

**SSH Connection Protocol**  
**draft-ietf-secsh-connect-24.txt**

Status of this Memo

This document is an Internet-Draft and is subject to all provisions of [Section 3 of RFC 3667](#). By submitting this Internet-Draft, each author represents that any applicable patent or other IPR claims of which he or she is aware have been or will be disclosed, and any of which he or she become aware will be disclosed, in accordance with [RFC 3668](#).

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF), its areas, and its working groups. Note that other groups may also distribute working documents as Internet-Drafts.

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."

The list of current Internet-Drafts can be accessed at <http://www.ietf.org/ietf/1id-abstracts.txt>.

The list of Internet-Draft Shadow Directories can be accessed at <http://www.ietf.org/shadow.html>.

This Internet-Draft will expire on August 21, 2005.

Copyright Notice

Copyright (C) The Internet Society (2005).

Abstract

SSH is a protocol for secure remote login and other secure network services over an insecure network.

This document describes the SSH Connection Protocol. It provides interactive login sessions, remote execution of commands, forwarded TCP/IP connections, and forwarded X11 connections. All of these channels are multiplexed into a single encrypted tunnel.

The SSH Connection Protocol has been designed to run on top of the SSH transport layer and user authentication protocols.

## Table of Contents

<a href="#">1.</a>	<a href="#">Contributors</a>	<a href="#">3</a>
<a href="#">2.</a>	<a href="#">Introduction</a>	<a href="#">3</a>
<a href="#">3.</a>	<a href="#">Conventions Used in This Document</a>	<a href="#">3</a>
<a href="#">4.</a>	<a href="#">Global Requests</a>	<a href="#">4</a>
<a href="#">5.</a>	<a href="#">Channel Mechanism</a>	<a href="#">5</a>
<a href="#">5.1</a>	<a href="#">Opening a Channel</a>	<a href="#">5</a>
<a href="#">5.2</a>	<a href="#">Data Transfer</a>	<a href="#">7</a>
<a href="#">5.3</a>	<a href="#">Closing a Channel</a>	<a href="#">8</a>
<a href="#">5.4</a>	<a href="#">Channel-Specific Requests</a>	<a href="#">9</a>
<a href="#">6.</a>	<a href="#">Interactive Sessions</a>	<a href="#">10</a>
<a href="#">6.1</a>	<a href="#">Opening a Session</a>	<a href="#">10</a>
<a href="#">6.2</a>	<a href="#">Requesting a Pseudo-Terminal</a>	<a href="#">10</a>
<a href="#">6.3</a>	<a href="#">X11 Forwarding</a>	<a href="#">11</a>
<a href="#">6.3.1</a>	<a href="#">Requesting X11 Forwarding</a>	<a href="#">11</a>
<a href="#">6.3.2</a>	<a href="#">X11 Channels</a>	<a href="#">11</a>
<a href="#">6.4</a>	<a href="#">Environment Variable Passing</a>	<a href="#">12</a>
<a href="#">6.5</a>	<a href="#">Starting a Shell or a Command</a>	<a href="#">12</a>
<a href="#">6.6</a>	<a href="#">Session Data Transfer</a>	<a href="#">13</a>
<a href="#">6.7</a>	<a href="#">Window Dimension Change Message</a>	<a href="#">13</a>
<a href="#">6.8</a>	<a href="#">Local Flow Control</a>	<a href="#">14</a>
<a href="#">6.9</a>	<a href="#">Signals</a>	<a href="#">14</a>
<a href="#">6.10</a>	<a href="#">Returning Exit Status</a>	<a href="#">14</a>
<a href="#">7.</a>	<a href="#">TCP/IP Port Forwarding</a>	<a href="#">16</a>
<a href="#">7.1</a>	<a href="#">Requesting Port Forwarding</a>	<a href="#">16</a>
<a href="#">7.2</a>	<a href="#">TCP/IP Forwarding Channels</a>	<a href="#">17</a>
<a href="#">8.</a>	<a href="#">Encoding of Terminal Modes</a>	<a href="#">18</a>
<a href="#">9.</a>	<a href="#">Summary of Message Numbers</a>	<a href="#">20</a>
<a href="#">10.</a>	<a href="#">IANA Considerations</a>	<a href="#">21</a>
<a href="#">11.</a>	<a href="#">Security Considerations</a>	<a href="#">21</a>
<a href="#">12.</a>	<a href="#">References</a>	<a href="#">21</a>
<a href="#">12.1</a>	<a href="#">Normative References</a>	<a href="#">21</a>
<a href="#">12.2</a>	<a href="#">Informative References</a>	<a href="#">22</a>
	<a href="#">Author's Address</a>	<a href="#">22</a>
	<a href="#">Intellectual Property and Copyright Statements</a>	<a href="#">23</a>



## **1. Contributors**

The major original contributors of this set of documents have been: Tatu Ylonen, Tero Kivinen, Timo J. Rinne, Sami Lehtinen (all of SSH Communications Security Corp), and Markku-Juhani O. Saarinen (University of Jyväskylä). Darren Moffit was the original editor of this set of documents and also made very substantial contributions.

Additional contributors to this document include [need list]. Listing their names here does not mean that they endorse this document, but that they have contributed to it.

Comments on this internet draft should be sent to the IETF SECSH working group, details at:  
<http://ietf.org/html.charters/secsh-charter.html> Note: This paragraph will be removed before this document progresses to become an RFC.

## **2. Introduction**

The SSH Connection Protocol has been designed to run on top of the SSH transport layer and user authentication protocols. It provides interactive login sessions, remote execution of commands, forwarded TCP/IP connections, and forwarded X11 connections. The service name for this protocol is "ssh-connection".

This document should be read only after reading the SSH architecture document [[SSH-ARCH](#)]. This document freely uses terminology and notation from the architecture document without reference or further explanation.

## **3. Conventions Used in This Document**

All documents related to the SSH protocols shall use the keywords "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" to describe requirements. These keywords are to be interpreted as described in [[RFC2119](#)].

The keywords "PRIVATE USE", "HIERARCHICAL ALLOCATION", "FIRST COME FIRST SERVED", "EXPERT REVIEW", "SPECIFICATION REQUIRED", "IESG APPROVAL", "IETF CONSENSUS", and "STANDARDS ACTION" that appear in this document when used to describe namespace allocation are to be interpreted as described in [[RFC2434](#)].

Protocol fields and possible values to fill them are defined in this set of documents. Protocol fields will be defined in the message definitions. As an example, SSH\_MSG\_CHANNEL\_DATA is defined as follows.



```
byte      SSH_MSG_CHANNEL_DATA
uint32    recipient channel
string    data
```

Throughout these documents, when the fields are referenced, they will appear within single quotes. When values to fill those fields are referenced, they will appear within double quotes. Using the above example, possible values for 'data' are "foo" and "bar".

#### 4. Global Requests

There are several kinds of requests that affect the state of the remote end globally, independent of any channels. An example is a request to start TCP/IP forwarding for a specific port. Note that both client and server MAY send global requests at any time, and the receiver MUST respond appropriately. All such requests use the following format.

```
byte      SSH_MSG_GLOBAL_REQUEST
string    request name in US-ASCII only
boolean   want reply
... request-specific data follows
```

The value of 'request name' follows the DNS extensibility naming convention outlined in [[SSH-ARCH](#)].

The recipient will respond to this message with SSH\_MSG\_REQUEST\_SUCCESS or SSH\_MSG\_REQUEST\_FAILURE if 'want reply' is TRUE.

```
byte      SSH_MSG_REQUEST_SUCCESS
.....    response specific data
```

Usually the 'response specific data' is non-existent.

If the recipient does not recognize or support the request, it simply responds with SSH\_MSG\_REQUEST\_FAILURE.

```
byte      SSH_MSG_REQUEST_FAILURE
```

In general, the reply messages do not include request type identifiers. To make it possible for the originator of a request to identify to which request each reply refers, it is REQUIRED that replies to SSH\_MSG\_GLOBAL\_REQUESTS MUST be sent in the same order as the corresponding request messages. For channel requests, replies that relate to the same channel MUST also be replied to in the right order. However, channel requests for distinct channels MAY be replied to out-of-order.



## 5. Channel Mechanism

All terminal sessions, forwarded connections, etc., are channels. Either side may open a channel. Multiple channels are multiplexed into a single connection.

Channels are identified by numbers at each end. The number referring to a channel may be different on each side. Requests to open a channel contain the sender's channel number. Any other channel-related messages contain the recipient's channel number for the channel.

Channels are flow-controlled. No data may be sent to a channel until a message is received to indicate that window space is available.

### 5.1 Opening a Channel

When either side wishes to open a new channel, it allocates a local number for the channel. It then sends the following message to the other side, and includes the local channel number and initial window size in the message.

```
byte      SSH_MSG_CHANNEL_OPEN
string     channel type in US-ASCII only
uint32     sender channel
uint32     initial window size
uint32     maximum packet size
... channel type specific data follows
```

The 'channel type' is a name as described in [[SSH-ARCH](#)] and [[SSH-NUMBERS](#)], with similar extension mechanisms. The 'sender channel' is a local identifier for the channel used by the sender of this message. The 'initial window size' specifies how many bytes of channel data can be sent to the sender of this message without adjusting the window. The 'maximum packet size' specifies the maximum size of an individual data packet that can be sent to the sender. For example: one might want to use smaller packets for interactive connections to get better interactive response on slow links.

The remote side then decides whether it can open the channel, and responds with either `SSH_MSG_CHANNEL_OPEN_CONFIRMATION` or `SSH_MSG_CHANNEL_OPEN_FAILURE`.

```
byte      SSH_MSG_CHANNEL_OPEN_CONFIRMATION
uint32     recipient channel
uint32     sender channel
```





```

uint32    initial window size
uint32    maximum packet size
... 'channel type' specific data follows

```

The 'recipient channel' is the channel number given in the original open request, and 'sender channel' is the channel number allocated by the other side.

```

byte      SSH_MSG_CHANNEL_OPEN_FAILURE
uint32    recipient channel
uint32    reason code
string    description in ISO-10646 UTF-8 encoding [RFC3629]
string    language tag as defined in [RFC3066]

```

If the recipient of the SSH\_MSG\_CHANNEL\_OPEN message does not support the specified 'channel type', it simply responds with SSH\_MSG\_CHANNEL\_OPEN\_FAILURE. The client MAY show the 'description' string to the user. If this is done, the client software should take the precautions discussed in [[SSH-ARCH](#)].

The SSH\_MSG\_CHANNEL\_OPEN\_FAILURE 'reason code' values are defined in the following table. Note that the values for the 'reason code' are given in decimal format for readability but that they are actually uint32 values.

Symbolic name	reason code
-----	-----
SSH_OPEN_ADMINISTRATIVELY_PROHIBITED	1
SSH_OPEN_CONNECT_FAILED	2
SSH_OPEN_UNKNOWN_CHANNEL_TYPE	3
SSH_OPEN_RESOURCE_SHORTAGE	4

Requests for assignments of new SSH\_MSG\_CHANNEL\_OPEN 'reason code' values (and associated 'description' text) in the range of 0x00000005 to 0xFDFFFFFF MUST be done through the IETF CONSENSUS method as described in [[RFC2434](#)]. The IANA will not assign Channel Connection Failure 'reason code' values in the range of 0xFE000000 to 0xFFFFFFFF. Channel Connection Failure 'reason code' values in that range are left for PRIVATE USE as described in [[RFC2434](#)].

While it is understood that the IANA will have no control over the range of 0xFE000000 to 0xFFFFFFFF, this range will be split in two parts and administered by the following conventions.

- o The range of 0xFE000000 to 0xFEFFFFFF is to be used in conjunction with locally assigned channels. For example: if a channel is proposed with a 'channel type' of "example\_session@example.com" but fails, then the response will contain either a 'reason code' assigned by the IANA (as listed above and in the range of



0x00000001 to 0xFDFDFDFD), or with a locally assigned value in the range of 0xFE000000 to 0xFEFFFFFF. Naturally, if the server does not understand the proposed 'channel type', even if it is a locally defined 'channel type', then the 'reason code' MUST be 0x00000003 as described above, if the 'reason code' is sent. If the server does understand the 'channel type' but the channel still fails to open, then the server SHOULD respond with a locally assigned 'reason code' value consistent with the proposed, local 'channel type'. It is assumed that practitioners will first attempt to use the IANA assigned 'reason code' values and then document their locally assigned 'reason code' values.

- o There are no restrictions or suggestions for the range starting with 0xFF. No interoperability is expected for anything used in this range. Essentially it is for experimentation.

## 5.2 Data Transfer

The window size specifies how many bytes the other party can send before it must wait for the window to be adjusted. Both parties use the following message to adjust the window.

byte	SSH_MSG_CHANNEL_WINDOW_ADJUST
uint32	recipient channel
uint32	bytes to add

After receiving this message, the recipient MAY send the given number of bytes more than it was previously allowed to send; the window size is incremented.

Data transfer is done with messages of the following type.

byte	SSH_MSG_CHANNEL_DATA
uint32	recipient channel
string	data

The maximum amount of data allowed is the current window size. The window size is decremented by the amount of data sent. Both parties MAY ignore all extra data sent after the allowed window is empty.

Additionally, some channels can transfer several types of data. An example of this is stderr data from interactive sessions. Such data can be passed with SSH\_MSG\_CHANNEL\_EXTENDED\_DATA messages, where a separate integer specifies the type of the data. The available types and their interpretation depend on the type of the channel.

byte	SSH_MSG_CHANNEL_EXTENDED_DATA
uint32	recipient_channel
uint32	data_type_code



string     data

Data sent with these messages consumes the same window as ordinary data.

Currently, only the following type is defined. Note that the value for the 'data\_type\_code' is given in decimal format for readability but that the values are actually uint32 values.

Symbolic name	data_type_code
-----	-----
SSH_EXTENDED_DATA_STDERR	1

Extended Channel Data Transfer 'data\_type\_code' values MUST be assigned sequentially. Requests for assignments of new Extended Channel Data Transfer 'data\_type\_code' values, and their associated Extended Channel Data Transfer 'data' strings, in the range of 0x00000002 to 0xFDFDFDFD MUST be done through the IETF CONSENSUS method as described in [[RFC2434](#)]. The IANA will not assign Extended Channel Data Transfer 'data\_type\_code' values in the range of 0xFE000000 to 0xFFFFFFFF. Extended Channel Data Transfer 'data\_type\_code' values in that range are left for PRIVATE USE as described in [[RFC2434](#)]. As is noted, the actual instructions to the IANA are in [[SSH-NUMBERS](#)].

### 5.3 Closing a Channel

When a party will no longer send more data to a channel, it SHOULD send SSH\_MSG\_CHANNEL\_EOF.

byte        SSH\_MSG\_CHANNEL\_EOF  
uint32      recipient\_channel

No explicit response is sent to this message. However, the application may send EOF to whatever is at the other end of the channel. Note that the channel remains open after this message, and more data may still be sent in the other direction. This message does not consume window space and can be sent even if no window space is available.

When either party wishes to terminate the channel, it sends SSH\_MSG\_CHANNEL\_CLOSE. Upon receiving this message, a party MUST send back a SSH\_MSG\_CHANNEL\_CLOSE unless it has already sent this message for the channel. The channel is considered closed for a party when it has both sent and received SSH\_MSG\_CHANNEL\_CLOSE, and the party may then reuse the channel number. A party MAY send SSH\_MSG\_CHANNEL\_CLOSE without having sent or received SSH\_MSG\_CHANNEL\_EOF.



```
byte      SSH_MSG_CHANNEL_CLOSE
uint32    recipient_channel
```

This message does not consume window space and can be sent even if no window space is available.

It is recommended that any data sent before this message is delivered to the actual destination, if possible.

#### 5.4 Channel-Specific Requests

Many 'channel type' values have extensions that are specific to that particular 'channel type'. An example is requesting a pty (pseudo terminal) for an interactive session.

All channel-specific requests use the following format.

```
byte      SSH_MSG_CHANNEL_REQUEST
uint32    recipient channel
string    request type in US-ASCII characters only
boolean   want reply
... type-specific data
```

If 'want reply' is FALSE, no response will be sent to the request. Otherwise, the recipient responds with either SSH\_MSG\_CHANNEL\_SUCCESS or SSH\_MSG\_CHANNEL\_FAILURE, or request-specific continuation messages. If the request is not recognized or is not supported for the channel, SSH\_MSG\_CHANNEL\_FAILURE is returned.

This message does not consume window space and can be sent even if no window space is available. The values of 'request type' are local to each channel type.

The client is allowed to send further messages without waiting for the response to the request.

'request type' names follow the DNS extensibility naming convention outlined in [[SSH-ARCH](#)] and [[SSH-NUMBERS](#)].

```
byte      SSH_MSG_CHANNEL_SUCCESS
uint32    recipient_channel
```

```
byte      SSH_MSG_CHANNEL_FAILURE
uint32    recipient_channel
```

These messages do not consume window space and can be sent even if no window space is available.





## **6. Interactive Sessions**

A session is a remote execution of a program. The program may be a shell, an application, a system command, or some built-in subsystem. It may or may not have a tty, and may or may not involve X11 forwarding. Multiple sessions can be active simultaneously.

### **6.1 Opening a Session**

A session is started by sending the following message.

byte	SSH_MSG_CHANNEL_OPEN
string	"session"
uint32	sender channel
uint32	initial window size
uint32	maximum packet size

Client implementations SHOULD reject any session channel open requests to make it more difficult for a corrupt server to attack the client.

### **6.2 Requesting a Pseudo-Terminal**

A pseudo-terminal can be allocated for the session by sending the following message.

byte	SSH_MSG_CHANNEL_REQUEST
uint32	recipient_channel
string	"pty-req"
boolean	want_reply
string	TERM environment variable value (e.g., vt100)
uint32	terminal width, characters (e.g., 80)
uint32	terminal height, rows (e.g., 24)
uint32	terminal width, pixels (e.g., 640)
uint32	terminal height, pixels (e.g., 480)
string	encoded terminal modes

The 'encoded terminal modes' are described in [Section 8](#). Zero dimension parameters MUST be ignored. The character/row dimensions override the pixel dimensions (when nonzero). Pixel dimensions refer to the drawable area of the window.

The dimension parameters are only informational.

The client SHOULD ignore pty requests.



### [6.3](#) X11 Forwarding

#### [6.3.1](#) Requesting X11 Forwarding

X11 forwarding may be requested for a session by sending a `SSH_MSG_CHANNEL_REQUEST` message.

byte	<code>SSH_MSG_CHANNEL_REQUEST</code>
uint32	recipient channel
string	"x11-req"
boolean	want reply
boolean	single connection
string	x11 authentication protocol
string	x11 authentication cookie
uint32	x11 screen number

It is RECOMMENDED that the 'x11 authentication cookie' that is sent be a fake, random cookie, and that the cookie is checked and replaced by the real cookie when a connection request is received.

X11 connection forwarding should stop when the session channel is closed. However, already opened forwardings should not be automatically closed when the session channel is closed.

If 'single connection' is TRUE, only a single connection should be forwarded. No more connections will be forwarded after the first, or after the session channel has been closed.

The 'x11 authentication protocol' is the name of the X11 authentication method used, e.g., "MIT-MAGIC-COOKIE-1".

The 'x11 authentication cookie' MUST be hexadecimal encoded.

The X Protocol is documented in [[SCHEIFLER](#)].

#### [6.3.2](#) X11 Channels

X11 channels are opened with a channel open request. The resulting channels are independent of the session, and closing the session channel does not close the forwarded X11 channels.

byte	<code>SSH_MSG_CHANNEL_OPEN</code>
string	"x11"
uint32	sender channel
uint32	initial window size
uint32	maximum packet size
string	originator address (e.g., "192.168.7.38")



uint32     originator port

The recipient should respond with SSH\_MSG\_CHANNEL\_OPEN\_CONFIRMATION or SSH\_MSG\_CHANNEL\_OPEN\_FAILURE.

Implementations MUST reject any X11 channel open requests if they have not requested X11 forwarding.

#### **6.4 Environment Variable Passing**

Environment variables may be passed to the shell/command to be started later. Uncontrolled setting of environment variables in a privileged process can be a security hazard. It is recommended that implementations either maintain a list of allowable variable names or only set environment variables after the server process has dropped sufficient privileges.

byte       SSH\_MSG\_CHANNEL\_REQUEST  
uint32     recipient channel  
string     "env"  
boolean    want reply  
string     variable name  
string     variable value

#### **6.5 Starting a Shell or a Command**

Once the session has been set up, a program is started at the remote end. The program can be a shell, an application program or a subsystem with a host-independent name. Only one of these requests can succeed per channel.

byte       SSH\_MSG\_CHANNEL\_REQUEST  
uint32     recipient channel  
string     "shell"  
boolean    want reply

This message will request the user's default shell (typically defined in /etc/passwd in UNIX systems) to be started at the other end.

byte       SSH\_MSG\_CHANNEL\_REQUEST  
uint32     recipient channel  
string     "exec"  
boolean    want reply  
string     command

This message will request the server to start the execution of the given command. The 'command' string may contain a path. Normal



precautions MUST be taken to prevent the execution of unauthorized commands.

byte	SSH_MSG_CHANNEL_REQUEST
uint32	recipient channel
string	"subsystem"
boolean	want reply
string	subsystem name

This last form executes a predefined subsystem. It is expected that these will include a general file transfer mechanism, and possibly other features. Implementations may also allow configuring more such mechanisms. As the user's shell is usually used to execute the subsystem, it is advisable for the subsystem protocol to have a "magic cookie" at the beginning of the protocol transaction to distinguish it from arbitrary output generated by shell initialization scripts, etc. This spurious output from the shell may be filtered out either at the server or at the client.

The server SHOULD NOT halt the execution of the protocol stack when starting a shell or a program. All input and output from these SHOULD be redirected to the channel or to the encrypted tunnel.

It is RECOMMENDED to request and check the reply for these messages. The client SHOULD ignore these messages.

Subsystem names follow the DNS extensibility naming convention outlined in [[SSH-NUMBERS](#)].

## **6.6 Session Data Transfer**

Data transfer for a session is done using SSH\_MSG\_CHANNEL\_DATA and SSH\_MSG\_CHANNEL\_EXTENDED\_DATA packets and the window mechanism. The extended data type SSH\_EXTENDED\_DATA\_STDERR has been defined for stderr data.

## **6.7 Window Dimension Change Message**

When the window (terminal) size changes on the client side, it MAY send a message to the other side to inform it of the new dimensions.

byte	SSH_MSG_CHANNEL_REQUEST
uint32	recipient_channel
string	"window-change"
boolean	FALSE
uint32	terminal width, columns
uint32	terminal height, rows
uint32	terminal width, pixels





uint32      terminal height, pixels

A response SHOULD NOT be sent to this message.

### **6.8 Local Flow Control**

On many systems, it is possible to determine if a pseudo-terminal is using control-S/control-Q flow control. When flow control is allowed, it is often desirable to do the flow control at the client end to speed up responses to user requests. This is facilitated by the following notification. Initially, the server is responsible for flow control. (Here, again, client means the side originating the session, and server means the other side.)

The message below is used by the server to inform the client when it can or cannot perform flow control (control-S/control-Q processing). If 'client can do' is TRUE, the client is allowed to do flow control using control-S and control-Q. The client MAY ignore this message.

byte          SSH\_MSG\_CHANNEL\_REQUEST  
uint32       recipient channel  
string        "xon-xoff"  
boolean       FALSE  
boolean       client can do

No response is sent to this message.

### **6.9 Signals**

A signal can be delivered to the remote process/service using the following message. Some systems may not implement signals, in which case they SHOULD ignore this message.

byte          SSH\_MSG\_CHANNEL\_REQUEST  
uint32       recipient channel  
string        "signal"  
boolean       FALSE  
string        signal name without the "SIG" prefix.

Signal names will be encoded as discussed in the "exit-signal" SSH\_MSG\_CHANNEL\_REQUEST.

### **6.10 Returning Exit Status**

When the command running at the other end terminates, the following message can be sent to return the exit status of the command. Returning the status is RECOMMENDED. No acknowledgment is sent for this message. The channel needs to be closed with



SSH\_MSG\_CHANNEL\_CLOSE after this message.

The client MAY ignore these messages.

byte	SSH_MSG_CHANNEL_REQUEST
uint32	recipient_channel
string	"exit-status"
boolean	FALSE
uint32	exit_status

The remote command may also terminate violently due to a signal. Such a condition can be indicated by the following message. A zero 'exit\_status' usually means that the command terminated successfully.

o byte	SSH_MSG_CHANNEL_REQUEST
o uint32	recipient channel
o string	"exit-signal"
o boolean	FALSE
o string	signal name without the "SIG" prefix.
o boolean	core dumped
o string	error message in ISO-10646 UTF-8 encoding
o string	language tag as defined in [ <a href="#">RFC3066</a> ]

The 'signal name' is one of the following (these are from [[POSIX](#)])

ABRT  
ALRM  
FPE  
HUP  
ILL  
INT  
KILL  
PIPE  
QUIT  
SEGV  
TERM  
USR1  
USR2

Additional 'signal name' values MAY be sent in the format "sig-name@xyz", where "sig-name" and "xyz" may be anything a particular implementor wants (except the "@" sign). However, it is suggested that if a 'configure' script is used, any non-standard 'signal name' values it finds be encoded as "SIG@xyz.config.guess", where "SIG" is the 'signal name' without the "SIG" prefix, and "xyz" be the host type, as determined by "config.guess".

The 'error message' contains an additional textual explanation of the error message. The message may consist of multiple lines. The



client software MAY display this message to the user. If this is done, the client software should take the precautions discussed in [\[SSH-ARCH\]](#).

## **7. TCP/IP Port Forwarding**

### **7.1 Requesting Port Forwarding**

A party need not explicitly request forwardings from its own end to the other direction. However, if it wishes that connections to a port on the other side be forwarded to the local side, it must explicitly request this.

byte	SSH_MSG_GLOBAL_REQUEST
string	"tcpip-forward"
boolean	want reply
string	address to bind (e.g., "0.0.0.0")
uint32	port number to bind

The 'address to bind' and 'port number to bind' specify the IP address or domain name and port to which the socket to be listened is bound. Some strings used for the 'address to bind' have special-case semantics.

- o "" means that connections are to be accepted on all protocol families supported by the SSH implementation.
- o "0.0.0.0" means to listen on all IPv4 addresses.
- o ":::" means to listen on all IPv6 addresses.
- o "localhost" means to listen on all protocol families supported by the SSH implementation on loopback addresses only, [\[RFC3330\]](#) and [\[RFC3513\]](#).
- o "127.0.0.1" and ":::1" indicate listening on the loopback interfaces for IPv4 and IPv6 respectively.

Note that the client can still filter connections based on information passed in the open request.

Implementations should only allow forwarding privileged ports if the user has been authenticated as a privileged user.

Client implementations SHOULD reject these messages; they are normally only sent by the client.

If a client passes 0 as port number to bind and has 'want reply' TRUE then the server allocates the next available unprivileged port number and replies with the following message, otherwise there is no response specific data.



```
byte      SSH_MSG_REQUEST_SUCCESS
uint32    port that was bound on the server
```

A port forwarding can be canceled with the following message. Note that channel open requests may be received until a reply to this message is received.

```
byte      SSH_MSG_GLOBAL_REQUEST
string     "cancel-tcpip-forward"
boolean    want reply
string     address_to_bind (e.g., "127.0.0.1")
uint32     port number to bind
```

Client implementations SHOULD reject these messages; they are normally only sent by the client.

## **7.2 TCP/IP Forwarding Channels**

When a connection comes to a port for which remote forwarding has been requested, a channel is opened to forward the port to the other side.

```
byte      SSH_MSG_CHANNEL_OPEN
string     "forwarded-tcpip"
uint32     sender channel
uint32     initial window size
uint32     maximum packet size
string     address that was connected
uint32     port that was connected
string     originator IP address
uint32     originator port
```

Implementations MUST reject these messages unless they have previously requested a remote TCP/IP port forwarding with the given port number.

When a connection comes to a locally forwarded TCP/IP port, the following packet is sent to the other side. Note that these messages MAY be sent also for ports for which no forwarding has been explicitly requested. The receiving side must decide whether to allow the forwarding.

```
byte      SSH_MSG_CHANNEL_OPEN
string     "direct-tcpip"
uint32     sender channel
uint32     initial window size
uint32     maximum packet size
string     host to connect
uint32     port to connect
```





```
string    originator IP address
uint32    originator port
```

The 'host to connect' and 'port to connect' specify the TCP/IP host and port where the recipient should connect the channel. The 'host to connect' may be either a domain name or a numeric IP address.

The 'originator IP address' is the numeric IP address of the machine where the connection request comes from, and the 'originator port' is the port on the originator host from where the connection originated.

Forwarded TCP/IP channels are independent of any sessions, and closing a session channel does not in any way imply that forwarded connections should be closed.

Client implementations SHOULD reject direct TCP/IP open requests for security reasons.

## **8. Encoding of Terminal Modes**

All "encoded terminal modes" (as passed in a pty request) are encoded into a byte stream. It is intended that the coding be portable across different environments.

The tty mode description is a stream of bytes. The stream consists of opcode-argument pairs where the opcode is a byte value. It is terminated by opcode TTY\_OP\_END (0x00). Opcodes 1 to 159 have a single uint32 argument. Opcodes 160 to 255 are not yet defined, and cause parsing to stop (they should only be used after any other data).

The client SHOULD put in the stream any modes it knows about, and the server MAY ignore any modes it does not know about. This allows some degree of machine-independence, at least between systems that use a POSIX-like tty interface. The protocol can support other systems as well, but the client may need to fill reasonable values for a number of parameters so the server pty gets set to a reasonable mode (the server leaves all unspecified mode bits in their default values, and only some combinations make sense).

The naming of opcode values mostly follows the POSIX terminal mode flags. The following opcode values have been defined. Note that the values given below are in decimal format for readability but that they are actually byte values.

opcode	argument	description
-----	-----	-----
0	TTY_OP_END	Indicates end of options.



1	VINTR	Interrupt character; 255 if none. Similarly for the other characters. Not all of these characters are supported on all systems.
2	VQUIT	The quit character (sends SIGQUIT signal on POSIX systems).
3	VERASE	Erase the character to left of the cursor.
4	VKILL	Kill the current input line.
5	VEOF	End-of-file character (sends EOF from the terminal).
6	VEOL	End-of-line character in addition to carriage return and/or linefeed.
7	VEOL2	Additional end-of-line character.
8	VSTART	Continues paused output (normally control-Q).
9	VSTOP	Pauses output (normally control-S).
10	VSUSP	Suspends the current program.
11	VDSUSP	Another suspend character.
12	VREPRINT	Reprints the current input line.
13	VWERASE	Erases a word left of cursor.
14	VLNEXT	Enter the next character typed literally, even if it is a special character
15	VFLUSH	Character to flush output.
16	VSWTCH	Switch to a different shell layer.
17	VSTATUS	Prints system status line (load, command, pid, etc).
18	VDISCARD	Toggles the flushing of terminal output.
30	IGNPAR	The ignore parity flag. The parameter SHOULD be 0 if this flag is FALSE, and 1 if it is TRUE.
31	PARMRK	Mark parity and framing errors.
32	INPCK	Enable checking of parity errors.
33	ISTRIP	Strip 8th bit off characters.
34	INLCR	Map NL into CR on input.
35	IGNCR	Ignore CR on input.
36	ICRNL	Map CR to NL on input.
37	IUCLC	Translate uppercase characters to lowercase.
38	IXON	Enable output flow control.
39	IXANY	Any char will restart after stop.
40	IXOFF	Enable input flow control.
41	IMAXBEL	Ring bell on input queue full.
50	ISIG	Enable signals INTR, QUIT, [D]SUSP.
51	ICANON	Canonicalize input lines.
52	XCASE	Enable input and output of uppercase characters by preceding their lowercase equivalents with "\".
53	ECHO	Enable echoing.
54	ECHOE	Visually erase chars.



55	ECHOK	Kill character discards current line.
56	ECHONL	Echo NL even if ECHO is off.
57	NOFLSH	Don't flush after interrupt.
58	TOSTOP	Stop background jobs from output.
59	IEXTEN	Enable extensions.
60	ECHOCTL	Echo control characters as ^(Char).
61	ECHOK	Visual erase for line kill.
62	PENDIN	Retype pending input.
70	OPOST	Enable output processing.
71	OLCUC	Convert lowercase to uppercase.
72	ONLCR	Map NL to CR-NL.
73	OCRNL	Translate carriage return to newline (output).
74	ONOCR	Translate newline to carriage return-newline (output).
75	ONLRET	Newline performs a carriage return (output).
90	CS7	7 bit mode.
91	CS8	8 bit mode.
92	PARENB	Parity enable.
93	PARODD	Odd parity, else even.
128	TTY_OP_ISPEED	Specifies the input baud rate in bits per second.
129	TTY_OP_OSPEED	Specifies the output baud rate in bits per second.

## 9. Summary of Message Numbers

The following is a summary of messages and their associated message number.

SSH_MSG_GLOBAL_REQUEST	80
SSH_MSG_REQUEST_SUCCESS	81
SSH_MSG_REQUEST_FAILURE	82
SSH_MSG_CHANNEL_OPEN	90
SSH_MSG_CHANNEL_OPEN_CONFIRMATION	91
SSH_MSG_CHANNEL_OPEN_FAILURE	92
SSH_MSG_CHANNEL_WINDOW_ADJUST	93
SSH_MSG_CHANNEL_DATA	94
SSH_MSG_CHANNEL_EXTENDED_DATA	95
SSH_MSG_CHANNEL_EOF	96
SSH_MSG_CHANNEL_CLOSE	97
SSH_MSG_CHANNEL_REQUEST	98
SSH_MSG_CHANNEL_SUCCESS	99
SSH_MSG_CHANNEL_FAILURE	100



## **10. IANA Considerations**

This document is part of a set. The IANA considerations for the SSH protocol as defined in [[SSH-ARCH](#)], [[SSH-TRANS](#)], [[SSH-USERAUTH](#)], and this document, are detailed in [[SSH-NUMBERS](#)].

## **11. Security Considerations**

This protocol is assumed to run on top of a secure, authenticated transport. User authentication and protection against network-level attacks are assumed to be provided by the underlying protocols.

Full security considerations for this protocol are provided in [[SSH-ARCH](#)]. Specific to this document, it is RECOMMENDED that implementations disable all the potentially dangerous features (e.g., agent forwarding, X11 forwarding, and TCP/IP forwarding) if the host key has changed without notice or explanation.

## **12. References**

### **12.1 Normative References**

[SSH-ARCH]

Lonvick, C., "SSH Protocol Architecture",  
I-D [draft-ietf-secsh-architecture-21.txt](#), February 2005.

[SSH-TRANS]

Lonvick, C., "SSH Transport Layer Protocol",  
I-D [draft-ietf-secsh-transport-23.txt](#), February 2005.

[SSH-USERAUTH]

Lonvick, C., "SSH Authentication Protocol",  
I-D [draft-ietf-secsh-userauth-26.txt](#), February 2005.

[SSH-NUMBERS]

Lonvick, C., "SSH Protocol Assigned Numbers",  
I-D [draft-ietf-secsh-assignednumbers-11.txt](#), February 2005.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [BCP 14](#), [RFC 2119](#), March 1997.

[RFC2434] Narten, T. and H. Alvestrand, "Guidelines for Writing an IANA Considerations Section in RFCs", [BCP 26](#), [RFC 2434](#), October 1998.

[RFC3066] Alvestrand, H., "Tags for the Identification of Languages", [BCP 47](#), [RFC 3066](#), January 2001.





- [RFC3629] Yergeau, F., "UTF-8, a transformation format of ISO 10646", STD 63, [RFC 3629](#), November 2003.

## **[12.2](#) Informative References**

- [RFC1884] Hinden, R. and S. Deering, "IP Version 6 Addressing Architecture", [RFC 1884](#), December 1995.
- [RFC3330] IANA, "Special-Use IPv4 Addresses", [RFC 3330](#), September 2002.
- [RFC3513] Hinden, R. and S. Deering, "Internet Protocol Version 6 (IPv6) Addressing Architecture", [RFC 3513](#), April 2003.
- [SCHEIFLER]  
Scheifler, R., "X Window System : The Complete Reference to Xlib, X Protocol, Icccm, Xlfd, 3rd edition.", Digital Press ISBN 1555580882, February 1992.
- [POSIX] ISO/IEC, 9945-1., "Information technology -- Portable Operating System Interface (POSIX)-Part 1: System Application Program Interface (API) C Language", ANSI/IEEE Std 1003.1, July 1996.

### Author's Address

Chris Lonvick (editor)  
Cisco Systems, Inc.  
12515 Research Blvd.  
Austin 78759  
USA

Email: [clonvick@cisco.com](mailto:clonvick@cisco.com)



## Intellectual Property Statement

The IETF takes no position regarding the validity or scope of any Intellectual Property Rights or other rights that might be claimed to pertain to the implementation or use of the technology described in this document or the extent to which any license under such rights might or might not be available; nor does it represent that it has made any independent effort to identify any such rights. Information on the procedures with respect to rights in RFC documents can be found in [BCP 78](#) and [BCP 79](#).

Copies of IPR disclosures made to the IETF Secretariat and any assurances of licenses to be made available, or the result of an attempt made to obtain a general license or permission for the use of such proprietary rights by implementers or users of this specification can be obtained from the IETF on-line IPR repository at <http://www.ietf.org/ipr>.

The IETF invites any interested party to bring to its attention any copyrights, patents or patent applications, or other proprietary rights that may cover technology that may be required to implement this standard. Please address the information to the IETF at [ietf-ipr@ietf.org](mailto:ietf-ipr@ietf.org).

The IETF has been notified of intellectual property rights claimed in regard to some or all of the specification contained in this document. For more information consult the online list of claimed rights.

## Disclaimer of Validity

This document and the information contained herein are provided on an "AS IS" basis and THE CONTRIBUTOR, THE ORGANIZATION HE/SHE REPRESENTS OR IS SPONSORED BY (IF ANY), THE INTERNET SOCIETY AND THE INTERNET ENGINEERING TASK FORCE DISCLAIM ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY THAT THE USE OF THE INFORMATION HEREIN WILL NOT INFRINGE ANY RIGHTS OR ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

## Copyright Statement

Copyright (C) The Internet Society (2005). This document is subject to the rights, licenses and restrictions contained in [BCP 78](#), and except as set forth therein, the authors retain all their rights.



#### Acknowledgment

Funding for the RFC Editor function is currently provided by the Internet Society.