

Internet Engineering Task Force  
Internet-Draft  
Intended status: Informational  
Expires: November 25, 2016

D. Miller  
OpenSSH  
May 24, 2016

**SSH Agent Protocol**  
**draft-miller-ssh-agent-00**

Abstract

This document describes a key agent protocol for use in the Secure Shell (SSH) protocol.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of [BCP 78](#) and [BCP 79](#).

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute working documents as Internet-Drafts. The list of current Internet-Drafts is at <http://datatracker.ietf.org/drafts/current/>.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

This Internet-Draft will expire on November 25, 2016.

Copyright Notice

Copyright (c) 2016 IETF Trust and the persons identified as the document authors. All rights reserved.

This document is subject to [BCP 78](#) and the IETF Trust's Legal Provisions Relating to IETF Documents (<http://trustee.ietf.org/license-info>) in effect on the date of publication of this document. Please review these documents carefully, as they describe your rights and restrictions with respect to this document. Code Components extracted from this document must include Simplified BSD License text as described in Section 4.e of the Trust Legal Provisions and are provided without warranty as described in the Simplified BSD License.

## Table of Contents

|                          |  |                    |
|--------------------------|--|--------------------|
| <a href="#">1.</a>       | <a href="#">Introduction</a>                                   | <a href="#">2</a>  |
| <a href="#">2.</a>       | <a href="#">Requirements Language</a>                          | <a href="#">3</a>  |
| <a href="#">3.</a>       | <a href="#">Protocol Overview</a>                              | <a href="#">3</a>  |
| <a href="#">4.</a>       | <a href="#">Protocol Messages</a>                              | <a href="#">3</a>  |
| <a href="#">4.1.</a>     | <a href="#">Generic server responses</a>                       | <a href="#">3</a>  |
| <a href="#">4.2.</a>     | <a href="#">Adding keys to the agent</a>                       | <a href="#">4</a>  |
| <a href="#">4.2.1.</a>   | <a href="#">DSA keys</a>                                       | <a href="#">4</a>  |
| <a href="#">4.2.2.</a>   | <a href="#">ECDSA keys</a>                                     | <a href="#">5</a>  |
| <a href="#">4.2.3.</a>   | <a href="#">ED25519 keys</a>                                   | <a href="#">5</a>  |
| <a href="#">4.2.4.</a>   | <a href="#">RSA keys</a>                                       | <a href="#">6</a>  |
| <a href="#">4.2.5.</a>   | <a href="#">Adding keys from a token</a>                       | <a href="#">6</a>  |
| <a href="#">4.2.6.</a>   | <a href="#">Key Constraints</a>                                | <a href="#">7</a>  |
| <a href="#">4.2.6.1.</a> | <a href="#">Key lifetime constraint</a>                        | <a href="#">7</a>  |
| <a href="#">4.2.6.2.</a> | <a href="#">Key confirmation constraint</a>                    | <a href="#">8</a>  |
| <a href="#">4.2.6.3.</a> | <a href="#">Constraint extensions</a>                          | <a href="#">8</a>  |
| <a href="#">4.3.</a>     | <a href="#">Removing keys from the agent</a>                   | <a href="#">8</a>  |
| <a href="#">4.4.</a>     | <a href="#">Requesting a list of keys</a>                      | <a href="#">9</a>  |
| <a href="#">4.5.</a>     | <a href="#">Private key operations</a>                         | <a href="#">9</a>  |
| <a href="#">4.5.1.</a>   | <a href="#">Signature flags</a>                                | <a href="#">10</a> |
| <a href="#">4.6.</a>     | <a href="#">Locking and unlocking an agent</a>                 | <a href="#">10</a> |
| <a href="#">4.7.</a>     | <a href="#">Extension mechanism</a>                            | <a href="#">11</a> |
| <a href="#">4.7.1.</a>   | <a href="#">Query extension</a>                                | <a href="#">11</a> |
| <a href="#">5.</a>       | <a href="#">Protocol numbers</a>                               | <a href="#">11</a> |
| <a href="#">5.1.</a>     | <a href="#">Message numbers</a>                                | <a href="#">12</a> |
| <a href="#">5.1.1.</a>   | <a href="#">Reserved message numbers</a>                       | <a href="#">12</a> |
| <a href="#">5.2.</a>     | <a href="#">Constraint identifiers</a>                         | <a href="#">12</a> |
| <a href="#">5.3.</a>     | <a href="#">Signature flags</a>                                | <a href="#">13</a> |
| <a href="#">6.</a>       | <a href="#">Acknowledgements</a>                               | <a href="#">13</a> |
| <a href="#">7.</a>       | <a href="#">IANA Considerations</a>                            | <a href="#">13</a> |
| <a href="#">7.1.</a>     | <a href="#">New registry: SSH agent protocol numbers</a>       | <a href="#">13</a> |
| <a href="#">7.2.</a>     | <a href="#">New registry: SSH agent key constraint numbers</a> | <a href="#">14</a> |
| <a href="#">7.3.</a>     | <a href="#">New registry: SSH agent signature flags</a>        | <a href="#">15</a> |
| <a href="#">8.</a>       | <a href="#">Security Considerations</a>                        | <a href="#">15</a> |
| <a href="#">9.</a>       | <a href="#">Normative References</a>                           | <a href="#">16</a> |
|                          | <a href="#">Author's Address</a>                               | <a href="#">17</a> |

**[1. Introduction](#)**

Secure Shell (SSH) is a protocol for secure remote connections and login over untrusted networks. It supports multiple authentication mechanisms, including public key authentication. This document describes the protocol for interacting with an agent that holds private keys. Clients (and possibly servers) can use invoke the agent via this protocol to perform operations using public and private keys held in the agent.

Miller

Expires November 25, 2016

[Page 2]

Holding keys in an agent offers usability and security advantages to loading and unwrapping them at each use. Moreover, the agent implements a simple protocol and presents a smaller attack surface than a key loaded into a full SSH server or client.

This agent protocol is already widely used and a de-facto standard, having been implemented by a number of popular SSH clients and servers for many years. The purpose of this document is to describe the protocol as it has been implemented.

## **2. Requirements Language**

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

## **3. Protocol Overview**

The agent protocol is a packetised request-response protocol, solely driven by the client. It consists of a number of requests sent from the client to the server and a set of reply messages that are sent in response. At no time does the server send messages except in response to a client request. Replies are sent in order.

All values in the agent protocol are encoded using the SSH wire representations specified by [[RFC4251](#)]. Messages consist of a length and contents. The first byte of the contents always indicates the type of the message.

```
uint32          message length
byte[message length] message contents
```

## **4. Protocol Messages**

### **4.1. Generic server responses**

The following generic messages may be sent by the server in response to requests from the client. On success the agent may reply either with:

```
byte          SSH_AGENT_SUCCESS
```

or a request-specific success message. On failure, the agent may reply with:

```
byte          SSH_AGENT_FAILURE
```



SSH\_AGENT\_FAILURE messages are also sent in reply to requests with unknown types.

#### **4.2. Adding keys to the agent**

Keys may be added to the agent using the SSH\_AGENTC\_ADD\_IDENTITY or SSH\_AGENTC\_ADD\_ID\_CONSTRAINED messages. The latter variant allows adding keys with optional constraints on their usage.

The generic format for the key SSH\_AGENTC\_ADD\_IDENTITY message is:

|        |                         |
|--------|-------------------------|
| byte   | SSH_AGENTC_ADD_IDENTITY |
| string | key type                |
| byte[] | key contents            |
| string | key comment             |

Here "type" is the specified key type name, for example "ssh-rsa" for a RSA key as defined by [[RFC4253](#)]. "contents" consists of the public and private components of the key and vary by key type, they are listed below for standard and commonly used key types. "comment" is an optional human-readable key name or comment as a UTF-8 string that may serve to identify the key in user-visible messages.

The SSH\_AGENTC\_ADD\_ID\_CONSTRAINED is similar, but adds a extra field:

|              |                               |
|--------------|-------------------------------|
| byte         | SSH_AGENTC_ADD_ID_CONSTRAINED |
| string       | type                          |
| byte[]       | contents                      |
| string       | comment                       |
| constraint[] | constraints                   |

Constraints are used to place limits on the validity or use of keys. [Section 4.2.6](#) details constraint types and their format.

An agent should reply with SSH\_AGENT\_SUCCESS if the key was successfully loaded as a result of one of these messages, or SSH\_AGENT\_FAILURE otherwise.

##### **4.2.1. DSA keys**

DSA keys have key type "ssh-dss" and are defined in [[RFC4253](#)]. They may be added to the agent using the following message. The "constraints" field is only present for the SSH\_AGENTC\_ADD\_ID\_CONSTRAINED message.



|              |   |
|--------------|---|
| byte         | SSH_AGENTC_ADD_IDENTITY or<br>SSH_AGENTC_ADD_ID_CONSTRAINED |
| string       | "ssh-dss"   |
| mpint        | p   |
| mpint        | q   |
| mpint        | g   |
| mpint        | y   |
| mpint        | x   |
| string       | comment   |
| constraint[] | constraints   |

The "p", "q", "g" values are the DSA domain parameters. "y" and "x" are the public and private keys respectively. These values are as defined by [[FIPS.186-4](#)].

#### **4.2.2. ECDSA keys**

ECDSA keys have key types starting with "ecdsa-sha2-" and are defined in [[RFC5656](#)]. They may be added to the agent using the following message. The "constraints" field is only present for the SSH\_AGENTC\_ADD\_ID\_CONSTRAINED message.

|              |   |
|--------------|---|
| byte         | SSH_AGENTC_ADD_IDENTITY or<br>SSH_AGENTC_ADD_ID_CONSTRAINED |
| string       | key type  |
| string       | ecdsa_curve_name  |
| string       | Q   |
| mpint        | d   |
| string       | comment   |
| constraint[] | constraints   |

The values "Q" and "d" are the ECDSA public and private values respectively. Both are defined by [[FIPS.186-4](#)].

#### **4.2.3. ED25519 keys**

Ed25519 keys have key type "ssh-ed25519" and are defined in [[I-D.ietf-curdle-ssh-ed25519](#)]. They may be added to the agent using the following message. The "key constraints" field is only present for the SSH\_AGENTC\_ADD\_ID\_CONSTRAINED message.

|              |   |
|--------------|---|
| byte         | SSH_AGENTC_ADD_IDENTITY or<br>SSH_AGENTC_ADD_ID_CONSTRAINED |
| string       | "ssh-ed25519"   |
| string       | ENC(A)  |
| string       | k    ENC(A)   |
| string       | comment   |
| constraint[] | constraints   |



The first value is the 32 byte Ed25519 public key "ENC(A)". The second value is a concatenation of the 32 byte private key "k" and 32 byte public "ENC(A)" key. The contents and interpretation of the "ENC(A)" and "k" values are defined by [[I-D.irtf-cfrg-eddsa](#)].

#### **4.2.4. RSA keys**

RSA keys have key type "ssh-rsa" and are defined in [[RFC4253](#)]. They may be added to the agent using the following message. The "key constraints" field is only present for the SSH\_AGENTC\_ADD\_ID\_CONSTRAINED message.

|              |   |
|--------------|---|
| byte         | SSH_AGENTC_ADD_IDENTITY or<br>SSH_AGENTC_ADD_ID_CONSTRAINED |
| string       | "ssh-rsa"   |
| mpint        | n   |
| mpint        | e   |
| mpint        | d   |
| mpint        | iqmp  |
| mpint        | p   |
| mpint        | q   |
| string       | comment   |
| constraint[] | constraints   |

"n" is the public composite modulus. "p" and "q" are its constituent private prime factors. "e" is the public exponent. "iqmp" is the inverse of "q" modulo "p". All these values except "iqmp" (which can be calculated from the others) are defined by [[FIPS.186-4](#)].

#### **4.2.5. Adding keys from a token**

Keys hosted on smart-cards or other hardware tokens may be added using the SSH\_AGENTC\_ADD\_SMARTCARD\_KEY and SSH\_AGENTC\_ADD\_SMARTCARD\_KEY\_CONSTRAINED requests. Note that "constraints" field is only included for the SSH\_AGENTC\_ADD\_SMARTCARD\_KEY\_CONSTRAINED variant of this message.

|              |   |
|--------------|---|
| byte         | SSH_AGENTC_ADD_SMARTCARD_KEY or<br>SSH_AGENTC_ADD_SMARTCARD_KEY_CONSTRAINED |
| string       | id  |
| string       | PIN   |
| constraint[] | constraints   |

Here "id" is an opaque identifier for the hardware token and "PIN" is an optional password on PIN to unlock the key. The interpretation of "id" is not defined by the protocol but is left solely up to the agent.



Typically only the public components of any keys supported on a hardware token will be loaded into an agent so, strictly speaking, this message really arranges future private key operations to be delegated to the hardware token in question.

An agent should reply with `SSH_AGENT_SUCCESS` if one or more keys were successfully loaded as a result of one of these messages, or `SSH_AGENT_FAILURE` if no keys were found. The agent should also return `SSH_AGENT_FAILURE` if the token "id" was not recognised or if the agent doesn't support token-hosted keys at all.

#### **4.2.6. Key Constraints**

A number of constraints and may be used in the constrained variants of the key add messages. Each constraint is represented by a type byte followed by zero or more value bytes.

Zero or more constraints may be specified when adding a key with one of the `*_CONSTRAINED` requests. Multiple constraints are appended consecutively to the end of the request:

```

byte          constraint1_type
byte[]       constraint1_data
byte         constraint2_type
byte[]       constraint2_data
....
byte         constraintN_type
byte[]       constraintN_data

```

If an agent does not recognise or support a requested constraint it MUST refuse the request and return a `SSH_AGENT_FAILURE` message to the client.

The following constraints are defined.

##### **4.2.6.1. Key lifetime constraint**

This constraint requests that the agent limit the key's lifetime by deleting it after the specified duration (in seconds) has elapsed from the time the key was added to the agent.

```

byte          SSH_AGENT_CONSTRAIN_LIFETIME
uint32        seconds

```



#### 4.2.6.2. Key confirmation constraint

This constraint requests that the agent require explicit user confirmation for each private key operation using the key. For example, the agent could present a confirmation dialog before completing a signature operation.

```
byte                SSH_AGENT_CONSTRAIN_CONFIRM
```

#### 4.2.6.3. Constraint extensions

Agents may implement experimental or private-use constraints through an extension constraint that supports named constraints.

```
byte                SSH_AGENT_CONSTRAIN_EXTENSION
string              extension name
byte[]              extension-specific details
```

The extension name MUST consist of a UTF-8 string suffixed by the implementation domain following the naming scheme defined in [Section 4.2 of \[RFC4251\]](#), e.g. "foo@example.com".

### 4.3. Removing keys from the agent

A client may request that an agent remove all keys that it stores:

```
byte                SSH_AGENTC_REMOVE_ALL_IDENTITIES
```

On receipt of such a message, an agent shall delete all keys that it is holding and reply with SSH\_AGENT\_SUCCESS.

Specific keys may also be removed:

```
byte                SSH_AGENTC_REMOVE_IDENTITY
string              key blob
```

Where "key blob" is the standard public key encoding of the key to be removed. SSH protocol key encodings are defined in [\[RFC4253\]](#) for "ssh-rsa" and "ssh-dss" keys, in [\[RFC5656\]](#) for "ecdsa-sha2-\*" keys and in [\[I-D.ietf-curdle-ssh-ed25519\]](#) for "ssh-ed25519" keys.

An agent shall reply with SSH\_AGENT\_SUCCESS if the key was deleted or SSH\_AGENT\_FAILURE if it was not found.

Smartcard keys may be removed using:



|        |                                 |
|--------|---------------------------------|
| byte   | SSH_AGENTC_REMOVE_SMARTCARD_KEY |
| string | reader id                       |
| string | PIN                             |

Where "reader id" is an opaque identifier for the smartcard reader and "PIN" is an optional password or PIN (not typically used). Requesting deletion of smartcard-hosted keys will cause the agent to remove all keys loaded from that smartcard.

An agent shall reply with SSH\_AGENT\_SUCCESS if the key was deleted or SSH\_AGENT\_FAILURE if it was not found.

#### 4.4. Requesting a list of keys

A client may request a list of keys from an agent using the following message:

|      |                               |
|------|-------------------------------|
| byte | SSH_AGENTC_REQUEST_IDENTITIES |
|------|-------------------------------|

The agent shall reply with a message with the following preamble.

|        |                             |
|--------|-----------------------------|
| byte   | SSH_AGENT_IDENTITIES_ANSWER |
| uint32 | nkeys                       |

Where "nkeys" indicates the number of keys to follow. Following the preamble are zero or more keys, each encoded as:

|        |          |
|--------|----------|
| string | key blob |
| string | comment  |

Where "key blob" is the wire encoding of the public key and "comment" is a human-readable comment encoded as a UTF-8 string.

#### 4.5. Private key operations

A client may request the agent perform a private key signature operation using the following message:

|        |                         |
|--------|-------------------------|
| byte   | SSH_AGENTC_SIGN_REQUEST |
| string | key blob                |
| string | data                    |
| uint32 | flags                   |

Where "key blob" is the key requested to perform the signature, "data" is the data to be signed and "flags" is a bitfield containing the bitwise OR of zero or more signature flags (see below).



If the agent is unable or unwilling to generate the signature (e.g. because it doesn't have the specified key, or the user refused confirmation of a constrained key), it must reply with a SSH\_AGENT\_FAILURE message.

On success, the agent shall reply with:

|        |                         |
|--------|-------------------------|
| byte   | SSH_AGENT_SIGN_RESPONSE |
| string | signature               |

The signature format is specific to the algorithm of the key type in use. SSH protocol signature formats are defined in [RFC4253] for "ssh-rsa" and "ssh-dss" keys, in [RFC5656] for "ecdsa-sha2-\*" keys and in [I-D.ietf-curdle-ssh-ed25519] for "ssh-ed25519" keys.

#### **4.5.1. Signature flags**

Two flags are currently defined for signature request messages: SSH\_AGENT\_RSA\_SHA2\_256 and SSH\_AGENT\_RSA\_SHA2\_512. These two flags are only valid for "ssh-rsa" keys and request that the agent return a signature using the "rsa-sha2-256" or "rsa-sha2-515" signature methods respectively. These signature schemes are defined in [I-D.ietf-curdle-rsa-sha2].

#### **4.6. Locking and unlocking an agent**

The agent protocol supports requesting that an agent temporarily lock itself with a pass-phrase. When locked an agent should suspend processing of sensitive operations (private key operations at the very least) until it has been unlocked with the same pass-phrase.

The following message requests agent locking

|        |                 |
|--------|-----------------|
| byte   | SSH_AGENTC_LOCK |
| string | passphrase      |

The agent shall reply with SSH\_AGENT\_SUCCESS if locked successfully or SSH\_AGENT\_FAILURE otherwise (e.g. if the agent was already locked).

The following message requests unlocking an agent:

|        |                   |
|--------|-------------------|
| byte   | SSH_AGENTC_UNLOCK |
| string | passphrase        |

If the agent is already locked and the pass-phrase matches the one used to lock it then it should unlock and reply with SSH\_AGENT\_SUCCESS. If the agent is unlocked or if the the pass-



phrase does not match it should reply with `SSH_AGENT_FAILURE`. An agent SHOULD take countermeasures against brute-force guessing attacks against the pass-phrase.

#### **4.7. Extension mechanism**

The agent protocol includes an optional extension mechanism that allows vendor-specific and experimental messages to be sent via the agent protocol. Extension requests from the client consist of:

|        |                                   |
|--------|-----------------------------------|
| byte   | <code>SSH_AGENTC_EXTENSION</code> |
| string | extension type                    |
| byte[] | extension contents                |

The extension type indicates the type of the extension message as a UTF-8 string. Implementation-specific extensions should be suffixed by the implementation domain following the extension naming scheme defined in [Section 4.2 of \[RFC4251\]](#), e.g. "foo@example.com".

An agent that does not support extensions of the supplied type MUST reply with an empty `SSH_AGENT_FAILURE` message. This reply is also sent by agents that do not support the extension mechanism at all.

The contents of successful extension reply messages are specific to the extension type. Extension requests may return `SSH_AGENT_SUCCESS` on success or some other extension-specific message.

Extension failure should be signaled using the `SSH_AGENT_EXTENSION_FAILURE` code - extensions should not use the standard `SSH_AGENT_FAILURE` message. This allows failed requests to be distinguished from the extension not being supported.

##### **4.7.1. Query extension**

A single, optional extension request "query" is defined to allow a client to query which, if any, extensions are supported by an agent.

If an agent supports the "query" extension it should reply with a list of supported extension names.

|          |                                |
|----------|--------------------------------|
| byte     | <code>SSH_AGENT_SUCCESS</code> |
| string[] | extension type                 |

## **5. Protocol numbers**



### **5.1. Message numbers**

The following numbers are used for requests from the client to the agent.

|  |    |
|--|----|
| SSH_AGENTC_REQUEST_IDENTITIES            | 11 |
| SSH_AGENTC_SIGN_REQUEST                  | 13 |
| SSH_AGENTC_ADD_IDENTITY                  | 17 |
| SSH_AGENTC_REMOVE_IDENTITY               | 18 |
| SSH_AGENTC_REMOVE_ALL_IDENTITIES         | 19 |
| SSH_AGENTC_ADD_ID_CONSTRAINED            | 25 |
| SSH_AGENTC_ADD_SMARTCARD_KEY             | 20 |
| SSH_AGENTC_REMOVE_SMARTCARD_KEY          | 21 |
| SSH_AGENTC_LOCK                          | 22 |
| SSH_AGENTC_UNLOCK                        | 23 |
| SSH_AGENTC_ADD_SMARTCARD_KEY_CONSTRAINED | 26 |
| SSH_AGENTC_EXTENSION                     | 27 |

The following numbers are used for replies from the agent to the client.

|                             |    |
|-----------------------------|----|
| SSH_AGENT_FAILURE           | 5  |
| SSH_AGENT_SUCCESS           | 6  |
| SSH_AGENT_EXTENSION_FAILURE | 28 |
| SSH_AGENT_IDENTITIES_ANSWER | 12 |
| SSH_AGENT_SIGN_RESPONSE     | 14 |

#### **5.1.1. Reserved message numbers**

The following message numbers are reserved for implementations that implement support for the legacy SSH protocol version 1: 1-4, 7-9 and 24 (inclusive). These message numbers MAY be used by an implementation supporting the legacy protocol but MUST NOT be reused otherwise.

### **5.2. Constraint identifiers**

The following numbers are used to identify key constraints. These are only used in key constraints and are not sent as message numbers.

|                               |   |
|-------------------------------|---|
| SSH_AGENT_CONSTRAIN_LIFETIME  | 1 |
| SSH_AGENT_CONSTRAIN_CONFIRM   | 2 |
| SSH_AGENT_CONSTRAIN_EXTENSION | 3 |



### **5.3. Signature flags**

The following numbers may be present in signature request (SSH\_AGENTC\_SIGN\_REQUEST) messages. These flags form a bit field by taking the logical OR of zero or more flags.

|                        |   |
|------------------------|---|
| SSH_AGENT_RSA_SHA2_256 | 2 |
| SSH_AGENT_RSA_SHA2_512 | 4 |

The flag value 1 is reserved for historical implementations.

### **6. Acknowledgements**

This protocol was designed and first implemented by Markus Friedl, based on a similar protocol for an agent to support the legacy SSH version 1 by Tatu Ylonen.

Thanks to Simon Tatham who reviewed and helped improve this document.

### **7. IANA Considerations**

This protocol requires three registries be established, one for message numbers, one for constraints and one for signature request flags.

#### **7.1. New registry: SSH agent protocol numbers**

This registry, titled "SSH agent protocol numbers" records the message numbers for client requests and agent responses. Its initial state should consist of the following numbers and reservations. Future message number allocations shall require specification in the form of an RFC (RFC REQUIRED as per [[RFC5226](#)]).



| Number | Identifier                               | Reference                   |
|--------|--|-----------------------------|
| 1      | reserved                                 | <a href="#">Section 5.1</a> |
| 2      | reserved                                 | <a href="#">Section 5.1</a> |
| 3      | reserved                                 | <a href="#">Section 5.1</a> |
| 4      | reserved                                 | <a href="#">Section 5.1</a> |
| 5      | SSH_AGENT_FAILURE                        | <a href="#">Section 5.1</a> |
| 6      | SSH_AGENT_SUCCESS                        | <a href="#">Section 5.1</a> |
| 7      | reserved                                 | <a href="#">Section 5.1</a> |
| 8      | reserved                                 | <a href="#">Section 5.1</a> |
| 9      | reserved                                 | <a href="#">Section 5.1</a> |
| 10     | reserved                                 | <a href="#">Section 5.1</a> |
| 11     | SSH_AGENTC_REQUEST_IDENTITIES            | <a href="#">Section 5.1</a> |
| 12     | SSH_AGENT_IDENTITIES_ANSWER              | <a href="#">Section 5.1</a> |
| 13     | SSH_AGENTC_SIGN_REQUEST                  | <a href="#">Section 5.1</a> |
| 14     | SSH_AGENT_SIGN_RESPONSE                  | <a href="#">Section 5.1</a> |
| 15     | reserved                                 | <a href="#">Section 5.1</a> |
| 16     | reserved                                 | <a href="#">Section 5.1</a> |
| 17     | SSH_AGENTC_ADD_IDENTITY                  | <a href="#">Section 5.1</a> |
| 18     | SSH_AGENTC_REMOVE_IDENTITY               | <a href="#">Section 5.1</a> |
| 19     | SSH_AGENTC_REMOVE_ALL_IDENTITIES         | <a href="#">Section 5.1</a> |
| 20     | SSH_AGENTC_ADD_SMARTCARD_KEY             | <a href="#">Section 5.1</a> |
| 21     | SSH_AGENTC_REMOVE_SMARTCARD_KEY          | <a href="#">Section 5.1</a> |
| 22     | SSH_AGENTC_LOCK                          | <a href="#">Section 5.1</a> |
| 23     | SSH_AGENTC_UNLOCK                        | <a href="#">Section 5.1</a> |
| 24     | reserved                                 | <a href="#">Section 5.1</a> |
| 25     | SSH_AGENTC_ADD_ID_CONSTRAINED            | <a href="#">Section 5.1</a> |
| 26     | SSH_AGENTC_ADD_SMARTCARD_KEY_CONSTRAINED | <a href="#">Section 5.1</a> |
| 27     | SSH_AGENTC_EXTENSION                     | <a href="#">Section 5.1</a> |
| 28     | SSH_AGENT_EXTENSION_FAILURE              | <a href="#">Section 5.1</a> |

Initial registry state: SSH agent protocol numbers

**7.2. New registry: SSH agent key constraint numbers**

This registry, titled "SSH agent key constraint numbers" records the message numbers for key use constraints. Its initial state should consist of the following numbers. Future constraint number allocations shall require specification in the form of an RFC (RFC REQUIRED as per [[RFC5226](#)]).

| Number | Identifier                    | Reference                   |
|--------|-------------------------------|-----------------------------|
| 1      | SSH_AGENT_CONSTRAIN_LIFETIME  | <a href="#">Section 5.2</a> |
| 2      | SSH_AGENT_CONSTRAIN_CONFIRM   | <a href="#">Section 5.2</a> |
| 3      | SSH_AGENT_CONSTRAIN_EXTENSION | <a href="#">Section 5.2</a> |

Initial registry state: SSH agent key constraint numbers



**7.3. New registry: SSH agent signature flags**

This registry, titled "SSH agent signature flags records the values for signature request (SSH\_AGENTC\_SIGN\_REQUEST) flag values. Its initial state should consist of the following numbers. Note that as the flags are combined by bitwise OR, all flag values must be powers of two and the maximum available flag value is 0x80000000.

Future constraint number allocations shall require specification in the form of an RFC (RFC REQUIRED as per [[RFC5226](#)]).

| Number | Identifier             | Reference                   |
|--------|------------------------|-----------------------------|
| 0x01   | reserved               | <a href="#">Section 5.3</a> |
| 0x02   | SSH_AGENT_RSA_SHA2_256 | <a href="#">Section 5.3</a> |
| 0x04   | SSH_AGENT_RSA_SHA2_512 | <a href="#">Section 5.3</a> |

Initial registry state: SSH agent signature flags

**8. Security Considerations**

The agent is a service that is tasked with retaining and providing controlled access to what are typically long-lived login authentication credentials. It is by nature a sensitive and trusted software component. Moreover, the agent protocol itself does not include any authentication or transport security; ability to communicate with an agent is usually sufficient to invoke it to perform private key operations.

Since being able to access an agent is usually sufficient to perform private key operations, it is critically important that the agent only be exposed to its owner.

The primary design intention of an agent is that an attacker with unprivileged access to their victim's agent should be prevented from gaining a copy of any keys that have been loaded in to it. This may not preclude the attacker from stealing use of those keys (e.g. if they have been loaded without a confirmation constraint).

Given this, the agent should, as far as possible, prevent its memory being read by other processes to direct theft of loaded keys. This typically include disabling debugging interfaces and preventing process memory dumps on abnormal termination.

Another, more subtle, means by which keys may be stolen are via cryptographic side-channels. Private key operations may leak information about the contents of keys via differences in timing, power use or by side-effects in the memory subsystems (e.g. CPU



caches) of the host running the agent. For the case of a local attacker and an agent holding unconstrained keys, the only limit on the number of private key operations the attacker may be able to observe is the rate at which the CPU can perform signatures. This grants the attacker an almost ideal oracle for side-channel attacks. While a full treatment of side-channel attacks is beyond the scope of this specification, agents SHOULD use cryptographic implementations that are resistant to side-channel attacks.

## 9. Normative References

[FIPS.186-4]

National Institute of Standards and Technology, "Digital Signature Standard (DSS)", FIPS PUB 186-4, July 2013.

[I-D.ietf-curdle-rsa-sha2]

bider, d., "Use of RSA Keys with SHA-2 256 and 512 in Secure Shell (SSH)", [draft-ietf-curdle-rsa-sha2-00](#) (work in progress), March 2016.

[I-D.ietf-curdle-ssh-ed25519]

Harris, B., "Ed25519 public key algorithm for the Secure Shell (SSH) protocol", [draft-ietf-curdle-ssh-ed25519-00](#) (work in progress), May 2016.

[I-D.irtf-cfrg-eddsa]

Josefsson, S. and I. Liusvaara, "Edwards-curve Digital Signature Algorithm (EdDSA)", [draft-irtf-cfrg-eddsa-05](#) (work in progress), March 2016.

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

[RFC4251] Ylonen, T. and C. Lonvick, Ed., "The Secure Shell (SSH) Protocol Architecture", [RFC 4251](#), DOI 10.17487/RFC4251, January 2006, <<http://www.rfc-editor.org/info/rfc4251>>.

[RFC4253] Ylonen, T. and C. Lonvick, Ed., "The Secure Shell (SSH) Transport Layer Protocol", [RFC 4253](#), DOI 10.17487/RFC4253, January 2006, <<http://www.rfc-editor.org/info/rfc4253>>.

[RFC5226] Narten, T. and H. Alvestrand, "Guidelines for Writing an IANA Considerations Section in RFCs", [BCP 26](#), [RFC 5226](#), DOI 10.17487/RFC5226, May 2008, <<http://www.rfc-editor.org/info/rfc5226>>.



[RFC5656] Stebila, D. and J. Green, "Elliptic Curve Algorithm Integration in the Secure Shell Transport Layer", [RFC 5656](#), DOI 10.17487/RFC5656, December 2009, <<http://www.rfc-editor.org/info/rfc5656>>.

## Author's Address

Damien Miller  
OpenSSH

Email: [djm@openssh.com](mailto:djm@openssh.com)

URI: <http://www.openssh.com/>