

SSH, SCP, and SFTP

REST EASY

SSH offers a secure approach to working on remote machines and encrypted data transfer. We'll show you other benefits of the secure shell. **BY HEIKE JURZIK**

SSH stands for “secure shell” and refers to both the protocol and the program itself. The OpenSSH [1] program suite, developed by the OpenBSD project, offers users a free SSH alternative with everything necessary to use encrypted connections on many operating systems: command-line tools for working on remote machines, the ability to execute programs remotely (including graphical applications via X11 forwarding) or to tunnel Internet services via SSH (and thus secure a connection against sniffing), tools for secure file copying, and more. Table 1 gives you an overview of the major applications.

OpenSSH is a mainstay of any recent Linux distribution, so installation is quite straightforward. Most systems offer separate packages for the client and the server. Although the client typically is pre-installed, setting up the server often is necessary if you want to access your Linux computer via SSH from another machine. Searching for *openssh* in your package manager should reveal the correct package.

In this article, I will investigate the use of hostkeys, how to verify hostkey fingerprints, how to manage private keys

with the SSH agent (including temporary management), how to tunnel SSH connections with the integrated SOCKS proxy, and how to transfer data interactively via secure ftp.

Hostkey

On first establishing contact, the other end of the connection reveals its public hostkey fingerprint (Figure 1). When warned that the authenticity of the machine has not been verified, you need to

say *yes*, and then you will be prompted to enter the password.

The remote system's hostkeys are stored in the `~/.ssh/known_hosts` file. The next time you log in to the machine, SSH will check to see whether the key is unchanged and, if not, will refuse to cooperate: *WARNING: REMOTE HOST IDENTIFICATION HAS CHANGED!*. This example could be a deliberate attempt at a man-in-the-middle attack, but a changed hostkey often has a more harm-

Table 1: OpenSSH Suite

| Program | Function |
|--------------------|--|
| <i>ssh</i> | The command-line client establishes encrypted connections to remote machines and will run commands on these machines if needed. |
| <i>scp</i> | To copy files (non-interactively) locally to or from remote computers, you can use <i>scp</i> (“secure copy”). |
| <i>sftp</i> | The ftp client (“secure ftp”) supports interactive copying. Like other command-line ftp clients, the tool offers many other options in addition to copying, such as changing and listing directories, modifying permissions, deleting directories and files, and more. |
| <i>sshd</i> | The SSH server is implemented as a daemon and listens on port 22 by default. SSH clients establish connections to the <i>sshd</i> . |
| <i>ssh-keygen</i> | The <i>ssh-keygen</i> tool is used for creating and converting SSH keys. |
| <i>ssh-keysign</i> | The tool <i>ssh-keysign</i> is used for host-based authentication. |
| <i>ssh-keyscan</i> | This application displays public hostkeys and appends them to the <code>~/.ssh/known_hosts</code> file. |
| <i>ssh-agent</i> | The SSH agent manages private SSH keys and simplifies password handling. |
| <i>ssh-add</i> | The <i>ssh-add</i> tool introduces the <i>ssh-agent</i> to new keys. |

less explanation: The administrator changed the key or reinstalled the system. If you are sure that the explanation is harmless, you can launch a text editor, open the `~/.ssh/known_hosts` file, and delete the entry in question.

The `/etc/ssh` directory stores both the private and public hostkeys. If an administrator has published the public key fingerprint (`/etc/ssh/ssh_host_rsa_key.pub`), you can verify the fingerprint on initial contact before accepting the connection. The `ssh-keygen` tool helps verify the fingerprint. Set the `-l` option to display the fingerprint for the public key that you are prompted to specify.

If, for example, a user called *petronella* wants to log in from a machine called *samesame* (Figure 1), and the administrator – on a machine called *macnugget* – wants to verify the hostkey fingerprint, the administrator would follow the steps in Listing 1.

Agent X Is Watching

Creating an SSH key, and thus supporting authentication without entering a password, might save typing but could also compromise security. Local, private keys are not safeguarded, which opens up the gates to an attacker should keys go astray.

By managing your private keys, the `ssh-agent` program gives you a more sensible approach. At the start of an `ssh-agent` session, you only need to enter your password once per key.

The versatile agent will run in the background as a daemon or you can call it like any normal program. Using the `-t` option, you can set a timer for the `ssh-agent` as an extra security feature. After the preset period has elapsed, the agent will forget any keywords it has stored; just specify the password lifetime with the `-t` parameter. `ssh-agent` understands various units: no unit or *s* means

Listing 1: Verify Hostkey Fingerprint

```
01 nonumber
02 # ssh-keygen -l
03 Enter file in which the key is
  (/root/.ssh/id_rsa): /etc/
  ssh/ssh_host_rsa_key
04 2048 a0:0a:aa:3b:d3:08:
  f1:90:45:4f:48:c9:f6:cb:92:37
  /etc/ssh/ssh_host_rsa_key.pub
```



Figure 1: On initial login, the remote machine uses its hostkey to identify itself.

seconds, *m* minutes, *h* hours, *d* days, and *w* weeks.

To launch the agent as an independent daemon and configure the agent to forget any keys you have added after two days, enter:

```
ssh-agent -t 2d
```

The output shows what values to set for the environment variables `SSH_AUTH_SOCK` and `SSH_AGENT_PID` for `ssh-agent` to work properly. To evaluate the output, you can either copy the program output and paste it or use `eval` when you launch the program:

```
$ eval $(ssh-agent -t 2d)
```

On launch, the program reveals its process ID, as confirmed by the subsequent call to `ps` (Figure 2). Even if you close the shell, the agent will not terminate on its own.

To terminate the program, you need to call `ssh-agent -k` in the shell in which you launched `ssh-agent`. If you can't do so – because the calling shell is no longer running, for example – your only option is the `kill` command:

```
$ kill 29692
```

To run `ssh-agent` with an application – such as a terminal program – rather than as a daemon, specify the name of the executable at the command line,

```
$ ssh-agent gnome-terminal &
```

which restricts the agent to this application and any programs launched in it. If you quit the terminal, this automatically terminates the `ssh-agent` and removes any key information it used.

Be aware that some distributions, including the current crop of Debian versions, launches the `ssh-agent` program with the X environment. Calling `ps | grep`, as shown in Figure 2, is the best

way to check for this. Loading keys into the agent without time restrictions and then forgetting to lock the screen can mean security exposure. To rid your system of this bad habit, you might want to modify your `/etc/X11/Xsession.options` file and comment out the line

```
use-ssh-agent
```

by inserting a pound sign (`#`) at the start of the line.

Keys for Agents

After launching the agent, you need to add your private keys. The `ssh-add` program takes care of this. Without any additional parameters, you can call the tool and let it automatically search the `~/.ssh` directory for private keys and request an identity for the password, or you can pass in a key file:

```
$ ssh-add ~/.ssh/id_dsa
```

By typing the matching password, the agent will output a success message (Listing 2).

Again, an option (`-t`) can provide more security. Just as when starting (`ssh-agent`), you can use this parameter to specify how long the agent should keep the keys. The command in line 1 of Listing 3 sets the timer to 10 minutes. The `-l` option returns a list of private keys managed by the agent (line 5).

The output shows the size (1,024 bits) and the fingerprint for the key you just added. Now you can launch SSH sessions from this shell (and from other sessions by setting the two environmental

Listing 2: Matching Password

```
01 Enter passphrase for /home/
  petronella/.ssh/id_dsa:
02 Identity added: /home/
  petronella/.ssh/id_dsa (/
  home/petronella/.ssh/id_dsa)
```

variables `SSH_AUTH_SOCK` and `SSH_AGENT_PID`) and log in to target machines without entering a password. The `-d` option, in combination with the key file name, removes the key (Listing 3, line 7). To remove all identities in one fell swoop, specify the `-D` option instead.

Light at the End

The secure shell gives you an option for securing other Internet services against sniffing via tunneling. To secure an otherwise-unencrypted protocol (such as POP3), forwarding TCP/IP connections to a remote machine by means of an encrypted protocol makes sense. The use of SSH as a SOCKS proxy is another elegant application that lets users transfer encrypted data via a web browser. Setting up a tunnel to a proxy also avoids web content censorship, which is a useful feature in countries that block some websites. If you have a shell account on a machine in a less restrictive country, this approach can give you unimpeded web access.

To start, enable the proxy with the SSH `-D` option, and at the same time pass in a freely selectable port number. In this scenario, the `-f` and `-N` parameters also are useful. The former pushes `ssh` into the background after logging in and before executing commands, and the latter tells `ssh` that no commands are to follow; for example:

```
$ ssh -fN -D 1080 <i>Proxy<i>
```

After entering the password, the prompt reappears and the shell is ready to accept further instructions. That's all there is to it – the SOCKS proxy is waiting for something to do.

The next step is to set up the SSH client as a SOCKS proxy in the network configuration for the program in question. If this is the Firefox web browser, you can select *Edit | Preferences* and go to *General | Network*.

In *Connection*, click *Settings*, enable the manual proxy configuration, enter the IP address `127.0.0.1` and the port you previously selected in the *SOCKS Host* field. SOCKS versions 4 and 5 are available; when in doubt, check the `ssh` man page to see which version your SSH installation supports. After accepting these changes in Firefox, you can type an address in your browser's address box

```
petronella@transpluto:~$ ssh-agent -t 2d
SSH_AUTH_SOCK=/tmp/ssh-zYnIa29691/agent.29691; export SSH_AUTH_SOCK;
SSH_AGENT_PID=29692; export SSH_AGENT_PID;
echo Agent pid 29692;
petronella@transpluto:~$ SSH_AUTH_SOCK=/tmp/ssh-zYnIa29691/agent.29691; export S
SSH_AUTH_SOCK;
petronella@transpluto:~$ SSH_AGENT_PID=29692; export SSH_AGENT_PID;
petronella@transpluto:~$ ps auxww | grep ssh-agent
1000  29692  0.0  0.0  4132  656 ?        Ss   23:56   0:00 ssh-agent -t 2d
1000  29700  0.0  0.0  3548  748 pts/2    R+   23:56   0:00 grep --color ss
h-agent
petronella@transpluto:~$
```

Figure 2: `ssh-agent` requires various environmental variables and discloses its PID when starting.

to verify the connection: `http://www.my-ipaddress.com/`; you should see the IP for the remote machine.

Interactive with sftp

In contrast to `scp`, users work interactively with `sftp`, just as in any “normal” ftp session. Secure ftp does not expect an ftp server at the other end of the connection, but rather an SSH daemon and, thus, a shell account. As with SSH, set up a connection to the target computer at the command line:

```
$ sftp huhn@macnugget
```

After entering your password, you will see the `sftp >` prompt, which tells you that the program is ready and waiting for further input.

The `sftp` program is not much different from those used by other shell-based ftp clients; however, you can't set the transfer mode (ASCII or binary) before trans-

ferring data because files are sent as-is across the network.

Secure ftp also has some advanced functions for modifying file permissions and ownership. For a comprehensive overview of the available commands, see the `help` command.

Some practical command-line options facilitate working with `sftp`. For example, the `-C` parameter for enabling data compression not only is available for `ssh` and `scp`, but also for `sftp`. The `-b <file>` option lets you pass in a batch file with the commands you want to run to `sftp`; however, this will work only if you do not need to enter a password to log in.

If you are interested in a graphical client for `sftp`, the answer is quite simple: Both KDE's Konqueror and Gnome's Nautilus support `sftp` perfectly. Just enter the following in the address line of either application,

```
sftp://user@rechner
```

and then authenticate with the correct password to use `sftp`, just like your local file manager. ■

Listing 3: Remove the Key

```
01 donumber
02 $ ssh-add -t 10m ~/.ssh/id_dsa
03 Enter passphrase for /home/
   petronella/.ssh/id_dsa:
04 Identity added: /home/
   petronella/.ssh/id_dsa (/
   home/petronella/.ssh/id_dsa)
05 Lifetime set to 600 seconds
06 $ ssh-add -l
07 1024 f3:c9:b6:5d:23:3a:9d:61:
   50:19:63:3c:e8:22:7c:86 /
   home/petronella/.ssh/id_dsa
   (DSA)
08 $ ssh-add -d /home/
   petronella/.ssh/id_dsa
09 Identity removed: /home/
   petronella/.ssh/id_dsa (/
   home/petronella/.ssh/id_dsa.
   pub)
```

INFO

[1] Free SSH implementation, OpenSSH:
<http://openssh.org>

THE AUTHOR

Heike Jurzik studied German, Computer Science and English at the University of Cologne, Germany. She discovered Linux in 1996 and has been fascinated with the scope of the Linux command line ever since. In her leisure time you might find Heike hanging out at Irish folk sessions or visiting Ireland.

