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YANG Groupings for SSH Clients and SSH Servers
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Abstract

This document defines three YANG 1.1 modules: the first defines features and groupings common to both SSH clients and SSH servers, the second defines a grouping for a generic SSH client, and the third defines a grouping for a generic SSH server.

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 draft-ietf-netconf-trust-anchors
* CCCC --> the assigned RFC value for draft-ietf-netconf-keystore
* DDDD --> the assigned RFC value for draft-ietf-netconf-tcp-client-server
* EEEE --> 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:

* 2022-05-24 --> the publication date of this draft

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

* Appendix B. Change Log

Status of This Memo

Copyright Notice

Table of Contents

1. Introduction

This document defines three YANG 1.1 [RFC7950] modules: the first defines features and groupings common to both SSH clients and SSH

servers, the second defines a grouping for a generic SSH client, and the third defines a grouping for a generic SSH server. It is intended that these groupings will be used by applications using the SSH protocol [RFC4252], [RFC4253], and [RFC4254]. For instance, these groupings could be used to help define the data model for an OpenSSH [OPENSSH] server or a NETCONF over SSH [RFC6242] based server.

The client and server YANG modules in this document each define one grouping, which is focused on just SSH-specific configuration, and specifically avoids any transport-level configuration, such as what ports to listen on or connect to. This affords applications the opportunity to define their own strategy for how the underlying TCP connection is established. For instance, applications supporting NETCONF Call Home [RFC8071] could use the "ssh-server-grouping" grouping for the SSH parts it provides, while adding data nodes for the TCP-level call-home configuration.

The modules defined in this document use groupings defined in [I-D.ietf-netconf-keystore] enabling keys to be either locally defined or a reference to globally configured values.

The modules defined in this document optionally support [RFC6187] enabling X.509v3 certificate based host keys and public keys.

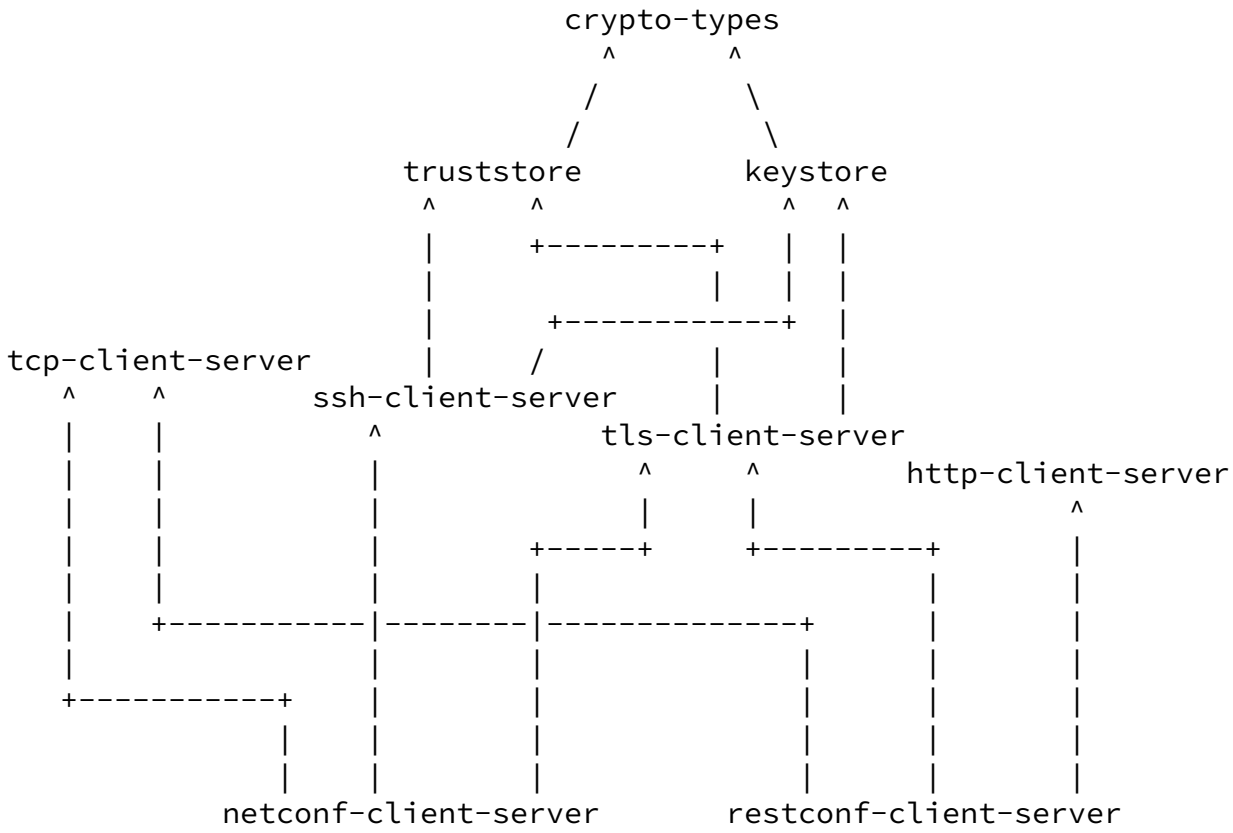
1.1. Relation to other RFCs

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

The modules have been defined in a modular fashion to enable their use by other efforts, some of which are known to be in progress at the time of this writing, with many more expected to be defined in time.

The normative dependency relationship between the various RFCs in the collection is presented in the below diagram. The labels in the diagram represent the primary purpose provided by each RFC.

Hyperlinks to each RFC are provided below the diagram.



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 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, as described in [I-D.ietf-netconf-trust-anchors] and [I-D.ietf-netconf-keystore], trust anchors and keys installed during manufacturing are expected to appear in <operational>.

1.4. Conventions

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

2. The "ietf-ssh-common" Module

The SSH common model presented in this section contains features and groupings common to both SSH clients and SSH servers. The "transport-params-grouping" grouping can be used to configure the list of SSH transport algorithms permitted by the SSH client or SSH server. The lists of permitted algorithms are in decreasing order of usage preference. The algorithm that appears first in the client

list that also appears in the server list is the one that is used for the SSH transport layer connection. The ability to restrict the algorithms allowed is provided in this grouping for SSH clients and SSH servers that are capable of doing so and may serve to make SSH clients and SSH servers compliant with security policies.

2.1. Data Model Overview

This section provides an overview of the "ietf-ssh-common" module in terms of its features, identities, and groupings.

2.1.1. Features

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

```
Features:
  +-- ssh-x509-certs
  +-- transport-params
  +-- public-key-generation
```

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

2.1.2. Groupings

The "ietf-ssh-common" module defines the following "grouping" statement:

* transport-params-grouping

This grouping is presented in the following subsection.

2.1.2.1. The "transport-params-grouping" Grouping

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


```
grouping transport-params-grouping:
```

```
      +-- host-key
      |  +-- host-key-alg*   identityref
      +-- key-exchange
      |  +-- key-exchange-alg*   identityref
      +-- encryption
      |  +-- encryption-alg*   identityref
      +-- mac
         +-- mac-alg*   identityref
```

Comments:

* This grouping is used by both the "ssh-client-grouping" and the "ssh-server-grouping" groupings defined in Section 3.1.2.1 and Section 4.1.2.1, respectively.

* This grouping enables client and server configurations to specify the algorithms that are to be used when establishing SSH sessions.

* Each list is "ordered-by user".

2.1.3. Protocol-accessible Nodes

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

module: ietf-ssh-common

```
  rpcs:
    +---x generate-public-key {public-key-generation}?
       +---w input
       |  +---w algorithm             sshpka:public-key-algorithm-ref
       |  +---w bits?                 uint16
       |  +---w (private-key-encoding)?
       |     +--:(cleartext)
       |     |  +---w cleartext?      empty
       |     +--:(encrypt) {ct:private-key-encryption}?
       |     |  +---w encrypt-with
       |     |     +---w ks:encrypted-by-choice-grouping
       |     +--:(hide) {ct:hidden-keys}?
       |        +---w hide?           empty
       +--ro output
          +---u ct:asymmetric-key-pair-grouping
```

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

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

module: ietf-ssh-common

  rpcs:
    +---x generate-public-key {public-key-generation}?
       +---w input
       |  +---w algorithm             sshpka:public-key-algorithm-ref
       |  +---w bits?                 uint16
       |  +---w (private-key-encoding)?
       |     +--:(cleartext)
       |     |  +---w cleartext?      empty
       |     +--:(encrypt) {ct:private-key-encryption}?
       |     |  +---w encrypt-with
       |     |     +---w (encrypted-by-choice)
       |     |        +--:(symmetric-key-ref)
       |     |        |        {central-keystore-supported,symmetric\
-keys}?
       |     |        |  +---w symmetric-key-ref?
       |     |        |          ks:symmetric-key-ref
       |     |        +--:(asymmetric-key-ref)
       |     |                 {central-keystore-supported,asymmetri\
c-keys}?
       |     |           +---w asymmetric-key-ref?
       |     |                   ks:asymmetric-key-ref
       |     +--:(hide) {ct:hidden-keys}?
       |        +---w hide?           empty
       +--ro output
          +--ro public-key-format              identityref
          +--ro public-key                     binary
          +--ro private-key-format?            identityref
          +--ro (private-key-type)
             +--:(cleartext-private-key)
             |  +--ro cleartext-private-key?   binary
             +--:(hidden-private-key) {hidden-keys}?
             |  +--ro hidden-private-key?      empty
             +--:(encrypted-private-key) {private-key-encryption}?
                +--ro encrypted-private-key
                   +--ro encrypted-by
                   +--ro encrypted-value-format    identityref
                   +--ro encrypted-value           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-ssh-common" module are limited to the RPC "generate-public-key", which is additionally constrained by the feature "public-key-generation".

* The "encrypted-by-choice-grouping" grouping is discussed in Section 2.1.3.1 of [I-D.ietf-netconf-keystore].

* The "asymmetric-key-pair-grouping" grouping is discussed in Section 2.1.4.5 of [I-D.ietf-netconf-crypto-types].

2.2. Example Usage

The following example illustrates the "transport-params-grouping' grouping when populated with some data.

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

   <!-- The outermost element below doesn't exist in the data model. -->
   <!--  It simulates if the "grouping" were a "container" instead.  -->

   <transport-params
     xmlns="urn:ietf:params:xml:ns:yang:ietf-ssh-common"
     xmlns:sshea="urn:ietf:params:xml:ns:yang:iana-ssh-encryption-algs"
     xmlns:sshkea="urn:ietf:params:xml:ns:yang:iana-ssh-key-exchange-al\
   gs"
     xmlns:sshma="urn:ietf:params:xml:ns:yang:iana-ssh-mac-algs"
     xmlns:sshpka="urn:ietf:params:xml:ns:yang:iana-ssh-public-key-algs\
   ">
     <host-key>
       <host-key-alg>sshpka:x509v3-rsa2048-sha256</host-key-alg>
       <host-key-alg>sshpka:ssh-rsa</host-key-alg>
     </host-key>
     <key-exchange>
       <key-exchange-alg>sshkea:diffie-hellman-group-exchange-sha256</k\
   ey-exchange-alg>
     </key-exchange>
     <encryption>
       <encryption-alg>sshea:aes256-ctr</encryption-alg>
       <encryption-alg>sshea:aes192-ctr</encryption-alg>
       <encryption-alg>sshea:aes128-ctr</encryption-alg>
       <encryption-alg>sshea:aes256-cbc</encryption-alg>
       <encryption-alg>sshea:aes192-cbc</encryption-alg>
       <encryption-alg>sshea:aes128-cbc</encryption-alg>
     </encryption>
     <mac>
       <mac-alg>sshma:hmac-sha2-256</mac-alg>
       <mac-alg>sshma:hmac-sha2-512</mac-alg>
```

```
      </mac>
    </transport-params>
```

The following example illustrates the "generate-public-key" RPC.


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

   <rpc message-id="101"
     xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
     <generate-public-key
       xmlns="urn:ietf:params:xml:ns:yang:ietf-ssh-common"
       xmlns:sshpka="urn:ietf:params:xml:ns:yang:iana-ssh-public-key-al\
   gs">
       <algorithm>sshpka:ecdsa-sha2-nistp256</algorithm>
       <bits>521</bits>
       <encrypt-with>
         <asymmetric-key-ref>hidden-asymmetric-key</asymmetric-key-ref>
       </encrypt-with>
     </generate-public-key>
   </rpc>
```

2.3. YANG Module

This YANG module has normative references to [RFC4253], [RFC4344], [RFC4419], [RFC5656], [RFC6187], and [RFC6668].

```
   <CODE BEGINS> file "ietf-ssh-common@2022-05-24.yang"

   module ietf-ssh-common {
     yang-version 1.1;
```

```
  namespace "urn:ietf:params:xml:ns:yang:ietf-ssh-common";
  prefix sshcmn;

  import iana-ssh-encryption-algs {
    prefix sshea;
    reference
      "RFC EEEE: YANG Groupings for SSH Clients and SSH Servers";
  }

  import iana-ssh-key-exchange-algs {
    prefix sshkea;
    reference
      "RFC EEEE: YANG Groupings for SSH Clients and SSH Servers";
  }

  import iana-ssh-mac-algs {
    prefix sshma;
    reference
      "RFC EEEE: YANG Groupings for SSH Clients and SSH Servers";
  }

  import iana-ssh-public-key-algs {
    prefix sshpka;
```



```
    reference
      "RFC EEEE: YANG Groupings for SSH Clients and SSH Servers";
  }

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

  import ietf-keystore {
    prefix ks;
    reference
      "RFC CCCC: A YANG Data Model for a Keystore";
  }

  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 <mailto:kent+ietf@watsen.net>
     Author:   Gary Wu <mailto:garywu@cisco.com>";

  description
    "This module defines a common features and groupings for
     Secure Shell (SSH).

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     as authors of the code. All rights reserved.

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

     This version of this YANG module is part of RFC EEEE
     (https://www.rfc-editor.org/info/rfcEEEE); 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 2022-05-24 {
    description
      "Initial version";
    reference
      "RFC EEEE: YANG Groupings for SSH Clients and SSH Servers";
  }

  // Features
```

```
  feature ssh-x509-certs {
    description
      "X.509v3 certificates are supported for SSH.";
    reference
      "RFC 6187: X.509v3 Certificates for Secure Shell
                 Authentication";
  }

  feature transport-params {
    description
      "SSH transport layer parameters are configurable.";
  }

  feature public-key-generation {
    description
      "Indicates that the server implements the
       'generate-public-key' RPC.";
  }

  // Groupings

  grouping transport-params-grouping {
    description
      "A reusable grouping for SSH transport parameters.";
    reference
      "RFC 4253: The Secure Shell (SSH) Transport Layer Protocol";
    container host-key {
      description
        "Parameters regarding host key.";
      leaf-list host-key-alg {
        type identityref {
          base sshpka:public-key-alg-base;
        }
        ordered-by user;
        description
          "Acceptable host key algorithms in order of descending
           preference.  The configured host key algorithms should
```



```
           be compatible with the algorithm used by the configured
           private key.  Please see Section 5 of RFC EEEE for
           valid combinations.
```

```
            If this leaf-list is not configured (has zero elements)
            the acceptable host key algorithms are implementation-
            defined.";
        reference
          "RFC EEEE: YANG Groupings for SSH Clients and SSH Servers";
      }
    }
    container key-exchange {
      description
        "Parameters regarding key exchange.";
      leaf-list key-exchange-alg {
        type identityref {
          base sshkea:key-exchange-alg-base;
        }
        ordered-by user;
        description
          "Acceptable key exchange algorithms in order of descending
           preference.

            If this leaf-list is not configured (has zero elements)
            the acceptable key exchange algorithms are implementation
            defined.";
      }
    }
    container encryption {
      description
        "Parameters regarding encryption.";
      leaf-list encryption-alg {
        type identityref {
          base sshea:encryption-alg-base;
        }
        ordered-by user;
        description
          "Acceptable encryption algorithms in order of descending
           preference.

            If this leaf-list is not configured (has zero elements)
            the acceptable encryption algorithms are implementation
            defined.";
      }
    }
    container mac {
      description
        "Parameters regarding message authentication code (MAC).";
```

```
        leaf-list mac-alg {
          type identityref {
            base sshma:mac-alg-base;
          }
          ordered-by user;
          description
            "Acceptable MAC algorithms in order of descending
             preference.

             If this leaf-list is not configured (has zero elements)
             the acceptable MAC algorithms are implementation-
             defined.";
        }
      }
    }

    // Protocol-accessible Nodes

    rpc generate-public-key {
      if-feature "public-key-generation";
      description
        "Requests the device to generate an public key using
         the specified key algorithm.";
      input {
        leaf algorithm {
          type sshpka:public-key-algorithm-ref;
          mandatory true;
          description
            "The algorithm to be used when generating the key.";
        }
        leaf bits {
          type uint16;
          description
            "Specifies the number of bits in the key to create.
             For RSA keys, the minimum size is 1024 bits and
             the default is 3072 bits. Generally, 3072 bits is
             considered sufficient. DSA keys must be exactly 1024
             bits as specified by FIPS 186-2.  For ECDSA keys, the
             'bits' value determines the key length by selecting
             from one of three elliptic curve sizes: 256, 384 or
             521 bits. Attempting to use bit lengths other than
             these three values for ECDSA keys will fail. ECDSA-SK,
             Ed25519 and Ed25519-SK keys have a fixed length and
             the 'bits' value, if specified, will be ignored.";
        }
        choice private-key-encoding {
          default cleartext;
```

```
          description
```



```
            "A choice amongst optional private key handling.";
          case cleartext {
            leaf cleartext {
              type empty;
              description
                "Indicates that the private key is to be returned
                 as a cleartext value.";
            }
          }
          case encrypt {
            if-feature "ct:private-key-encryption";
            container encrypt-with {
              description
                 "Indicates that the key is to be encrypted using
                  the specified symmetric or asymmetric key.";
              uses ks:encrypted-by-choice-grouping;
            }
          }
          case hide {
            if-feature "ct:hidden-keys";
            leaf hide {
              type empty;
              description
                "Indicates that the private key is to be hidden.

                 Unlike the 'cleartext' and 'encrypt' options, the
                 key returned is a placeholder for an internally
                 stored key.  See the 'Support for Built-in Keys'
                 section in RFC CCCC for information about hidden
                 keys.";
            }
          }
        }
      }
      output {
        uses ct:asymmetric-key-pair-grouping;
      }
    } // end generate-public-key

  }
```

<CODE ENDS>

3. The "ietf-ssh-client" Module

This section defines a YANG 1.1 [RFC7950] module called "ietf-ssh-client". A high-level overview of the module is provided in Section 3.1. Examples illustrating the module's use are provided in Examples (Section 3.2). The YANG module itself is defined in Section 3.3.

3.1. Data Model Overview

This section provides an overview of the "ietf-ssh-client" module in terms of its features and groupings.

3.1.1. Features

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

```
Features:
  +-- ssh-client-keepalives
  +-- client-ident-password
  +-- client-ident-publickey
  +-- client-ident-hostbased
  +-- client-ident-none
```

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

3.1.2. Groupings

The "ietf-ssh-client" module defines the following "grouping" statement:

* ssh-client-grouping

This grouping is presented in the following subsection.

3.1.2.1. The "ssh-client-grouping" Grouping

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


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

  grouping ssh-client-grouping:
    +-- client-identity
    |  +-- username?      string
    |  +-- public-key! {client-ident-publickey}?
    |  |  +---u ks:local-or-keystore-asymmetric-key-grouping
    |  +-- password! {client-ident-password}?
    |  |  +---u ct:password-grouping
    |  +-- hostbased! {client-ident-hostbased}?
    |  |  +---u ks:local-or-keystore-asymmetric-key-grouping
    |  +-- none?          empty {client-ident-none}?
    |  +-- certificate! {sshcmn:ssh-x509-certs}?
    |     +---u ks:local-or-keystore-end-entity-cert-with-key-groupi\
ng
    +-- server-authentication
    |  +-- ssh-host-keys!
    |  |  +---u ts:local-or-truststore-public-keys-grouping
    |  +-- ca-certs! {sshcmn:ssh-x509-certs}?
    |  |  +---u ts:local-or-truststore-certs-grouping
    |  +-- ee-certs! {sshcmn:ssh-x509-certs}?
    |     +---u ts:local-or-truststore-certs-grouping
    +-- transport-params {sshcmn:transport-params}?
    |  +---u sshcmn:transport-params-grouping
    +-- keepalives! {ssh-client-keepalives}?
       +-- max-wait?       uint16
```

```
        +-- max-attempts?   uint8
```

Comments:

* The "client-identity" node configures a "username" and authentication methods, each enabled by a "feature" statement defined in Section 3.1.1.

* The "server-authentication" node configures trust anchors for authenticating the SSH server, with each option enabled by a "feature" statement.

* The "transport-params" node, which must be enabled by a feature, configures parameters for the SSH sessions established by this configuration.

* The "keepalives" node, which must be enabled by a feature, configures a "presence" container for testing the aliveness of the SSH server. The aliveness-test occurs at the SSH protocol layer.

* For the referenced grouping statement(s):

  - The "local-or-keystore-asymmetric-key-grouping" grouping is discussed in Section 2.1.3.4 of [I-D.ietf-netconf-keystore].
  - The "local-or-keystore-end-entity-cert-with-key-grouping" grouping is discussed in Section 2.1.3.6 of [I-D.ietf-netconf-keystore].
  - The "local-or-truststore-public-keys-grouping" grouping is discussed in Section 2.1.3.2 of [I-D.ietf-netconf-trust-anchors].
  - The "local-or-truststore-certs-grouping" grouping is discussed in Section 2.1.3.1 of [I-D.ietf-netconf-trust-anchors].
  - The "transport-params-grouping" grouping is discussed in Section 2.1.2.1 in this document.

3.1.3. Protocol-accessible Nodes

The "ietf-ssh-client" module defines only "grouping" statements that are used by other modules to instantiate protocol-accessible nodes.

3.2. Example Usage

This section presents two examples showing the "ssh-client-grouping" grouping populated with some data. These examples are effectively the same except the first configures the client identity using a local key while the second uses a key configured in a keystore. Both examples are consistent with the examples presented in Section 2 of [I-D.ietf-netconf-trust-anchors] and Section 3.2 of [I-D.ietf-netconf-keystore].

The following configuration example uses local-definitions for the client identity and server authentication:

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

<!-- The outermost element below doesn't exist in the data model. -->
<!--  It simulates if the "grouping" were a "container" instead.  -->

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

  <!-- how this client will authenticate itself to the server -->
  <client-identity>
    <username>foobar</username>
    <public-key>
      <local-definition>
        <public-key-format>ct:ssh-public-key-format</public-key-form\
at>
        <public-key>BASE64VALUE=</public-key>
```



```
        <private-key-format>ct:rsa-private-key-format</private-key-f\
ormat>
        <cleartext-private-key>BASE64VALUE=</cleartext-private-key>
      </local-definition>
    </public-key>
  </client-identity>

  <!-- which host keys will this client trust -->
  <server-authentication>
    <ssh-host-keys>
      <local-definition>
        <public-key>
```

```
            <name>corp-fw1</name>
            <public-key-format>ct:ssh-public-key-format</public-key-fo\
rmat>
            <public-key>BASE64VALUE=</public-key>
          </public-key>
          <public-key>
            <name>corp-fw2</name>
            <public-key-format>ct:ssh-public-key-format</public-key-fo\
rmat>
            <public-key>BASE64VALUE=</public-key>
          </public-key>
        </local-definition>
      </ssh-host-keys>
      <ca-certs>
        <local-definition>
          <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>
        </local-definition>
      </ca-certs>
      <ee-certs>
        <local-definition>
          <certificate>
            <name>My Application #1</name>
            <cert-data>BASE64VALUE=</cert-data>
          </certificate>
          <certificate>
            <name>My Application #2</name>
            <cert-data>BASE64VALUE=</cert-data>
          </certificate>
        </local-definition>
```



```
      </ee-certs>
    </server-authentication>

    <keepalives>
      <max-wait>30</max-wait>
```

```
      <max-attempts>3</max-attempts>
    </keepalives>

  </ssh-client>
```

The following configuration example uses keystore-references for the client identity and truststore-references for server authentication: from the keystore:

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

<!-- The outermost element below doesn't exist in the data model. -->
<!--  It simulates if the "grouping" were a "container" instead.  -->

<ssh-client
  xmlns="urn:ietf:params:xml:ns:yang:ietf-ssh-client"
  xmlns:algs="urn:ietf:params:xml:ns:yang:ietf-ssh-common">

  <!-- how this client will authenticate itself to the server -->
  <client-identity>
    <username>foobar</username>
    <!-- can an SSH client have move than one key?
    <public-key>
      <keystore-reference>ssh-rsa-key</keystore-reference>
    </public-key>
    -->
    <certificate>
      <keystore-reference>
        <asymmetric-key>ssh-rsa-key-with-cert</asymmetric-key>
        <certificate>ex-rsa-cert2</certificate>
      </keystore-reference>
    </certificate>
  </client-identity>

  <!-- which host-keys will this client trust -->
  <server-authentication>
    <ssh-host-keys>
      <truststore-reference>trusted-ssh-public-keys</truststore-refe\
rence>
    </ssh-host-keys>
    <ca-certs>
      <truststore-reference>trusted-server-ca-certs</truststore-refe\
rence>
    </ca-certs>
    <ee-certs>
      <truststore-reference>trusted-server-ee-certs</truststore-refe\
rence>
    </ee-certs>
  </server-authentication>

  <keepalives>
    <max-wait>30</max-wait>
    <max-attempts>3</max-attempts>
  </keepalives>

</ssh-client>
```

3.3. YANG Module

This YANG module has normative references to [I-D.ietf-netconf-trust-anchors], and [I-D.ietf-netconf-keystore].

<CODE BEGINS> file "ietf-ssh-client@2022-05-24.yang"

```
module ietf-ssh-client {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-ssh-client";
  prefix sshc;

  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";
  }

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

  import ietf-keystore {
    prefix ks;
    reference
      "RFC CCCC: A YANG Data Model for a Keystore";
  }

  import ietf-ssh-common {
    prefix sshcmn;
    revision-date 2022-05-24; // stable grouping definitions
    reference
      "RFC EEEE: YANG Groupings for SSH Clients and SSH Servers";
  }
```

```
    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 <mailto:kent+ietf@watsen.net>
       Author:   Gary Wu <mailto:garywu@cisco.com>";

    description
      "This module defines reusable groupings for SSH clients that
       can be used as a basis for specific SSH client instances.

       Copyright (c) 2022 IETF Trust and the persons identified
       as authors of the code. All rights reserved.

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

       This version of this YANG module is part of RFC EEEE
       (https://www.rfc-editor.org/info/rfcEEEE); 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 2022-05-24 {
      description
        "Initial version";
      reference
        "RFC EEEE: YANG Groupings for SSH Clients and SSH Servers";
    }
```

```
  // Features

  feature ssh-client-keepalives {
    description
      "Per socket SSH keepalive parameters are configurable for
       SSH clients on the server implementing this feature.";
  }

  feature client-ident-publickey {
    description
      "Indicates that the 'publickey' authentication type, per
       RFC 4252, is supported for client identification.
```



```
       The 'publickey' authentication type is required by
       RFC 4252, but common implementations enable it to
       be disabled.";
    reference
      "RFC 4252:
       The Secure Shell (SSH) Authentication Protocol";
  }

  feature client-ident-password {
    description
      "Indicates that the 'password' authentication type, per
       RFC 4252, is supported for client identification.";
    reference
      "RFC 4252:
       The Secure Shell (SSH) Authentication Protocol";
  }

  feature client-ident-hostbased {
    description
      "Indicates that the 'hostbased' authentication type, per
       RFC 4252, is supported for client identification.";
    reference
      "RFC 4252:
       The Secure Shell (SSH) Authentication Protocol";
  }

  feature client-ident-none {
    description
```

```
        "Indicates that the 'none' authentication type, per
         RFC 4252, is supported for client identification.";
      reference
        "RFC 4252:
          The Secure Shell (SSH) Authentication Protocol";
    }

    // Groupings

    grouping ssh-client-grouping {
      description
        "A reusable grouping for configuring a SSH client without
         any consideration for how an underlying TCP session is
         established.

         Note that this grouping uses fairly typical descendant
         node names such that a stack of 'uses' statements will
         have name conflicts.  It is intended that the consuming
         data model will resolve the issue (e.g., by wrapping
         the 'uses' statement in a container called
```



```
         'ssh-client-parameters').  This model purposely does
         not do this itself so as to provide maximum flexibility
         to consuming models.";

      container client-identity {
        nacm:default-deny-write;
        description
          "The username and authentication methods for the client.
           The authentication methods are unordered.  Clients may
           initially send any configured method or, per RFC 4252,
           Section 5.2, send the 'none' method to prompt the server
           to provide a list of productive methods.  Whenever a
           choice amongst methods arises, implementations SHOULD
           use a default ordering that prioritizes automation
           over human-interaction.";
        leaf username {
          type string;
          description
            "The username of this user.  This will be the username
             used, for instance, to log into an SSH server.";
        }
```

```
        container public-key {
          if-feature "client-ident-publickey";
          presence
            "Indicates that publickey-based authentication has been
             configured.  This statement is present so the mandatory
             descendant nodes do not imply that this node must be
             configured.";
          description
            "A locally-defined or referenced asymmetric key
             pair to be used for client identification.";
          reference
            "RFC CCCC: A YANG Data Model for a Keystore";
          uses ks:local-or-keystore-asymmetric-key-grouping {
            refine "local-or-keystore/local/local-definition" {
              must 'public-key-format = "ct:ssh-public-key-format"';
            }
            refine "local-or-keystore/keystore/keystore-reference" {
              must 'deref(.)/../ks:public-key-format'
                 + ' = "ct:ssh-public-key-format"';
            }
          }
        }
        container password {
          if-feature "client-ident-password";
          presence
            "Indicates that password-based authentication has been
             configured.  This statement is present so the mandatory
```



```
             descendant nodes do not imply that this node must be
             configured.";
          description
            "A password to be used to authenticate the client's
             identity.";
          uses ct:password-grouping;
        }
        container hostbased {
          if-feature "client-ident-hostbased";
          presence
            "Indicates that hostbased authentication is configured.
             This statement is present so the mandatory descendant
             nodes do not imply that this node must be configured.";
          description
```

```
            "A locally-defined or referenced asymmetric key
             pair to be used for host identification.";
          reference
            "RFC CCCC: A YANG Data Model for a Keystore";
          uses ks:local-or-keystore-asymmetric-key-grouping {
            refine "local-or-keystore/local/local-definition" {
              must 'public-key-format = "ct:ssh-public-key-format"';
            }
            refine "local-or-keystore/keystore/keystore-reference" {
              must 'deref(.)/../ks:public-key-format'
                 + ' = "ct:ssh-public-key-format"';
            }
          }
        }
        leaf none {
          if-feature "client-ident-none";
          type empty;
          description
            "Indicates that 'none' algorithm is used for client
             identification.";
        }
        container certificate {
          if-feature "sshcmn:ssh-x509-certs";
          presence
            "Indicates that certificate-based authentication has been
             configured.  This statement is present so the mandatory
             descendant nodes do not imply that this node must be
             configured.";
          description
            "A locally-defined or referenced certificate
             to be used for client identification.";
          reference
            "RFC CCCC: A YANG Data Model for a Keystore";
          uses ks:local-or-keystore-end-entity-cert-with-key-grouping {
```



```
            refine "local-or-keystore/local/local-definition" {
              must 'public-key-format'
                 + ' = "ct:subject-public-key-info-format"';
            }
            refine "local-or-keystore/keystore/keystore-reference"
                 + "/asymmetric-key" {
              must 'deref(.)/../ks:public-key-format'
```

```
                + ' = "ct:subject-public-key-info-format"';
            }
          }
        }
      } // container client-identity

      container server-authentication {
        nacm:default-deny-write;
        must 'ssh-host-keys or ca-certs or ee-certs';
        description
          "Specifies how the SSH client can authenticate SSH servers.
           Any combination of authentication methods is additive and
           unordered.";
        container ssh-host-keys {
          presence
            "Indicates that the SSH host key have been configured.
             This statement is present so the mandatory descendant
             nodes do not imply that this node must be configured.";
          description
            "A bag of SSH host keys used by the SSH client to
             authenticate SSH server host keys.  A server host key
             is authenticated if it is an exact match to a
             configured SSH host key.";
          reference
            "RFC BBBB: A YANG Data Model for a Truststore";
          uses ts:local-or-truststore-public-keys-grouping {
            refine
              "local-or-truststore/local/local-definition/public-key" {
              must 'public-key-format = "ct:ssh-public-key-format"';
            }
            refine
              "local-or-truststore/truststore/truststore-reference" {
              must 'deref(.)/../*/ts:public-key-format'
                 + ' = "ct:ssh-public-key-format"';
            }
          }
        }
        container ca-certs {
          if-feature "sshcmn:ssh-x509-certs";
          presence
            "Indicates that the CA certificates have been configured.
```

```
          This statement is present so the mandatory descendant
          nodes do not imply that this node must be configured.";
        description
          "A set of certificate authority (CA) certificates used by
           the SSH client to authenticate SSH servers.  A server
           is authenticated if its certificate  has a valid chain
           of trust to a configured CA certificate.";
        reference
          "RFC BBBB: A YANG Data Model for a Truststore";
        uses ts:local-or-truststore-certs-grouping;
      }
      container ee-certs {
        if-feature "sshcmn:ssh-x509-certs";
        presence
          "Indicates that the EE certificates have been configured.
           This statement is present so the mandatory descendant
           nodes do not imply that this node must be configured.";
        description
          "A set of end-entity certificates used by the SSH client
           to authenticate SSH servers.  A server is authenticated
           if its certificate is an exact match to a configured
           end-entity certificate.";
        reference
          "RFC BBBB: A YANG Data Model for a Truststore";
        uses ts:local-or-truststore-certs-grouping;
      }
    } // container server-authentication

    container transport-params {
      nacm:default-deny-write;
      if-feature "sshcmn:transport-params";
      description
        "Configurable parameters of the SSH transport layer.";
      uses sshcmn:transport-params-grouping;
    } // container transport-parameters

    container keepalives {
      nacm:default-deny-write;
      if-feature "ssh-client-keepalives";
      presence
        "Indicates that the SSH client proactively tests the
         aliveness of the remote SSH server.";
      description
        "Configures the keep-alive policy, to proactively test
         the aliveness of the SSH server.  An unresponsive TLS
         server is dropped after approximately max-wait *
         max-attempts seconds.  Per Section 4 of RFC 4254,
         the SSH client SHOULD send an SSH_MSG_GLOBAL_REQUEST
```

```
           message with a purposely nonexistent 'request name'
           value (e.g., keepalive@ietf.org) and the 'want reply'
           value set to '1'.";
        reference
          "RFC 4254: The Secure Shell (SSH) Connection Protocol";
        leaf max-wait {
          type uint16 {
            range "1..max";
          }
          units "seconds";
          default "30";
          description
            "Sets the amount of time in seconds after which if
             no data has been received from the SSH server, a
             TLS-level message will be sent to test the
             aliveness of the SSH server.";
        }
        leaf max-attempts {
          type uint8;
          default "3";
          description
            "Sets the maximum number of sequential keep-alive
             messages that can fail to obtain a response from
             the SSH server before assuming the SSH server is
             no longer alive.";
        }
      } // container keepalives
    } // grouping ssh-client-grouping

  }

  <CODE ENDS>
```

4. The "ietf-ssh-server" Module

This section defines a YANG 1.1 module called "ietf-ssh-server". A high-level overview of the module is provided in Section 4.1. Examples illustrating the module's use are provided in Examples (Section 4.2). The YANG module itself is defined in Section 4.3.

4.1. Data Model Overview

This section provides an overview of the "ietf-ssh-server" module in

terms of its features and groupings.

4.1.1. Features

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

```
Features:
  +-- ssh-server-keepalives
  +-- local-users-supported
  +-- local-user-auth-publickey {local-users-supported}?
  +-- local-user-auth-password {local-users-supported}?
  +-- local-user-auth-hostbased {local-users-supported}?
  +-- local-user-auth-none {local-users-supported}?
```

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

4.1.2. Groupings

The "ietf-ssh-server" module defines the following "grouping" statement:

* ssh-server-grouping

This grouping is presented in the following subsection.

4.1.2.1. The "ssh-server-grouping" Grouping

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

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

     grouping ssh-server-grouping:
       +-- server-identity
       |  +-- host-key* [name]
       |     +-- name?                string
       |     +-- (host-key-type)
       |        +--:(public-key)
       |        |  +-- public-key
       |        |     +---u ks:local-or-keystore-asymmetric-key-grouping
       |        +--:(certificate)
       |           +-- certificate {sshcmn:ssh-x509-certs}?
       |              +---u ks:local-or-keystore-end-entity-cert-with-k\
   ey-grouping
       +-- client-authentication
       |  +-- users {local-users-supported}?
       |  |  +-- user* [name]
       |  |     +-- name?          string
       |  |     +-- public-keys! {local-user-auth-publickey}?
       |  |     |  +---u ts:local-or-truststore-public-keys-grouping
       |  |     +-- password?      ianach:crypt-hash
       |  |     |       {local-user-auth-password}?
       |  |     +-- hostbased! {local-user-auth-hostbased}?
       |  |     |  +---u ts:local-or-truststore-public-keys-grouping
       |  |     +-- none?          empty {local-user-auth-none}?
       |  +-- ca-certs! {sshcmn:ssh-x509-certs}?
       |  |  +---u ts:local-or-truststore-certs-grouping
       |  +-- ee-certs! {sshcmn:ssh-x509-certs}?
       |     +---u ts:local-or-truststore-certs-grouping
```

```
      +-- transport-params {sshcmn:transport-params}?
      |  +---u sshcmn:transport-params-grouping
      +-- keepalives! {ssh-server-keepalives}?
         +-- max-wait?       uint16
         +-- max-attempts?   uint8
```

Comments:

* The "server-identity" node configures the authentication methods the server can use to identify itself to clients. The ability to use a certificate is enabled by a "feature".

* The "client-authentication" node configures trust anchors for authenticating the SSH client, with each option enabled by a "feature" statement.

* The "transport-params" node, which must be enabled by a feature, configures parameters for the SSH sessions established by this configuration.

* The "keepalives" node, which must be enabled by a feature, configures a "presence" container for testing the aliveness of the SSH client. The aliveness-test occurs at the SSH protocol layer.

* For the referenced grouping statement(s):

  - The "local-or-keystore-asymmetric-key-grouping" grouping is discussed in Section 2.1.3.4 of [I-D.ietf-netconf-keystore].
  - The "local-or-keystore-end-entity-cert-with-key-grouping" grouping is discussed in Section 2.1.3.6 of [I-D.ietf-netconf-keystore].
  - The "local-or-truststore-public-keys-grouping" grouping is discussed in Section 2.1.3.2 of [I-D.ietf-netconf-trust-anchors].
  - The "local-or-truststore-certs-grouping" grouping is discussed in Section 2.1.3.1 of [I-D.ietf-netconf-trust-anchors].
  - The "transport-params-grouping" grouping is discussed in Section 2.1.2.1 in this document.

4.1.3. Protocol-accessible Nodes

The "ietf-ssh-server" module defines only "grouping" statements that

are used by other modules to instantiate protocol-accessible nodes.

4.2. Example Usage

This section presents two examples showing the "ssh-server-grouping" grouping populated with some data. These examples are effectively the same except the first configures the server identity using a local key while the second uses a key configured in a keystore. Both examples are consistent with the examples presented in Section 2 of [I-D.ietf-netconf-trust-anchors] and Section 3.2 of [I-D.ietf-netconf-keystore].

The following configuration example uses local-definitions for the server identity and client authentication:

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

<!-- The outermost element below doesn't exist in the data model. -->
<!--  It simulates if the "grouping" were a "container" instead.  -->

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

  <!-- the host-key this SSH server will present -->
  <server-identity>
```



```
      <host-key>
        <name>my-pubkey-based-host-key</name>
        <public-key>
          <local-definition>
            <public-key-format>ct:ssh-public-key-format</public-key-fo\
rmat>
            <public-key>BASE64VALUE=</public-key>
            <private-key-format>ct:rsa-private-key-format</private-key\
-format>
            <cleartext-private-key>BASE64VALUE=</cleartext-private-key>
          </local-definition>
        </public-key>
      </host-key>
      <host-key>
        <name>my-cert-based-host-key</name>
```

```
        <certificate>
          <local-definition>
            <public-key-format>ct:subject-public-key-info-format</publ\
ic-key-format>
            <public-key>BASE64VALUE=</public-key>
            <private-key-format>ct:rsa-private-key-format</private-key\
-format>
            <cleartext-private-key>BASE64VALUE=</cleartext-private-key>
            <cert-data>BASE64VALUE=</cert-data>
          </local-definition>
        </certificate>
      </host-key>
    </server-identity>

    <!-- the client credentials this SSH server will trust -->
    <client-authentication>
      <users>
        <user>
          <name>mary</name>
          <password>$0$secret</password>
          <public-keys>
            <local-definition>
              <public-key>
                <name>User A</name>
                <public-key-format>ct:ssh-public-key-format</public-ke\
y-format>
                <public-key>BASE64VALUE=</public-key>
              </public-key>
              <public-key>
                <name>User B</name>
                <public-key-format>ct:ssh-public-key-format</public-ke\
y-format>
                <public-key>BASE64VALUE=</public-key>
```



```
              </public-key>
            </local-definition>
          </public-keys>
        </user>
      </users>
      <ca-certs>
        <local-definition>
          <certificate>
```

```
            <name>Identity Cert Issuer #1</name>
            <cert-data>BASE64VALUE=</cert-data>
          </certificate>
          <certificate>
            <name>Identity Cert Issuer #2</name>
            <cert-data>BASE64VALUE=</cert-data>
          </certificate>
        </local-definition>
      </ca-certs>
      <ee-certs>
        <local-definition>
          <certificate>
            <name>Application #1</name>
            <cert-data>BASE64VALUE=</cert-data>
          </certificate>
          <certificate>
            <name>Application #2</name>
            <cert-data>BASE64VALUE=</cert-data>
          </certificate>
        </local-definition>
      </ee-certs>
    </client-authentication>

    <keepalives>
      <max-wait>30</max-wait>
      <max-attempts>3</max-attempts>
    </keepalives>

  </ssh-server>
```

The following configuration example uses keystore-references for the server identity and truststore-references for client authentication: from the keystore:

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

<!-- The outermost element below doesn't exist in the data model. -->
<!--  It simulates if the "grouping" were a "container" instead.  -->

<ssh-server
```



```
    xmlns="urn:ietf:params:xml:ns:yang:ietf-ssh-server">
```

```
      <!-- the host-key this SSH server will present -->
      <server-identity>
        <host-key>
          <name>my-pubkey-based-host-key</name>
          <public-key>
            <keystore-reference>ssh-rsa-key</keystore-reference>
          </public-key>
        </host-key>
        <host-key>
          <name>my-cert-based-host-key</name>
          <certificate>
            <keystore-reference>
              <asymmetric-key>ssh-rsa-key-with-cert</asymmetric-key>
              <certificate>ex-rsa-cert2</certificate>
            </keystore-reference>
          </certificate>
        </host-key>
      </server-identity>

      <!-- the client credentials this SSH server will trust -->
      <client-authentication>
        <users>
          <user>
            <name>mary</name>
            <password>$0$secret</password>
            <public-keys>
              <truststore-reference>SSH Public Keys for Application A</t\
    ruststore-reference>
            </public-keys>
          </user>
        </users>
        <ca-certs>
          <truststore-reference>trusted-client-ca-certs</truststore-refe\
    rence>
        </ca-certs>
        <ee-certs>
          <truststore-reference>trusted-client-ee-certs</truststore-refe\
    rence>
        </ee-certs>
      </client-authentication>

      <keepalives>
        <max-wait>30</max-wait>
        <max-attempts>3</max-attempts>
      </keepalives>
```

```
   </ssh-server>
```

4.3. YANG Module

This YANG module has normative references to [I-D.ietf-netconf-trust-anchors] and [I-D.ietf-netconf-keystore] and informative references to [RFC4253] and [RFC7317].

```
   <CODE BEGINS> file "ietf-ssh-server@2022-05-24.yang"

   module ietf-ssh-server {
     yang-version 1.1;
     namespace "urn:ietf:params:xml:ns:yang:ietf-ssh-server";
     prefix sshs;

     import iana-crypt-hash {
       prefix ianach;
       reference
         "RFC 7317: A YANG Data Model for System Management";
     }

     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";
     }

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

     import ietf-keystore {
       prefix ks;
       reference
         "RFC CCCC: A YANG Data Model for a Keystore";
     }

     import ietf-ssh-common {
```

```
    prefix sshcmn;
    revision-date 2022-05-24; // stable grouping definitions
```



```
    reference
      "RFC EEEE: YANG Groupings for SSH Clients and SSH Servers";
  }

  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 <mailto:kent+ietf@watsen.net>
     Author:   Gary Wu <mailto:garywu@cisco.com>";

  description
    "This module defines reusable groupings for SSH servers that
     can be used as a basis for specific SSH server instances.

     Copyright (c) 2022 IETF Trust and the persons identified
     as authors of the code. All rights reserved.

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

     This version of this YANG module is part of RFC EEEE
     (https://www.rfc-editor.org/info/rfcEEEE); 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 2022-05-24 {
```

```
    description
      "Initial version";
    reference
      "RFC EEEE: YANG Groupings for SSH Clients and SSH Servers";
  }

  // Features

  feature ssh-server-keepalives {
```



```
    description
      "Per socket SSH keepalive parameters are configurable for
       SSH servers on the server implementing this feature.";
  }

  feature local-users-supported {
    description
      "Indicates that the configuration for users can be
       configured herein, as opposed to in an application
       specific location.";
  }

  feature local-user-auth-publickey {
    if-feature "local-users-supported";
    description
      "Indicates that the 'publickey' authentication type,
       per RFC 4252, is supported for locally-defined users.

       The 'publickey' authentication type is required by
       RFC 4252, but common implementations enable it to
       be disabled.";
    reference
      "RFC 4252:
        The Secure Shell (SSH) Authentication Protocol";
  }

  feature local-user-auth-password {
    if-feature "local-users-supported";
    description
      "Indicates that the 'password' authentication type,
       per RFC 4252, is supported for locally-defined users.";
    reference
```

```
        "RFC 4252:
          The Secure Shell (SSH) Authentication Protocol";
      }

      feature local-user-auth-hostbased {
        if-feature "local-users-supported";
        description
          "Indicates that the 'hostbased' authentication type,
           per RFC 4252, is supported for locally-defined users.";
        reference
          "RFC 4252:
          The Secure Shell (SSH) Authentication Protocol";
      }

      feature local-user-auth-none {
        if-feature "local-users-supported";
```



```
        description
          "Indicates that the 'none' authentication type, per
           RFC 4252, is supported.  It is NOT RECOMMENDED to
           enable this feature.";
        reference
          "RFC 4252:
          The Secure Shell (SSH) Authentication Protocol";
      }

      // Groupings

      grouping ssh-server-grouping {
        description
          "A reusable grouping for configuring a SSH server without
           any consideration for how underlying TCP sessions are
           established.

           Note that this grouping uses fairly typical descendant
           node names such that a stack of 'uses' statements will
           have name conflicts.  It is intended that the consuming
           data model will resolve the issue (e.g., by wrapping
           the 'uses' statement in a container called
           'ssh-server-parameters').  This model purposely does
           not do this itself so as to provide maximum flexibility
           to consuming models.";
```

```
        container server-identity {
          nacm:default-deny-write;
          description
            "The list of host keys the SSH server will present when
             establishing a SSH connection.";
          list host-key {
            key "name";
            min-elements 1;
            ordered-by user;
            description
              "An ordered list of host keys the SSH server will use to
               construct its ordered list of algorithms, when sending
               its SSH_MSG_KEXINIT message, as defined in Section 7.1
               of RFC 4253.";
            reference
              "RFC 4253: The Secure Shell (SSH) Transport Layer
                         Protocol";
            leaf name {
              type string;
              description
                "An arbitrary name for this host key";
            }
```



```
            choice host-key-type {
              mandatory true;
              description
                "The type of host key being specified";
              container public-key {
                description
                  "A locally-defined or referenced asymmetric key pair
                   to be used for the SSH server's host key.";
                reference
                  "RFC CCCC: A YANG Data Model for a Keystore";
                uses ks:local-or-keystore-asymmetric-key-grouping {
                  refine "local-or-keystore/local/local-definition" {
                    must
                      'public-key-format = "ct:ssh-public-key-format"';
                  }
                  refine "local-or-keystore/keystore/"
                       + "keystore-reference" {
                    must 'deref(.)/../ks:public-key-format'
```

```
                    + ' = "ct:ssh-public-key-format"';
                }
              }
            }
            container certificate {
              if-feature "sshcmn:ssh-x509-certs";
              description
                "A locally-defined or referenced end-entity
                 certificate to be used for the SSH server's
                 host key.";
              reference
                "RFC CCCC: A YANG Data Model for a Keystore";
              uses
              ks:local-or-keystore-end-entity-cert-with-key-grouping {
                refine "local-or-keystore/local/local-definition" {
                  must 'public-key-format'
                     + ' = "ct:subject-public-key-info-format"';
                }
                refine "local-or-keystore/keystore/keystore-reference"
                       + "/asymmetric-key" {
                  must 'deref(.)/../ks:public-key-format'
                       + ' = "ct:subject-public-key-info-format"';
                }
              }
            }
          }
        }
      } // container server-identity

      container client-authentication {
```



```
        nacm:default-deny-write;
        description
          "Specifies how the SSH server can authenticate SSH clients.";
        container users {
          if-feature "local-users-supported";
          description
            "A list of locally configured users.";
          list user {
            key "name";
            description
              "A locally configured user.
```

```
          The server SHOULD derive the list of authentication
          'method names' returned to the SSH client from the
          descendant nodes configured herein, per Sections
          5.1 and 5.2 in RFC 4252.

          The authentication methods are unordered.  Clients
          must authenticate to all configured methods.
          Whenever a choice amongst methods arises,
          implementations SHOULD use a default ordering
          that prioritizes automation over human-interaction.";
        leaf name {
          type string;
          description
            "The 'user name' for the SSH client, as defined in
             the SSH_MSG_USERAUTH_REQUEST message in RFC 4253.";
        }
        container public-keys {
          if-feature "local-user-auth-publickey";
          presence
            "Indicates that public keys have been configured.
             This statement is present so the mandatory descendant
             nodes do not imply that this node must be
             configured.";
          description
            "A set of SSH public keys may be used by the SSH
             server to authenticate this user.  A user is
             authenticated if its public key is an exact
             match to a configured public key.";
          reference
            "RFC BBBB: A YANG Data Model for a Truststore";
          uses ts:local-or-truststore-public-keys-grouping {
            refine "local-or-truststore/local/local-definition"
                   + "/public-key" {
              must 'public-key-format'
                   + ' = "ct:ssh-public-key-format"';
            }
```



```
            refine "local-or-truststore/truststore/"
                   + "truststore-reference" {
              must 'deref(.)/../*/ts:public-key-format'
                   + ' = "ct:ssh-public-key-format"';
```

```
        }
      }
    }
    leaf password {
      if-feature "local-user-auth-password";
      type ianach:crypt-hash;
      description
        "The password for this user.";
    }
    container hostbased {
      if-feature "local-user-auth-hostbased";
      presence
        "Indicates that hostbased keys have been configured.
         This statement is present so the mandatory descendant
         nodes do not imply that this node must be
         configured.";
      description
        "A set of SSH host keys used by the SSH server to
         authenticate this user's host.  A user's host is
         authenticated if its host key is an exact match
         to a configured host key.";
      reference
        "RFC 4253: The Secure Shell (SSH) Transport Layer
         RFC BBBB: A YANG Data Model for a Truststore";
      uses ts:local-or-truststore-public-keys-grouping {
        refine "local-or-truststore/local/local-definition"
               + "/public-key" {
          must 'public-key-format'
               + ' = "ct:ssh-public-key-format"';
        }
        refine "local-or-truststore/truststore"
               + "/truststore-reference" {
          must 'deref(.)/../*/ts:public-key-format'
               + ' = "ct:ssh-public-key-format"';
        }
      }
    }
    leaf none {
      if-feature "local-user-auth-none";
      type empty;
      description
        "Indicates that the 'none' method is configured
         for this user.";
      reference
```

```
                "RFC 4252: The Secure Shell (SSH) Authentication
                           Protocol.";
            }
          }
        }
        container ca-certs {
          if-feature "sshcmn:ssh-x509-certs";
          presence
            "Indicates that CA certificates have been configured.
             This statement is present so the mandatory descendant
             nodes do not imply this node must be configured.";
          description
            "A set of certificate authority (CA) certificates used by
             the SSH server to authenticate SSH client certificates.
             A client certificate is authenticated if it has a valid
             chain of trust to a configured CA certificate.";
          reference
            "RFC BBBB: A YANG Data Model for a Truststore";
          uses ts:local-or-truststore-certs-grouping;
        }
        container ee-certs {
          if-feature "sshcmn:ssh-x509-certs";
          presence
            "Indicates that EE certificates have been configured.
             This statement is present so the mandatory descendant
             nodes do not imply this node must be configured.";
          description
            "A set of client certificates (i.e., end entity
             certificates) used by the SSH server to authenticate
             the certificates presented by SSH clients.  A client
             certificate is authenticated if it is an exact match
             to a configured end-entity certificate.";
          reference
            "RFC BBBB: A YANG Data Model for a Truststore";
          uses ts:local-or-truststore-certs-grouping;
        }
      } // container client-authentication

      container transport-params {
        nacm:default-deny-write;
        if-feature "sshcmn:transport-params";
        description
          "Configurable parameters of the SSH transport layer.";
        uses sshcmn:transport-params-grouping;
      } // container transport-params

      container keepalives {
```

```
        nacm:default-deny-write;
```



```
        if-feature "ssh-server-keepalives";
        presence
          "Indicates that the SSH server proactively tests the
           aliveness of the remote SSH client.";
        description
          "Configures the keep-alive policy, to proactively test
           the aliveness of the SSL client.  An unresponsive SSL
           client is dropped after approximately max-wait *
           max-attempts seconds.  Per Section 4 of RFC 4254,
           the SSH server SHOULD send an SSH_MSG_GLOBAL_REQUEST
           message with a purposely nonexistent 'request name'
           value (e.g., keepalive@ietf.org) and the 'want reply'
           value set to '1'.";
        reference
          "RFC 4254: The Secure Shell (SSH) Connection Protocol";
        leaf max-wait {
          type uint16 {
            range "1..max";
          }
          units "seconds";
          default "30";
          description
            "Sets the amount of time in seconds after which
             if no data has been received from the SSL client,
             a SSL-level message will be sent to test the
             aliveness of the SSL client.";
        }
        leaf max-attempts {
          type uint8;
          default "3";
          description
            "Sets the maximum number of sequential keep-alive
             messages that can fail to obtain a response from
             the SSL client before assuming the SSL client is
             no longer alive.";
        }
      }
    } // grouping ssh-server-grouping

  }
```

<CODE ENDS>

5. Security Considerations

5.1. The "iana-ssh-key-exchange-algs" Module

The "iana-ssh-key-exchange-algs" YANG module defines a data model that 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 NETCONF 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.

This YANG module defines YANG identities, for a public IANA-maintained registry, and a single protocol-accessible read-only node for the subset of those identities supported by a server.

YANG identities are not security-sensitive, as they are statically defined in the publicly-accessible YANG module.

The protocol-accessible read-only node for the algorithms supported by a server is mildly sensitive, but not to the extent that special NACM annotations are needed to prevent read-access to regular authenticated administrators.

This module does not define any writable-nodes, RPCs, actions, or notifications, and thus the security consideration for such is not provided here.

5.2. The "iana-ssh-encryption-algs" Module

The "iana-ssh-encryption-algs" YANG module defines a data model that 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 NETCONF 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.

This YANG module defines YANG identities, for a public IANA-maintained registry, and a single protocol-accessible read-only node for the subset of those identities supported by a server.

YANG identities are not security-sensitive, as they are statically defined in the publicly-accessible YANG module.

The protocol-accessible read-only node for the algorithms supported by a server is mildly sensitive, but not to the extent that special NACM annotations are needed to prevent read-access to regular authenticated administrators.

This module does not define any writable-nodes, RPCs, actions, or notifications, and thus the security consideration for such is not provided here.

5.3. The "iana-ssh-mac-algs" Module

The "iana-ssh-mac-algs" YANG module defines a data model that 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 NETCONF 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.

This YANG module defines YANG identities, for a public IANA-maintained registry, and a single protocol-accessible read-only node for the subset of those identities supported by a server.

YANG identities are not security-sensitive, as they are statically

defined in the publicly-accessible YANG module.

The protocol-accessible read-only node for the algorithms supported by a server is mildly sensitive, but not to the extent that special NACM annotations are needed to prevent read-access to regular authenticated administrators.

This module does not define any writable-nodes, RPCs, actions, or notifications, and thus the security consideration for such is not provided here.

5.4. The "iana-ssh-public-key-algs" Module

The "iana-ssh-public-key-algs" YANG module defines a data model that 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 NETCONF 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.

This YANG module defines YANG identities, for a public IANA-maintained registry, and a single protocol-accessible read-only node for the subset of those identities supported by a server.

YANG identities are not security-sensitive, as they are statically defined in the publicly-accessible YANG module.

The protocol-accessible read-only node for the algorithms supported by a server is mildly sensitive, but not to the extent that special NACM annotations are needed to prevent read-access to regular authenticated administrators.

This module does not define any writable-nodes, RPCs, actions, or notifications, and thus the security consideration for such is not provided here.

5.5. The "ietf-ssh-common" YANG Module

The "ietf-ssh-common" YANG module defines "grouping" statements that

are 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 NETCONF 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.

Since this module only define groupings, these considerations are primarily for the designers of other modules that use these groupings.

None of the readable data nodes defined in this YANG module are considered sensitive or vulnerable in network environments. The NACM "default-deny-all" extension has not been set for any data nodes defined in this module.

None of the writable data nodes defined in this YANG module are considered sensitive or vulnerable in network environments. The NACM "default-deny-write" extension has not been set for any data nodes defined in this module.

This module does not define any RPCs, actions, or notifications, and thus the security consideration for such is not provided here.

5.6. The "ietf-ssh-client" YANG Module

The "ietf-ssh-client" YANG module defines "grouping" statements that are 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 NETCONF 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.

Since this module only define groupings, these considerations are primarily for the designers of other modules that use these groupings.

One readable data node defined in this YANG module may be considered sensitive or vulnerable in some network environments. This node is as follows:

* The "client-identity/password" node:

  The cleartext "password" node defined in the "ssh-client-grouping" grouping is additionally sensitive to read operations such that, in normal use cases, it should never be returned to a client. For this reason, the NACM extension "default-deny-all" has been applied to it.

  | Please be aware that this module uses the "key" and "private-key" nodes from the "ietf-crypto-types" module [I-D.ietf-netconf-crypto-types], where said nodes have the NACM extension "default-deny-all" set, thus preventing unrestricted read-access to the cleartext key values.

All the writable data nodes defined by this module may be considered sensitive or vulnerable in some network environments. For instance, any modification to a key or reference to a key 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 RPCs, actions, or notifications, and thus the security consideration for such is not provided here.

5.7. The "ietf-ssh-server" YANG Module

The "ietf-ssh-server" YANG module defines "grouping" statements that are 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 NETCONF 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.

Since this module only define groupings, these considerations are primarily for the designers of other modules that use these groupings.

None of the readable data nodes defined in this YANG module are considered sensitive or vulnerable in network environments. The NACM "default-deny-all" extension has not been set for any data nodes defined in this module.

> | Please be aware that this module uses the "key" and "private-key" nodes from the "ietf-crypto-types" module [I-D.ietf-netconf-crypto-types], where said nodes have the NACM extension "default-deny-all" set, thus preventing unrestricted read-access to the cleartext key values.

All the writable data nodes defined by this module may be considered sensitive or vulnerable in some network environments. For instance, the addition or removal of references to keys, certificates, trusted anchors, etc., or even the modification of transport or keepalive parameters can 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 RPCs, actions, or notifications, and thus the security consideration for such is not provided here.

6. IANA Considerations

6.1. The "IETF XML" Registry

This document registers seven URIs in the "ns" subregistry of the IETF XML Registry [RFC3688]. Following the format in [RFC3688], the following registrations are requested:

URI: urn:ietf:params:xml:ns:yang:iana-ssh-key-exchange-algs
Registrant Contact: IANA
XML: N/A, the requested URI is an XML namespace.

URI: urn:ietf:params:xml:ns:yang:iana-ssh-encryption-algs
Registrant Contact: IANA
XML: N/A, the requested URI is an XML namespace.

URI: urn:ietf:params:xml:ns:yang:iana-ssh-mac-algs
Registrant Contact: IANA
XML: N/A, the requested URI is an XML namespace.

URI: urn:ietf:params:xml:ns:yang:iana-ssh-public-key-algs
Registrant Contact: IANA
XML: N/A, the requested URI is an XML namespace.

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

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

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

6.2. The "YANG Module Names" Registry

This document registers seven YANG modules in the YANG Module Names registry [RFC6020]. Following the format in [RFC6020], the following registrations are requested:

```
   name:         iana-ssh-key-exchange-algs
   namespace:    urn:ietf:params:xml:ns:yang:iana-ssh-key-exchange-algs
   prefix:       sshkea
   reference:    RFC EEEE

   name:         iana-ssh-encryption-algs
   namespace:    urn:ietf:params:xml:ns:yang:iana-ssh-encryption-algs
   prefix:       sshea
   reference:    RFC EEEE

   name:         iana-ssh-mac-algs
   namespace:    urn:ietf:params:xml:ns:yang:iana-ssh-mac-algs
   prefix:       sshma
   reference:    RFC EEEE

   name:         iana-ssh-public-key-algs
   namespace:    urn:ietf:params:xml:ns:yang:iana-ssh-public-key-algs
   prefix:       sshpka
   reference:    RFC EEEE

   name:         ietf-ssh-common
   namespace:    urn:ietf:params:xml:ns:yang:ietf-ssh-common
   prefix:       sshcmn
   reference:    RFC EEEE

   name:         ietf-ssh-client
   namespace:    urn:ietf:params:xml:ns:yang:ietf-ssh-client
   prefix:       sshc
   reference:    RFC EEEE

   name:         ietf-ssh-server
   namespace:    urn:ietf:params:xml:ns:yang:ietf-ssh-server
   prefix:       sshs
   reference:    RFC EEEE
```

6.3. The "iana-ssh-encryption-algs" Module

IANA is requested to maintain a YANG module called "iana-ssh-encryption-algs" that shadows the "Encryption Algorithm Names" sub-registry of the "Secure Shell (SSH) Protocol Parameters" registry [IANA-ENC-ALGS].

This registry defines a YANG identity for each encryption algorithm, and a "base" identity from which all of the other identities are derived.

An initial version of this module can be found in Appendix A.1

* Please note that this module was created on June 1st, 2021, and that additional entries may have been added in the interim before this document's publication. If this is that case, IANA may either publish just an updated module containing the new entries, or publish the initial module as is immediately followed by a "revision" containing the additional algorithm names.

6.4. The "iana-ssh-mac-algs" Module

IANA is requested to maintain a YANG module called "iana-ssh-mac-algs" that shadows the "MAC Algorithm Names" sub-registry of the "Secure Shell (SSH) Protocol Parameters" registry [IANA-MAC-ALGS].

This registry defines a YANG identity for each MAC algorithm, and a "base" identity from which all of the other identities are derived.

An initial version of this module can be found in Appendix A.2.

* Please note that this module was created on June 1st, 2021, and that additional entries may have been added in the interim before this document's publication. If this is that case, IANA may either publish just an updated module containing the new entries, or publish the initial module as is immediately followed by a "revision" containing the additional algorithm names.

6.5. The "iana-ssh-public-key-algs" Module

IANA is requested to maintain a YANG module called "iana-ssh-public-key-algs" that shadows the "Public Key Algorithm Names" sub-registry of the "Secure Shell (SSH) Protocol Parameters" registry [IANA-PUBKEY-ALGS].

This registry defines a YANG identity for each public key algorithm, and a "base" identity from which all of the other identities are derived.

Registry entries for which the '*All values beginning with the specified string and not containing "@".' note applies MUST be expanded so that there is a distinct YANG identity for each enumeration.

An initial version of this module can be found in Appendix A.3.

* Please note that this module was created on June 1st, 2021, and that additional entries may have been added in the interim before this document's publication. If this is that case, IANA may either publish just an updated module containing the new entries, or publish the initial module as is immediately followed by a "revision" containing the additional algorithm names.

6.6. The "iana-ssh-key-exchange-algs" Module

IANA is requested to maintain a YANG module called "iana-ssh-key-exchange-algs" that shadows the "Key Exchange Method Names" sub-registry of the "Secure Shell (SSH) Protocol Parameters" registry [IANA-KEYEX-ALGS].

This registry defines a YANG identity for each key exchange algortihm, and a "base" identity from which all of the other identities are derived.

Registry entries for which the '*All values beginning with the specified string and not containing "@".' note applies MUST be expanded so that there is a distinct YANG identity for each enumeration.

An initial version of this module can be found in Appendix A.4.

* Please note that this module was created on June 1st, 2021, and that additional entries may have been added in the interim before this document's publication. If this is that case, IANA may

either publish just an updated module containing the new entries, or publish the initial module as is immediately followed by a "revision" containing the additional algorithm names.

* Please also note that the "status" statement has been set to "deprecated" https://datatracker.ietf.org/doc/html/rfc8732#section-6. It is recommended that IANA adds a column to the registry to more easily track the deprecation status of algorithms.

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Appendix A. YANG Modules for IANA

The modules contained in this section were generated by scripts using the contents of the associated sub-registry as they existed on June 1st, 2021.

A.1. Initial Module for the "Encryption Algorithm Names" Registry

A.1.1. Data Model Overview

This section provides an overview of the "iana-ssh-encryption-algs" module in terms of its identities and protocol-accessible nodes.

A.1.1.1. Identities

The following diagram lists the base "identity" statements defined in the module, of which there is just one, and illustrates that all the derived identity statements are generated from the associated IANA-maintained registry [IANA-ENC-ALGS].

```
Identities:
  +-- encryption-alg-base
    +-- <identity-name from IANA registry>

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

A.1.1.2. Typedefs

The following diagram illustrates the "typedef" statements defined in the "iana-ssh-encryption-algs" module:

```
Typedefs:
  identityref
    +-- encryption-algorithm-ref

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

Comments:

* The typedef defined in the "iana-ssh-encryption-algs" module extends the "identityref" type defined in [RFC7950].

A.1.1.3. Protocol-accessible Nodes

The following tree diagram [RFC8340] lists all the protocol-accessible nodes defined in the "iana-ssh-encryption-algs" module:

```
module: iana-ssh-encryption-algs
  +--ro supported-algorithms
```

```
      +--ro supported-algorithm*   encryption-algorithm-ref
```

Comments:

* Protocol-accessible nodes are those nodes that are accessible when the module is "implemented", as described in Section 5.6.5 of [RFC7950].

A.1.2. Example Usage

The following example illustrates operational state data indicating the SSH encryption algorithms supported by the server:

```
<supported-algorithms
  xmlns="urn:ietf:params:xml:ns:yang:iana-ssh-encryption-algs"
  xmlns:sshea="urn:ietf:params:xml:ns:yang:iana-ssh-encryption-algs">
  <supported-algorithm>sshea:aes256-ctr</supported-algorithm>
  <supported-algorithm>sshea:aes256-cbc</supported-algorithm>
  <supported-algorithm>sshea:twofish256-cbc</supported-algorithm>
  <supported-algorithm>sshea:serpent256-cbc</supported-algorithm>
  <supported-algorithm>sshea:arcfour256</supported-algorithm>
  <supported-algorithm>sshea:serpent256-ctr</supported-algorithm>
  <supported-algorithm>sshea:aead-aes-256-gcm</supported-algorithm>
</supported-algorithms>
```

A.1.3. YANG Module

Following are the complete contents to the initial IANA-maintained YANG module. Please note that the date "2021-06-01" reflects the day on which the extraction occurred.

```
<CODE BEGINS> file "iana-ssh-encryption-algs@2021-06-01.yang"

module iana-ssh-encryption-algs {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:iana-ssh-encryption-algs";
  prefix sshea;

  organization
    "Internet Assigned Numbers Authority (IANA)";
```

```
      contact
        "Postal: ICANN
                 12025 Waterfront Drive, Suite 300
                 Los Angeles, CA  90094-2536
                 United States of America
         Tel:    +1 310 301 5800
         Email:  iana@iana.org";

      description
        "This module defines identities for the encryption algorithms
         defined in the 'Encryption Algorithm Names' sub-registry of the
```



```
         'Secure Shell (SSH) Protocol Parameters' registry maintained
         by IANA.

         Copyright (c) 2021 IETF Trust and the persons identified as
         authors of the code. All rights reserved.

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

         The initial version of this YANG module is part of RFC EEEE
         (https://www.rfc-editor.org/info/rfcEEEE); see the RFC
         itself for full legal notices.";

      revision 2021-06-01 {
        description
          "Initial version";
        reference
          "RFC EEEE: YANG Groupings for SSH Clients and SSH Servers";
      }

      // Typedefs

      typedef encryption-algorithm-ref {
        type identityref {
          base "encryption-alg-base";
```

```
    }
    description
      "A reference to a SSH encryption algorithm identifier.";
  }


  // Identities

  identity encryption-alg-base {
    description
      "Base identity used to identify encryption algorithms.";
  }

  identity triple-des-cbc { // YANG IDs cannot begin with a number
    base encryption-alg-base;
    description
      "3DES-CBC";
    reference
      "RFC 4253:
```



```
         The Secure Shell (SSH) Transport Layer Protocol";
  }

  identity blowfish-cbc {
    base encryption-alg-base;
    description
      "BLOWFISH-CBC";
    reference
      "RFC 4253:
         The Secure Shell (SSH) Transport Layer Protocol";
  }

  identity twofish256-cbc {
    base encryption-alg-base;
    description
      "TWOFISH256-CBC";
    reference
      "RFC 4253:
         The Secure Shell (SSH) Transport Layer Protocol";
  }

  identity twofish-cbc {
```

```
      base encryption-alg-base;
      description
        "TWOFISH-CBC";
      reference
        "RFC 4253:
           The Secure Shell (SSH) Transport Layer Protocol";
    }

    identity twofish192-cbc {
      base encryption-alg-base;
      description
        "TWOFISH192-CBC";
      reference
        "RFC 4253:
           The Secure Shell (SSH) Transport Layer Protocol";
    }

    identity twofish128-cbc {
      base encryption-alg-base;
      description
        "TWOFISH128-CBC";
      reference
        "RFC 4253:
           The Secure Shell (SSH) Transport Layer Protocol";
    }
```



```
    identity aes256-cbc {
      base encryption-alg-base;
      description
        "AES256-CBC";
      reference
        "RFC 4253:
           The Secure Shell (SSH) Transport Layer Protocol";
    }

    identity aes192-cbc {
      base encryption-alg-base;
      description
        "AES192-CBC";
      reference
        "RFC 4253:
```

```
          The Secure Shell (SSH) Transport Layer Protocol";
      }

      identity aes128-cbc {
        base encryption-alg-base;
        description
          "AES128-CBC";
        reference
          "RFC 4253:
          The Secure Shell (SSH) Transport Layer Protocol";
      }

      identity serpent256-cbc {
        base encryption-alg-base;
        description
          "SERPENT256-CBC";
        reference
          "RFC 4253:
          The Secure Shell (SSH) Transport Layer Protocol";
      }

      identity serpent192-cbc {
        base encryption-alg-base;
        description
          "SERPENT192-CBC";
        reference
          "RFC 4253:
          The Secure Shell (SSH) Transport Layer Protocol";
      }

      identity serpent128-cbc {
        base encryption-alg-base;
        description
```



```
          "SERPENT128-CBC";
        reference
          "RFC 4253:
          The Secure Shell (SSH) Transport Layer Protocol";
      }

      identity arcfour {
        base encryption-alg-base;
```

```
      status obsolete;
      description
        "ARCFOUR";
      reference
        "RFC 8758:
           Deprecating RC4 in Secure Shell (SSH)";
    }

    identity idea-cbc {
      base encryption-alg-base;
      description
        "IDEA-CBC";
      reference
        "RFC 4253:
           The Secure Shell (SSH) Transport Layer Protocol";
    }

    identity cast128-cbc {
      base encryption-alg-base;
      description
        "CAST128-CBC";
      reference
        "RFC 4253:
           The Secure Shell (SSH) Transport Layer Protocol";
    }

    identity none {
      base encryption-alg-base;
      description
        "NONE";
      reference
        "RFC 4253:
           The Secure Shell (SSH) Transport Layer Protocol";
    }

    identity des-cbc {
      base encryption-alg-base;
      status obsolete;
      description
        "DES-CBC";
```



```
      reference
```

```
      "FIPS 46-3:
         Data Encryption Standard (DES)";
    }

    identity arcfour128 {
      base encryption-alg-base;
      status obsolete;
      description
        "ARCFOUR128";
      reference
        "RFC 8758:
         Deprecating RC4 in Secure Shell (SSH)";
    }

    identity arcfour256 {
      base encryption-alg-base;
      status obsolete;
      description
        "ARCFOUR256";
      reference
        "RFC 8758:
         Deprecating RC4 in Secure Shell (SSH)";
    }

    identity aes128-ctr {
      base encryption-alg-base;
      description
        "AES128-CTR";
      reference
        "RFC 4344:
         The Secure Shell (SSH) Transport Layer Encryption Modes";
    }

    identity aes192-ctr {
      base encryption-alg-base;
      description
        "AES192-CTR";
      reference
        "RFC 4344:
         The Secure Shell (SSH) Transport Layer Encryption Modes";
    }

    identity aes256-ctr {
      base encryption-alg-base;
      description
        "AES256-CTR";
      reference
```

```
        "RFC 4344:
          The Secure Shell (SSH) Transport Layer Encryption Modes";
      }

      identity triple-des-ctr { // YANG IDs cannot begin with a number
        base encryption-alg-base;
        description
          "3DES-CTR";
        reference
          "RFC 4344:
            The Secure Shell (SSH) Transport Layer Encryption Modes";
      }

      identity blowfish-ctr {
        base encryption-alg-base;
        description
          "BLOWFISH-CTR";
        reference
          "RFC 4344:
            The Secure Shell (SSH) Transport Layer Encryption Modes";
      }

      identity twofish128-ctr {
        base encryption-alg-base;
        description
          "TWOFISH128-CTR";
        reference
          "RFC 4344:
            The Secure Shell (SSH) Transport Layer Encryption Modes";
      }

      identity twofish192-ctr {
        base encryption-alg-base;
        description
          "TWOFISH192-CTR";
        reference
          "RFC 4344:
            The Secure Shell (SSH) Transport Layer Encryption Modes";
      }

      identity twofish256-ctr {
        base encryption-alg-base;
        description
          "TWOFISH256-CTR";
        reference
          "RFC 4344:
```

```
          The Secure Shell (SSH) Transport Layer Encryption Modes";
    }
```



```
    identity serpent128-ctr {
      base encryption-alg-base;
      description
        "SERPENT128-CTR";
      reference
        "RFC 4344:
          The Secure Shell (SSH) Transport Layer Encryption Modes";
    }

    identity serpent192-ctr {
      base encryption-alg-base;
      description
        "SERPENT192-CTR";
      reference
        "RFC 4344:
          The Secure Shell (SSH) Transport Layer Encryption Modes";
    }

    identity serpent256-ctr {
      base encryption-alg-base;
      description
        "SERPENT256-CTR";
      reference
        "RFC 4344:
          The Secure Shell (SSH) Transport Layer Encryption Modes";
    }

    identity idea-ctr {
      base encryption-alg-base;
      description
        "IDEA-CTR";
      reference
        "RFC 4344:
          The Secure Shell (SSH) Transport Layer Encryption Modes";
    }

    identity cast128-ctr {
      base encryption-alg-base;
      description
```

```
        "CAST128-CTR";
      reference
        "RFC 4344:
           The Secure Shell (SSH) Transport Layer Encryption Modes";
    }

    identity aead-aes-128-gcm {
      base encryption-alg-base;
      description
```



```
        "AEAD_AES_128_GCM";
      reference
        "RFC 5647:
           AES Galois Counter Mode for the
           Secure Shell Transport Layer Protocol";
    }

    identity aead-aes-256-gcm {
      base encryption-alg-base;
      description
        "AEAD_AES_256_GCM";
      reference
        "RFC 5647:
           AES Galois Counter Mode for the
           Secure Shell Transport Layer Protocol";
    }

    // Protocol-accessible Nodes

    container supported-algorithms {
      config false;
      description
        "A container for a list of encryption algorithms
         supported by the server.";
      leaf-list supported-algorithm {
        type encryption-algorithm-ref;
        description
          "A encryption algorithm supported by the server.";
      }
    }

  }
```

```
<CODE ENDS>
```

A.2. Initial Module for the "MAC Algorithm Names" Registry

A.2.1. Data Model Overview

This section provides an overview of the "iana-ssh-mac-algs" module in terms of its identities and protocol-accessible nodes.

A.2.1.1. Identities

The following diagram lists the base "identity" statements defined in the module, of which there is just one, and illustrates that all the derived identity statements are generated from the associated IANA-maintained registry [IANA-MAC-ALGS].


```
Identities:
  +-- mac-alg-base
    +-- <identity-name from IANA registry>

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

A.2.1.2. Typedefs

The following diagram illustrates the "typedef" statements defined in the "iana-ssh-mac-algs" module:

```
Typedefs:
  identityref
    +-- mac-algorithm-ref

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

Comments:

* The typedef defined in the "iana-ssh-mac-algs" module extends the "identityref" type defined in [RFC7950].

A.2.1.3. Protocol-accessible Nodes

The following tree diagram [RFC8340] lists all the protocol-accessible nodes defined in the "iana-ssh-mac-algs" module:

```
module: iana-ssh-mac-algs
  +--ro supported-algorithms
     +--ro supported-algorithm*   mac-algorithm-ref
```

Comments:

* Protocol-accessible nodes are those nodes that are accessible when the module is "implemented", as described in Section 5.6.5 of [RFC7950].

A.2.2. Example Usage

The following example illustrates operational state data indicating the SSH MAC algorithms supported by the server:


```
<supported-algorithms
  xmlns="urn:ietf:params:xml:ns:yang:iana-ssh-mac-algs"
  xmlns:sshma="urn:ietf:params:xml:ns:yang:iana-ssh-mac-algs">
  <supported-algorithm>sshma:hmac-sha2-256</supported-algorithm>
  <supported-algorithm>sshma:hmac-sha2-512</supported-algorithm>
  <supported-algorithm>sshma:aead-aes-256-gcm</supported-algorithm>
</supported-algorithms>
```

A.2.3. YANG Module

Following are the complete contents to the initial IANA-maintained YANG module. Please note that the date "2021-06-01" reflects the day on which the extraction occurred.

```
<CODE BEGINS> file "iana-ssh-mac-algs@2021-06-01.yang"

module iana-ssh-mac-algs {
  yang-version 1.1;
```

```
namespace "urn:ietf:params:xml:ns:yang:iana-ssh-mac-algs";
prefix sshma;

organization
  "Internet Assigned Numbers Authority (IANA)";

contact
  "Postal: ICANN
           12025 Waterfront Drive, Suite 300
           Los Angeles, CA  90094-2536
           United States of America
   Tel:    +1 310 301 5800
   Email:  iana@iana.org";

description
  "This module defines identities for the MAC algorithms
   defined in the 'MAC Algorithm Names' sub-registry of the
   'Secure Shell (SSH) Protocol Parameters' registry maintained
   by IANA.

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   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).
```



```
   The initial version of this YANG module is part of RFC EEEE
   (https://www.rfc-editor.org/info/rfcEEEE); see the RFC
   itself for full legal notices.";

revision 2021-06-01 {
  description
    "Initial version";
  reference
    "RFC EEEE: YANG Groupings for SSH Clients and SSH Servers";
}
```

```
  // Typedefs

  typedef mac-algorithm-ref {
    type identityref {
      base "mac-alg-base";
    }
    description
      "A reference to a SSH mac algorithm identifier.";
  }


  // Identities

  identity mac-alg-base {
    description
      "Base identity used to identify message authentication
       code (MAC) algorithms.";
  }

  identity hmac-sha1 {
    base mac-alg-base;
    description
      "HMAC-SHA1";
    reference
      "RFC 4253:
         The Secure Shell (SSH) Transport Layer Protocol";
  }

  identity hmac-sha1-96 {
    base mac-alg-base;
    description
      "HMAC-SHA1-96";
    reference
      "RFC 4253:
         The Secure Shell (SSH) Transport Layer Protocol";
  }
```



```
  identity hmac-md5 {
    base mac-alg-base;
    description
      "HMAC-MD5";
```

```
      reference
        "RFC 4253:
           The Secure Shell (SSH) Transport Layer Protocol";
    }

    identity hmac-md5-96 {
      base mac-alg-base;
      description
        "HMAC-MD5-96";
      reference
        "RFC 4253:
           The Secure Shell (SSH) Transport Layer Protocol";
    }

    identity none {
      base mac-alg-base;
      description
        "NONE";
      reference
        "RFC 4253:
           The Secure Shell (SSH) Transport Layer Protocol";
    }

    identity aead-aes-128-gcm {
      base mac-alg-base;
      description
        "AEAD_AES_128_GCM";
      reference
        "RFC 5647:
           AES Galois Counter Mode for the
           Secure Shell Transport Layer Protocol";
    }

    identity aead-aes-256-gcm {
      base mac-alg-base;
      description
        "AEAD_AES_256_GCM";
      reference
        "RFC 5647:
           AES Galois Counter Mode for the
           Secure Shell Transport Layer Protocol";
    }

    identity hmac-sha2-256 {
```

```
      base mac-alg-base;
      description
        "HMAC-SHA2-256";
      reference
        "RFC 6668:
           SHA-2 Data Integrity Verification for the
           Secure Shell (SSH) Transport Layer Protocol";
    }

    identity hmac-sha2-512 {
      base mac-alg-base;
      description
        "HMAC-SHA2-512";
      reference
        "RFC 6668:
           SHA-2 Data Integrity Verification for the
           Secure Shell (SSH) Transport Layer Protocol";
    }

    // Protocol-accessible Nodes

    container supported-algorithms {
      config false;
      description
        "A container for a list of MAC algorithms
         supported by the server.";
      leaf-list supported-algorithm {
        type mac-algorithm-ref;
        description
          "A MAC algorithm supported by the server.";
      }
    }

  }

  <CODE ENDS>
```

A.3. Initial Module for the "Public Key Algorithm Names" Registry

A.3.1. Data Model Overview

This section provides an overview of the "iana-ssh-public-key-algs" module in terms of its identities and protocol-accessible nodes.

A.3.1.1. Identities

The following diagram lists the base "identity" statements defined in the module, of which there is just one, and illustrates that all the derived identity statements are generated from the associated IANA-maintained registry [IANA-PUBKEY-ALGS].

```
Identities:
  +-- public-key-alg-base
    +-- <identity-name from IANA registry>

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

A.3.1.2. Typedefs

The following diagram illustrates the "typedef" statements defined in the "iana-ssh-public-key-algs" module:

```
Typedefs:
  identityref
    +-- public-key-algorithm-ref

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

Comments:

* The typedef defined in the "iana-ssh-public-key-algs" module extends the "identityref" type defined in [RFC7950].

A.3.1.3. Protocol-accessible Nodes

The following tree diagram [RFC8340] lists all the protocol-accessible nodes defined in the "iana-ssh-public-key-algs" module:

```
module: iana-ssh-public-key-algs
  +--ro supported-algorithms
     +--ro supported-algorithm*   public-key-algorithm-ref
```

Comments:

* Protocol-accessible nodes are those nodes that are accessible when the module is "implemented", as described in Section 5.6.5 of [RFC7950].

A.3.2. Example Usage

The following example illustrates operational state data indicating the SSH public key algorithms supported by the server:

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

<supported-algorithms
  xmlns="urn:ietf:params:xml:ns:yang:iana-ssh-public-key-algs"
  xmlns:sshpka="urn:ietf:params:xml:ns:yang:iana-ssh-public-key-algs\
">
  <supported-algorithm>sshpka:rsa-sha2-256</supported-algorithm>
  <supported-algorithm>sshpka:rsa-sha2-512</supported-algorithm>
  <supported-algorithm>sshpka:spki-sign-rsa</supported-algorithm>
  <supported-algorithm>sshpka:pgp-sign-dss</supported-algorithm>
  <supported-algorithm>sshpka:x509v3-rsa2048-sha256</supported-algor\
ithm>
  <supported-algorithm>sshpka:ecdsa-sha2-nistp256</supported-algorit\
hm>
  <supported-algorithm>sshpka:ecdsa-sha2-1.3.132.0.37</supported-alg\
orithm>
  <supported-algorithm>sshpka:ssh-ed25519</supported-algorithm>
</supported-algorithms>
```

A.3.3. YANG Module

Following are the complete contents to the initial IANA-maintained YANG module. Please note that the date "2021-06-01" reflects the day on which the extraction occurred.

```
<CODE BEGINS> file "iana-ssh-public-key-algs@2021-06-01.yang"

module iana-ssh-public-key-algs {
```

```
yang-version 1.1;
namespace "urn:ietf:params:xml:ns:yang:iana-ssh-public-key-algs";
prefix sshpka;

organization
  "Internet Assigned Numbers Authority (IANA)";

contact
  "Postal: ICANN
           12025 Waterfront Drive, Suite 300
           Los Angeles, CA  90094-2536
           United States of America
   Tel:    +1 310 301 5800
   Email:  iana@iana.org";
```



```
description
  "This module defines identities for the public key algorithms
   defined in the 'Public Key Algorithm Names' sub-registry of the
   'Secure Shell (SSH) Protocol Parameters' registry maintained
   by IANA.

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   authors of the code. All rights reserved.

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   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).

   The initial version of this YANG module is part of RFC EEEE
   (https://www.rfc-editor.org/info/rfcEEEE); see the RFC
   itself for full legal notices.";

revision 2021-06-01 {
  description
    "Initial version";
  reference
    "RFC EEEE: YANG Groupings for SSH Clients and SSH Servers";
}
```

```
  // Typedefs

  typedef public-key-algorithm-ref {
    type identityref {
      base "public-key-alg-base";
    }
    description
      "A reference to a SSH public key algorithm identifier.";
  }


  // Identities

  identity public-key-alg-base {
    description
      "Base identity used to identify public key algorithms.";
  }

  identity ssh-dss {
    base public-key-alg-base;
    description
```



```
      "SSH-DSS";
    reference
      "RFC 4253:
         The Secure Shell (SSH) Transport Layer Protocol";
  }

  identity ssh-rsa {
    base public-key-alg-base;
    description
      "SSH-RSA";
    reference
      "RFC 4253:
         The Secure Shell (SSH) Transport Layer Protocol";
  }

  identity rsa-sha2-256 {
    base public-key-alg-base;
    description
      "RSA-SHA2-256";
```

```
      reference
        "RFC 8332:
           Use of RSA Keys with SHA-256 and SHA-512
           in the Secure Shell (SSH) Protocol";
    }

    identity rsa-sha2-512 {
      base public-key-alg-base;
      description
        "RSA-SHA2-512";
      reference
        "RFC 8332:
           Use of RSA Keys with SHA-256 and SHA-512
           in the Secure Shell (SSH) Protocol";
    }

    identity spki-sign-rsa {
      base public-key-alg-base;
      description
        "SPKI-SIGN-RSA";
      reference
        "RFC 4253:
           The Secure Shell (SSH) Transport Layer Protocol";
    }

    identity spki-sign-dss {
      base public-key-alg-base;
      description
        "SPKI-SIGN-DSS";
```



```
      reference
        "RFC 4253:
           The Secure Shell (SSH) Transport Layer Protocol";
    }

    identity pgp-sign-rsa {
      base public-key-alg-base;
      description
        "PGP-SIGN-RSA";
      reference
        "RFC 4253:
           The Secure Shell (SSH) Transport Layer Protocol";
```

```
    }

    identity pgp-sign-dss {
      base public-key-alg-base;
      description
        "PGP-SIGN-DSS";
      reference
        "RFC 4253:
           The Secure Shell (SSH) Transport Layer Protocol";
    }

    identity null {
      base public-key-alg-base;
      description
        "NULL";
      reference
        "RFC 4462:
           Generic Security Service Application Program Interface
           (GSS-API) Authentication and Key Exchange for the
           Secure Shell (SSH) Protocol";
    }

    identity ecdsa-sha2-nistp256 {
      base public-key-alg-base;
      description
        "ECDSA-SHA2-NISTP256 (secp256r1)";
      reference
        "RFC 5656:
           Elliptic Curve Algorithm Integration in the
           Secure Shell Transport Layer";
    }

    identity ecdsa-sha2-nistp384 {
      base public-key-alg-base;
      description
        "ECDSA-SHA2-NISTP384 (secp384r1)";
```



```
      reference
        "RFC 5656:
           Elliptic Curve Algorithm Integration in the
           Secure Shell Transport Layer";
    }
```

```
    identity ecdsa-sha2-nistp521 {
      base public-key-alg-base;
      description
        "ECDSA-SHA2-NISTP521 (secp521r1)";
      reference
        "RFC 5656:
           Elliptic Curve Algorithm Integration in the
           Secure Shell Transport Layer";
    }

    identity ecdsa-sha2-1.3.132.0.1 {
      base public-key-alg-base;
      description
        "ECDSA-SHA2-1.3.132.0.1 (nistk163, sect163k1)";
      reference
        "RFC 5656:
           Elliptic Curve Algorithm Integration in the
           Secure Shell Transport Layer";
    }

    identity ecdsa-sha2-1.2.840.10045.3.1.1 {
      base public-key-alg-base;
      description
        "ECDSA-SHA2-1.2.840.10045.3.1.1 (nistp192, secp192r1)";
      reference
        "RFC 5656:
           Elliptic Curve Algorithm Integration in the
           Secure Shell Transport Layer";
    }

    identity ecdsa-sha2-1.3.132.0.33 {
      base public-key-alg-base;
      description
        "ECDSA-SHA2-1.3.132.0.33 (nistp224, secp224r1)";
      reference
        "RFC 5656:
           Elliptic Curve Algorithm Integration in the
           Secure Shell Transport Layer";
    }

    identity ecdsa-sha2-1.3.132.0.26 {
      base public-key-alg-base;
```

```
  description
    "ECDSA-SHA2-1.3.132.0.26 (nistk233, sect233k1)";
  reference
    "RFC 5656:
       Elliptic Curve Algorithm Integration in the
       Secure Shell Transport Layer";
}

identity ecdsa-sha2-1.3.132.0.27 {
  base public-key-alg-base;
  description
    "ECDSA-SHA2-1.3.132.0.27 (nistb233, sect233r1)";
  reference
    "RFC 5656:
       Elliptic Curve Algorithm Integration in the
       Secure Shell Transport Layer";
}

identity ecdsa-sha2-1.3.132.0.16 {
  base public-key-alg-base;
  description
    "ECDSA-SHA2-1.3.132.0.16 (nistk283, sect283k1)";
  reference
    "RFC 5656:
       Elliptic Curve Algorithm Integration in the
       Secure Shell Transport Layer";
}

identity ecdsa-sha2-1.3.132.0.36 {
  base public-key-alg-base;
  description
    "ECDSA-SHA2-1.3.132.0.36 (nistk409, sect409k1)";
  reference
    "RFC 5656:
       Elliptic Curve Algorithm Integration in the
       Secure Shell Transport Layer";
}

identity ecdsa-sha2-1.3.132.0.37 {
  base public-key-alg-base;
  description
    "ECDSA-SHA2-1.3.132.0.37 (nistb409, sect409r1)";
  reference
    "RFC 5656:
       Elliptic Curve Algorithm Integration in the
       Secure Shell Transport Layer";
}
```

```
      identity ecdsa-sha2-1.3.132.0.38 {
        base public-key-alg-base;
        description
          "ECDSA-SHA2-1.3.132.0.38 (nistt571, sect571k1)";
        reference
          "RFC 5656:
             Elliptic Curve Algorithm Integration in the
             Secure Shell Transport Layer";
      }

      identity x509v3-ssh-dss {
        base public-key-alg-base;
        description
          "X509V3-SSH-DSS";
        reference
          "RFC 6187:
             X.509v3 Certificates for Secure Shell Authentication";
      }

      identity x509v3-ssh-rsa {
        base public-key-alg-base;
        description
          "X509V3-SSH-RSA";
        reference
          "RFC 6187:
             X.509v3 Certificates for Secure Shell Authentication";
      }

      identity x509v3-rsa2048-sha256 {
        base public-key-alg-base;
        description
          "X509V3-RSA2048-SHA256";
        reference
          "RFC 6187:
             X.509v3 Certificates for Secure Shell Authentication";
      }

      identity x509v3-ecdsa-sha2-nistp256 {
        base public-key-alg-base;
        description
          "X509V3-ECDSA-SHA2-NISTP256 (secp256r1)";
        reference
```

```
        "RFC 6187:
           X.509v3 Certificates for Secure Shell Authentication";
      }

      identity x509v3-ecdsa-sha2-nistp384 {
        base public-key-alg-base;
```



```
        description
          "X509V3-ECDSA-SHA2-NISTP384 (secp384r1)";
        reference
          "RFC 6187:
           X.509v3 Certificates for Secure Shell Authentication";
      }

      identity x509v3-ecdsa-sha2-nistp521 {
        base public-key-alg-base;
        description
          "X509V3-ECDSA-SHA2-NISTP521 (secp521r1)";
        reference
          "RFC 6187:
           X.509v3 Certificates for Secure Shell Authentication";
      }

      identity x509v3-ecdsa-sha2-1.3.132.0.1 {
        base public-key-alg-base;
        description
          "X509V3-ECDSA-SHA2-1.3.132.0.1 (nistk163, sect163k1)";
        reference
          "RFC 6187:
           X.509v3 Certificates for Secure Shell Authentication";
      }

      identity x509v3-ecdsa-sha2-1.2.840.10045.3.1.1 {
        base public-key-alg-base;
        description
          "X509V3-ECDSA-SHA2-1.2.840.10045.3.1.1 (nistp192, secp192r1)";
        reference
          "RFC 6187:
           X.509v3 Certificates for Secure Shell Authentication";
      }

      identity x509v3-ecdsa-sha2-1.3.132.0.33 {
```

```
    base public-key-alg-base;
    description
      "X509V3-ECDSA-SHA2-1.3.132.0.33 (nistp224, secp224r1)";
    reference
      "RFC 6187:
         X.509v3 Certificates for Secure Shell Authentication";
  }

  identity x509v3-ecdsa-sha2-1.3.132.0.26 {
    base public-key-alg-base;
    description
      "X509V3-ECDSA-SHA2-1.3.132.0.26 (nistk233, sect233k1)";
    reference
```



```
      "RFC 6187:
         X.509v3 Certificates for Secure Shell Authentication";
  }

  identity x509v3-ecdsa-sha2-1.3.132.0.27 {
    base public-key-alg-base;
    description
      "X509V3-ECDSA-SHA2-1.3.132.0.27 (nistb233, sect233r1)";
    reference
      "RFC 6187:
         X.509v3 Certificates for Secure Shell Authentication";
  }

  identity x509v3-ecdsa-sha2-1.3.132.0.16 {
    base public-key-alg-base;
    description
      "X509V3-ECDSA-SHA2-1.3.132.0.16 (nistk283, sect283k1)";
    reference
      "RFC 6187:
         X.509v3 Certificates for Secure Shell Authentication";
  }

  identity x509v3-ecdsa-sha2-1.3.132.0.36 {
    base public-key-alg-base;
    description
      "X509V3-ECDSA-SHA2-1.3.132.0.36 (nistk409, sect409k1)";
    reference
      "RFC 6187:
```

```
          X.509v3 Certificates for Secure Shell Authentication";
    }

    identity x509v3-ecdsa-sha2-1.3.132.0.37 {
      base public-key-alg-base;
      description
        "X509V3-ECDSA-SHA2-1.3.132.0.37 (nistb409, sect409r1)";
      reference
        "RFC 6187:
          X.509v3 Certificates for Secure Shell Authentication";
    }

    identity x509v3-ecdsa-sha2-1.3.132.0.38 {
      base public-key-alg-base;
      description
        "X509V3-ECDSA-SHA2-1.3.132.0.38 (nistt571, sect571k1)";
      reference
        "RFC 6187:
          X.509v3 Certificates for Secure Shell Authentication";
    }
```



```
    identity ssh-ed25519 {
      base public-key-alg-base;
      description
        "SSH-ED25519";
      reference
        "RFC 8709:
          Ed25519 and Ed448 Public Key Algorithms for the
          Secure Shell (SSH) Protocol";
    }

    identity ssh-ed448 {
      base public-key-alg-base;
      description
        "SSH-ED448";
      reference
        "RFC 8709:
          Ed25519 and Ed448 Public Key Algorithms for the
          Secure Shell (SSH) Protocol";
    }

    // Protocol-accessible Nodes
```

```
    container supported-algorithms {
      config false;
      description
        "A container for a list of public key algorithms
         supported by the server.";
      leaf-list supported-algorithm {
        type public-key-algorithm-ref;
        description
          "A public key algorithm supported by the server.";
      }
    }

  }

  <CODE ENDS>
```

A.4. Initial Module for the "Key Exchange Method Names" Registry

A.4.1. Data Model Overview

This section provides an overview of the "iana-ssh-key-exchange-algs" module in terms of its identities and protocol-accessible nodes.

A.4.1.1. Identities

The following diagram lists the base "identity" statements defined in the module, of which there is just one, and illustrates that all the derived identity statements are generated from the associated IANA-maintained registry [IANA-KEYEX-ALGS].

```
Identities:
  +-- key-exchange-alg-base
    +-- <identity-name from IANA registry>

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

A.4.1.2. Typedefs

The following diagram illustrates the "typedef" statements defined in the "iana-ssh-key-exchange-algs" module:

```
Typedefs:
  identityref
    +-- key-exchange-algorithm-ref

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

Comments:

* The typedef defined in the "iana-ssh-key-exchange-algs" module extends the "identityref" type defined in [RFC7950].

A.4.1.3. Protocol-accessible Nodes

The following tree diagram [RFC8340] lists all the protocol-accessible nodes defined in the "iana-ssh-key-exchange-algs" module:

```
module: iana-ssh-key-exchange-algs
  +--ro supported-algorithms
     +--ro supported-algorithm*   key-exchange-algorithm-ref
```

Comments:

* Protocol-accessible nodes are those nodes that are accessible when the module is "implemented", as described in Section 5.6.5 of [RFC7950].

A.4.2. Example Usage

The following example illustrates operational state data indicating the SSH key exchange algorithms supported by the server:

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

```
<supported-algorithms
  xmlns="urn:ietf:params:xml:ns:yang:iana-ssh-key-exchange-algs"
  xmlns:sshkea="urn:ietf:params:xml:ns:yang:iana-ssh-key-exchange-al\
gs">
  <supported-algorithm>sshkea:diffie-hellman-group-exchange-sha256</\
supported-algorithm>
  <supported-algorithm>sshkea:ecdh-sha2-nistp256</supported-algorith\
m>
  <supported-algorithm>sshkea:rsa2048-sha256</supported-algorithm>
  <supported-algorithm>sshkea:gss-group1-sha1-curve25519-sha256</sup\
ported-algorithm>
  <supported-algorithm>sshkea:gss-group14-sha1-nistp256</supported-a\
lgorithm>
  <supported-algorithm>sshkea:gss-gex-sha1-nistp256</supported-algor\
ithm>
  <supported-algorithm>sshkea:gss-group14-sha256-1.2.840.10045.3.1.1\
</supported-algorithm>
  <supported-algorithm>sshkea:curve25519-sha256</supported-algorithm>
</supported-algorithms>
```

A.4.3. YANG Module

Following are the complete contents to the initial IANA-maintained YANG module. Please note that the date "2021-06-01" reflects the day on which the extraction occurred.

```
<CODE BEGINS> file "iana-ssh-key-exchange-algs@2021-06-01.yang"

module iana-ssh-key-exchange-algs {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:iana-ssh-key-exchange-algs";
  prefix sshkea;

  organization
    "Internet Assigned Numbers Authority (IANA)";

  contact
    "Postal: ICANN
             12025 Waterfront Drive, Suite 300
             Los Angeles, CA  90094-2536
             United States of America
```

```
   Tel:    +1 310 301 5800
   Email:  iana@iana.org";

 description
   "This module defines identities for the key exchange algorithms
    defined in the 'Key Exchange Method Names' sub-registry of the
    'Secure Shell (SSH) Protocol Parameters' registry maintained
    by IANA.

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    Legal Provisions Relating to IETF Documents
    (https://trustee.ietf.org/license-info).

    The initial version of this YANG module is part of RFC EEEE
    (https://www.rfc-editor.org/info/rfcEEEE); see the RFC
    itself for full legal notices.";

 revision 2021-06-01 {
   description
     "Initial version";
   reference
     "RFC EEEE: YANG Groupings for SSH Clients and SSH Servers";
 }

 // Typedefs

 typedef key-exchange-algorithm-ref {
   type identityref {
     base "key-exchange-alg-base";
   }
   description
     "A reference to a SSH key exchange algorithm identifier.";
 }


 // Identities

 identity key-exchange-alg-base {
   description
     "Base identity used to identify key exchange algorithms.";
 }
```

```
     identity diffie-hellman-group-exchange-sha1 {
       base key-exchange-alg-base;
       description
         "DIFFIE-HELLMAN-GROUP-EXCHANGE-SHA1";
       reference
         "RFC 4419:
            Diffie-Hellman Group Exchange for the
            Secure Shell (SSH) Transport Layer Protocol";
     }

     identity diffie-hellman-group-exchange-sha256 {
       base key-exchange-alg-base;
       description
         "DIFFIE-HELLMAN-GROUP-EXCHANGE-SHA256";
       reference
         "RFC 4419:
            Diffie-Hellman Group Exchange for the
            Secure Shell (SSH) Transport Layer Protocol";
     }

     identity diffie-hellman-group1-sha1 {
       base key-exchange-alg-base;
       description
         "DIFFIE-HELLMAN-GROUP1-SHA1";
       reference
         "RFC 4253:
            The Secure Shell (SSH) Transport Layer Protocol";
     }

     identity diffie-hellman-group14-sha1 {
       base key-exchange-alg-base;
       description
         "DIFFIE-HELLMAN-GROUP14-SHA1";
       reference
         "RFC 4253:
            The Secure Shell (SSH) Transport Layer Protocol";
     }

     identity diffie-hellman-group14-sha256 {
       base key-exchange-alg-base;
       description
         "DIFFIE-HELLMAN-GROUP14-SHA256";
       reference
```

```
        "RFC 8268:
           More Modular Exponentiation (MODP) Diffie-Hellman (DH)
           Key Exchange (KEX) Groups for Secure Shell (SSH)";
    }
```



```
    identity diffie-hellman-group15-sha512 {
      base key-exchange-alg-base;
      description
        "DIFFIE-HELLMAN-GROUP15-SHA512";
      reference
        "RFC 8268:
           More Modular Exponentiation (MODP) Diffie-Hellman (DH)
           Key Exchange (KEX) Groups for Secure Shell (SSH)";
    }

    identity diffie-hellman-group16-sha512 {
      base key-exchange-alg-base;
      description
        "DIFFIE-HELLMAN-GROUP16-SHA512";
      reference
        "RFC 8268:
           More Modular Exponentiation (MODP) Diffie-Hellman (DH)
           Key Exchange (KEX) Groups for Secure Shell (SSH)";
    }

    identity diffie-hellman-group17-sha512 {
      base key-exchange-alg-base;
      description
        "DIFFIE-HELLMAN-GROUP17-SHA512";
      reference
        "RFC 8268:
           More Modular Exponentiation (MODP) Diffie-Hellman (DH)
           Key Exchange (KEX) Groups for Secure Shell (SSH)";
    }

    identity diffie-hellman-group18-sha512 {
      base key-exchange-alg-base;
      description
        "DIFFIE-HELLMAN-GROUP18-SHA512";
      reference
        "RFC 8268:
```

```
          More Modular Exponentiation (MODP) Diffie-Hellman (DH)
          Key Exchange (KEX) Groups for Secure Shell (SSH)";
    }

    identity ecdh-sha2-nistp256 {
      base key-exchange-alg-base;
      description
        "ECDH-SHA2-NISTP256 (secp256r1)";
      reference
        "RFC 5656:
          Elliptic Curve Algorithm Integration in the
          Secure Shell Transport Layer";
```



```
    }

    identity ecdh-sha2-nistp384 {
      base key-exchange-alg-base;
      description
        "ECDH-SHA2-NISTP384 (secp384r1)";
      reference
        "RFC 5656:
          Elliptic Curve Algorithm Integration in the
          Secure Shell Transport Layer";
    }

    identity ecdh-sha2-nistp521 {
      base key-exchange-alg-base;
      description
        "ECDH-SHA2-NISTP521 (secp521r1)";
      reference
        "RFC 5656:
          Elliptic Curve Algorithm Integration in the
          Secure Shell Transport Layer";
    }

    identity ecdh-sha2-1.3.132.0.1 {
      base key-exchange-alg-base;
      description
        "ECDH-SHA2-1.3.132.0.1 (nistk163, sect163k1)";
      reference
        "RFC 5656:
          Elliptic Curve Algorithm Integration in the
```

```
        Secure Shell Transport Layer";
    }

    identity ecdh-sha2-1.2.840.10045.3.1.1 {
      base key-exchange-alg-base;
      description
        "ECDH-SHA2-1.2.840.10045.3.1.1 (nistp192, secp192r1)";
      reference
        "RFC 5656:
          Elliptic Curve Algorithm Integration in the
          Secure Shell Transport Layer";
    }

    identity ecdh-sha2-1.3.132.0.33 {
      base key-exchange-alg-base;
      description
        "ECDH-SHA2-1.3.132.0.33 (nistp224, secp224r1)";
      reference
        "RFC 5656:
```



```
          Elliptic Curve Algorithm Integration in the
          Secure Shell Transport Layer";
    }

    identity ecdh-sha2-1.3.132.0.26 {
      base key-exchange-alg-base;
      description
        "ECDH-SHA2-1.3.132.0.26 (nistk233, sect233k1)";
      reference
        "RFC 5656:
          Elliptic Curve Algorithm Integration in the
          Secure Shell Transport Layer";
    }

    identity ecdh-sha2-1.3.132.0.27 {
      base key-exchange-alg-base;
      description
        "ECDH-SHA2-1.3.132.0.27 (nistb233, sect233r1)";
      reference
        "RFC 5656:
          Elliptic Curve Algorithm Integration in the
          Secure Shell Transport Layer";
```

```
  }

  identity ecdh-sha2-1.3.132.0.16 {
    base key-exchange-alg-base;
    description
      "ECDH-SHA2-1.3.132.0.16 (nistk283, sect283k1)";
    reference
      "RFC 5656:
         Elliptic Curve Algorithm Integration in the
         Secure Shell Transport Layer";
  }

  identity ecdh-sha2-1.3.132.0.36 {
    base key-exchange-alg-base;
    description
      "ECDH-SHA2-1.3.132.0.36 (nistk409, sect409k1)";
    reference
      "RFC 5656:
         Elliptic Curve Algorithm Integration in the
         Secure Shell Transport Layer";
  }

  identity ecdh-sha2-1.3.132.0.37 {
    base key-exchange-alg-base;
    description
      "ECDH-SHA2-1.3.132.0.37 (nistb409, sect409r1)";
```



```
    reference
      "RFC 5656:
         Elliptic Curve Algorithm Integration in the
         Secure Shell Transport Layer";
  }

  identity ecdh-sha2-1.3.132.0.38 {
    base key-exchange-alg-base;
    description
      "ECDH-SHA2-1.3.132.0.38 (nistt571, sect571k1)";
    reference
      "RFC 5656:
         Elliptic Curve Algorithm Integration in the
         Secure Shell Transport Layer";
  }
```

```
  identity ecmqv-sha2 {
    base key-exchange-alg-base;
    description
      "ECMQV-SHA2";
    reference
      "RFC 5656:
         Elliptic Curve Algorithm Integration in the
         Secure Shell Transport Layer";
  }

  identity gss-group1-sha1-nistp256 {
    base key-exchange-alg-base;
    status deprecated;
    description
      "GSS-GROUP1-SHA1-NISTP256 (secp256r1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-group1-sha1-nistp384 {
    base key-exchange-alg-base;
    status deprecated;
    description
      "GSS-GROUP1-SHA1-NISTP384 (secp384r1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }
```



```
  identity gss-group1-sha1-nistp521 {
    base key-exchange-alg-base;
    status deprecated;
    description
      "GSS-GROUP1-SHA1-NISTP521 (secp521r1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
```

```
        (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group1-sha1-1.3.132.0.1 {
      base key-exchange-alg-base;
      status deprecated;
      description
        "GSS-GROUP1-SHA1-1.3.132.0.1 (nistk163, sect163k1)";
      reference
        "RFC 8732:
          Generic Security Service Application Program Interface
          (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group1-sha1-1.2.840.10045.3.1.1 {
      base key-exchange-alg-base;
      status deprecated;
      description
        "GSS-GROUP1-SHA1-1.2.840.10045.3.1.1 (nistp192, secp192r1)";
      reference
        "RFC 8732:
          Generic Security Service Application Program Interface
          (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group1-sha1-1.3.132.0.33 {
      base key-exchange-alg-base;
      status deprecated;
      description
        "GSS-GROUP1-SHA1-1.3.132.0.33 (nistp224, secp224r1)";
      reference
        "RFC 8732:
          Generic Security Service Application Program Interface
          (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group1-sha1-1.3.132.0.26 {
      base key-exchange-alg-base;
      status deprecated;
      description
```



```
        "GSS-GROUP1-SHA1-1.3.132.0.26 (nistk233, sect233k1)";
```

```
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-group1-sha1-1.3.132.0.27 {
    base key-exchange-alg-base;
    status deprecated;
    description
      "GSS-GROUP1-SHA1-1.3.132.0.27 (nistb233, sect233r1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-group1-sha1-1.3.132.0.16 {
    base key-exchange-alg-base;
    status deprecated;
    description
      "GSS-GROUP1-SHA1-1.3.132.0.16 (nistk283, sect283k1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-group1-sha1-1.3.132.0.36 {
    base key-exchange-alg-base;
    status deprecated;
    description
      "GSS-GROUP1-SHA1-1.3.132.0.36 (nistk409, sect409k1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-group1-sha1-1.3.132.0.37 {
    base key-exchange-alg-base;
    status deprecated;
    description
      "GSS-GROUP1-SHA1-1.3.132.0.37 (nistb409, sect409r1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
```

```
          (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group1-sha1-1.3.132.0.38 {
      base key-exchange-alg-base;
      status deprecated;
      description
        "GSS-GROUP1-SHA1-1.3.132.0.38 (nistt571, sect571k1)";
      reference
        "RFC 8732:
          Generic Security Service Application Program Interface
          (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group1-sha1-curve25519-sha256 {
      base key-exchange-alg-base;
      status deprecated;
      description
        "GSS-GROUP1-SHA1-CURVE25519-SHA256";
      reference
        "RFC 8732:
          Generic Security Service Application Program Interface
          (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group1-sha1-curve448-sha512 {
      base key-exchange-alg-base;
      status deprecated;
      description
        "GSS-GROUP1-SHA1-CURVE448-SHA512";
      reference
        "RFC 8732:
          Generic Security Service Application Program Interface
          (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group14-sha1-nistp256 {
      base key-exchange-alg-base;
      status deprecated;
      description
        "GSS-GROUP14-SHA1-NISTP256 (secp256r1)";
      reference
        "RFC 8732:
          Generic Security Service Application Program Interface
          (GSS-API) Key Exchange with SHA-2";
    }
```

```
identity gss-group14-sha1-nistp384 {
```



```
  base key-exchange-alg-base;
  status deprecated;
  description
    "GSS-GROUP14-SHA1-NISTP384 (secp384r1)";
  reference
    "RFC 8732:
       Generic Security Service Application Program Interface
       (GSS-API) Key Exchange with SHA-2";
}

identity gss-group14-sha1-nistp521 {
  base key-exchange-alg-base;
  status deprecated;
  description
    "GSS-GROUP14-SHA1-NISTP521 (secp521r1)";
  reference
    "RFC 8732:
       Generic Security Service Application Program Interface
       (GSS-API) Key Exchange with SHA-2";
}

identity gss-group14-sha1-1.3.132.0.1 {
  base key-exchange-alg-base;
  status deprecated;
  description
    "GSS-GROUP14-SHA1-1.3.132.0.1 (nistk163, sect163k1)";
  reference
    "RFC 8732:
       Generic Security Service Application Program Interface
       (GSS-API) Key Exchange with SHA-2";
}

identity gss-group14-sha1-1.2.840.10045.3.1.1 {
  base key-exchange-alg-base;
  status deprecated;
  description
    "GSS-GROUP14-SHA1-1.2.840.10045.3.1.1 (nistp192, secp192r1)";
  reference
    "RFC 8732:
```

```
          Generic Security Service Application Program Interface
          (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group14-sha1-1.3.132.0.33 {
      base key-exchange-alg-base;
      status deprecated;
      description
        "GSS-GROUP14-SHA1-1.3.132.0.33 (nistp224, secp224r1)";
```



```
      reference
        "RFC 8732:
          Generic Security Service Application Program Interface
          (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group14-sha1-1.3.132.0.26 {
      base key-exchange-alg-base;
      status deprecated;
      description
        "GSS-GROUP14-SHA1-1.3.132.0.26 (nistk233, sect233k1)";
      reference
        "RFC 8732:
          Generic Security Service Application Program Interface
          (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group14-sha1-1.3.132.0.27 {
      base key-exchange-alg-base;
      status deprecated;
      description
        "GSS-GROUP14-SHA1-1.3.132.0.27 (nistb233, sect233r1)";
      reference
        "RFC 8732:
          Generic Security Service Application Program Interface
          (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group14-sha1-1.3.132.0.16 {
      base key-exchange-alg-base;
      status deprecated;
      description
```

```
        "GSS-GROUP14-SHA1-1.3.132.0.16 (nistk283, sect283k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group14-sha1-1.3.132.0.36 {
      base key-exchange-alg-base;
      status deprecated;
      description
        "GSS-GROUP14-SHA1-1.3.132.0.36 (nistk409, sect409k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
```



```
    }

    identity gss-group14-sha1-1.3.132.0.37 {
      base key-exchange-alg-base;
      status deprecated;
      description
        "GSS-GROUP14-SHA1-1.3.132.0.37 (nistb409, sect409r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group14-sha1-1.3.132.0.38 {
      base key-exchange-alg-base;
      status deprecated;
      description
        "GSS-GROUP14-SHA1-1.3.132.0.38 (nistt571, sect571k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group14-sha1-curve25519-sha256 {
```

```
      base key-exchange-alg-base;
      status deprecated;
      description
        "GSS-GROUP14-SHA1-CURVE25519-SHA256";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group14-sha1-curve448-sha512 {
      base key-exchange-alg-base;
      status deprecated;
      description
        "GSS-GROUP14-SHA1-CURVE448-SHA512";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-gex-sha1-nistp256 {
      base key-exchange-alg-base;
```



```
      status deprecated;
      description
        "GSS-GEX-SHA1-NISTP256 (secp256r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-gex-sha1-nistp384 {
      base key-exchange-alg-base;
      status deprecated;
      description
        "GSS-GEX-SHA1-NISTP384 (secp384r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
```

```
  }

  identity gss-gex-sha1-nistp521 {
    base key-exchange-alg-base;
    status deprecated;
    description
      "GSS-GEX-SHA1-NISTP521 (secp521r1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-gex-sha1-1.3.132.0.1 {
    base key-exchange-alg-base;
    status deprecated;
    description
      "GSS-GEX-SHA1-1.3.132.0.1 (nistk163, sect163k1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-gex-sha1-1.2.840.10045.3.1.1 {
    base key-exchange-alg-base;
    status deprecated;
    description
      "GSS-GEX-SHA1-1.2.840.10045.3.1.1 (nistp192, secp192r1)";
    reference
```



```
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-gex-sha1-1.3.132.0.33 {
    base key-exchange-alg-base;
    status deprecated;
    description
      "GSS-GEX-SHA1-1.3.132.0.33 (nistp224, secp224r1)";
    reference
```

```
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-gex-sha1-1.3.132.0.26 {
      base key-exchange-alg-base;
      status deprecated;
      description
        "GSS-GEX-SHA1-1.3.132.0.26 (nistk233, sect233k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-gex-sha1-1.3.132.0.27 {
      base key-exchange-alg-base;
      status deprecated;
      description
        "GSS-GEX-SHA1-1.3.132.0.27 (nistb233, sect233r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-gex-sha1-1.3.132.0.16 {
      base key-exchange-alg-base;
      status deprecated;
      description
        "GSS-GEX-SHA1-1.3.132.0.16 (nistk283, sect283k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }
```



```
    identity gss-gex-sha1-1.3.132.0.36 {
      base key-exchange-alg-base;
      status deprecated;
      description
```

```
      "GSS-GEX-SHA1-1.3.132.0.36 (nistk409, sect409k1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-gex-sha1-1.3.132.0.37 {
    base key-exchange-alg-base;
    status deprecated;
    description
      "GSS-GEX-SHA1-1.3.132.0.37 (nistb409, sect409r1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-gex-sha1-1.3.132.0.38 {
    base key-exchange-alg-base;
    status deprecated;
    description
      "GSS-GEX-SHA1-1.3.132.0.38 (nistt571, sect571k1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-gex-sha1-curve25519-sha256 {
    base key-exchange-alg-base;
    status deprecated;
    description
      "GSS-GEX-SHA1-CURVE25519-SHA256";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-gex-sha1-curve448-sha512 {
    base key-exchange-alg-base;
    status deprecated;
    description
```

```
        "GSS-GEX-SHA1-CURVE448-SHA512";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity rsa1024-sha1 {
      base key-exchange-alg-base;
      description
        "RSA1024-SHA1";
      reference
        "RFC 4432:
           RSA Key Exchange for the Secure Shell (SSH)
           Transport Layer Protocol";
    }

    identity rsa2048-sha256 {
      base key-exchange-alg-base;
      description
        "RSA2048-SHA256";
      reference
        "RFC 4432:
           RSA Key Exchange for the Secure Shell (SSH)
           Transport Layer Protocol";
    }

    identity ext-info-s {
      base key-exchange-alg-base;
      description
        "EXT-INFO-S";
      reference
        "RFC 8308:
           Extension Negotiation in the Secure Shell (SSH) Protocol";
    }

    identity ext-info-c {
      base key-exchange-alg-base;
      description
        "EXT-INFO-C";
      reference
        "RFC 8308:
           Extension Negotiation in the Secure Shell (SSH) Protocol";
    }

    identity gss-group14-sha256-nistp256 {
      base key-exchange-alg-base;
```

```
      description
```



```
        "GSS-GROUP14-SHA256-NISTP256 (secp256r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group14-sha256-nistp384 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP14-SHA256-NISTP384 (secp384r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group14-sha256-nistp521 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP14-SHA256-NISTP521 (secp521r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group14-sha256-1.3.132.0.1 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP14-SHA256-1.3.132.0.1 (nistk163, sect163k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group14-sha256-1.2.840.10045.3.1.1 {
      base key-exchange-alg-base;
      description
```

```
        "GSS-GROUP14-SHA256-1.2.840.10045.3.1.1 (nistp192, secp192r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group14-sha256-1.3.132.0.33 {
```



```
      base key-exchange-alg-base;
      description
        "GSS-GROUP14-SHA256-1.3.132.0.33 (nistp224, secp224r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group14-sha256-1.3.132.0.26 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP14-SHA256-1.3.132.0.26 (nistk233, sect233k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group14-sha256-1.3.132.0.27 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP14-SHA256-1.3.132.0.27 (nistb233, sect233r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group14-sha256-1.3.132.0.16 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP14-SHA256-1.3.132.0.16 (nistk283, sect283k1)";
```

```
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group14-sha256-1.3.132.0.36 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP14-SHA256-1.3.132.0.36 (nistk409, sect409k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }
```



```
    identity gss-group14-sha256-1.3.132.0.37 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP14-SHA256-1.3.132.0.37 (nistb409, sect409r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group14-sha256-1.3.132.0.38 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP14-SHA256-1.3.132.0.38 (nistt571, sect571k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group14-sha256-curve25519-sha256 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP14-SHA256-CURVE25519-SHA256";
      reference
        "RFC 8732:
```

```
        Generic Security Service Application Program Interface
        (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group14-sha256-curve448-sha512 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP14-SHA256-CURVE448-SHA512";
      reference
        "RFC 8732:
          Generic Security Service Application Program Interface
          (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group15-sha512-nistp256 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP15-SHA512-NISTP256 (secp256r1)";
      reference
        "RFC 8732:
          Generic Security Service Application Program Interface
          (GSS-API) Key Exchange with SHA-2";
```



```
    }

    identity gss-group15-sha512-nistp384 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP15-SHA512-NISTP384 (secp384r1)";
      reference
        "RFC 8732:
          Generic Security Service Application Program Interface
          (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group15-sha512-nistp521 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP15-SHA512-NISTP521 (secp521r1)";
      reference
        "RFC 8732:
          Generic Security Service Application Program Interface
```

```
          (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group15-sha512-1.3.132.0.1 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP15-SHA512-1.3.132.0.1 (nistk163, sect163k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group15-sha512-1.2.840.10045.3.1.1 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP15-SHA512-1.2.840.10045.3.1.1 (nistp192, secp192r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group15-sha512-1.3.132.0.33 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP15-SHA512-1.3.132.0.33 (nistp224, secp224r1)";
      reference
        "RFC 8732:
```



```
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group15-sha512-1.3.132.0.26 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP15-SHA512-1.3.132.0.26 (nistk233, sect233k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
```

```
  }

  identity gss-group15-sha512-1.3.132.0.27 {
    base key-exchange-alg-base;
    description
      "GSS-GROUP15-SHA512-1.3.132.0.27 (nistb233, sect233r1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-group15-sha512-1.3.132.0.16 {
    base key-exchange-alg-base;
    description
      "GSS-GROUP15-SHA512-1.3.132.0.16 (nistk283, sect283k1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-group15-sha512-1.3.132.0.36 {
    base key-exchange-alg-base;
    description
      "GSS-GROUP15-SHA512-1.3.132.0.36 (nistk409, sect409k1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-group15-sha512-1.3.132.0.37 {
    base key-exchange-alg-base;
    description
      "GSS-GROUP15-SHA512-1.3.132.0.37 (nistb409, sect409r1)";
```



```
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }
```

```
identity gss-group15-sha512-1.3.132.0.38 {
  base key-exchange-alg-base;
  description
    "GSS-GROUP15-SHA512-1.3.132.0.38 (nistt571, sect571k1)";
  reference
    "RFC 8732:
       Generic Security Service Application Program Interface
       (GSS-API) Key Exchange with SHA-2";
}

identity gss-group15-sha512-curve25519-sha256 {
  base key-exchange-alg-base;
  description
    "GSS-GROUP15-SHA512-CURVE25519-SHA256";
  reference
    "RFC 8732:
       Generic Security Service Application Program Interface
       (GSS-API) Key Exchange with SHA-2";
}

identity gss-group15-sha512-curve448-sha512 {
  base key-exchange-alg-base;
  description
    "GSS-GROUP15-SHA512-CURVE448-SHA512";
  reference
    "RFC 8732:
       Generic Security Service Application Program Interface
       (GSS-API) Key Exchange with SHA-2";
}

identity gss-group16-sha512-nistp256 {
  base key-exchange-alg-base;
  description
    "GSS-GROUP16-SHA512-NISTP256 (secp256r1)";
  reference
    "RFC 8732:
       Generic Security Service Application Program Interface
       (GSS-API) Key Exchange with SHA-2";
}

identity gss-group16-sha512-nistp384 {
  base key-exchange-alg-base;
```

```
  description
    "GSS-GROUP16-SHA512-NISTP384 (secp384r1)";
  reference
    "RFC 8732:
       Generic Security Service Application Program Interface
       (GSS-API) Key Exchange with SHA-2";
}

identity gss-group16-sha512-nistp521 {
  base key-exchange-alg-base;
  description
    "GSS-GROUP16-SHA512-NISTP521 (secp521r1)";
  reference
    "RFC 8732:
       Generic Security Service Application Program Interface
       (GSS-API) Key Exchange with SHA-2";
}

identity gss-group16-sha512-1.3.132.0.1 {
  base key-exchange-alg-base;
  description
    "GSS-GROUP16-SHA512-1.3.132.0.1 (nistk163, sect163k1)";
  reference
    "RFC 8732:
       Generic Security Service Application Program Interface
       (GSS-API) Key Exchange with SHA-2";
}

identity gss-group16-sha512-1.2.840.10045.3.1.1 {
  base key-exchange-alg-base;
  description
    "GSS-GROUP16-SHA512-1.2.840.10045.3.1.1 (nistp192, secp192r1)";
  reference
    "RFC 8732:
       Generic Security Service Application Program Interface
       (GSS-API) Key Exchange with SHA-2";
}

identity gss-group16-sha512-1.3.132.0.33 {
  base key-exchange-alg-base;
  description
    "GSS-GROUP16-SHA512-1.3.132.0.33 (nistp224, secp224r1)";
  reference
    "RFC 8732:
       Generic Security Service Application Program Interface
       (GSS-API) Key Exchange with SHA-2";
}
```

```
    identity gss-group16-sha512-1.3.132.0.26 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP16-SHA512-1.3.132.0.26 (nistk233, sect233k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group16-sha512-1.3.132.0.27 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP16-SHA512-1.3.132.0.27 (nistb233, sect233r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group16-sha512-1.3.132.0.16 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP16-SHA512-1.3.132.0.16 (nistk283, sect283k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group16-sha512-1.3.132.0.36 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP16-SHA512-1.3.132.0.36 (nistk409, sect409k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group16-sha512-1.3.132.0.37 {
      base key-exchange-alg-base;
```

```
      description
        "GSS-GROUP16-SHA512-1.3.132.0.37 (nistb409, sect409r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
```



```
    }

    identity gss-group16-sha512-1.3.132.0.38 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP16-SHA512-1.3.132.0.38 (nistt571, sect571k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group16-sha512-curve25519-sha256 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP16-SHA512-CURVE25519-SHA256";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group16-sha512-curve448-sha512 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP16-SHA512-CURVE448-SHA512";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group17-sha512-nistp256 {
      base key-exchange-alg-base;
      description
```

```
        "GSS-GROUP17-SHA512-NISTP256 (secp256r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group17-sha512-nistp384 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP17-SHA512-NISTP384 (secp384r1)";
      reference
        "RFC 8732:
```



```
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group17-sha512-nistp521 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP17-SHA512-NISTP521 (secp521r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group17-sha512-1.3.132.0.1 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP17-SHA512-1.3.132.0.1 (nistk163, sect163k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group17-sha512-1.2.840.10045.3.1.1 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP17-SHA512-1.2.840.10045.3.1.1 (nistp192, secp192r1)";
```

```
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group17-sha512-1.3.132.0.33 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP17-SHA512-1.3.132.0.33 (nistp224, secp224r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group17-sha512-1.3.132.0.26 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP17-SHA512-1.3.132.0.26 (nistk233, sect233k1)";
```



```
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group17-sha512-1.3.132.0.27 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP17-SHA512-1.3.132.0.27 (nistb233, sect233r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group17-sha512-1.3.132.0.16 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP17-SHA512-1.3.132.0.16 (nistk283, sect283k1)";
      reference
```

```
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group17-sha512-1.3.132.0.36 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP17-SHA512-1.3.132.0.36 (nistk409, sect409k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group17-sha512-1.3.132.0.37 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP17-SHA512-1.3.132.0.37 (nistb409, sect409r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group17-sha512-1.3.132.0.38 {
      base key-exchange-alg-base;
```



```
      description
        "GSS-GROUP17-SHA512-1.3.132.0.38 (nistt571, sect571k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group17-sha512-curve25519-sha256 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP17-SHA512-CURVE25519-SHA256";
      reference
        "RFC 8732:
```

```
          Generic Security Service Application Program Interface
          (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group17-sha512-curve448-sha512 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP17-SHA512-CURVE448-SHA512";
      reference
        "RFC 8732:
          Generic Security Service Application Program Interface
          (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group18-sha512-nistp256 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP18-SHA512-NISTP256 (secp256r1)";
      reference
        "RFC 8732:
          Generic Security Service Application Program Interface
          (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group18-sha512-nistp384 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP18-SHA512-NISTP384 (secp384r1)";
      reference
        "RFC 8732:
          Generic Security Service Application Program Interface
          (GSS-API) Key Exchange with SHA-2";
    }
```



```
    identity gss-group18-sha512-nistp521 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP18-SHA512-NISTP521 (secp521r1)";
      reference
        "RFC 8732:
          Generic Security Service Application Program Interface
```

```
          (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group18-sha512-1.3.132.0.1 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP18-SHA512-1.3.132.0.1 (nistk163, sect163k1)";
      reference
        "RFC 8732:
          Generic Security Service Application Program Interface
          (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group18-sha512-1.2.840.10045.3.1.1 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP18-SHA512-1.2.840.10045.3.1.1 (nistp192, secp192r1)";
      reference
        "RFC 8732:
          Generic Security Service Application Program Interface
          (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group18-sha512-1.3.132.0.33 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP18-SHA512-1.3.132.0.33 (nistp224, secp224r1)";
      reference
        "RFC 8732:
          Generic Security Service Application Program Interface
          (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group18-sha512-1.3.132.0.26 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP18-SHA512-1.3.132.0.26 (nistk233, sect233k1)";
      reference
        "RFC 8732:
          Generic Security Service Application Program Interface
          (GSS-API) Key Exchange with SHA-2";
```

```
}

identity gss-group18-sha512-1.3.132.0.27 {
  base key-exchange-alg-base;
  description
    "GSS-GROUP18-SHA512-1.3.132.0.27 (nistb233, sect233r1)";
  reference
    "RFC 8732:
       Generic Security Service Application Program Interface
       (GSS-API) Key Exchange with SHA-2";
}

identity gss-group18-sha512-1.3.132.0.16 {
  base key-exchange-alg-base;
  description
    "GSS-GROUP18-SHA512-1.3.132.0.16 (nistk283, sect283k1)";
  reference
    "RFC 8732:
       Generic Security Service Application Program Interface
       (GSS-API) Key Exchange with SHA-2";
}

identity gss-group18-sha512-1.3.132.0.36 {
  base key-exchange-alg-base;
  description
    "GSS-GROUP18-SHA512-1.3.132.0.36 (nistk409, sect409k1)";
  reference
    "RFC 8732:
       Generic Security Service Application Program Interface
       (GSS-API) Key Exchange with SHA-2";
}

identity gss-group18-sha512-1.3.132.0.37 {
  base key-exchange-alg-base;
  description
    "GSS-GROUP18-SHA512-1.3.132.0.37 (nistb409, sect409r1)";
  reference
    "RFC 8732:
       Generic Security Service Application Program Interface
       (GSS-API) Key Exchange with SHA-2";
}

identity gss-group18-sha512-1.3.132.0.38 {
  base key-exchange-alg-base;
  description
    "GSS-GROUP18-SHA512-1.3.132.0.38 (nistt571, sect571k1)";
  reference
    "RFC 8732:
```

```
          Generic Security Service Application Program Interface
          (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group18-sha512-curve25519-sha256 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP18-SHA512-CURVE25519-SHA256";
      reference
        "RFC 8732:
          Generic Security Service Application Program Interface
          (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-group18-sha512-curve448-sha512 {
      base key-exchange-alg-base;
      description
        "GSS-GROUP18-SHA512-CURVE448-SHA512";
      reference
        "RFC 8732:
          Generic Security Service Application Program Interface
          (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-nistp256-sha256-nistp256 {
      base key-exchange-alg-base;
      description
        "GSS-NISTP256-SHA256-NISTP256 (secp256r1)";
      reference
        "RFC 8732:
          Generic Security Service Application Program Interface
          (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-nistp256-sha256-nistp384 {
      base key-exchange-alg-base;
      description
        "GSS-NISTP256-SHA256-NISTP384 (secp384r1)";
      reference
        "RFC 8732:
          Generic Security Service Application Program Interface
          (GSS-API) Key Exchange with SHA-2";
    }
```

```
      identity gss-nistp256-sha256-nistp521 {
        base key-exchange-alg-base;
        description
          "GSS-NISTP256-SHA256-NISTP521 (secp521r1)";
```



```
        reference
          "RFC 8732:
             Generic Security Service Application Program Interface
             (GSS-API) Key Exchange with SHA-2";
      }

      identity gss-nistp256-sha256-1.3.132.0.1 {
        base key-exchange-alg-base;
        description
          "GSS-NISTP256-SHA256-1.3.132.0.1 (nistk163, sect163k1)";
        reference
          "RFC 8732:
             Generic Security Service Application Program Interface
             (GSS-API) Key Exchange with SHA-2";
      }

      identity gss-nistp256-sha256-1.2.840.10045.3.1.1 {
        base key-exchange-alg-base;
        description
         "GSS-NISTP256-SHA256-1.2.840.10045.3.1.1 (nistp192, secp192r1)";
        reference
          "RFC 8732:
             Generic Security Service Application Program Interface
             (GSS-API) Key Exchange with SHA-2";
      }

      identity gss-nistp256-sha256-1.3.132.0.33 {
        base key-exchange-alg-base;
        description
          "GSS-NISTP256-SHA256-1.3.132.0.33 (nistp224, secp224r1)";
        reference
          "RFC 8732:
             Generic Security Service Application Program Interface
             (GSS-API) Key Exchange with SHA-2";
      }
```

```
identity gss-nistp256-sha256-1.3.132.0.26 {
  base key-exchange-alg-base;
  description
    "GSS-NISTP256-SHA256-1.3.132.0.26 (nistk233, sect233k1)";
  reference
    "RFC 8732:
       Generic Security Service Application Program Interface
       (GSS-API) Key Exchange with SHA-2";
}

identity gss-nistp256-sha256-1.3.132.0.27 {
  base key-exchange-alg-base;
```



```
  description
    "GSS-NISTP256-SHA256-1.3.132.0.27 (nistb233, sect233r1)";
  reference
    "RFC 8732:
       Generic Security Service Application Program Interface
       (GSS-API) Key Exchange with SHA-2";
}

identity gss-nistp256-sha256-1.3.132.0.16 {
  base key-exchange-alg-base;
  description
    "GSS-NISTP256-SHA256-1.3.132.0.16 (nistk283, sect283k1)";
  reference
    "RFC 8732:
       Generic Security Service Application Program Interface
       (GSS-API) Key Exchange with SHA-2";
}

identity gss-nistp256-sha256-1.3.132.0.36 {
  base key-exchange-alg-base;
  description
    "GSS-NISTP256-SHA256-1.3.132.0.36 (nistk409, sect409k1)";
  reference
    "RFC 8732:
       Generic Security Service Application Program Interface
       (GSS-API) Key Exchange with SHA-2";
}

identity gss-nistp256-sha256-1.3.132.0.37 {
```

```
    base key-exchange-alg-base;
    description
      "GSS-NISTP256-SHA256-1.3.132.0.37 (nistb409, sect409r1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-nistp256-sha256-1.3.132.0.38 {
    base key-exchange-alg-base;
    description
      "GSS-NISTP256-SHA256-1.3.132.0.38 (nistt571, sect571k1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }
```



```
  identity gss-nistp256-sha256-curve25519-sha256 {
    base key-exchange-alg-base;
    description
      "GSS-NISTP256-SHA256-CURVE25519-SHA256";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-nistp256-sha256-curve448-sha512 {
    base key-exchange-alg-base;
    description
      "GSS-NISTP256-SHA256-CURVE448-SHA512";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-nistp384-sha384-nistp256 {
    base key-exchange-alg-base;
```

```
      description
        "GSS-NISTP384-SHA384-NISTP256 (secp256r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-nistp384-sha384-nistp384 {
      base key-exchange-alg-base;
      description
        "GSS-NISTP384-SHA384-NISTP384 (secp384r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-nistp384-sha384-nistp521 {
      base key-exchange-alg-base;
      description
        "GSS-NISTP384-SHA384-NISTP521 (secp521r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
```



```
    }

    identity gss-nistp384-sha384-1.3.132.0.1 {
      base key-exchange-alg-base;
      description
        "GSS-NISTP384-SHA384-1.3.132.0.1 (nistk163, sect163k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-nistp384-sha384-1.2.840.10045.3.1.1 {
      base key-exchange-alg-base;
      description
```

```
       "GSS-NISTP384-SHA384-1.2.840.10045.3.1.1 (nistp192, secp192r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-nistp384-sha384-1.3.132.0.33 {
      base key-exchange-alg-base;
      description
        "GSS-NISTP384-SHA384-1.3.132.0.33 (nistp224, secp224r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-nistp384-sha384-1.3.132.0.26 {
      base key-exchange-alg-base;
      description
        "GSS-NISTP384-SHA384-1.3.132.0.26 (nistk233, sect233k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-nistp384-sha384-1.3.132.0.27 {
      base key-exchange-alg-base;
      description
        "GSS-NISTP384-SHA384-1.3.132.0.27 (nistb233, sect233r1)";
      reference
        "RFC 8732:
```



```
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-nistp384-sha384-1.3.132.0.16 {
      base key-exchange-alg-base;
      description
        "GSS-NISTP384-SHA384-1.3.132.0.16 (nistk283, sect283k1)";
```

```
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-nistp384-sha384-1.3.132.0.36 {
      base key-exchange-alg-base;
      description
        "GSS-NISTP384-SHA384-1.3.132.0.36 (nistk409, sect409k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-nistp384-sha384-1.3.132.0.37 {
      base key-exchange-alg-base;
      description
        "GSS-NISTP384-SHA384-1.3.132.0.37 (nistb409, sect409r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-nistp384-sha384-1.3.132.0.38 {
      base key-exchange-alg-base;
      description
        "GSS-NISTP384-SHA384-1.3.132.0.38 (nistt571, sect571k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-nistp384-sha384-curve25519-sha256 {
      base key-exchange-alg-base;
      description
        "GSS-NISTP384-SHA384-CURVE25519-SHA256";
```



```
      reference
```

```
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-nistp384-sha384-curve448-sha512 {
    base key-exchange-alg-base;
    description
      "GSS-NISTP384-SHA384-CURVE448-SHA512";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-nistp521-sha512-nistp256 {
    base key-exchange-alg-base;
    description
      "GSS-NISTP521-SHA512-NISTP256 (secp256r1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-nistp521-sha512-nistp384 {
    base key-exchange-alg-base;
    description
      "GSS-NISTP521-SHA512-NISTP384 (secp384r1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-nistp521-sha512-nistp521 {
    base key-exchange-alg-base;
    description
      "GSS-NISTP521-SHA512-NISTP521 (secp521r1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-nistp521-sha512-1.3.132.0.1 {
    base key-exchange-alg-base;
```

```
      description
        "GSS-NISTP521-SHA512-1.3.132.0.1 (nistk163, sect163k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-nistp521-sha512-1.2.840.10045.3.1.1 {
      base key-exchange-alg-base;
      description
       "GSS-NISTP521-SHA512-1.2.840.10045.3.1.1 (nistp192, secp192r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-nistp521-sha512-1.3.132.0.33 {
      base key-exchange-alg-base;
      description
        "GSS-NISTP521-SHA512-1.3.132.0.33 (nistp224, secp224r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-nistp521-sha512-1.3.132.0.26 {
      base key-exchange-alg-base;
      description
        "GSS-NISTP521-SHA512-1.3.132.0.26 (nistk233, sect233k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-nistp521-sha512-1.3.132.0.27 {
      base key-exchange-alg-base;
      description
        "GSS-NISTP521-SHA512-1.3.132.0.27 (nistb233, sect233r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
```

```
    }
```



```
    identity gss-nistp521-sha512-1.3.132.0.16 {
      base key-exchange-alg-base;
      description
        "GSS-NISTP521-SHA512-1.3.132.0.16 (nistk283, sect283k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-nistp521-sha512-1.3.132.0.36 {
      base key-exchange-alg-base;
      description
        "GSS-NISTP521-SHA512-1.3.132.0.36 (nistk409, sect409k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-nistp521-sha512-1.3.132.0.37 {
      base key-exchange-alg-base;
      description
        "GSS-NISTP521-SHA512-1.3.132.0.37 (nistb409, sect409r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-nistp521-sha512-1.3.132.0.38 {
      base key-exchange-alg-base;
      description
        "GSS-NISTP521-SHA512-1.3.132.0.38 (nistt571, sect571k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }
```

```
      identity gss-nistp521-sha512-curve25519-sha256 {
        base key-exchange-alg-base;
        description
          "GSS-NISTP521-SHA512-CURVE25519-SHA256";
        reference
          "RFC 8732:
             Generic Security Service Application Program Interface
             (GSS-API) Key Exchange with SHA-2";
```



```
      }

      identity gss-nistp521-sha512-curve448-sha512 {
        base key-exchange-alg-base;
        description
          "GSS-NISTP521-SHA512-CURVE448-SHA512";
        reference
          "RFC 8732:
             Generic Security Service Application Program Interface
             (GSS-API) Key Exchange with SHA-2";
      }

      identity gss-curve25519-sha256-nistp256 {
        base key-exchange-alg-base;
        description
          "GSS-CURVE25519-SHA256-NISTP256 (secp256r1)";
        reference
          "RFC 8732:
             Generic Security Service Application Program Interface
             (GSS-API) Key Exchange with SHA-2";
      }

      identity gss-curve25519-sha256-nistp384 {
        base key-exchange-alg-base;
        description
          "GSS-CURVE25519-SHA256-NISTP384 (secp384r1)";
        reference
          "RFC 8732:
             Generic Security Service Application Program Interface
             (GSS-API) Key Exchange with SHA-2";
      }
```

```
      identity gss-curve25519-sha256-nistp521 {
        base key-exchange-alg-base;
        description
          "GSS-CURVE25519-SHA256-NISTP521 (secp521r1)";
        reference
          "RFC 8732:
             Generic Security Service Application Program Interface
             (GSS-API) Key Exchange with SHA-2";
      }

      identity gss-curve25519-sha256-1.3.132.0.1 {
        base key-exchange-alg-base;
        description
          "GSS-CURVE25519-SHA256-1.3.132.0.1 (nistk163, sect163k1)";
        reference
          "RFC 8732:
```



```
             Generic Security Service Application Program Interface
             (GSS-API) Key Exchange with SHA-2";
      }

      identity gss-curve25519-sha256-1.2.840.10045.3.1.1 {
        base key-exchange-alg-base;
        description
          "GSS-CURVE25519-SHA256-1.2.840.10045.3.1.1 (nistp192,
           secp192r1)";
        reference
          "RFC 8732:
             Generic Security Service Application Program Interface
             (GSS-API) Key Exchange with SHA-2";
      }

      identity gss-curve25519-sha256-1.3.132.0.33 {
        base key-exchange-alg-base;
        description
          "GSS-CURVE25519-SHA256-1.3.132.0.33 (nistp224, secp224r1)";
        reference
          "RFC 8732:
             Generic Security Service Application Program Interface
             (GSS-API) Key Exchange with SHA-2";
      }
```

```
  identity gss-curve25519-sha256-1.3.132.0.26 {
    base key-exchange-alg-base;
    description
      "GSS-CURVE25519-SHA256-1.3.132.0.26 (nistk233, sect233k1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-curve25519-sha256-1.3.132.0.27 {
    base key-exchange-alg-base;
    description
      "GSS-CURVE25519-SHA256-1.3.132.0.27 (nistb233, sect233r1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-curve25519-sha256-1.3.132.0.16 {
    base key-exchange-alg-base;
    description
```



```
      "GSS-CURVE25519-SHA256-1.3.132.0.16 (nistk283, sect283k1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-curve25519-sha256-1.3.132.0.36 {
    base key-exchange-alg-base;
    description
      "GSS-CURVE25519-SHA256-1.3.132.0.36 (nistk409, sect409k1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-curve25519-sha256-1.3.132.0.37 {
```

```
      base key-exchange-alg-base;
      description
        "GSS-CURVE25519-SHA256-1.3.132.0.37 (nistb409, sect409r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-curve25519-sha256-1.3.132.0.38 {
      base key-exchange-alg-base;
      description
        "GSS-CURVE25519-SHA256-1.3.132.0.38 (nistt571, sect571k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-curve25519-sha256-curve25519-sha256 {
      base key-exchange-alg-base;
      description
        "GSS-CURVE25519-SHA256-CURVE25519-SHA256";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-curve25519-sha256-curve448-sha512 {
```



```
      base key-exchange-alg-base;
      description
        "GSS-CURVE25519-SHA256-CURVE448-SHA512";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-curve448-sha512-nistp256 {
      base key-exchange-alg-base;
```

```
      description
        "GSS-CURVE448-SHA512-NISTP256 (secp256r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-curve448-sha512-nistp384 {
      base key-exchange-alg-base;
      description
        "GSS-CURVE448-SHA512-NISTP384 (secp384r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-curve448-sha512-nistp521 {
      base key-exchange-alg-base;
      description
        "GSS-CURVE448-SHA512-NISTP521 (secp521r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-curve448-sha512-1.3.132.0.1 {
      base key-exchange-alg-base;
      description
        "GSS-CURVE448-SHA512-1.3.132.0.1 (nistk163, sect163k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }
```



```
    identity gss-curve448-sha512-1.2.840.10045.3.1.1 {
      base key-exchange-alg-base;
      description
       "GSS-CURVE448-SHA512-1.2.840.10045.3.1.1 (nistp192, secp192r1)";
```

```
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-curve448-sha512-1.3.132.0.33 {
    base key-exchange-alg-base;
    description
      "GSS-CURVE448-SHA512-1.3.132.0.33 (nistp224, secp224r1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-curve448-sha512-1.3.132.0.26 {
    base key-exchange-alg-base;
    description
      "GSS-CURVE448-SHA512-1.3.132.0.26 (nistk233, sect233k1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-curve448-sha512-1.3.132.0.27 {
    base key-exchange-alg-base;
    description
      "GSS-CURVE448-SHA512-1.3.132.0.27 (nistb233, sect233r1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
  }

  identity gss-curve448-sha512-1.3.132.0.16 {
    base key-exchange-alg-base;
    description
      "GSS-CURVE448-SHA512-1.3.132.0.16 (nistk283, sect283k1)";
    reference
      "RFC 8732:
         Generic Security Service Application Program Interface
         (GSS-API) Key Exchange with SHA-2";
```

```
    }

    identity gss-curve448-sha512-1.3.132.0.36 {
      base key-exchange-alg-base;
      description
        "GSS-CURVE448-SHA512-1.3.132.0.36 (nistk409, sect409k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-curve448-sha512-1.3.132.0.37 {
      base key-exchange-alg-base;
      description
        "GSS-CURVE448-SHA512-1.3.132.0.37 (nistb409, sect409r1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-curve448-sha512-1.3.132.0.38 {
      base key-exchange-alg-base;
      description
        "GSS-CURVE448-SHA512-1.3.132.0.38 (nistt571, sect571k1)";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-curve448-sha512-curve25519-sha256 {
      base key-exchange-alg-base;
      description
        "GSS-CURVE448-SHA512-CURVE25519-SHA256";
      reference
        "RFC 8732:
           Generic Security Service Application Program Interface
           (GSS-API) Key Exchange with SHA-2";
    }

    identity gss-curve448-sha512-curve448-sha512 {
      base key-exchange-alg-base;
      description
        "GSS-CURVE448-SHA512-CURVE448-SHA512";
      reference
```

```
            Generic Security Service Application Program Interface
            (GSS-API) Key Exchange with SHA-2";
      }

      identity curve25519-sha256 {
        base key-exchange-alg-base;
        description
          "CURVE25519-SHA256";
        reference
          "RFC 8731:
             Secure Shell (SSH) Key Exchange Method
             Using Curve25519 and Curve448";
      }

      identity curve448-sha512 {
        base key-exchange-alg-base;
        description
          "CURVE448-SHA512";
        reference
          "RFC 8731:
             Secure Shell (SSH) Key Exchange Method
             Using Curve25519 and Curve448";
      }

      // Protocol-accessible Nodes

      container supported-algorithms {
        config false;
        description
          "A container for a list of key exchange algorithms
           supported by the server.";
        leaf-list supported-algorithm {
          type key-exchange-algorithm-ref;
          description
            "A key exchange algorithm supported by the server.";
        }
      }

    }
```

<CODE ENDS>

Appendix B. Change Log

This section is to be removed before publishing as an RFC.

B.1. 00 to 01

* Noted that '0.0.0.0' and '::' might have special meanings.
* Renamed "keychain" to "keystore".

B.2. 01 to 02

* Removed the groupings 'listening-ssh-client-grouping' and 'listening-ssh-server-grouping'. Now modules only contain the transport-independent groupings.
* Simplified the "client-auth" part in the ietf-ssh-client module. It now inlines what it used to point to keystore for.
* Added cipher suites for various algorithms into new 'ietf-ssh-common' module.

B.3. 02 to 03

* Removed 'RESTRICTED' enum from 'password' leaf type.
* Added a 'must' statement to container 'server-auth' asserting that at least one of the various auth mechanisms must be specified.
* Fixed description statement for leaf 'trusted-ca-certs'.

B.4. 03 to 04

* Change title to "YANG Groupings for SSH Clients and SSH Servers"
* Added reference to RFC 6668
* Added RFC 8174 to Requirements Language Section.

* Enhanced description statement for ietf-ssh-server's "trusted-ca-certs" leaf.

* Added mandatory true to ietf-ssh-client's "client-auth" 'choice' statement.

* Changed the YANG prefix for module ietf-ssh-common from 'sshcom' to 'sshcmn'.

* Removed the compression algorithms as they are not commonly configurable in vendors' implementations.

* Updating descriptions in transport-params-grouping and the servers's usage of it.

* Now tree diagrams reference ietf-netmod-yang-tree-diagrams

* Updated YANG to use typedefs around leafrefs to common keystore paths

* Now inlines key and certificates (no longer a leafref to keystore)

B.5. 04 to 05

* Merged changes from co-author.

B.6. 05 to 06

* Updated to use trust anchors from trust-anchors draft (was keystore draft)

* Now uses new keystore grouping enabling asymmetric key to be either locally defined or a reference to the keystore.

B.7. 06 to 07

* factored the ssh-[client|server]-groupings into more reusable groupings.

* added if-feature statements for the new "ssh-host-keys" and "x509-certificates" features defined in draft-ietf-netconf-trust-

anchors.

B.8. 07 to 08

* Added a number of compatibility matrices to Section 5 (thanks Frank!)

* Clarified that any configured "host-key-alg" values need to be compatible with the configured private key.

B.9. 08 to 09

* Updated examples to reflect update to groupings defined in the keystore -09 draft.

* Add SSH keepalives features and groupings.

* Prefixed top-level SSH grouping nodes with 'ssh-' and support mashups.

* Updated copyright date, boilerplate template, affiliation, and folding algorithm.

B.10. 09 to 10

* Reformatted the YANG modules.

B.11. 10 to 11

* Reformatted lines causing folding to occur.

B.12. 11 to 12

* Collapsed all the inner groupings into the top-level grouping.

* Added a top-level "demux container" inside the top-level grouping.

* Added NACM statements and updated the Security Considerations section.

* Added "presence" statements on the "keepalive" containers, as was needed to address a validation error that appeared after adding

the "must" statements into the NETCONF/RESTCONF client/server modules.

* Updated the boilerplate text in module-level "description" statement to match copyeditor convention.

B.13. 12 to 13

* Removed the "demux containers", floating the nacm:default-deny-write to each descendant node, and adding a note to model designers regarding the potential need to add their own demux containers.

* Fixed a couple references (section 2 --> section 3)

* In the server model, replaced <client-cert-auth> with <client-authentication> and introduced 'local-or-external' choice.

B.14. 13 to 14

* Updated to reflect changes in trust-anchors drafts (e.g., s/trust-anchors/truststore/g + s/pinned.//)

B.15. 14 to 15

* Updated examples to reflect ietf-crypto-types change (e.g., identities --> enumerations)

* Updated "server-authentication" and "client-authentication" nodes from being a leaf of type "ts:host-keys-ref" or "ts:certificates-ref" to a container that uses "ts:local-or-truststore-host-keys-grouping" or "ts:local-or-truststore-certs-grouping".

B.16. 15 to 16

* Removed unnecessary if-feature statements in the -client and -server modules.

* Cleaned up some description statements in the -client and -server modules.

* Fixed a canonical ordering issue in ietf-ssh-common detected by new pyang.

B.17. 16 to 17

* Removed choice local-or-external by removing the 'external' case and flattening the 'local' case and adding a "local-users-supported" feature.

* Updated examples to include the "*-key-format" nodes.

* Augmented-in "must" expressions ensuring that locally-defined public-key-format are "ct:ssh-public-key-format" (must expr for ref'ed keys are TBD).

B.18. 17 to 18

* Removed leaf-list 'other' from ietf-ssh-server.

* Removed unused 'external-client-auth-supported' feature.

* Added features client-auth-password, client-auth-hostbased, and client-auth-none.

* Renamed 'host-key' to 'public-key' for when refering to 'publickey' based auth.

* Added new feature-protected 'hostbased' and 'none' to the 'user' node's config.

* Added new feature-protected 'hostbased' and 'none' to the 'client-identity' node's config.

* Updated examples to reflect new "bag" addition to truststore.

* Refined truststore/keystore groupings to ensure the key formats "must" be particular values.

* Switched to using truststore's new "public-key" bag (instead of separate "ssh-public-key" and "raw-public-key" bags.

* Updated client/server examples to cover ALL cases (local/ref x cert/raw-key/psk).

B.19. 18 to 19

* Updated the "keepalives" containers to address Michal Vasko's request to align with RFC 8071.

* Removed algorithm-mapping tables from the "SSH Common Model" section

* Removed 'algorithm' node from examples.

* Added feature "userauth-publickey"

* Removed "choice auth-type", as auth-types are not exclusive.

* Renamed both "client-certs" and "server-certs" to "ee-certs"

* Switch "must" to assert the public-key-format is "subject-public-key-info-format" when certificates are used.

* Added a "Note to Reviewers" note to first page.

B.20. 19 to 20

* Added a "must 'public-key or password or hostbased or none or certificate'" statement to the "user" node in ietf-ssh-client

* Expanded "Data Model Overview section(s) [remove "wall" of tree diagrams].

* Moved the "ietf-ssh-common" module section to proceed the other two module sections.

* Updated the Security Considerations section.

B.21. 20 to 21

* Updated examples to reflect new "cleartext-" prefix in the crypto-types draft.

B.22. 21 to 22

* Cleaned up the SSH-client examples (i.e., removing FIXMEs)

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

* Updated the "ietf-ssh-client" module to use the new "password-grouping" grouping from the "crypto-types" module.

B.23. 22 to 23

* Addressed comments raised by YANG Doctor in the ct/ts/ks drafts.

B.24. 23 to 24

* Removed the 'supported-authentication-methods' from {grouping ssh-server-grouping}/client-authentication.

* Added XML-comment above examples explaining the reason for the unexepected top-most element's presence.

* Added RFC-references to various 'feature' statements.

* Renamed "credentials" to "authentication methods"

* Renamed "client-auth-*" to "userauth-*"

* Renamed "client-identity-*" to "userauth-*"

* Fixed nits found by YANG Doctor reviews.

* Aligned modules with `pyang -f` formatting.

* Added a 'Contributors' section.

B.25. 24 to 25

* Moved algorithms in ietf-ssh-common (plus more) to IANA-maintained modules

* Added "config false" lists for algorithms supported by the server.

* Renamed "{ietf-ssh-client}userauth-*" to "client-ident-*"

* Renamed "{ietf-ssh-server}userauth-*" to "local-user-auth-*"

* Fixed issues found during YANG Doctor review.

* Fixed issues found during Secdir review.

B.26. 25 to 26

* Replaced "base64encodedvalue==" with "BASE64VALUE=" in examples.

* Minor editorial nits

B.27. 26 to 27

* Fixed up the 'WG Web' and 'WG List' lines in YANG module(s)

* Fixed up copyright (i.e., s/Simplified/Revised/) in YANG module(s)

* Created identityref-based typedefs for each of the four IANA alg identity bases.

* Added ietf-ssh-common:generate-public-key() RPC for discussion.

B.28. 27 to 28

* Fixed example to not have line-returns around "identity" values.

* Fixed examples to not include "xmlns:algs".

* Added an example for the "generate-public-key" RPC.

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Contributors

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