti-DDoS, IPS, and VoIP/VoLTE.";
        reference
          "RFC 8329: Framework for Interface to Network Security
           Functions - Differences from ACL Data Models
           draft-dong-i2nsf-asf-config-01: Configuration of
           Advanced Security Functions with I2NSF Security
           Controller";

        leaf-list anti-virus-capability {
          type identityref {
            base anti-virus-capability;
          }
          description
            "Anti-virus capabilities";
          reference
            "draft-dong-i2nsf-asf-config-01: Configuration of
```

```
             Advanced Security Functions with I2NSF Security
             Controller";
        }

        leaf-list anti-ddos-capability {
          type identityref {
            base anti-ddos-capability;
          }
          description
            "Anti-ddos capabilities";
          reference
            "draft-dong-i2nsf-asf-config-01: Configuration of
             Advanced Security Functions with I2NSF Security
             Controller";
        }

        leaf-list ips-capability {
          type identityref {
            base ips-capability;
          }
          description
            "Intrusion Prevention System (IPS) capabilities";
          reference
            "draft-dong-i2nsf-asf-config-01: Configuration of
             Advanced Security Functions with I2NSF Security
             Controller";
        }

        leaf-list url-capability {
          type identityref {
            base url-capability;
          }
          description
            "URL capabilities";
          reference
            "draft-dong-i2nsf-asf-config-01: Configuration of
             Advanced Security Functions with I2NSF Security
             Controller";
        }

        leaf-list voip-volte-capability {
          type identityref {
            base voip-volte-capability;
         }
          description
            "VoIP and VoLTE capabilities";
          reference
            "draft-dong-i2nsf-asf-config-01: Configuration of
```

```
             Advanced Security Functions with I2NSF Security
             Controller";
        }
      }

      leaf-list context-capabilities {
        type identityref {
          base context-capability;
        }
        description
          "Security context capabilities";
      }
    }

    container action-capabilities {
      description
        "Action capabilities.
         If a network security function has the action
         capabilities, the network security function supports
         the attendant actions for policy rules.";

      leaf-list ingress-action-capability {
        type identityref {
          base ingress-action-capability;
        }
        description
          "Ingress-action capabilities";
      }

      leaf-list egress-action-capability {
        type identityref {
          base egress-action-capability;
        }
        description
          "Egress-action capabilities";
      }

      leaf-list log-action-capability {
        type identityref {
          base log-action-capability;
        }
        description
          "Log-action capabilities";
      }
    }

    leaf-list resolution-strategy-capabilities {
      type identityref {
```

```
        base resolution-strategy-capability;
      }
      description
        "Resolution strategy capabilities.
         The resolution strategies can be used to specify how
         to resolve conflicts that occur between the actions
         of the same or different policy rules that are matched
         for the same packet and by particular NSF";
      reference
        "draft-ietf-i2nsf-capability-05: Information Model of
         NSFs Capabilities - Resolution strategy";
    }

    leaf-list default-action-capabilities {
      type identityref {
        base default-action-capability;
      }
      description
        "Default action capabilities.
         A default action is used to execute I2NSF policy rules
         when no rule matches a packet. The default action is
         defined as pass, drop, alert, or mirror.";
      reference
        "RFC 8329: Framework for Interface to Network Security
         Functions - Ingress and egress actions
         draft-ietf-i2nsf-capability-05: Information Model of
         NSFs Capabilities - Default action";
    }

    leaf-list ipsec-method {
      type identityref {
        base ipsec-capability;
      }
      description
        "IPsec method capabilities";
      reference
        "draft-ietf-i2nsf-sdn-ipsec-flow-protection-08:
         Software-Defined Networking (SDN)-based IPsec Flow
         Protection - IPsec methods such as IKE and IKE-less";
    }
  }

  /*
   * Data nodes
   */

  list nsf {
    key "nsf-name";
```

```
    description
      "The list of Network Security Function (NSF) capabilities";
    leaf nsf-name {
      type string;
      mandatory true;
      description
        "The name of network security function";
    }
  }
}

<CODE ENDS>
```

Figure 3: YANG Data Module of I2NSF Capability

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-capability

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-capability

namespace: urn:ietf:params:xml:ns:yang:ietf-i2nsf-capability

prefix: nsfcap

reference: RFC XXXX

8. 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 transport secure transport is Secure Shell (SSH) [RFC6242]. The lowest RESTCONF layer is HTTPS, and the required transport 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, and deletable (i.e., config true, which is the default). These data nodes may be considered sensitive or vulnerable in some network environments. Write operations to these data nodes could have a negative effect on network and security operations.

- o ietf-i2nsf-capability: An attacker could alter the security capabilities associated with an NSF whereby disabling or enabling the evasion of security mitigations.

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. These are the subtrees and data nodes and their sensitivity/vulnerability:

- o ietf-i2nsf-capability: An attacker could gather the security capability information of any NSF and use this information to evade detection or filtering.

9. References

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Appendix A. Configuration Examples

This section shows configuration examples of "ietf-i2nsf-capability" module for capabilities registration of general firewall.

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

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

```
<nsf xmlns="urn:ietf:params:xml:ns:yang:ietf-i2nsf-capability">
 <nsf-name>general_firewall</nsf-name>
 <condition-capabilities>
  <generic-nsf-capabilities>
   <ipv4-capability>ipv4-protocol</ipv4-capability>
   <ipv4-capability>exact-ipv4-address</ipv4-capability>
   <ipv4-capability>range-ipv4-address</ipv4-capability>
   <tcp-capability>exact-fourth-layer-port-num</tcp-capability>
   <tcp-capability>range-fourth-layer-port-num</tcp-capability>
  </generic-nsf-capabilities>
 </condition-capabilities>
 <action-capabilities>
  <ingress-action-capability>pass</ingress-action-capability>
  <ingress-action-capability>drop</ingress-action-capability>
  <ingress-action-capability>alert</ingress-action-capability>
  <egress-action-capability>pass</egress-action-capability>
  <egress-action-capability>drop</egress-action-capability>
  <egress-action-capability>alert</egress-action-capability>
 </action-capabilities>
</nsf>
```

Figure 4: Configuration XML for Capabilities Registration of General Firewall

Figure 4 shows the configuration XML for capabilities registration of general firewall and its capabilities are as follows.

1. The 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 fourth layer packets.

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

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

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

```
<nsf xmlns="urn:ietf:params:xml:ns:yang:ietf-i2nsf-capability">
 <nsf-name>time_based_firewall</nsf-name>
 <time-capabilities>absolute-time</time-capabilities>
 <time-capabilities>periodic-time</time-capabilities>
 <condition-capabilities>
  <generic-nsf-capabilities>
   <ipv4-capability>ipv4-protocol</ipv4-capability>
   <ipv4-capability>exact-ipv4-address</ipv4-capability>
   <ipv4-capability>range-ipv4-address</ipv4-capability>
  </generic-nsf-capabilities>
 </condition-capabilities>
 <action-capabilities>
  <ingress-action-capability>pass</ingress-action-capability>
  <ingress-action-capability>drop</ingress-action-capability>
  <ingress-action-capability>alert</ingress-action-capability>
  <egress-action-capability>pass</egress-action-capability>
  <egress-action-capability>drop</egress-action-capability>
  <egress-action-capability>alert</egress-action-capability>
 </action-capabilities>
</nsf>
```

Figure 5: Configuration XML for Capabilities Registration of Time based Firewall

Figure 5 shows the configuration XML for capabilities registration of time based firewall and its capabilities are as follows.

1. The 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.

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

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

```
<nsf xmlns="urn:ietf:params:xml:ns:yang:ietf-i2nsf-capability">
 <nsf-name>web_filter</nsf-name>
 <condition-capabilities>
  <advanced-nsf-capabilities>
   <url-capability>user-defined</url-capability>
  </advanced-nsf-capabilities>
 </condition-capabilities>
 <action-capabilities>
  <ingress-action-capability>pass</ingress-action-capability>
  <ingress-action-capability>drop</ingress-action-capability>
  <ingress-action-capability>alert</ingress-action-capability>
  <egress-action-capability>pass</egress-action-capability>
  <egress-action-capability>drop</egress-action-capability>
  <egress-action-capability>alert</egress-action-capability>
 </action-capabilities>
</nsf>
```

Figure 6: Configuration XML for Capabilities Registration of Web Filter

Figure 6 shows the configuration XML for capabilities registration of web filter and its capabilities are as follows.

1. The 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.

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

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

```
<nsf xmlns="urn:ietf:params:xml:ns:yang:ietf-i2nsf-capability">
 <nsf-name>voip_volte_filter</nsf-name>
 <condition-capabilities>
  <advanced-nsf-capabilities>
   <voip-volte-capability>voice-id</voip-volte-capability>
  </advanced-nsf-capabilities>
 </condition-capabilities>
 <action-capabilities>
  <ingress-action-capability>pass</ingress-action-capability>
  <ingress-action-capability>drop</ingress-action-capability>
  <ingress-action-capability>alert</ingress-action-capability>
  <egress-action-capability>pass</egress-action-capability>
  <egress-action-capability>drop</egress-action-capability>
  <egress-action-capability>alert</egress-action-capability>
 </action-capabilities>
</nsf>
```

Figure 7: Configuration XML for Capabilities Registration of VoIP/ VoLTE Filter

Figure 7 shows the configuration XML for capabilities registration of VoIP/VoLTE filter and its capabilities are as follows.

1. The 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.

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.

```
<nsf xmlns="urn:ietf:params:xml:ns:yang:ietf-i2nsf-capability">
 <nsf-name>http_and_https_flood_mitigation</nsf-name>
 <condition-capabilities>
  <advanced-nsf-capabilities>
   <anti-ddos-capability>http-flood-action</anti-ddos-capability>
   <anti-ddos-capability>https-flood-action</anti-ddos-capability>
  </advanced-nsf-capabilities>
 </condition-capabilities>
 <action-capabilities>
  <ingress-action-capability>pass</ingress-action-capability>
  <ingress-action-capability>drop</ingress-action-capability>
  <ingress-action-capability>alert</ingress-action-capability>
  <egress-action-capability>pass</egress-action-capability>
  <egress-action-capability>drop</egress-action-capability>
  <egress-action-capability>alert</egress-action-capability>
 </action-capabilities>
</nsf>
```

Figure 8: Configuration XML for Capabilities Registration of HTTP and HTTPS Flood Mitigation

Figure 8 shows the configuration XML for capabilities registration of http and https flood mitigation and its capabilities are as follows.

1. The name of the NSF is http_and_https_flood_mitigation.

2. The location of the NSF is 221.159.112.140.

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

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

Appendix B. Changes from draft-ietf-i2nsf-capability-data-model-05

The following changes are made from draft-ietf-i2nsf-capability-data-model-05:

- o The version is revised according to the comments from Romans Danyliw for his AD review.

Appendix C. Acknowledgments

This work was supported by Institute of Information & Communications Technology Planning & Evaluation (IITP) grant funded by the Korea MSIT (Ministry of Science and ICT) (R-20160222-002755, Cloud based

Security Intelligence Technology Development for the Customized Security Service Provisioning).

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