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A YANG Data Model for a Truststore
draft-ietf-netconf-trust-anchors-28

Abstract

This document presents a YANG module for configuring bags of certificates and bags of public keys that can be referenced by other data models for trust. Notifications are sent when certificates are about to expire.

Editorial Note (To be removed by RFC Editor)

This draft contains placeholder values that need to be replaced with finalized values at the time of publication. This note summarizes all of the substitutions that are needed. No other RFC Editor instructions are specified elsewhere in this document.

Artwork in this document contains shorthand references to drafts in progress. Please apply the following replacements:

- * AAAA --> the assigned RFC value for draft-ietf-netconf-crypto-types
- * BBBB --> the assigned RFC value for this draft

Artwork in this document contains placeholder values for the date of publication of this draft. Please apply the following replacement:

- * 2024-03-16 --> the publication date of this draft

The "Relation to other RFCs" section Section 1.1 contains the text "one or more YANG modules" and, later, "modules". This text is sourced from a file in a context where it is unknown how many modules a draft defines. The text is not wrong as is, but it may be improved by stating more directly how many modules are defined.

The "Relation to other RFCs" section Section 1.1 contains a self-reference to this draft, along with a corresponding reference in the Appendix. Please replace the self-reference in this section with "This RFC" (or similar) and remove the self-reference in the "Normative/Informative References" section, whichever it is in.

Tree-diagrams in this draft may use the '\' line-folding mode defined in RFC 8792. However, nicer-to-the-eye is when the '\\ line-folding mode is used. The AD suggested putting a request here for the RFC Editor to help convert "ugly" '\' folded examples to use the '\\ folding mode. "Help convert" may be interpreted as, identify what looks ugly and ask the authors to make the adjustment.

The following Appendix section is to be removed prior to publication:

* Appendix A. Change Log

Status of This Memo

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

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1. Introduction

This document presents a YANG 1.1 [RFC7950] module having the following characteristics:

Provide a central truststore for storing raw public keys and/or certificates.

Provide support for storing named bags of raw public keys and/or named bags of certificates.

Provide types that can be used to reference raw public keys or certificates stored in the central truststore.

Provide groupings that enable raw public keys and certificates to be configured inline or as references to truststore instances.

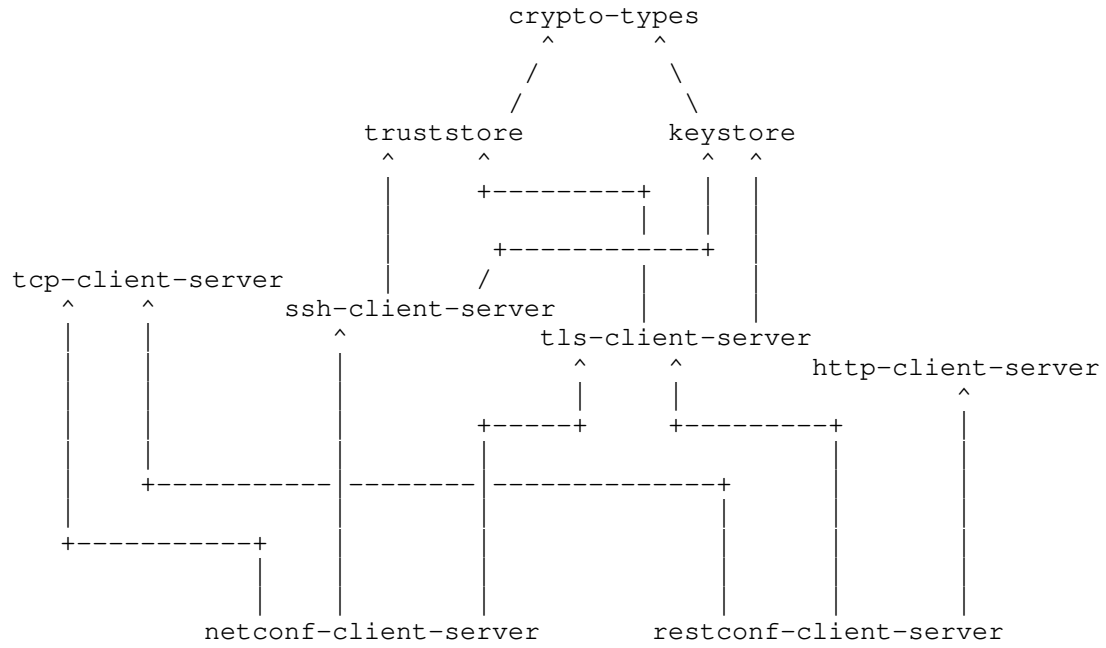
Enable the truststore to be instantiated in other data models, in addition to or in lieu of the central truststore instance.

1.1. Relation to other RFCs

This document presents one or more YANG modules [RFC7950] that are part of a collection of RFCs that work together to, ultimately, support the configuration of both the clients and servers of both the NETCONF [RFC6241] and RESTCONF [RFC8040] protocols.

The dependency relationship between the primary YANG groupings defined in the various RFCs is presented in the below diagram. In some cases, a draft may define secondary groupings that introduce dependencies not illustrated in the diagram. The labels in the diagram are a shorthand name for the defining RFC. The citation reference for shorthand name is provided below the diagram.

Please note that the arrows in the diagram point from referencer to referenced. For example, the "crypto-types" RFC does not have any dependencies, whilst the "keystore" RFC depends on the "crypto-types" RFC.



Label in Diagram	Originating RFC
crypto-types	[I-D.ietf-netconf-crypto-types]
truststore	[I-D.ietf-netconf-trust-anchors]
keystore	[I-D.ietf-netconf-keystore]
tcp-client-server	[I-D.ietf-netconf-tcp-client-server]
ssh-client-server	[I-D.ietf-netconf-ssh-client-server]
tls-client-server	[I-D.ietf-netconf-tls-client-server]
http-client-server	[I-D.ietf-netconf-http-client-server]
netconf-client-server	[I-D.ietf-netconf-netconf-client-server]
restconf-client-server	[I-D.ietf-netconf-restconf-client-server]

Table 1: Label in Diagram to RFC Mapping

1.2. Specification Language

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.

1.3. Adherence to the NMDA

This document is compliant with the Network Management Datastore Architecture (NMDA) [RFC8342]. For instance, trust anchors installed during manufacturing (e.g., for trusted well-known services), are expected to appear in <operational> (see Section 3).

1.4. Conventions

Various examples in this document use "BASE64VALUE=" as a placeholder value for binary data that has been base64 encoded (see Section 4 in [RFC4648]). This placeholder value is used because real base64 encoded structures are often many lines long and hence distracting to the example being presented.

This document uses the adjective "central" to the word "truststore" to refer to the top-level instance of the "truststore-grouping", when the "central-truststore-supported" feature is enabled. Please be aware that consuming YANG modules MAY instantiate the "truststore-grouping" in other locations. All such other instances are not the "central" instance.

2. The "ietf-truststore" Module

This section defines a YANG 1.1 [RFC7950] module called "ietf-truststore". A high-level overview of the module is provided in Section 2.1. Examples illustrating the module's use are provided in Examples (Section 2.2). The YANG module itself is defined in Section 2.3.

2.1. Data Model Overview

This section provides an overview of the "ietf-truststore" module in terms of its features, typedefs, groupings, and protocol-accessible nodes.

2.1.1. Features

The following diagram lists all the "feature" statements defined in the "ietf-truststore" module:

Features:

```
+-- central-truststore-supported
+-- inline-definitions-supported
+-- certificates
+-- public-keys
```

The diagram above uses syntax that is similar to but not defined in [RFC8340].

2.1.2. Typedefs

The following diagram lists the "typedef" statements defined in the "ietf-truststore" module:

Typedefs:

```
leafref
+-- central-certificate-bag-ref
+-- central-certificate-ref
+-- central-public-key-bag-ref
+-- central-public-key-ref
```

The diagram above uses syntax that is similar to but not defined in [RFC8340].

Comments:

- * All the typedefs defined in the "ietf-truststore" module extend the base "leafref" type defined in [RFC7950].
- * The leafrefs refer to certificates, public keys, and bags in the central truststore, when this module is implemented.
- * These typedefs are provided as an aid to consuming modules that import the "ietf-truststore" module.

2.1.3. Groupings

The "ietf-truststore" module defines the following "grouping" statements:

```
* central-certificate-ref-grouping
* central-public-key-ref-grouping
* inline-or-truststore-certs-grouping
* inline-or-truststore-public-keys-grouping
* truststore-grouping
```

Each of these groupings are presented in the following subsections.

2.1.3.1. The "central-certificate-ref-grouping" Grouping

The following tree diagram [RFC8340] illustrates the "central-certificate-ref-grouping" grouping:

```
grouping central-certificate-ref-grouping:
  +-- certificate-bag?   ts:central-certificate-bag-ref
  |                     {central-truststore-supported,certificates}?
  +-- certificate?      ts:central-certificate-ref
                        {central-truststore-supported,certificates}?
```

Comments:

- * The "central-certificate-ref-grouping" grouping is provided solely as convenience to consuming modules that wish to enable the configuration of a reference to a certificate in a certificate-bag in the truststore.
- * The "certificate-bag" leaf uses the "central-certificate-bag-ref" typedef defined in Section 2.1.2.
- * The "certificate" leaf uses the "central-certificate-ref" typedef defined in Section 2.1.2.

2.1.3.2. The "central-public-key-ref-grouping" Grouping

The following tree diagram [RFC8340] illustrates the "central-public-key-ref-grouping" grouping:

```
grouping central-public-key-ref-grouping:
  +-- public-key-bag?   ts:central-public-key-bag-ref
  |                     {central-truststore-supported,public-keys}?
  +-- public-key?      ts:central-public-key-ref
                        {central-truststore-supported,public-keys}?
```

Comments:

- * The "central-public-key-ref-grouping" grouping is provided solely as convenience to consuming modules that wish to enable the configuration of a reference to a public-key in a public-key-bag in the truststore.
- * The "public-key-bag" leaf uses the "public-key-bag-ref" typedef defined in Section 2.1.2.
- * The "public-key" leaf uses the "public-key-ref" typedef defined in Section 2.1.2.

2.1.3.3. The "inline-or-truststore-certs-grouping" Grouping

The following tree diagram [RFC8340] illustrates the "inline-or-truststore-certs-grouping" grouping:

```

grouping inline-or-truststore-certs-grouping:
  +-- (inline-or-truststore)
    +--:(inline) {inline-definitions-supported}?
      |   +-- inline-definition
      |     +-- certificate* [name]
      |       +-- name?                                     string
      |       +---u ct:trust-anchor-cert-grouping
    +--:(central-truststore)
      {central-truststore-supported,certificates}?
      +-- central-truststore-reference?
        ts:central-certificate-bag-ref

```

Comments:

- * The "inline-or-truststore-certs-grouping" grouping is provided solely as convenience to consuming modules that wish to offer an option whether a bag of certificates can be defined inline or as a reference to a bag in the truststore.
- * A "choice" statement is used to expose the various options. Each option is enabled by a "feature" statement. Additional "case" statements MAY be augmented in if, e.g., there is a need to reference a bag in an alternate location.
- * For the "inline-definition" option, the "certificate" node uses the "trust-anchor-cert-grouping" grouping discussed in Section 2.1.4.7 of [I-D.ietf-netconf-crypto-types].
- * For the "central-truststore" option, the "central-truststore-reference" is an instance of the "certificate-bag-ref" discussed in Section 2.1.2.

2.1.3.4. The "inline-or-truststore-public-keys-grouping" Grouping

The following tree diagram [RFC8340] illustrates the "inline-or-truststore-public-keys-grouping" grouping:

```
grouping inline-or-truststore-public-keys-grouping:
  +-- (inline-or-truststore)
    +--:(inline) {inline-definitions-supported}?
      +-- inline-definition
        +-- public-key* [name]
          +-- name? string
          +---u ct:public-key-grouping
    +--:(central-truststore)
      {central-truststore-supported,public-keys}?
      +-- central-truststore-reference?
        ts:central-public-key-bag-ref
```

Comments:

- * The "inline-or-truststore-public-keys-grouping" grouping is provided solely as convenience to consuming modules that wish to offer an option whether a bag of public keys can be defined inline or as a reference to a bag in the truststore.
- * A "choice" statement is used to expose the various options. Each option is enabled by a "feature" statement. Additional "case" statements MAY be augmented in if, e.g., there is a need to reference a bag in an alternate location.
- * For the "inline-definition" option, the "public-key" node uses the "public-key-grouping" grouping discussed in Section 2.1.4.4 of [I-D.ietf-netconf-crypto-types].
- * For the "central-truststore" option, the "central-truststore-reference" is an instance of the "certificate-bag-ref" discussed in Section 2.1.2.

2.1.3.5. The "truststore-grouping" Grouping

The following tree diagram [RFC8340] illustrates the "truststore-grouping" grouping:

```

grouping truststore-grouping:
  +-- certificate-bags {certificates}?
    |   +-- certificate-bag* [name]
    |       +-- name?          string
    |       +-- description?   string
    |       +-- certificate* [name]
    |           +-- name?          string
    |           +---u ct:trust-anchor-cert-grouping
  +-- public-key-bags {public-keys}?
    |   +-- public-key-bag* [name]
    |       +-- name?          string
    |       +-- description?   string
    |       +-- public-key* [name]
    |           +-- name?          string
    |           +---u ct:public-key-grouping

```

Comments:

- * The "truststore-grouping" grouping defines a truststore instance as being composed of certificates and/or public keys, both of which are enabled by "feature" statements. The structure supporting certificates and public keys is essentially the same, having an outer list of "bags" containing an inner list of objects (certificates or public keys). The bags enable trust anchors serving a common purpose to be grouped and referenced together.
- * For certificates, each certificate is defined by the "trust-anchor-cert-grouping" grouping Section 2.1.4.7 of [I-D.ietf-netconf-crypto-types]. The "cert-data" node is a CMS structure that can be composed of a chain of one or more certificates. Additionally, the "certificate-expiration" notification enables the server to alert clients when certificates are nearing or have already expired.
- * For public keys, each public key is defined by the "public-key-grouping" grouping Section 2.1.4.4 of [I-D.ietf-netconf-crypto-types]. The "public-key" node can be one of any number of structures specified by the "public-key-format" identity node.

2.1.4. Protocol-accessible Nodes

The following tree diagram [RFC8340] lists all the protocol-accessible nodes defined in the "ietf-truststore" module, without expanding the "grouping" statements:

```

module: ietf-truststore
  +--rw truststore {central-truststore-supported}?
    +---u truststore-grouping

```

The following tree diagram [RFC8340] lists all the protocol-accessible nodes defined in the "ietf-truststore" module, with all "grouping" statements expanded, enabling the truststore's full structure to be seen:

```

module: ietf-truststore
  +--rw truststore {central-truststore-supported}?
    +--rw certificate-bags {certificates}?
      |
      |   +--rw certificate-bag* [name]
      |   |   +--rw name          string
      |   |   +--rw description?  string
      |   |   +--rw certificate* [name]
      |   |   |   +--rw name          string
      |   |   |   +--rw cert-data      trust-anchor-cert-cms
      |   |   |   +---n certificate-expiration
      |   |   |       {certificate-expiration-notification}?
      |   |   |       +-- expiration-date  yang:date-and-time
      |   +--rw public-key-bags {public-keys}?
      |   |   +--rw public-key-bag* [name]
      |   |   |   +--rw name          string
      |   |   |   +--rw description?  string
      |   |   |   +--rw public-key* [name]
      |   |   |   |   +--rw name          string
      |   |   |   |   +--rw public-key-format  identityref
      |   |   |   |   +--rw public-key      binary

```

Comments:

- * Protocol-accessible nodes are those nodes that are accessible when the module is "implemented", as described in Section 5.6.5 of [RFC7950].
- * The protocol-accessible nodes for the "ietf-truststore" module are an instance of the "truststore-grouping" grouping discussed in Section 2.1.3.5.
- * The top-level node "truststore" is additionally constrained by the feature "central-truststore-supported".
- * The "truststore-grouping" grouping is discussed in Section 2.1.3.5.

- * The reason for why the "truststore-grouping" exists separate from the protocol-accessible nodes definition is to enable instances of the truststore to be instantiated in other locations, as may be needed or desired by some modules.

2.2. Example Usage

The examples in this section are encoded using XML, such as might be the case when using the NETCONF protocol. Other encodings MAY be used, such as JSON when using the RESTCONF protocol.

2.2.1. A Truststore Instance

This section presents an example illustrating trust anchors in <intended>, as per Section 2.1.4. Please see Section 3 for an example illustrating built-in values in <operational>.

The example contained in this section defines eight bags of trust anchors. There are four certificate-based bags and four public key based bags. The following diagram provides an overview of the contents in the example:

Certificate Bags

- +++ Trust anchor certs for authenticating a set of remote servers
- +++ End entity certs for authenticating a set of remote servers
- +++ Trust anchor certs for authenticating a set of remote clients
- +++ End entity certs for authenticating a set of remote clients

Public Key Bags

- +++ SSH keys to authenticate a set of remote SSH server
- +++ SSH keys to authenticate a set of remote SSH clients
- +++ Raw public keys to authenticate a set of remote SSH server
- +++ Raw public keys to authenticate a set of remote SSH clients

Following is the full example:

===== NOTE: '\ ' line wrapping per RFC 8792 =====

```
<truststore
  xmlns="urn:ietf:params:xml:ns:yang:ietf-truststore"
  xmlns:ct="urn:ietf:params:xml:ns:yang:ietf-crypto-types">

  <!-- A bag of Certificate Bags -->
  <certificate-bags>

    <!-- Trust Anchor Certs for Authenticating Servers -->
    <certificate-bag>
      <name>trusted-server-ca-certs</name>
```

```
<description>
  Trust anchors (i.e. CA certs) used to authenticate server
  certificates.  A server certificate is authenticated if its
  end-entity certificate has a chain of trust to one of these
  certificates.
</description>
<certificate>
  <name>Server Cert Issuer #1</name>
  <cert-data>BASE64VALUE=</cert-data>
</certificate>
<certificate>
  <name>Server Cert Issuer #2</name>
  <cert-data>BASE64VALUE=</cert-data>
</certificate>
</certificate-bag>

<!-- End Entity Certs for Authenticating Servers -->
<certificate-bag>
  <name>trusted-server-ee-certs</name>
  <description>
    Specific end-entity certificates used to authenticate server
    certificates.  A server certificate is authenticated if its
    end-entity certificate is an exact match to one of these
    certificates.
  </description>
  <certificate>
    <name>My Application #1</name>
    <cert-data>BASE64VALUE=</cert-data>
  </certificate>
  <certificate>
    <name>My Application #2</name>
    <cert-data>BASE64VALUE=</cert-data>
  </certificate>
</certificate-bag>

<!-- Trust Anchor Certs for Authenticating Clients -->
<certificate-bag>
  <name>trusted-client-ca-certs</name>
  <description>
    Trust anchors (i.e. CA certs) used to authenticate client
    certificates.  A client certificate is authenticated if its
    end-entity certificate has a chain of trust to one of these
    certificates.
  </description>
  <certificate>
    <name>Client Identity Issuer #1</name>
    <cert-data>BASE64VALUE=</cert-data>
  </certificate>
```

```

    <certificate>
      <name>Client Identity Issuer #2</name>
      <cert-data>BASE64VALUE=</cert-data>
    </certificate>
  </certificate-bag>

  <!-- End Entity Certs for Authenticating Clients -->
  <certificate-bag>
    <name>trusted-client-ee-certs</name>
    <description>
      Specific end-entity certificates used to authenticate client
      certificates. A client certificate is authenticated if its
      end-entity certificate is an exact match to one of these
      certificates.
    </description>
    <certificate>
      <name>George Jetson</name>
      <cert-data>BASE64VALUE=</cert-data>
    </certificate>
    <certificate>
      <name>Fred Flintstone</name>
      <cert-data>BASE64VALUE=</cert-data>
    </certificate>
  </certificate-bag>
</certificate-bags>

<!-- A List of Public Key Bags -->
<public-key-bags>

  <!-- Public Keys for Authenticating SSH Servers -->
  <public-key-bag>
    <name>trusted-ssh-public-keys</name>
    <description>
      Specific SSH public keys used to authenticate SSH server
      public keys. An SSH server public key is authenticated if
      its public key is an exact match to one of these public keys.

      This list of SSH public keys is analogous to OpenSSH's
      "/etc/ssh/ssh_known_hosts" file.
    </description>
    <public-key>
      <name>corp-fw1</name>
      <public-key-format>ct:ssh-public-key-format</public-key-form\
at>
      <public-key>BASE64VALUE=</public-key>
    </public-key>
    <public-key>
      <name>corp-fw2</name>

```

```

    <public-key-format>ct:ssh-public-key-format</public-key-form\
at>
    <public-key>BASE64VALUE=</public-key>
  </public-key>
</public-key-bag>

<!-- SSH Public Keys for Authenticating Application A -->
<public-key-bag>
  <name>SSH Public Keys for Application A</name>
  <description>
    SSH public keys used to authenticate application A's SSH
    public keys. An SSH public key is authenticated if it
    is an exact match to one of these public keys.
  </description>
  <public-key>
    <name>Application Instance #1</name>
    <public-key-format>ct:ssh-public-key-format</public-key-form\
at>
    <public-key>BASE64VALUE=</public-key>
  </public-key>
  <public-key>
    <name>Application Instance #2</name>
    <public-key-format>ct:ssh-public-key-format</public-key-form\
at>
    <public-key>BASE64VALUE=</public-key>
  </public-key>
</public-key-bag>

<!-- Raw Public Keys for TLS Servers -->
<public-key-bag>
  <name>Raw Public Keys for TLS Servers</name>
  <public-key>
    <name>Raw Public Key #1</name>
    <public-key-format>ct:subject-public-key-info-format</public\
-key-format>
    <public-key>BASE64VALUE=</public-key>
  </public-key>
  <public-key>
    <name>Raw Public Key #2</name>
    <public-key-format>ct:subject-public-key-info-format</public\
-key-format>
    <public-key>BASE64VALUE=</public-key>
  </public-key>
</public-key-bag>

<!-- Raw Public Keys for TLS Clients -->
<public-key-bag>
  <name>Raw Public Keys for TLS Clients</name>

```



```

    <public-key>
      <name>Raw Public Key #1</name>
      <public-key-format>ct:subject-public-key-info-format</public\
-key-format>
      <public-key>BASE64VALUE=</public-key>
    </public-key>
    <public-key>
      <name>Raw Public Key #2</name>
      <public-key-format>ct:subject-public-key-info-format</public\
-key-format>
      <public-key>BASE64VALUE=</public-key>
    </public-key>
  </public-key-bag>
</public-key-bags>
</truststore>

```

2.2.2. A Certificate Expiration Notification

The following example illustrates the "certificate-expiration" notification (per Section 2.1.4.6 of [I-D.ietf-netconf-crypto-types]) for a certificate configured in the truststore in Section 2.2.1.

===== NOTE: '\ ' line wrapping per RFC 8792 =====

```

<notification
  xmlns="urn:ietf:params:xml:ns:netconf:notification:1.0">
  <eventTime>2018-05-25T00:01:00Z</eventTime>
  <truststore xmlns="urn:ietf:params:xml:ns:yang:ietf-truststore">
    <certificate-bags>
      <certificate-bag>
        <name>trusted-client-ee-certs</name>
        <certificate>
          <name>George Jetson</name>
          <certificate-expiration>
            <expiration-date>2024-01-05T14:18:53-05:00</expiration-d\
ate>
          </certificate-expiration>
        </certificate>
      </certificate-bag>
    </certificate-bags>
  </truststore>
</notification>

```

2.2.3. The "Local or Truststore" Groupings

This section illustrates the various "inline-or-truststore" groupings defined in the "ietf-truststore" module, specifically the "inline-or-truststore-certs-grouping" (Section 2.1.3.3) and "inline-or-truststore-public-keys-grouping" (Section 2.1.3.4) groupings.

These examples assume the existence of an example module called "ex-truststore-usage" having the namespace "https://example.com/ns/example-truststore-usage".

The ex-truststore-usage module is first presented using tree diagrams [RFC8340], followed by an instance example illustrating all the "inline-or-truststore" groupings in use, followed by the YANG module itself.

The following tree diagram illustrates "ex-truststore-usage" without expanding the "grouping" statements:

```

module: ex-truststore-usage
  +--rw truststore-usage
    +--rw cert* [name]
      |   +--rw name                               string
      |   +---u ts:inline-or-truststore-certs-grouping
    +--rw public-key* [name]
      |   +--rw name                               string
      |   +---u ts:inline-or-truststore-public-keys-grouping

```

The following tree diagram illustrates the "ex-truststore-usage" module, with all "grouping" statements expanded, enabling the truststore's full structure to be seen:

```

module: ex-truststore-usage
+--rw truststore-usage
  +--rw cert* [name]
    +--rw name string
    +--rw (inline-or-truststore)
      +--:(inline) {inline-definitions-supported}?
        +--rw inline-definition
          +--rw certificate* [name]
            +--rw name string
            +--rw cert-data
              | trust-anchor-cert-cms
            +---n certificate-expiration
              {certificate-expiration-notification}?
              +-- expiration-date yang:date-and-time
          +--:(central-truststore)
            {central-truststore-supported,certificates}?
          +--rw central-truststore-reference?
            ts:central-certificate-bag-ref
      +--rw public-key* [name]
        +--rw name string
        +--rw (inline-or-truststore)
          +--:(inline) {inline-definitions-supported}?
            +--rw inline-definition
              +--rw public-key* [name]
                +--rw name string
                +--rw public-key-format identityref
                +--rw public-key binary
            +--:(central-truststore)
              {central-truststore-supported,public-keys}?
            +--rw central-truststore-reference?
              ts:central-public-key-bag-ref

```

The following example provides two equivalent instances of each grouping, the first being a reference to a truststore and the second being defined inline. The instance having a reference to a truststore is consistent with the truststore defined in Section 2.2.1. The two instances are equivalent, as the inlined instance example contains the same values defined by the truststore instance referenced by its sibling example.

===== NOTE: '\ ' line wrapping per RFC 8792 =====

```

<truststore-usage
  xmlns="https://example.com/ns/example-truststore-usage"
  xmlns:ct="urn:ietf:params:xml:ns:yang:ietf-crypto-types">

  <!-- The following two equivalent examples illustrate -->
  <!-- the "inline-or-truststore-certs-grouping" grouping: -->

```

```
<cert>
  <name>example 1a</name>
  <central-truststore-reference>trusted-client-ca-certs</central-t\
ruststore-reference>
</cert>

<cert>
  <name>example 1b</name>
  <inline-definition>
    <name>my-trusted-client-ca-certs</name>
    <certificate>
      <name>Client Identity Issuer #1</name>
      <cert>BASE64VALUE=</cert>
    </certificate>
    <certificate>
      <name>Client Identity Issuer #2</name>
      <cert>BASE64VALUE=</cert>
    </certificate>
  </inline-definition>
</cert>

<!-- The following two equivalent examples illustrate the -->
<!-- "inline-or-truststore-public-keys-grouping" grouping: -->

<public-key>
  <name>example 2a</name>
  <central-truststore-reference>trusted-ssh-public-keys</central-t\
ruststore-reference>
</public-key>

<public-key>
  <name>example 2b</name>
  <inline-definition>
    <name>trusted-ssh-public-keys</name>
    <public-key>
      <name>corp-fw1</name>
      <public-key-format>
        ct:ssh-public-key-format
      </public-key-format>
      <public-key>BASE64VALUE=</public-key>
    </public-key>
    <public-key>
      <name>corp-fw2</name>
      <public-key-format>
        ct:ssh-public-key-format
      </public-key-format>
      <public-key>BASE64VALUE=</public-key>
```

```
        </public-key>
      </inline-definition>
    </public-key>
  </truststore-usage>
```

Following is the "ex-truststore-usage" module's YANG definition:

```
module ex-truststore-usage {
  yang-version 1.1;
  namespace "https://example.com/ns/example-truststore-usage";
  prefix etu;

  import ietf-truststore {
    prefix ts;
    reference
      "RFC BBBB: A YANG Data Model for a Truststore";
  }

  organization
    "Example Corporation";

  contact
    "Author: YANG Designer <mailto:yang.designer@example.com>";

  description
    "This example module illustrates notable groupings defined
    in the 'ietf-truststore' module.";

  revision 2024-03-16 {
    description
      "Initial version";
    reference
      "RFC BBBB: A YANG Data Model for a Truststore";
  }

  container truststore-usage {
    description
      "An illustration of the various truststore groupings.";
    list cert {
      key "name";
      leaf name {
        type string;
        description
          "An arbitrary name for this cert.";
      }
    }
    uses ts:inline-or-truststore-certs-grouping;
    description
```

```
        "A cert that may be configured locally or be
        a reference to a cert in the truststore.";
    }
    list public-key {
        key "name";
        leaf name {
            type string;
            description
                "An arbitrary name for this cert.";
        }
        uses ts:inline-or-truststore-public-keys-grouping;
        description
            "A public key that may be configured locally or be
            a reference to a public key in the truststore.";
    }
}
}
```

2.3. YANG Module

This YANG module imports modules from [RFC8341] and [I-D.ietf-netconf-crypto-types].

<CODE BEGINS> file "ietf-truststore@2024-03-16.yang"

```
module ietf-truststore {
    yang-version 1.1;
    namespace "urn:ietf:params:xml:ns:yang:ietf-truststore";
    prefix ts;

    import ietf-netconf-acm {
        prefix nacm;
        reference
            "RFC 8341: Network Configuration Access Control Model";
    }

    import ietf-crypto-types {
        prefix ct;
        reference
            "RFC AAAA: YANG Data Types and Groupings for Cryptography";
    }

    organization
        "IETF NETCONF (Network Configuration) Working Group";

    contact
        "WG Web  : https://datatracker.ietf.org/wg/netconf
        WG List  : NETCONF WG list <mailto:netconf@ietf.org>"
}
```

Author : Kent Watsen <kent+ietf@watsen.net>;

description

"This module defines a 'truststore' to centralize management of trust anchors including certificates and public keys.

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

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

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 (RFC 2119) (RFC 8174) when, and only when, they appear in all capitals, as shown here.";

revision 2024-03-16 {

description

"Initial version";

reference

"RFC BBBB: A YANG Data Model for a Truststore";

}

/*****/

/* Features */

/*****/

feature central-truststore-supported {

description

"The 'central-truststore-supported' feature indicates that the server supports the truststore (i.e., implements the 'ietf-truststore' module).";

}

feature inline-definitions-supported {

description

"The 'inline-definitions-supported' feature indicates that

```
        the server supports locally-defined trust anchors.";
    }

    feature certificates {
        description
            "The 'certificates' feature indicates that the server
            implements the /truststore/certificate-bags subtree.";
    }

    feature public-keys {
        description
            "The 'public-keys' feature indicates that the server
            implements the /truststore/public-key-bags subtree.";
    }

    /*****/
    /*  Typedefs  */
    /*****/

    typedef central-certificate-bag-ref {
        type leafref {
            path "/ts:truststore/ts:certificate-bags/"
                + "ts:certificate-bag/ts:name";
        }
        description
            "This typedef defines a reference to a certificate bag
            in the central truststore.";
    }

    typedef central-certificate-ref {
        type leafref {
            path "/ts:truststore/ts:certificate-bags/ts:certificate-bag"
                + "[ts:name = current()../certificate-bag]/"
                + "ts:certificate/ts:name";
        }
        description
            "This typedef defines a reference to a specific certificate
            in a certificate bag in the central truststore. This typedef
            requires that there exist a sibling 'leaf' node called
            'certificate-bag' that SHOULD have the typedef
            'central-certificate-bag-ref'.";
    }

    typedef central-public-key-bag-ref {
        type leafref {
            path "/ts:truststore/ts:public-key-bags/"
                + "ts:public-key-bag/ts:name";
        }
    }
```



```
    description
      "This typedef defines a reference to a public key bag
      in the central truststore.";
  }

  typedef central-public-key-ref {
    type leafref {
      path "/ts:truststore/ts:public-key-bags/ts:public-key-bag"
        + "[ts:name = current()../../public-key-bag]/"
        + "ts:public-key/ts:name";
    }
    description
      "This typedef defines a reference to a specific public key
      in a public key bag in the truststore. This typedef
      requires that there exist a sibling 'leaf' node called
      'public-key-bag' that SHOULD have the typedef
      'central-public-key-bag-ref'.";
  }

  /*****
  /* Groupings */
  *****/

  // *-ref groupings

  grouping central-certificate-ref-grouping {
    description
      "Grouping for the reference to a certificate in a
      certificate-bag in the central truststore.";
    leaf certificate-bag {
      nacm:default-deny-write;
      if-feature "central-truststore-supported";
      if-feature "certificates";
      type ts:central-certificate-bag-ref;
      must "../certificate";
      description
        "Reference to a certificate-bag in the truststore.";
    }
    leaf certificate {
      nacm:default-deny-write;
      if-feature "central-truststore-supported";
      if-feature "certificates";
      type ts:central-certificate-ref;
      must "../certificate-bag";
      description
        "Reference to a specific certificate in the
        referenced certificate-bag.";
    }
  }
```

```
}

grouping central-public-key-ref-grouping {
  description
    "Grouping for the reference to a public key in a
    public-key-bag in the central truststore.";
  leaf public-key-bag {
    nacm:default-deny-write;
    if-feature "central-truststore-supported";
    if-feature "public-keys";
    type ts:central-public-key-bag-ref;
    description
      "Reference of a public key bag in the truststore including
      the certificate to authenticate the TLS client.";
  }
  leaf public-key {
    nacm:default-deny-write;
    if-feature "central-truststore-supported";
    if-feature "public-keys";
    type ts:central-public-key-ref;
    description
      "Reference to a specific public key in the
      referenced public-key-bag.";
  }
}

// inline-or-truststore-* groupings

grouping inline-or-truststore-certs-grouping {
  description
    "A grouping for the configuration of a list of certificates.
    The list of certificate may be defined inline or as a
    reference to a certificate bag in the central truststore.

    Servers that wish to define alternate truststore locations
    MUST augment in custom 'case' statements enabling
    references to those alternate truststore locations.";
  choice inline-or-truststore {
    nacm:default-deny-write;
    mandatory true;
    description
      "A choice between an inlined definition and a definition
      that exists in the truststore.";
    case inline {
      if-feature "inline-definitions-supported";
      container inline-definition {
        description
          "A container for locally configured trust anchor
```

```
        certificates.";
    list certificate {
        key "name";
        min-elements 1;
        description
            "A trust anchor certificate or chain of certificates.";
        leaf name {
            type string;
            description
                "An arbitrary name for this certificate.";
        }
        uses ct:trust-anchor-cert-grouping {
            refine "cert-data" {
                mandatory true;
            }
        }
    }
}

case central-truststore {
    if-feature "central-truststore-supported";
    if-feature "certificates";
    leaf central-truststore-reference {
        type ts:central-certificate-bag-ref;
        description
            "A reference to a certificate bag that exists in the
             central truststore.";
    }
}

}

grouping inline-or-truststore-public-keys-grouping {
    description
        "A grouping that allows the public keys to be either
         configured locally, within the using data model, or be a
         reference to a public key bag stored in the truststore.

         Servers that wish to define alternate truststore locations
         SHOULD augment in custom 'case' statements enabling
         references to those alternate truststore locations.";
    choice inline-or-truststore {
        nacm:default-deny-write;
        mandatory true;
        description
            "A choice between an inlined definition and a definition
             that exists in the truststore.";
        case inline {
```

```
    if-feature "inline-definitions-supported";
    container inline-definition {
      description
        "A container to hold local public key definitions.";
      list public-key {
        key "name";
        description
          "A public key definition.";
        leaf name {
          type string;
          description
            "An arbitrary name for this public key.";
        }
        uses ct:public-key-grouping;
      }
    }
  }
case central-truststore {
  if-feature "central-truststore-supported";
  if-feature "public-keys";
  leaf central-truststore-reference {
    type ts:central-public-key-bag-ref;
    description
      "A reference to a bag of public keys that exists
       in the central truststore.";
  }
}
}
```

// the truststore grouping

```
grouping truststore-grouping {
  description
    "A grouping definition that enables use in other contexts.
     Where used, implementations MUST augment new 'case'
     statements into the various inline-or-truststore 'choice'
     statements to supply leafrefs to the model-specific
     location(s).";
  container certificate-bags {
    nacm:default-deny-write;
    if-feature "certificates";
    description
      "A collection of certificate bags.";
    list certificate-bag {
      key "name";
      description
```

```
    "A bag of certificates. Each bag of certificates should
    be for a specific purpose. For instance, one bag could
    be used to authenticate a specific set of servers, while
    another could be used to authenticate a specific set of
    clients.";
  leaf name {
    type string;
    description
      "An arbitrary name for this bag of certificates.";
  }
  leaf description {
    type string;
    description
      "A description for this bag of certificates. The
      intended purpose for the bag SHOULD be described.";
  }
  list certificate {
    key "name";
    description
      "A trust anchor certificate or chain of certificates.";
    leaf name {
      type string;
      description
        "An arbitrary name for this certificate.";
    }
    uses ct:trust-anchor-cert-grouping {
      refine "cert-data" {
        mandatory true;
      }
    }
  }
}

container public-key-bags {
  nacm:default-deny-write;
  if-feature "public-keys";
  description
    "A collection of public key bags.";
  list public-key-bag {
    key "name";
    description
      "A bag of public keys. Each bag of keys SHOULD be for
      a specific purpose. For instance, one bag could be used
      authenticate a specific set of servers, while another
      could be used to authenticate a specific set of clients.";
    leaf name {
      type string;
      description
```

```
        "An arbitrary name for this bag of public keys.";
    }
    leaf description {
        type string;
        description
            "A description for this bag public keys. The
             intended purpose for the bag MUST be described.";
    }
    list public-key {
        key "name";
        description
            "A public key.";
        leaf name {
            type string;
            description
                "An arbitrary name for this public key.";
        }
        uses ct:public-key-grouping;
    }
}

}

/*****/
/*   Protocol accessible nodes   */
/*****/

container truststore {
    if-feature central-truststore-supported;
    nacm:default-deny-write;
    description
        "The truststore contains bags of certificates and
         public keys.";
    uses truststore-grouping;
}
}
```

<CODE ENDS>

3. Support for Built-in Trust Anchors

In some implementations, a server may define some built-in trust anchors. For instance, there may be built-in trust anchors enabling the server to securely connect to well-known services (e.g., an SZTP [RFC8572] bootstrap server) or public CA certificates to connect to arbitrary Web services using public PKI.

Built-in trust anchors are expected to be set by a vendor-specific process. Any ability for operators to set and/or modify built-in trust anchors is outside the scope of this document.

The primary characteristic of the built-in trust anchors is that they are provided by the server, as opposed to configuration. As such, they are present in <operational> (Section 5.3 of [RFC8342]), and <system> [I-D.ietf-netmod-system-config], if implemented.

The example below illustrates what the truststore in <operational> might look like for a server in its factory default state. Note that the built-in trust anchor bags have the "or:origin" annotation value "or:system".

```
<truststore
  xmlns="urn:ietf:params:xml:ns:yang:ietf-truststore"
  xmlns:ct="urn:ietf:params:xml:ns:yang:ietf-crypto-types"
  xmlns:or="urn:ietf:params:xml:ns:yang:ietf-origin"
  or:origin="or:intended">
  <certificate-bags>

    <certificate-bag or:origin="or:system">
      <name>Built-In Manufacturer Trust Anchor Certificates</name>
      <description>
        Certificates built into the device for authenticating
        manufacturer-signed objects, such as TLS server certificates,
        vouchers, etc.
      </description>
      <certificate>
        <name>Manufacturer Root CA Cert</name>
        <cert-data>BASE64VALUE=</cert-data>
      </certificate>
    </certificate-bag>

    <certificate-bag or:origin="or:system">
      <name>Built-In Public Trust Anchor Certificates</name>
      <description>
        Certificates built into the device for authenticating
        certificates issued by public certificate authorities,
        such as the end-entity certificate for web servers.
      </description>
      <certificate>
        <name>Public Root CA Cert 1</name>
        <cert-data>BASE64VALUE=</cert-data>
      </certificate>
      <certificate>
        <name>Public Root CA Cert 2</name>
        <cert-data>BASE64VALUE=</cert-data>
      </certificate>
      <certificate>
        <name>Public Root CA Cert 3</name>
        <cert-data>BASE64VALUE=</cert-data>
      </certificate>
    </certificate-bag>

  </certificate-bags>
</truststore>
```

4. Security Considerations

4.1. Security of Data at Rest

The YANG module defined in this document defines a mechanism called a "truststore" that, by its name, suggests that its contents are protected from unauthorized modification.

Security controls for the API (i.e., data in motion) are discussed in Section 4.3, but controls for the data at rest (e.g., on disk) cannot be specified by the YANG module.

In order to satisfy the expectations of a "truststore", server implementations MUST ensure that the truststore contents are protected from unauthorized modifications when at rest.

4.2. Unconstrained Public Key Usage

This module enables the configuration of public keys without constraints on their usage, e.g., what operations the key is allowed to be used for (encryption, verification, both).

Trust anchors configured via this module are implicitly trusted to validate certification paths that may include any name, be used for any purpose, subject to constraints imposed by an intermediate CA or by context in which the truststore is used. Implementations are free to use alternative or auxiliary structures and validation rules to define constraints that limit the applicability of a trust anchor.

4.3. Considerations for the "ietf-truststore" YANG Module

This section follows the template defined in Section 3.7.1 of [RFC8407].

The YANG module defined in this document is designed to be accessed via YANG based management protocols, such as NETCONF [RFC6241] and RESTCONF [RFC8040]. Both of these protocols have mandatory-to-implement secure transport layers (e.g., SSH, TLS) with mutual authentication.

The Network Access Control Model (NACM) [RFC8341] provides the means to restrict access for particular users to a pre-configured subset of all available protocol operations and content.

Please be aware that this YANG module uses groupings from other YANG modules that define nodes that may be considered sensitive or vulnerable in network environments. Please review the Security Considerations for dependent YANG modules for information as to which nodes may be considered sensitive or vulnerable in network environments.

Most of the readable data nodes defined in this YANG module are not considered sensitive or vulnerable in network environments. However, the "cert-data" node uses the NACM "default-deny-all" extension, for reasons described in Section 3.9 of [I-D.ietf-netconf-crypto-types].

All the writable data nodes defined by this module, both in the "grouping" statements as well as the protocol-accessible "truststore" instance, may be considered sensitive or vulnerable in some network environments. For instance, any modification to a trust anchor or reference to a trust anchor may dramatically alter the implemented security policy. For this reason, the NACM extension "default-deny-write" has been set for all data nodes defined in this module.

This module does not define any "rpc" or "action" statements, and thus the security considerations for such is not provided here.

5. IANA Considerations

5.1. The "IETF XML" Registry

This document registers one URI in the "ns" subregistry of the IETF XML Registry [RFC3688]. Following the format in [RFC3688], the following registration is requested:

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

5.2. The "YANG Module Names" Registry

This document registers one YANG module in the YANG Module Names registry [RFC6020]. Following the format in [RFC6020], the following registration is requested:

name: ietf-truststore
namespace: urn:ietf:params:xml:ns:yang:ietf-truststore
prefix: ts
reference: RFC BBBB

6. References

6.1. Normative References

[I-D.ietf-netconf-crypto-types]

Watsen, K., "YANG Data Types and Groupings for Cryptography", Work in Progress, Internet-Draft, draft-ietf-netconf-crypto-types-33, 1 March 2024, <<https://datatracker.ietf.org/doc/html/draft-ietf-netconf-crypto-types-33>>.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <<https://www.rfc-editor.org/info/rfc2119>>.

[RFC7950] Bjorklund, M., Ed., "The YANG 1.1 Data Modeling Language", RFC 7950, DOI 10.17487/RFC7950, August 2016, <<https://www.rfc-editor.org/info/rfc7950>>.

[RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174, May 2017, <<https://www.rfc-editor.org/info/rfc8174>>.

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

6.2. Informative References

[I-D.ietf-netconf-http-client-server]

Watsen, K., "YANG Groupings for HTTP Clients and HTTP Servers", Work in Progress, Internet-Draft, draft-ietf-netconf-http-client-server-19, 1 March 2024, <<https://datatracker.ietf.org/doc/html/draft-ietf-netconf-http-client-server-19>>.

[I-D.ietf-netconf-keystore]

Watsen, K., "A YANG Data Model for a Keystore and Keystore Operations", Work in Progress, Internet-Draft, draft-ietf-netconf-keystore-34, 1 March 2024, <<https://datatracker.ietf.org/doc/html/draft-ietf-netconf-keystore-34>>.

[I-D.ietf-netconf-netconf-client-server]

Watsen, K., "NETCONF Client and Server Models", Work in Progress, Internet-Draft, draft-ietf-netconf-netconf-client-server-35, 1 March 2024, <<https://datatracker.ietf.org/doc/html/draft-ietf-netconf-netconf-client-server-35>>.

- [I-D.ietf-netconf-restconf-client-server]
Watsen, K., "RESTCONF Client and Server Models", Work in Progress, Internet-Draft, draft-ietf-netconf-restconf-client-server-35, 1 March 2024,
<<https://datatracker.ietf.org/doc/html/draft-ietf-netconf-restconf-client-server-35>>.
- [I-D.ietf-netconf-ssh-client-server]
Watsen, K., "YANG Groupings for SSH Clients and SSH Servers", Work in Progress, Internet-Draft, draft-ietf-netconf-ssh-client-server-39, 1 March 2024,
<<https://datatracker.ietf.org/doc/html/draft-ietf-netconf-ssh-client-server-39>>.
- [I-D.ietf-netconf-tcp-client-server]
Watsen, K. and M. Scharf, "YANG Groupings for TCP Clients and TCP Servers", Work in Progress, Internet-Draft, draft-ietf-netconf-tcp-client-server-23, 1 March 2024,
<<https://datatracker.ietf.org/doc/html/draft-ietf-netconf-tcp-client-server-23>>.
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Appendix A. Change Log

A.1. 00 to 01

- * Added features "x509-certificates" and "ssh-host-keys".
- * Added nacm:default-deny-write to "trust-anchors" container.

A.2. 01 to 02

- * Switched "list pinned-certificate" to use the "trust-anchor-cert-grouping" from crypto-types. Effectively the same definition as before.

A.3. 02 to 03

- * Updated copyright date, boilerplate template, affiliation, folding algorithm, and reformatted the YANG module.

A.4. 03 to 04

- * Added groupings 'inline-or-truststore-certs-grouping' and 'inline-or-truststore-host-keys-grouping', matching similar definitions in the keystore draft. Note new (and incomplete) "truststore" usage!
- * Related to above, also added features 'truststore-supported' and 'local-trust-anchors-supported'.

A.5. 04 to 05

- * Renamed "trust-anchors" to "truststore"
- * Removed "pinned." prefix everywhere, to match truststore rename
- * Moved everything under a top-level 'grouping' to enable use in other contexts.
- * Renamed feature from 'local-trust-anchors-supported' to 'inline-definitions-supported' (same name used in keystore)
- * Removed the "require-instance false" statement from the "*-ref" typedefs.
- * Added missing "ssh-host-keys" and "x509-certificates" if-feature statements

A.6. 05 to 06

- * Editorial changes only.

A.7. 06 to 07

- * Added Henk Birkholz as a co-author (thanks Henk!)
- * Added PSKs and raw public keys to truststore.

A.8. 07 to 08

- * Added new "Support for Built-in Trust Anchors" section.
- * Removed spurious "uses ct:trust-anchor-certs-grouping" line.
- * Removed PSK from model.

A.9. 08 to 09

- * Removed remaining PSK references from text.
- * Wrapped each top-level list with a container.
- * Introduced "bag" term.
- * Merged "SSH Public Keys" and "Raw Public Keys" in a single "Public Keys" bag. Consuming downstream modules (i.e., "ietf-[ssh/tls]-[client/server]") refine the "public-key-format" to be either SSH or TLS specific as needed.

A.10. 09 to 10

- * Removed "algorithm" node from examples.
- * Removed the no longer used statements supporting the old "ssh-public-key" and "raw-public-key" nodes.
- * Added a "Note to Reviewers" note to first page.

A.11. 10 to 11

- * Corrected module prefix registered in the IANA Considerations section.
- * Modified 'inline-or-truststore-certs-grouping' to use a list (not a leaf-list).
- * Added new example section "The Local or Truststore Groupings".
- * Clarified expected behavior for "built-in" certificates in <operational>
- * Expanded "Data Model Overview section(s) [remove "wall" of tree diagrams].
- * Updated the Security Considerations section.

A.12. 11 to 12

- * Fixed a copy/paste issue in the "Data at Rest" Security Considerations section.

A.13. 12 to 13

- * Fixed issues found by the SecDir review of the "keystore" draft.

A.14. 13 to 14

- * Added an "Unconstrained Public Key Usage" Security Consideration to address concern raised by SecDir.
- * Addressed comments raised by YANG Doctor.

A.15. 14 to 15

- * Added prefixes to 'path' statements per trust-anchors/issues/1
- * Renamed feature "truststore-supported" to "central-truststore-supported".
- * Associated with above, generally moved text to refer to a "central" truststore.
- * Removed two unnecessary/unwanted "min-elements 1" and associated "presence" statements.
- * Aligned modules with 'pyang -f' formatting.
- * Fixed nits found by YANG Doctor reviews.

A.16. 15 to 16

- * Replaced "base64encodedvalue==" with "BASE64VALUE=" in examples.
- * Minor editorial nits

A.17. 16 to 17

- * fixup the 'WG Web' and 'WG List' lines in YANG module(s)
- * fixup copyright (i.e., s/Simplified/Revised/) in YANG module(s)
- * Added Informative reference to ma-netmod-with-system

A.18. 17 to 18

- * Updated Security Considerations section to address comment received from Carl Wallace.
- * Fixed examples to not have line-returns around "identity" encodings.
- * Fixed a couple tree diagrams to not create diagrams for "groupings" too.
- * Added "if-feature central-truststore-supported" to top-level "truststore" container.

A.19. 18 to 19

- * Updated per Shepherd reviews impacting the suite of drafts.

A.20. 19 to 20

- * Updated per Shepherd reviews impacting the suite of drafts.

A.21. 20 to 21

- * Updated (implicitly) per Tom Petch review.
- * Updated per AD's review.
- * s/local/inline/ in feature names, grouping names, and node names.
- * Updated ref from 'ma-netmod-with-system' to 'ietf-netmod-system-config'.
- * Removed special handling text for built-in certs
- * Updated section on built-in trust anchors to read almost the same as the section in the keystore draft.

A.22. 21 to 22

- * Mostly addresses AD review comments.
- * Also added typedefs and groupings similar to those created by Alto WG.
- * Added note to Editor to fix line foldings.
- * Renamed "truststore" to "central truststore" throughout.

- * Removed "built-in" section text that overlaps with the "system-config" draft.
- * Added "certificate-ref-grouping" and "public-key-ref-grouping"
- * Modified typedef certificate-ref's leafref path to NOT prefix "certificate-bag".
- * Modified typedef public-key-ref's leafref path to NOT prefix "public-key-bag".
- * Added groupings "certificate-ref-grouping" and "public-key-ref-grouping".

A.23. 22 to 23

- * Addresses Gen-ART review by Dale Worley.
- * Addresses review by Tom Petch.

A.24. 23 to 24

- * Addresses 1st-round of IESG reviews.

A.25. 24 to 26

- * Addresses issues found in OpsDir review of the ssh-client-server draft.
- * Renamed Security Considerations section s/Template for/ Considerations for/
- * s/defines/presents/ in a few places.
- * Add refs to where the 'operational' and 'system' datastores are defined.
- * Improved Security Consideration for 'cert-data' node.
- * s/should/SHOULD/ is one place

A.26. 26 to 28

- * Nothing changed. Only bumped for automation...

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