Steve Friedl UNIXWIZ.NET

Steve Friedl's Unixwiz.net Tech Tips

Secure Linux/UNIX access with PuTTY and OpenSSH

Many users have implemented Secure Shell (ssh) to provide protected access to a remote Linux system, but don't realize that by allowing password authentication, they are still open to brute-force attacks from anywhere on the internet. There are worms running rampant on the internet which do an effective job finding weak username/password combinations, and these are not stopped by the use of Secure Shell.

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This Tech Tip details how to use the free PuTTY SSH client to connect to a Linux system running the OpenSSH server, all while using public key encryption and SSH agent support.

Much of this information applies to any OpenSSH installation on any UNIX system - Solaris, *BSD, OpenServer - but we've targetted this to the Linux platform when specifics are called for.

Installation and simple config/login

Providing for full passwordless, agent-based access requires a lot of steps, so we'll approach this in steps by first providing for regular passworded access to the system. This allows for testing of the initial installation and the ability to login before enabling the more advanced features.

Download and install the programs

Unlike most Windows programs, the PuTTY suite does not require an installer: the individual **.EXE** files are simply dropped into a directory where they are run directly. We admire the economy and style which PuTTY's author demonstrates.

The files can be dropped into any directory which is in the user's command path, and we normally use **C:\BIN** (see the next item for how configure this).

Five files should be downloaded from the PuTTY site:

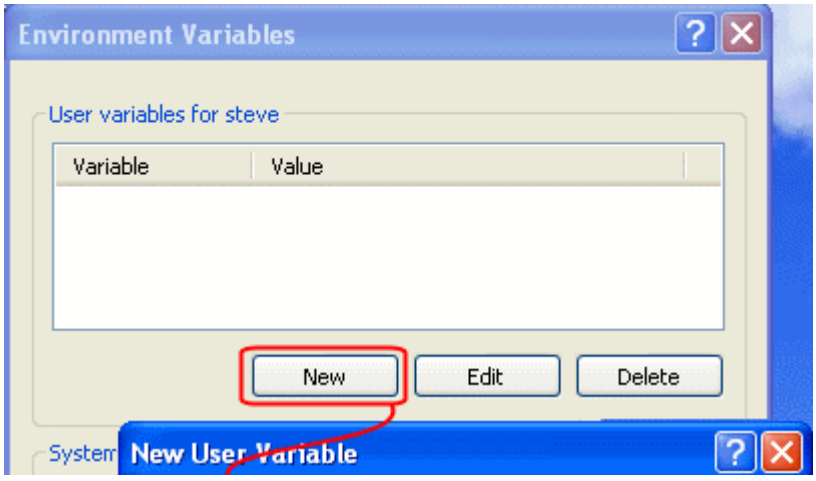
- **PuTTY.exe** — Secure Shell client
- **PuTTYgen.exe** — SSH public/private key generator
- **Pagent.exe** — SSH key agent
- **PSCP.exe** — Secure Copy from command line
- **PSFTP.exe** — Secure Copy with FTP-like interface

Insure the installation directory is in the command path

Though it's possible to run PuTTY with a full path or shortcut, in practice it's helpful when it's fully available at the CMD prompt to access or copy files from anywhere in the filesystem.

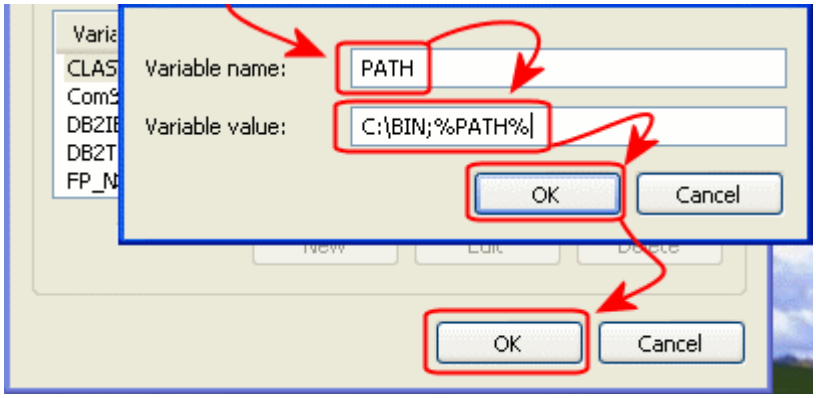
Right-click on **My Computer** on the desktop and select **Properties**. Click the **Advanced** tab at the top, then click the **Environment Variables** button. This brings up the dialog box shown on the right.

There is always **PATH** variable in the "System Variables" section, and sometimes in the "User Variables" section as well. Only administrators have access to System Variables, so



Edit or Add the PATH as required.

We typically put the new directory at the start of the path, and it's separated from the rest of the list with a semicolon. Click **OK** to save all the changes.



Create a shortcut on the desktop

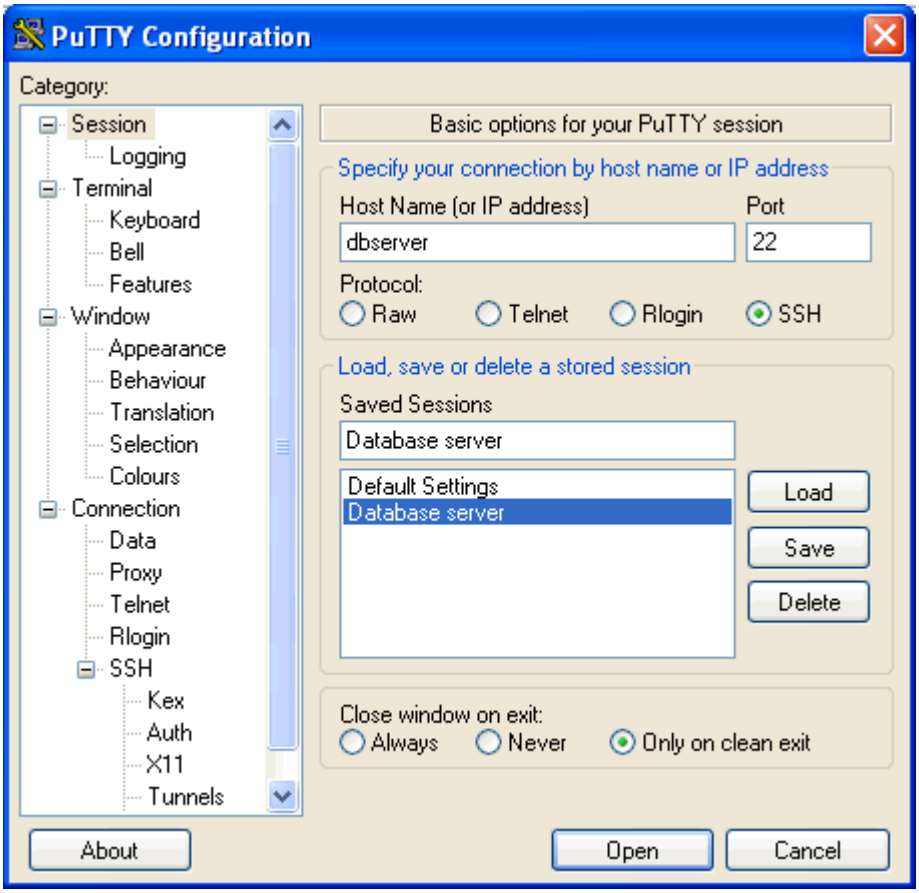
PuTTY is often used heavily by an IT worker, so it's helpful to have a shortcut on the desktop to make for easy access. To add this, right-click on the desktop and click **New** + **Shortcut**. Either Browse to, or type in the name of, the path of the PuTTY executable. In our example, it's been **C:\bin\putty.exe**. Click OK and give the shortcut a convenient name.

Launch PuTTY and configure for the target system

Launch PuTTY via the shortcut, and it will display the configuration dialog box: there are many options here. We'll fill in several to provide for passworded access to the system, then configure for public-key access later.

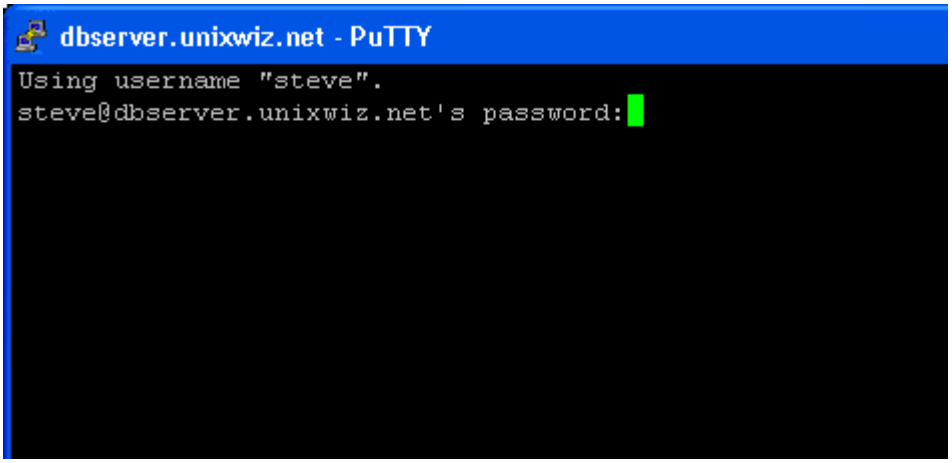
- **Category:**
  - Hostname: ***dbserver***
  - Protocol: (*) SSH
- **Connection : Data**
  - Auto-login username: ***steve***
- **Connection : SSH**
  - Preferred SSH Protocol Version: (*) 2 Only

Once these simple settings have been entered, they can be saved to make for easy access next time. Click **Session** on the left, then enter a name in **Saved Sessions** - this name will usually be related to the machine you're connecting to. Click **Save** to store these settings in the Registry: we've chosen the name **Database server**.



Login!

With the saved settings from the previous step, we'd like to use them to connect to the target system. Launch PuTTY (if not already open), and in the **Session** section, click on the name of the saved session and click **Load**. Click **Open** to launch the connection.



When prompted, enter the password for your account on the remote system, and if correct, you'll receive a shell. Now you may begin working on the system.

However - every time PuTTY connects with a server, it exchanges identification in the form of host keys. If the host key is unknown, or doesn't match what we've seen previously, it warns the user. For unknown hosts, this is mostly a *pro forma* operation, but for previously-known systems it may suggest that the host is not the same one as originally connected.

Host keys which have changed without warning can occur when the target operating system is reinstalled without restoring the host keys from backup, or it could be something more nefarious such as a rogue host masquerading as the genuine one.

One should always inquire into unexpectedly-changed host keys

Creating and using multiple sessions

When the user only needs to connect with one system, it's possible to program in these parameters into the Default Session, but it's much more common to access multiple systems. With a bit of setup, we can easily create and connect to these systems with one click.

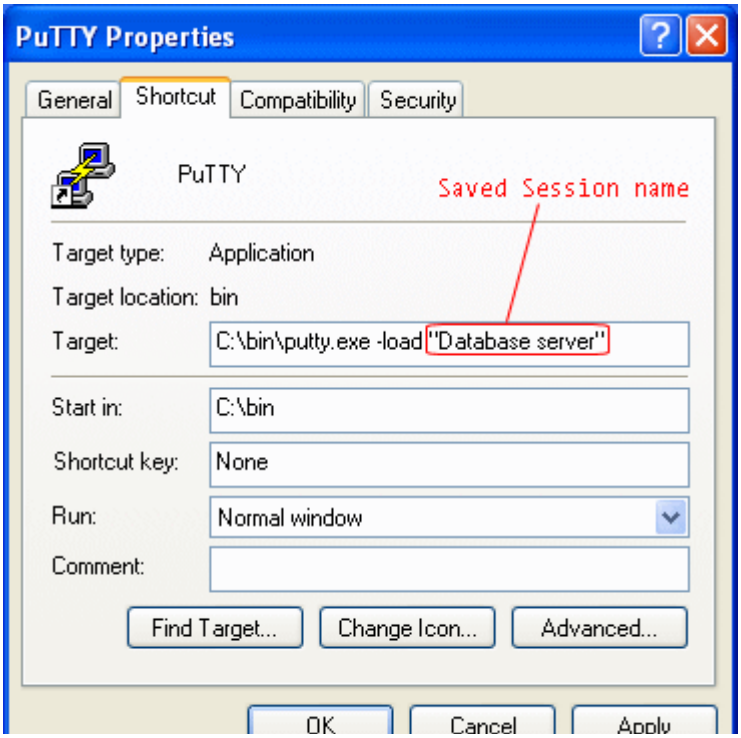
Create and save the sessions

As we did in the previous section, create and save as many named sessions as needed, and make a note of the session names. These names can be referenced on the command line with the **-load** parameter, and can be embedded into the shortcut.

Right-click on the shortcut and select Properties, then enter the parameter **-load** along with the name of the session (in quotes, if necessary). Click OK to save the shortcut properties.

It's also a good idea to rename the shortcut to reflect the name of the server it's connecting to: right-click on the shortcut and select **Rename**.

Once the session shortcut is fully configured, double-clicking the icon launches the connection. Create as many pre-programmed shortcuts as needed.



Create and install a public/private keypair

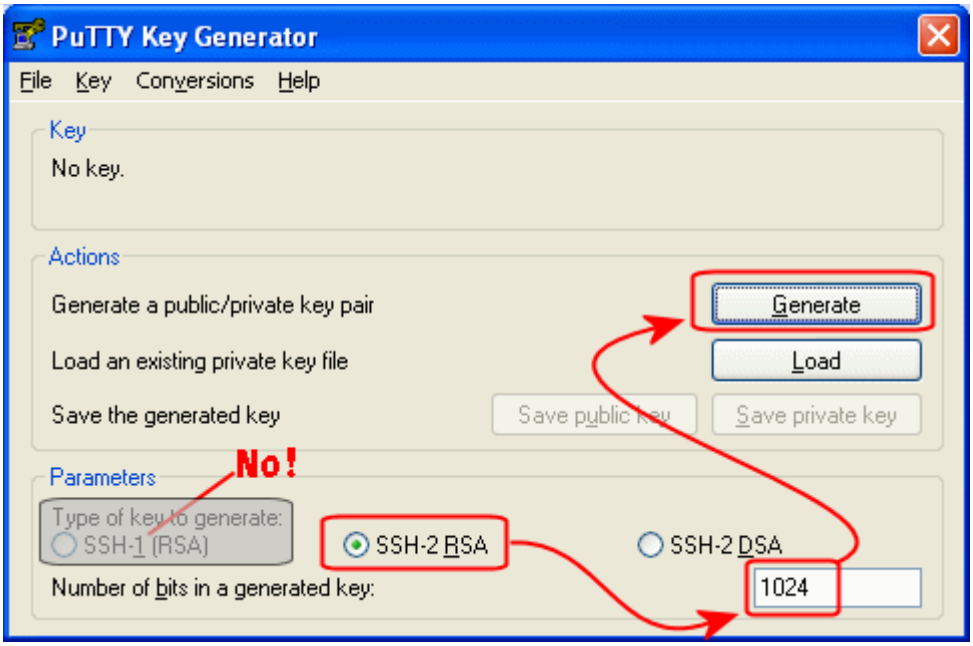
The real power of Secure Shell comes into play when public/private keys are used. Unlike password authentication, public key access is done by performing a one-time creation of a pair of very long binary numbers which are mathematically related.

The initial configuration step is moderately involved, but need be done only once: once created, the key can be easily installed on as many remote systems as desired.

Run PuTTYgen

A pair of public/private keys — small files containing very large binary numbers — is required, and PuTTYgen does this. It's run just one time to create a personal pair of keys, which are then installed wherever needed.

Click **Start**, then **Run**, then enter **puttygen** in the command-line box. This displays the main dialog box, shown on the right. Select the key parameters as shown, then click **Generate**. One can choose either an RSA or a DSA key (we don't believe the difference is terribly significant), but do not create an SSH version 1 key of any kind: they're not secure.

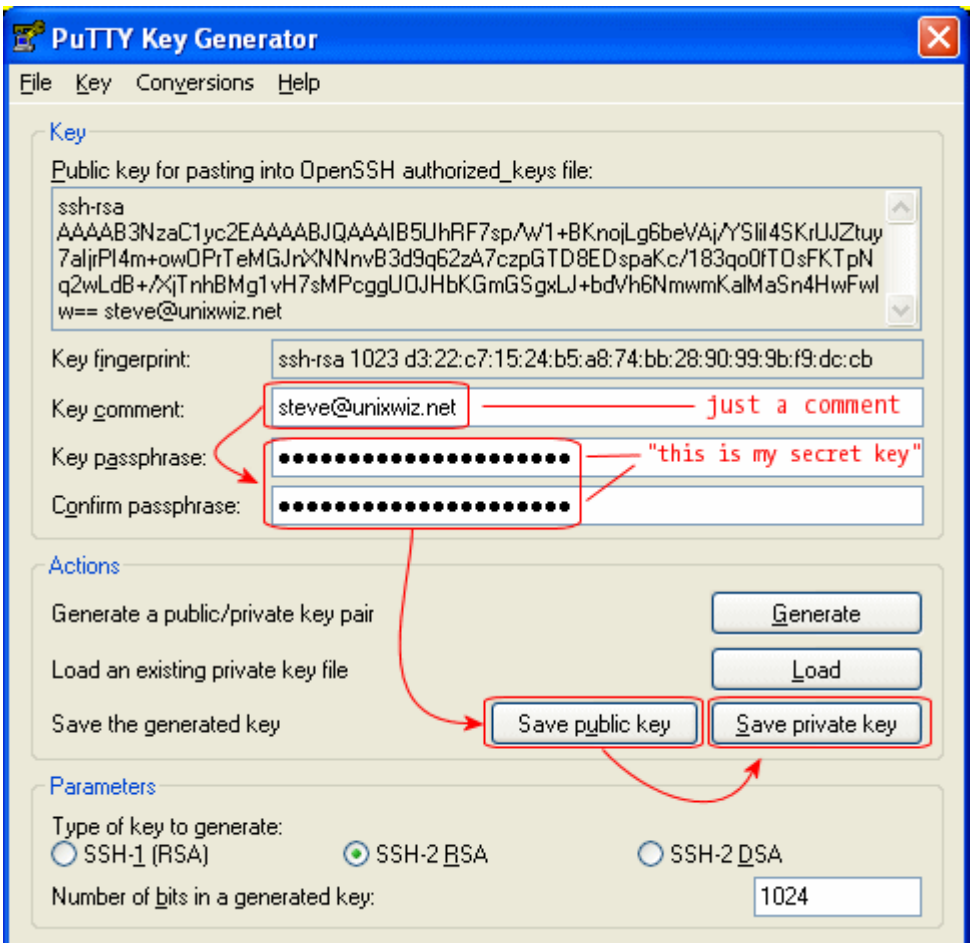


You'll be prompted to create some randomness by moving the mouse around: this gives the system some additional entropy which helps create better keys. This takes just a few seconds to fully generate the keypair.

Protect and save the keys

Now the keypair has been generated, but exists only in PuTTYgen's memory: it has to be saved to disk to be of any use. Though the public key contains no sensitive information and will be installed on remote systems, the private key must be protected vigorously: anyone knowing the private key has full run of all remote systems.

The private key is typically protected with a passphrase, and this phrase is entered twice in the fields indicated. The comment is optional but is customarily the email address of the key owner. It could also just be the owner's name.



Do not forget the passphrase; the keypair is useless without it.

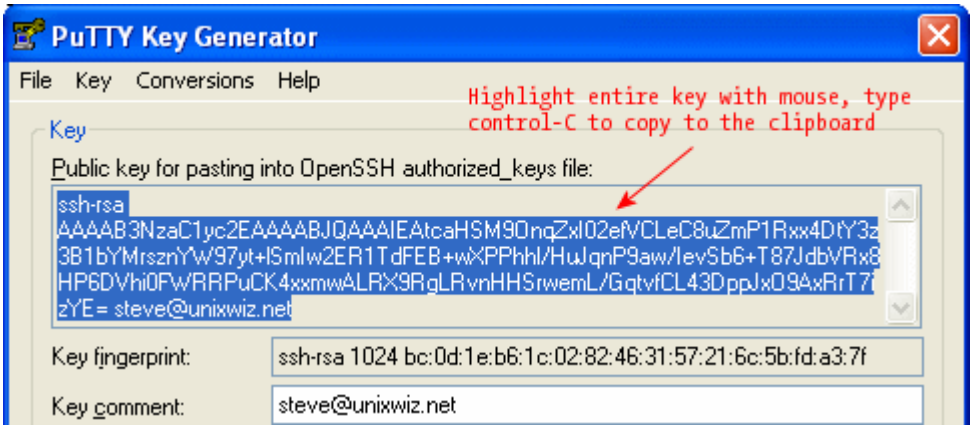
The key generated must now be saved, and this is done in three parts: **Save Public Key** and **Save Private Key** both prompt for a filename, and the private key (with **.ppk** extension) should be saved in a safe place.

The public key is in a standard format and can be used directly or indirectly by other software, and it looks like this:

```
---- BEGIN SSH2 PUBLIC KEY ----
Comment: "steve@unixwiz.net"
AAAAB3NzaC1yc2EAAAABJQAAAIBtZzfrF2AOpwvvU/0ikNgOsFWfP9zW8GlT5iGg
c487S3ooA+OY0u882r8/T/dwc6EHJM+QhRdTlv1NBLCmz46R4F5draFhibHEWuKA
Qg/UutZbMkC6rpd0H2DBXTTCcZ2y4FL3u5kOV1+XWqmmII568+/twEGAO6MS0HDv
OYK+BQ==
---- END SSH2 PUBLIC KEY ----
```

The private key is in a PuTTY-specific format which can't be used by any other software. It won't ever be looked at directly by the operator.

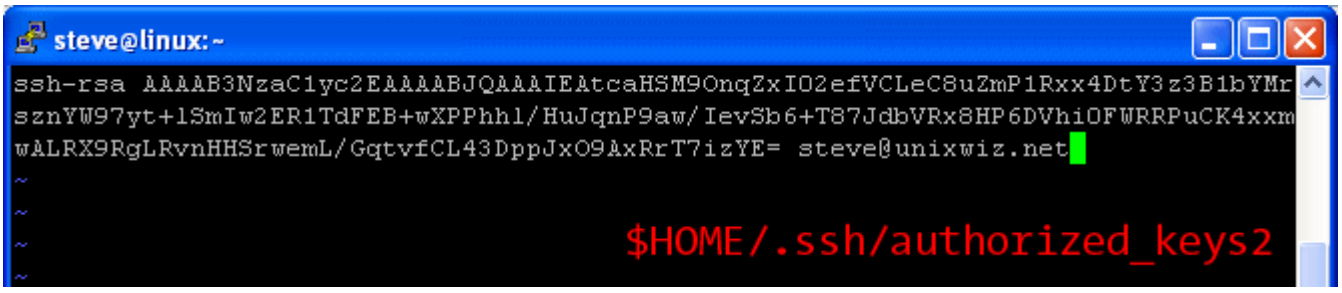
Install public key on Linux system



With **puttygen** still open, highlight the entire "Public Key for pasting into OpenSSH authorized_keys file" area and type control-C to copy to the local system's clipboard. This is essentially the same data as found in the saved public-key file, but it's in a form which can be directly used on the Linux system.

Login to the Linux computer using the account's password, create the **.ssh** directory if necessary, then edit the file **.ssh/authorized_keys2**. This will be a text file, and the clipboard should be pasted into it. Note: the file **authorized_keys** is for an older format; we're using **authorized_keys2**.

The public key will be just one long line, and it's really easy to paste the data in a way which truncates the first few characters. This renders the key inoperable, so be sure that the key begins **ssh-rsa** or **ssh-dsa**. Save the file.



Insure that both the **.ssh** directory and the files within it are readable only by the current user (this is a security precaution), and this can be achieved using the **chmod** command with parameters applying to the entire directory:

```
$ mkdir $HOME/.ssh

$ chmod -R og= $HOME/.ssh
```

Log out of the system.

Note - the **authorized_keys2** file must be owned by the user and unreadable/unwritable by anybody else - the OpenSSH server will deny logins if this is not the case. One can check this with the **ls** command:

```
$ ls -lR $HOME/.ssh
/home/steve/.ssh:
```

```
total 16
drwx------    2 steve    steve        4096 Nov 22 13:11 ./
drwx------    6 steve    steve        4096 Nov 22 16:10 ../
-rw-------    1 steve    steve         460 Nov 22 13:11 authorized_keys2
```

The file must be mode **-rw-------**.

Attach the private key to the SSH session

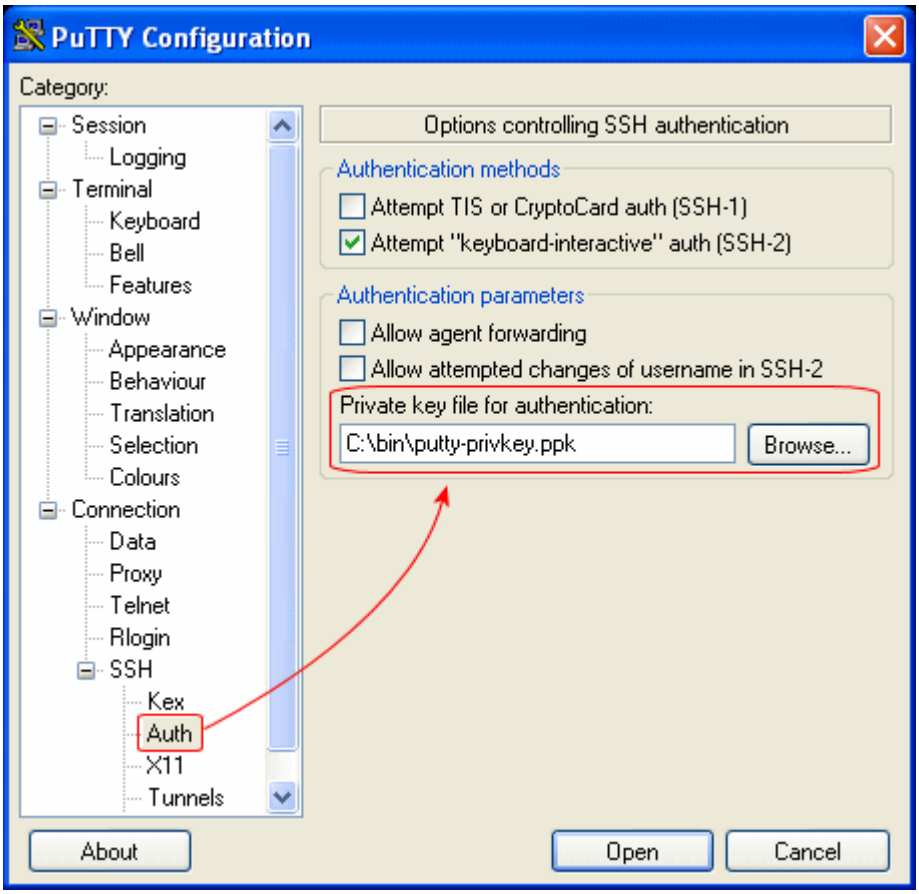
Now that the public/private keypair has been created, it can be associated with an SSH session. First, we'll do this in PuTTY by launching the program and loading the session of interest.

Navigate to **Connection** : **SSH** : **Auth** in the Category pane on the left, then populate the **Private key file for authentication** field by browsing to the **.ppk** file saved previously.

Note - With other Secure Shell clients, we've seen the ability to attach a private key to *all* sessions (as part of a global configuration), but with PuTTY it appears to require configuration for each session. We're not sure why.

Return to the **Session** category level and save the current session.

At this point, PuTTY (on Windows) and OpenSSH (on Linux) are both configured for secure, public-key access.

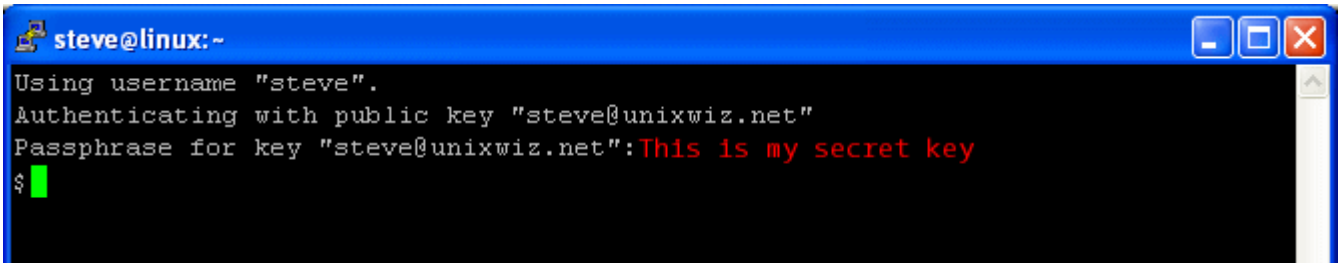


Connect via the public key

Now that the configuration steps have been completed, we're ready to actually login using the public key mechanism, completely avoiding the password step.

Connect securely

Launch PuTTY with options to load the saved session with the private key:



Rather than prompt for the account's password (which will differ on every remote system), it's instead asking for the passphrase which is protecting the local private key. When the private key fits into the public key on the OpenSSH server, access granted and a shell presented to the user.

It's important to note that though the user must type a secret word when logging in, the passphrase is associated with the **local private key**, not the remote account. Even if the user's public key is installed on 1,000 different remote servers, the same private-key passphrase is demanded for all of them. This greatly simplifies the task of remembering access credentials and encourages the choosing of strong, secure ones.

Disabling password authentication on OpenSSH

Once the user's public and private keypair are verified as correct, it's possible to disable password authentication on the Linux server entirely. This entirely forestalls all possible password-guessing attempts and dramatically secures a machine.

However, for machines not physically local, it's wise to defer on disabling password authentication until it's **absolutely** clear that the keyed access is working properly, especially if multiple users are involved. Once password authentication has been disabled, even the root password won't allow one into the system.

Those new to public key access are encouraged to test **very** carefully.

The configuration of the SSH Daemon is found in the **sshd_config** file, often stored in the **/etc/ssh/** directory. This is a text file which is relatively easy to read; we'll be looking for two entries to modify.

First is to set **PasswordAuthentication** to the value **no**. This may be explicitly set to **yes**, or it may be commented out to rely on the default, but we wish to explicitly disable this:

Second, we wish to disable SSH protocol version 1: this is old, has several substantial security weaknesses, and should not be allowed from the outside world.

Edit the configuration file and ensure that the two keyword entries are set properly; comment out the old entries if necessary.

/etc/ssh/sshd_config

```
# Protocol 1,2
Protocol 2
PasswordAuthentication no
```

Once the configuration file has been saved, the Secure Shell daemon must be restarted; on most platforms this can be done with the "service" mechanism:

```
# service sshd restart
```

This kills the listening daemon and restarts it, but does not terminate any existing individual user sessions. Those who feel this might be a risky step are invited to simply reboot the machine.

At this point, OpenSSH will no longer accept passwords of any kind, with access granted **only** for users with pre-established public keys.

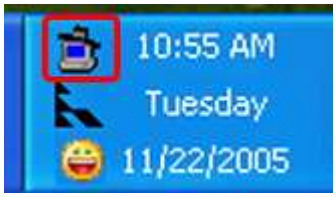
Enabling SSH Agent Support

Up to this point, we've provided a large manner of security of system access, but it's still not terribly convenient: we still must type a (hopefully) complex pass phrase each time. This can get tedious when large numbers of systems are involved.

Fortunately, the SSH suite provides a wonderful mechanism for unlocking the private key once, and allowing individual ssh connections to piggyback on it without querying for the passphrase every time.

Launch the agent

Navigate to and launch the **pageant.exe** program from the same location as the other PuTTY-related files, and it will put itself into the system tray (in the lower right near the clock).



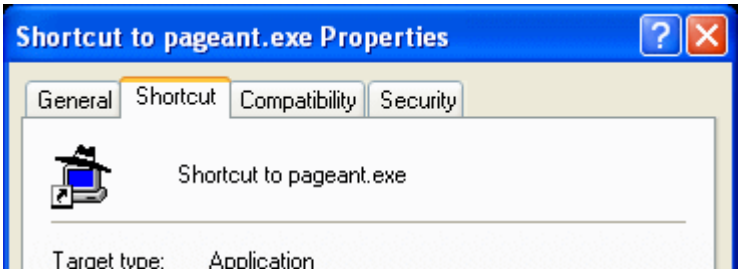
Double-click the icon in the tray, and it launches a dialog box with an empty list of keys. Click **Add Key** and navigate to the **.ppk** file which contains your private key. When prompted for the passphrase, enter it and click OK. Click **Close** to dismiss the agent.

Now, launch one of the already-configured SSH sessions to a pubkey-secured remote host: it will query the agent for the private key, exchange it with the remote, and grant access without further user intervention.

Note - the thoughtful reader may wonder just how the agent stores the data, and whether untrusted programs are able to obtain this secret key surreptitiously. We're not sure how it works, but we've not ever heard of real security concerns on this front. We'll update this document if we learn something.

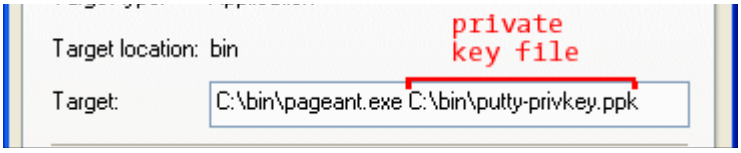
Preload the private key

The first thing that many PuTTY users do when logging into the system for the day is to launch the agent and add the private key. This is just a few steps, but we can optimize it just a bit more. If we launch the agent with the private key file as a parameter, it loads the key automatically.



Navigate to **pageant.exe** and right-click to copy this icon. Paste this as a shortcut on the

desktop, then right-click and select Properties. Enter the full path of the **.ppk** private key file as the parameter, then save the changes.



Double-clicking this icon will load the keyfile, demanding the passphrase. Once entered, that's the last time it's needed as long as the agent sticks around.

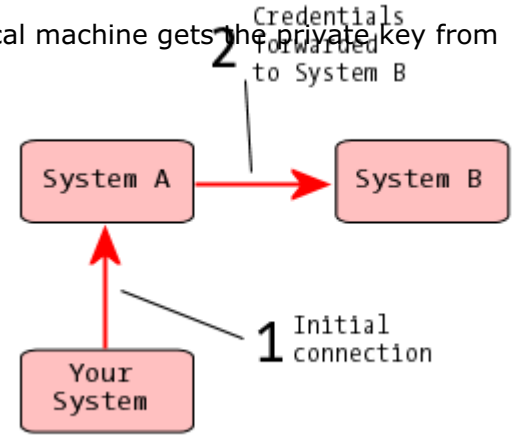
There is very little not to like about SSH agent support.

Agent Forwarding

But we've not exhausted the benefits of SSH agent support.

It's a clear win to avoid typing the passphrase every time a new connection is launched, but SSH also provides *Agent Forwarding* which can pass the credential down the connection to the remote server. This credential can then be passed to yet another server where the user's public key has been installed, obviating passwords or the secret passphrase for the entire duration of a network navigation.

1. User launches a connection to Server A: PuTTY on the local machine gets the private key from the agent and provides it to the remote server.
2. Remote server processes the public and private key data and grants access. The user is given a shell on the local system.
3. User attempts to connect to SystemB with **ssh -A systemb** (**-A** enables agent forwarding), and it connects to the SSH server there.
4. System B asks system A for the user's private key data, and the SSH server on system A in turn forwards this back to the original workstation where the agent is queried.
5. The local agent passes the data back up the connection, where it's forwarded from SystemA to SystemB. SystemB receives this credential, and access is granted by comparing to the public key stored on that machine for that user.



This happens automatically and quickly: it takes no more than a second or two for the entire exchange to occur, and this forwarding can go over quite a long chain of SSH connections. This provides for transparent, secure access to a wide range of remote systems.

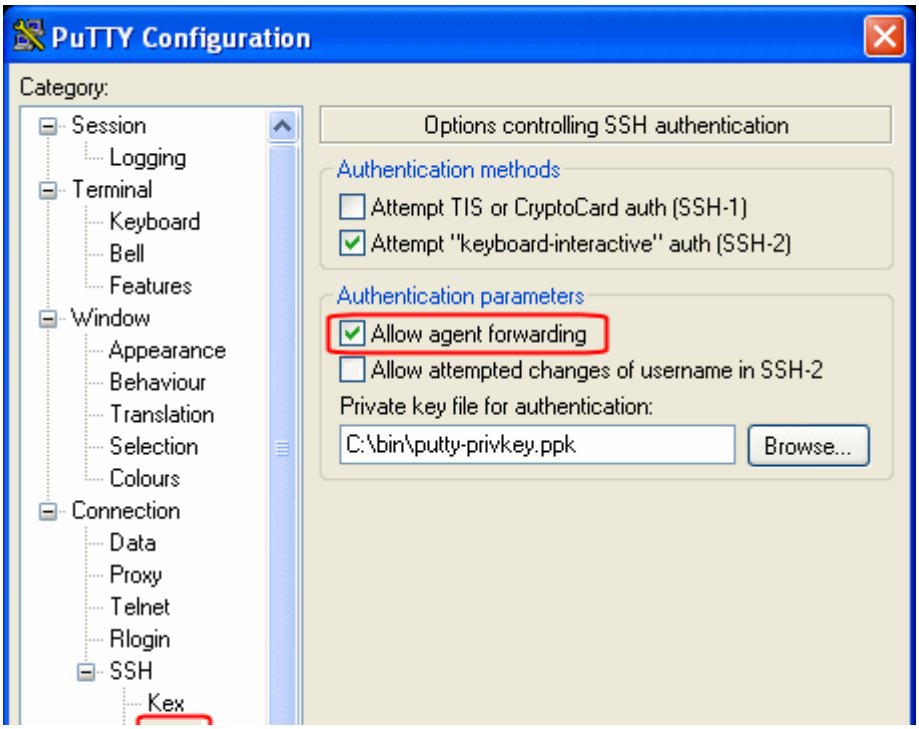
Note - All of this requires that the user have an account on each machine in question, and that the user's public key is installed properly on each one. SSH forwarding doesn't provide any access which would not be granted absent forwarding; it just adds a more convenient mechanism to what's already provided.

Enable Forwarding in PuTTY

Enabling agent forwarding is done in the PuTTY configuration dialogs much like all the rest, and just one additional box need to be checked.

This option requires, of course, the use of **pageant** on the local system - without an agent, there's nothing to forward.

Should a key-protected connection be attempted with no agent present, PuTTY will simply prompt for the passphrase as it has all along (and will do so *on each connection*).



Enable Forwarding on the Server

In the example above, we saw that the user typed **ssh -A *host***, but it's common to make "Use agent forwarding" the default setting to remove the need to type the "-A".

The OpenSSH server configuration is found in **sshd_config**, while the client configuration is in **ssh_config** (typically in the **/etc/ssh/** directory). The file can be edited and the **ForwardAgent** setting set to yes:

/etc/ssh/ssh_config

```
...
ForwardAgent yes
...
```

This setting doesn't affect the server, so it requires no reboot or special operation for it to take effect: the next outbound connection will enable forwarding automatically. This change need be made only once (and it's the default on some systems).

Note: much more background on this can be found elsewhere on this server: Unixwiz.net Tech Tip: An Illustrated Guide to SSH Agent Forwarding

Copying files securely

With the configuration of PuTTY, public key access, and agent support (with forwarding), we're prepared to step beyond terminal shell access and move files around. Secure Shell provides multiple methods for copying files from one machine to another, all working together with the same keys and agents.

PSCP allows for command-line copying of files to and from a remote SSH server, and **PSFTP** provides an FTP-like interface for convenient file transfer. We'll discuss both.

PSFTP - an FTP-like client

The **PSFTP** program can be launched from the command line or from a desktop shortcut, and in both cases accepts either a hostname or a saved session name.

When launched, it connects to the target server (fully taking advantage of public keys and the local agent, if any), and presents a **psftp>** prompt:

```
C> psftp dbserver
Using username "steve".
Remote working directory is /home/steve
psftp>
```

Regular users of command-line FTP clients will find this familiar, though it's certainly not up to the ease of use as popular GUI clients. The **help** command may provide some guidance.

PSCP - Secure Copy

Users at the command line may wish to copy files directly, and this is done with **pscp**, the Secure Copy command. Just like copying regular files on the local filesystem, **pscp** takes a machine name and directory as a source or destination.

pscp can transfer one file at a time, or a whole set in a single instance:

```
C> pscp *.gbk dbserver:/db/evolution
CL_100.gbk       |      97 kB |   97.4 kB/s | ETA: 00:00:00 | 100%
CL_101.gbk       |      68 kB |   68.2 kB/s | ETA: 00:00:00 | 100%
CL_103.gbk       |      44 kB |   44.5 kB/s | ETA: 00:00:00 | 100%
CL_110.gbk       |      34 kB |   34.6 kB/s | ETA: 00:00:00 | 100%
CL_123.gbk       |      45 kB |   45.4 kB/s | ETA: 00:00:00 | 100%
```

Curiously, the saved session name need not be provided; just the hostname and the current username (which is usually taken automatically from the environment. It appears that **psftp** and **pscp** both consult the saved-session list, find an appropriate match, and then use the access information associated. This makes for a smooth file-transfer experience.

Security Concerns and the Finer Points

This Tech Tip has intended to provide a fast path to setting up a Secure Shell environment from workstation to server, but it has skipped over many of the finer points. The whole point of using Secure Shell is "Security", and we'd be remiss if we didn't touch on some of these points here.

We'll make the broader point that one must take care when working on an untrusted system: when using advanced features such as agent forwarding or private keys, one is at the mercy of a hostile operator. Kernel-based keyloggers and Trojaned **/bin/ssh** binaries are just a few of many obvious risks when operating in that kind of environment.

Here we'll touch on a few of the non-obvious points and note that in a trusted and controlled environment, these issues simply don't arise.

Protect your private key

Though the public key is of only minor concern, the private key must be protected vigorously. Anyone who can get to the decrypted private key (either by learning the passphrase, or brute-forcing it) has full run of all networks where the public key is installed. We strongly recommend limiting dramatically the number of places where the private key is kept.

We presume that applications exist which can take a private-key file and attempt to brute-force the key, though we've not yet run across one.

Agent use requires trusted machines

Whenever an SSH key agent is present, whether it be on the local machine which initiates the outgoing connection, or on intermediate machines which are forwarding them, it's technically possible for interlopers on those machines to get access to the secure channel.

In OpenSSH, an ssh client communicates with the agent via a UNIX domain socket under the **/tmp/** directory(a representative file is **/tmp/ssh-DeB10132/agent.10132**), and it's restricted to the local user. But superusers also have access to the socket, and it's relatively straightforward to hijack the agent to connect to the same target machine.

Related Resources

- Unixwiz.net Tech Tip: Building and configuring OpenSSH
- Unixwiz.net Tech Tip: An Illustrated Guide to SSH Agent Forwarding
- PuTTY home page

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Home ▮ Stephen J. Friedl ▮ Software Consultant ▮ Orange County, CA USA ▮
steve@unixwiz.net ▮