config@WEB Key & Certificate Generation

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For Reference Only

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1.0	September 20, 2012	Initial release	
1.1	December 6, 2013	Added Introduction. Updates to procedures for SSH and SSL Generation.	
			Dan Stark, Manager, RTU S/W Engineering

1 Introduction

This document explains the process for creating the keys and certificates required for secure communications between the RTU and other devices on the network.

The two main methods for use to secure the communications are SSH (Secure Shell protocol), and SSL (Secure Socket Layer). Each of these methods will be explained in its own chapter.

SSH requires the creation of public and private keys. The program used to create these keys in the examples is PuTTYgen. These keys are used with SSH and SFTP protocols. The SSH chapter explains the creation of the following necessary keys for secure communication of the RTU on the network.

Server RSA Key Pair

Server DSA Key Pair

Client RSA Key Pairs

Client DSA Key Pair (NOT recommended, therefore no example is given)

SSL requires the creation of keys and a certificate of authenticity. The program used to create the keys and certificates in the examples is OpenSSL. These keys and certificates are used with the HTTPS and IPsec protocols. The SSL chapter explains the creation of two types of certificate and key creation:

SSL Self-Signed Certificate & Key Creation

SSL CA Certificate & Key Creation

(CA = Certificate Authority

2 SSH Key Generation

2.1 RTU (Server) Keys

2.1.1 The RTU Private Keys

DSA_PRV.KEY
RSA_PRV.KEY

The two files listed above contain the private key generated using the RSA and DSA algorithms. These files enable the RTU to decrypt messages sent that have been encrypted using the public keys described in the following section. The private keys are generated with 2048-bit size.

2.1.2 The RTU Public Keys

DSA_PUB.KEY
RSA_PUB.KEY

The two files listed above contain the public key corresponding to the private keys above, generated with the DSA and RSA algorithms. Typically, this public key is transmitted over the network to the remote SSH client during the SSH connection setup, as it does not need to be kept a secret like the private key. These keys are provided in case the SSH client being used does not know how to obtain this key information over the network (yes, there are some SSH client software like this). The public keys are generated with 2048-bit size.

2.2 User (Client) Keys

It is recommended that the DSA algorithm **NOT** be used to generate the user's private/public key pairs, therefore this document only describes key pairs generated using the RSA algorithm.

2.2.1 User Private Keys

If PuTTYGen key generator was used to generate the keypair, the default format is a ".ppk" file. This format is understood by the PuTTY SSH client software. If you are not using PuTTY, the ".ppk" file may not be recognizable by the SSH client, and the private key may need to be converted into either the OpenSSH or the ssh.com format, depending on your SSH client software needs. Consult your SSH Client software manual to learn which format and file naming convention is supported for the private keys.

"Username".ppk	default suffix by PuTTYGen, with user's name same as the public key

OpenSSH or ssh.com formats are not defined. The following are suggested conventions:

"Username"_OpenSSH_prv.key	Users name same as public key, suffix Is whatever customer desires.
"Username"_ssh_dot_com.key	Users name same as public key, suffix Is whatever customer desires.

2.2.2 User's Public Keys

"Username".pk2	There must be one unique key file for each user, where "Username" is the login userid for that user.

For example, if there are three userid's created with SSH permissions, and the userid's are: Administrator, JohnSmith, and JaneDoe, there must be a unique public/private key pairs generated for each user as follows:

Public Key	&	Private Key
Administrator.pk2	&	Administrator.ppk
JohnSmith.pk2	&	JohnSmith.ppk
JaneDoe.pk2	&	JaneDoe.ppk

2.3 Client RSA Key Example

Launch PuTTYGen Key Generator.

Figure 2-1 Set "Type of key to generate:" to "SSH-2 RSA" (SSH-2 RSA is default)

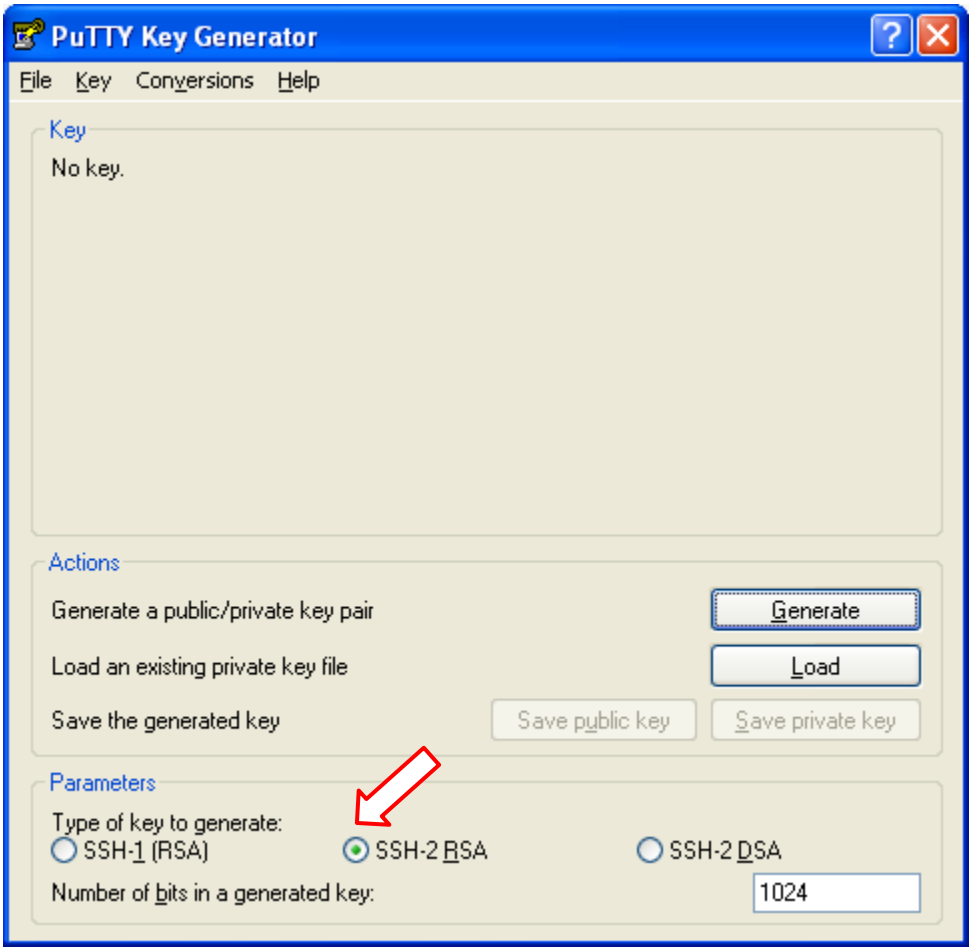


Figure 2-2 Set the "Number of bits in a generated key:" to 2048 as shown

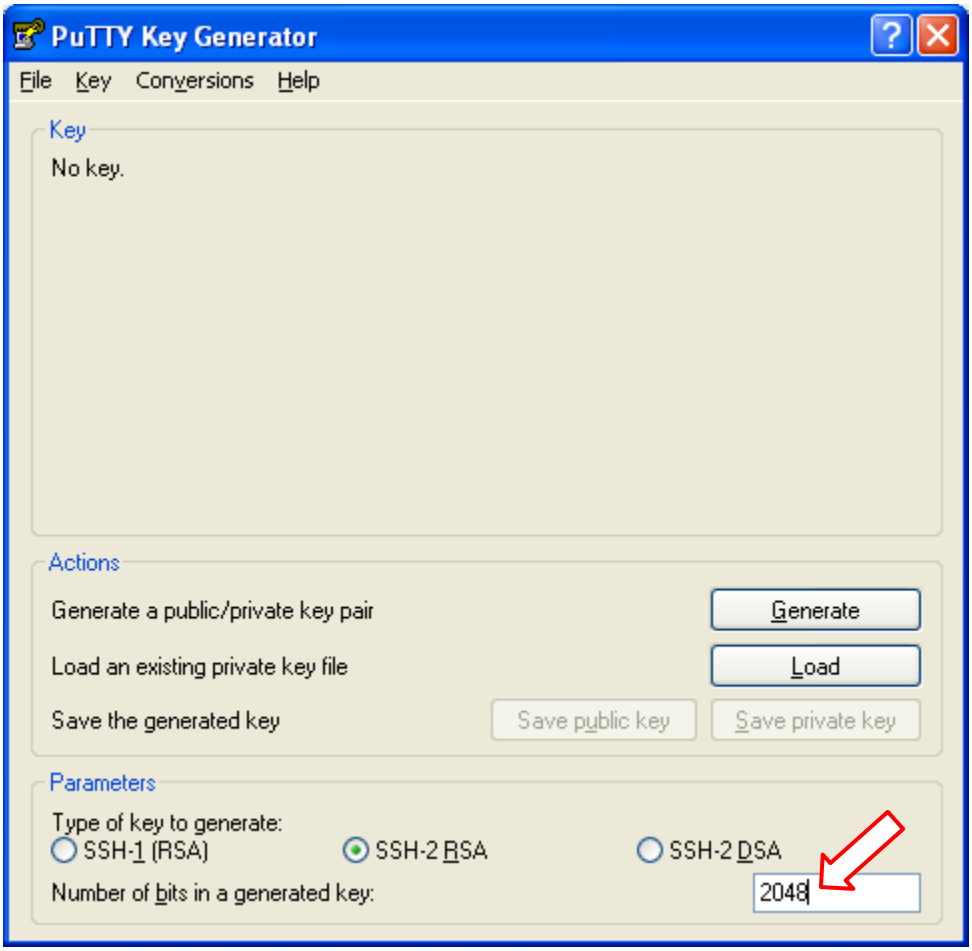


Figure 2-3 Click the “Generate” button

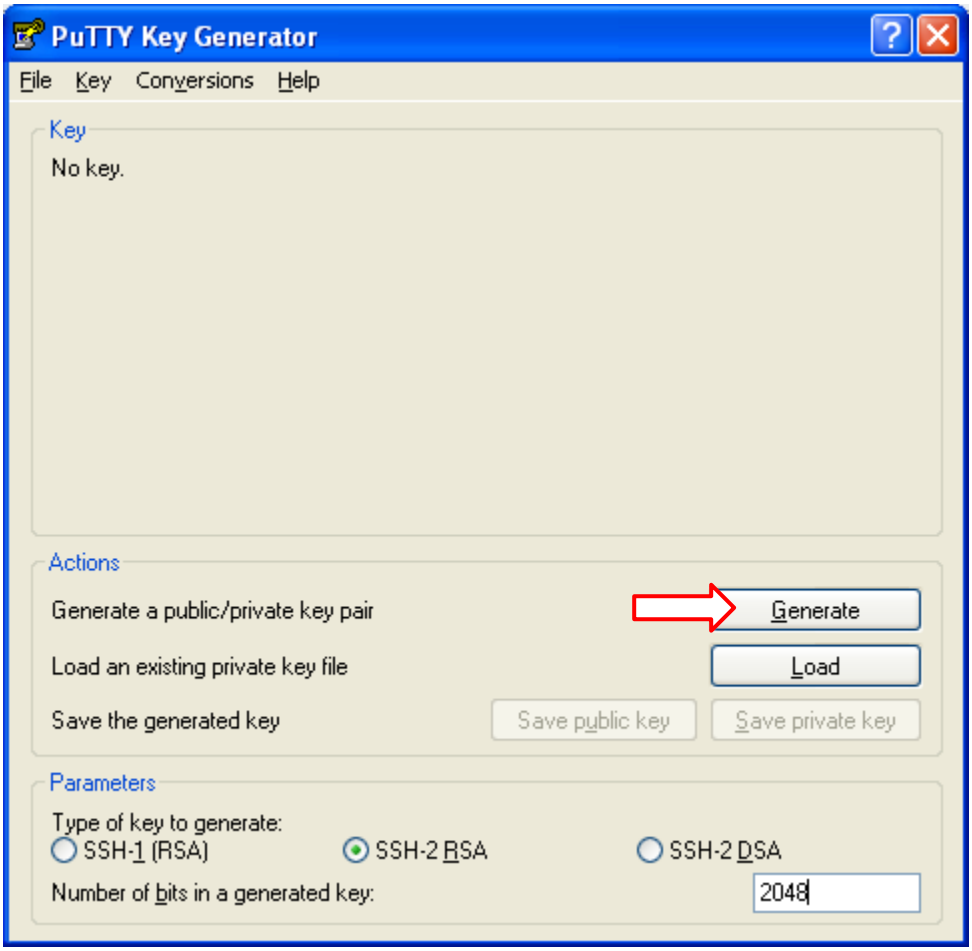


Figure 2-4 Moving the mouse in the blank area generates the progress bar

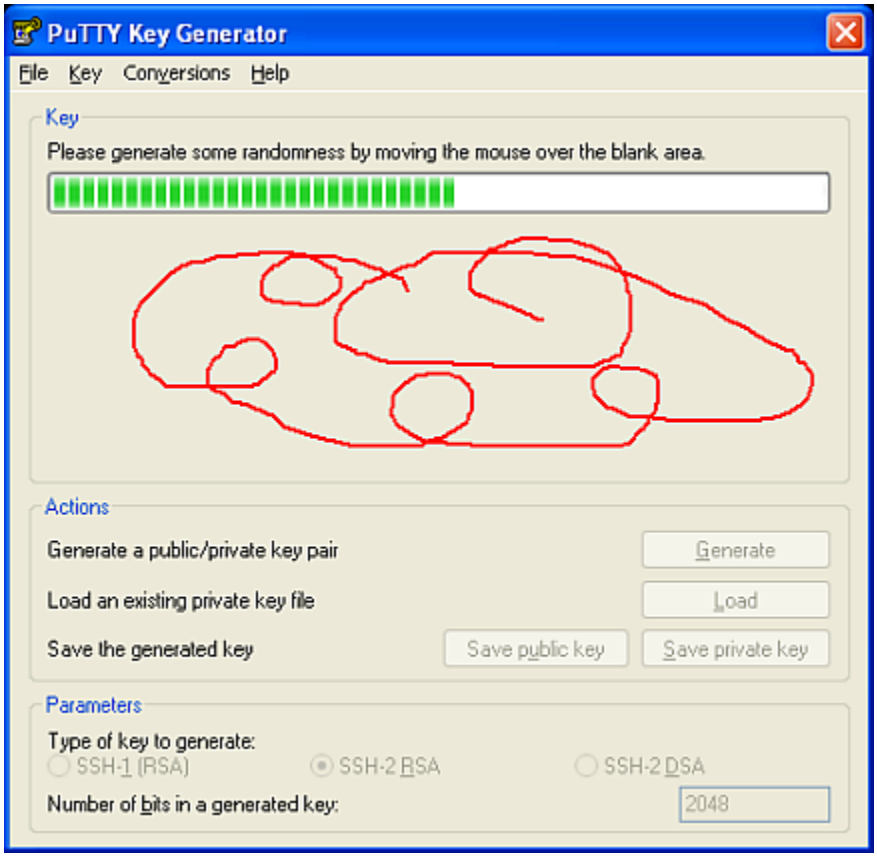


Figure 2-5 RSA key generation is complete

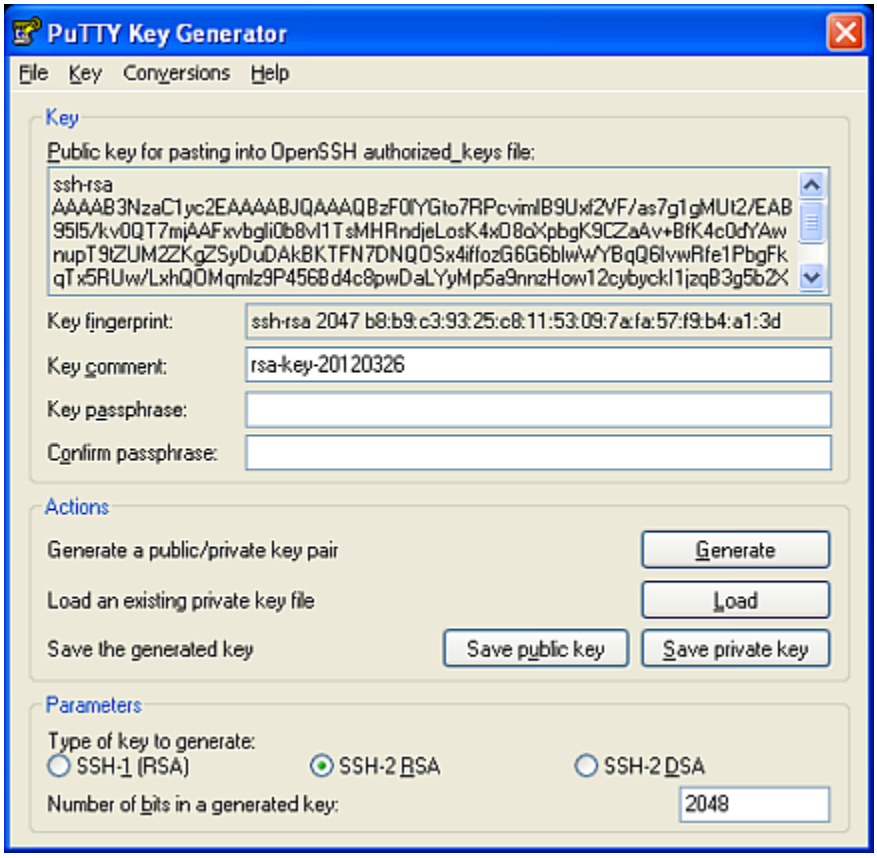


Figure 2-6 Enter secret passphrase for the private key, and again to confirm

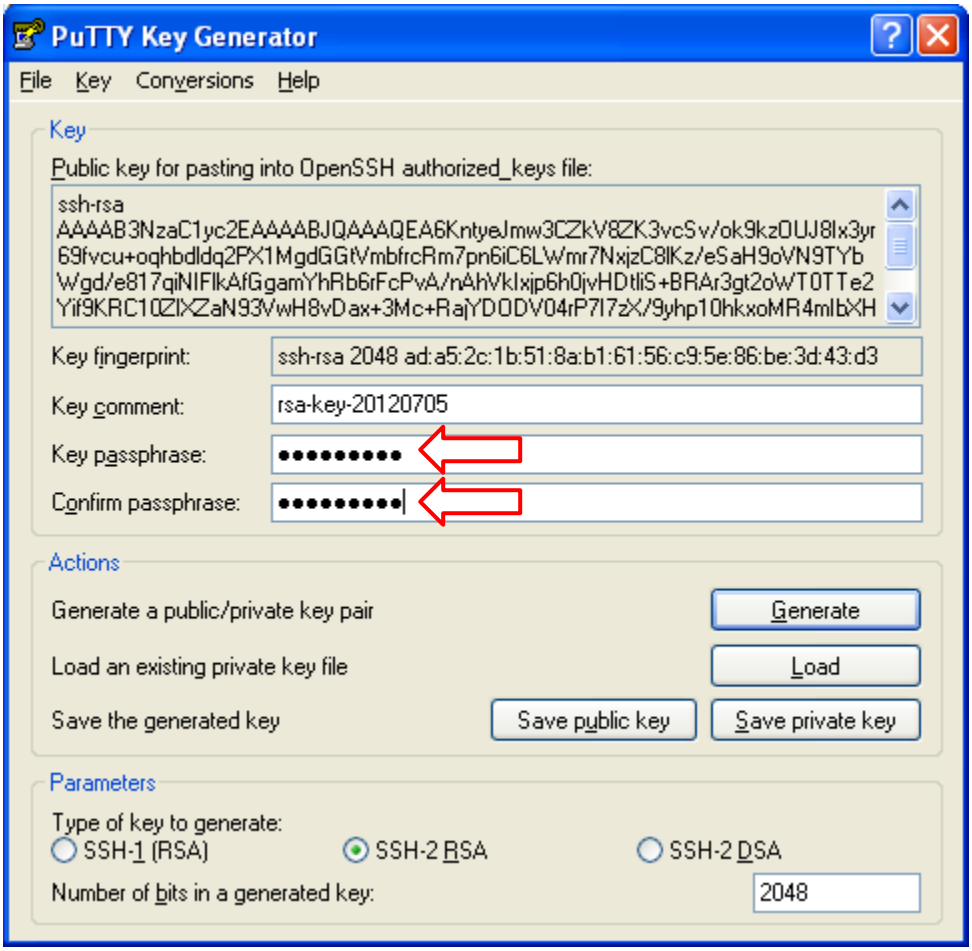


Figure 2-7 Click "Save private key" button to save private key in PuTTY format

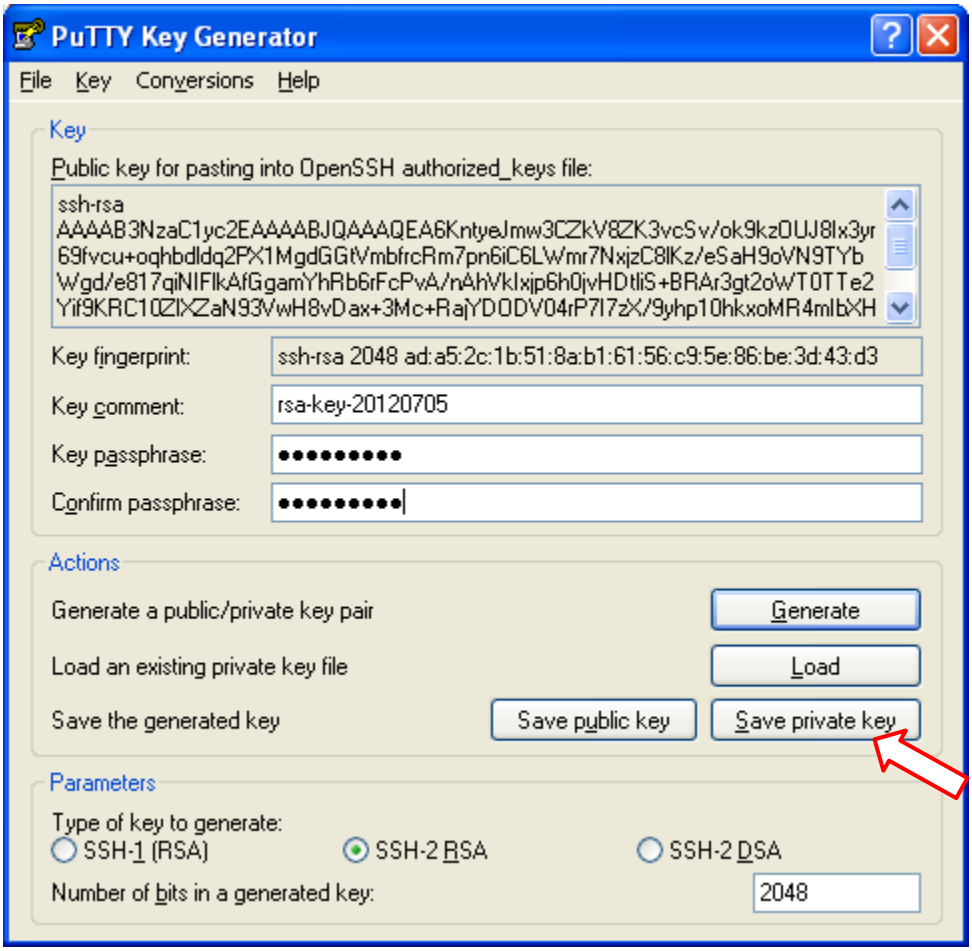
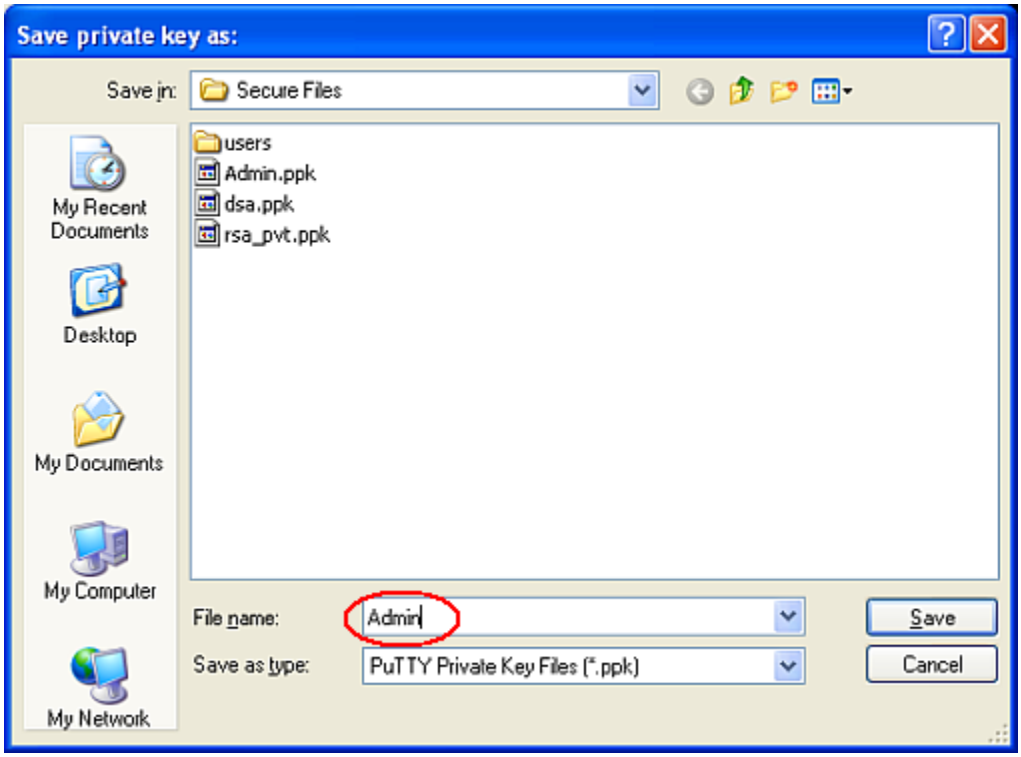
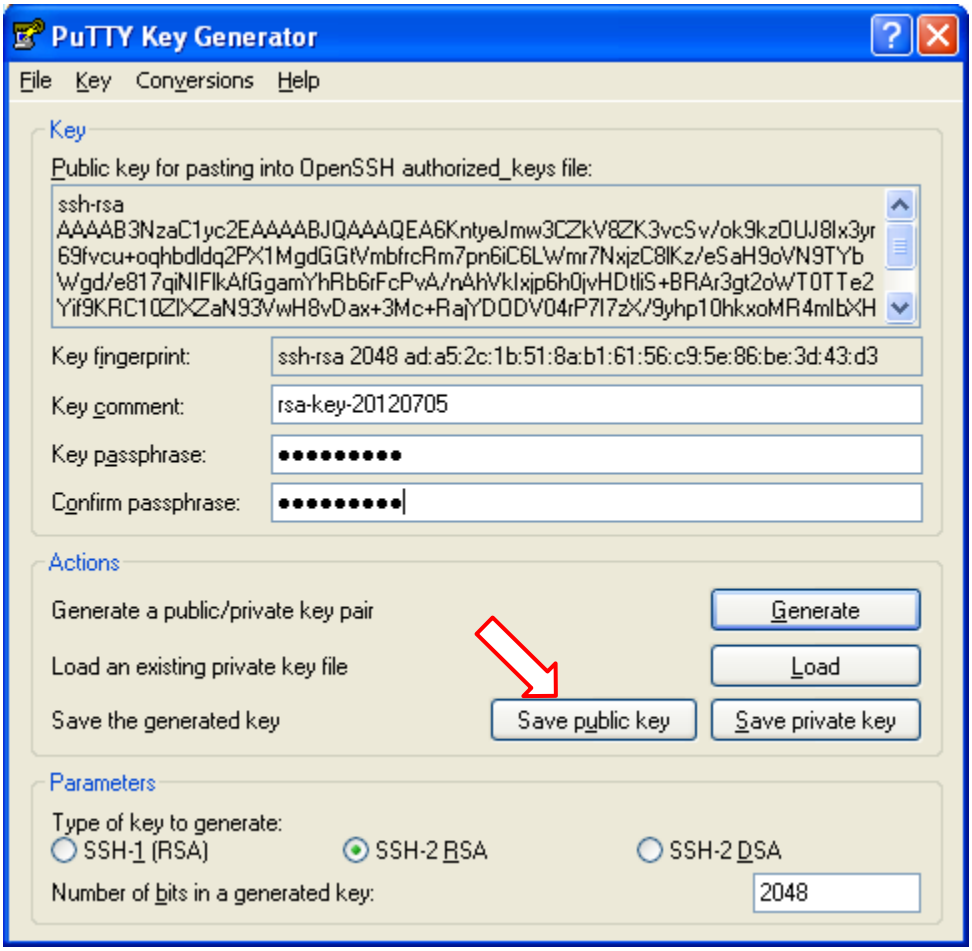


Figure 2-8 Enter the name of the user



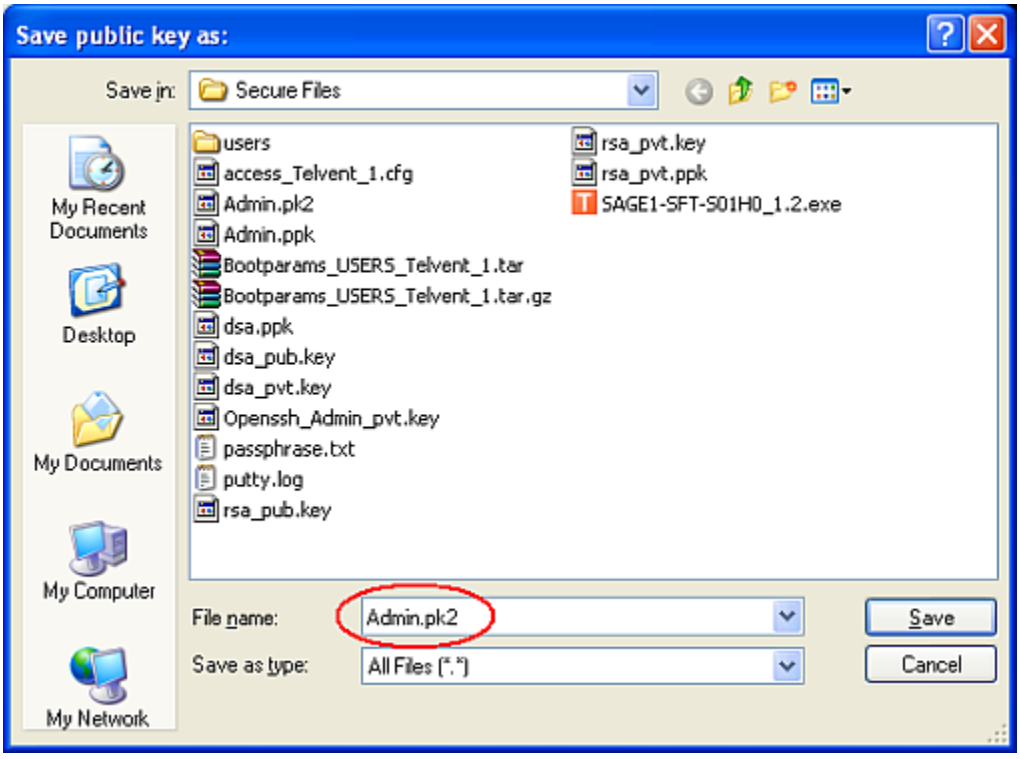
Enter the name of the user that this key will authorize SSH access to the RTU (the example is. Admin). The PuTTYGen software will append the ".ppk" suffix. This private key will need to be entered into the settings of the SSH client running on your local computer being used to gain SSH access to the RTU.

Figure 2-9 Click “Save public key” button to generate client public key



Do Not Click Generate Before Saving the Public Key!

Figure 2-10 Enter the name of the user



Enter the name of the user that is being authorized to gain SSH access to the RTU. Be sure to add the ".pk2" suffix, as the RTU looks for this extension when trying to locate the client public key for authentication.

The client RSA Private and Public key pair generation is complete. To upload the client **public** key into the RTU, use the User_Manager_YZ_YZ.exe program to create the secure upload file. See the "Secure Administration" chapter of the "" for instructions on using this program. The client **private** key is kept on the local PC to be loaded into the SSH client software's user settings.

2.4 Client DSA Key

We recommend that the DSA algorithm **NOT** be used to generate the user's private/public key pairs, therefore this document only describes client key pairs generated using the RSA algorithm.

2.5 Server RSA Key Example

Launch PuTTY Key Generator.

Figure 2-11 Set “Type of key to generate:” to “SSH-2 RSA” (default)

Figure 2-12 Set the "Number of bits in a generated key:" to 2048 as shown

Figure 2-13 "Generate" button

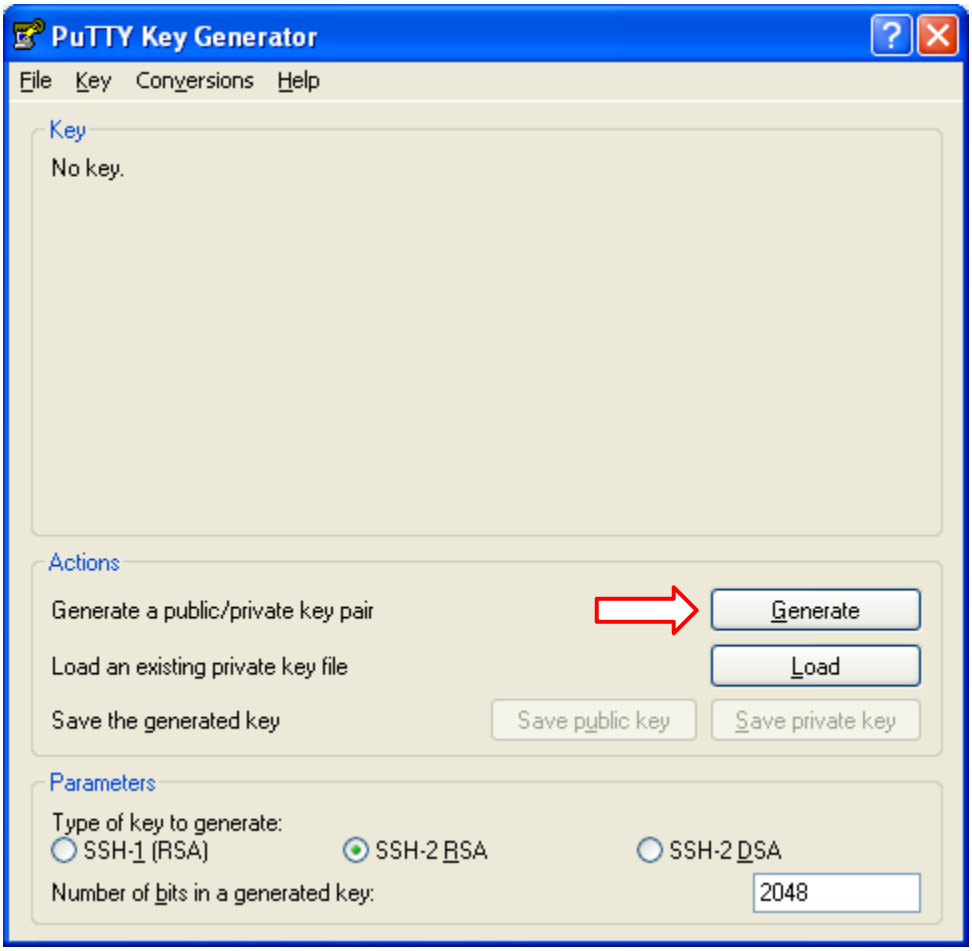
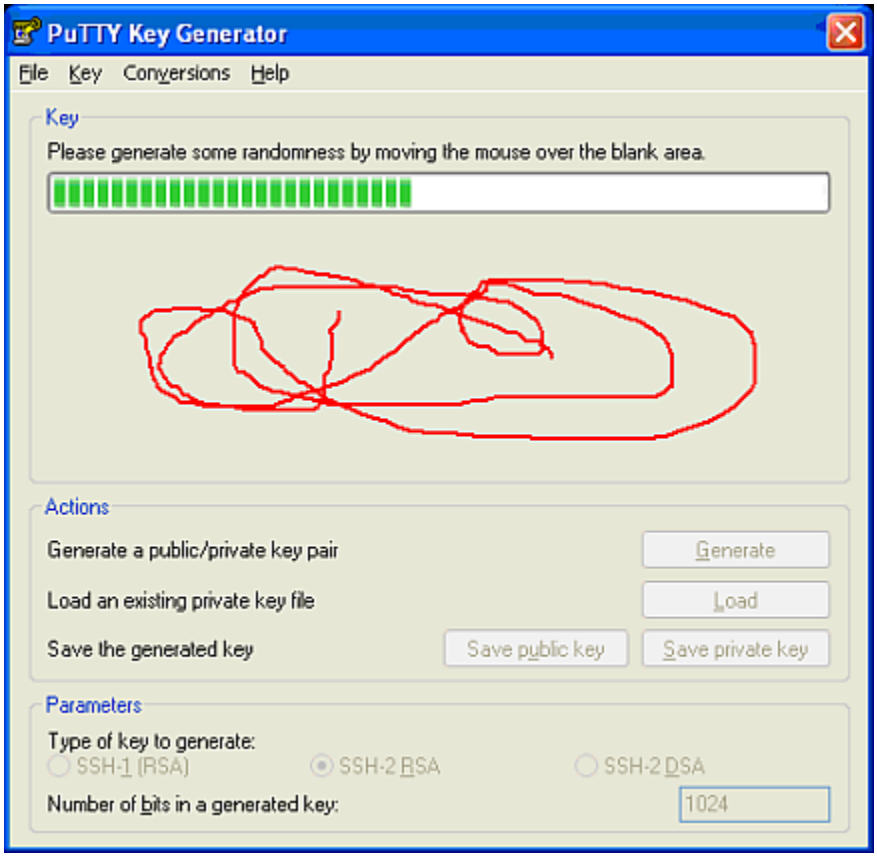


Figure 2-14 Moving the mouse in the blank area generates the progress bar



Keep moving the mouse until the program completes the key.

Figure 2-15 RSA key generation is complete

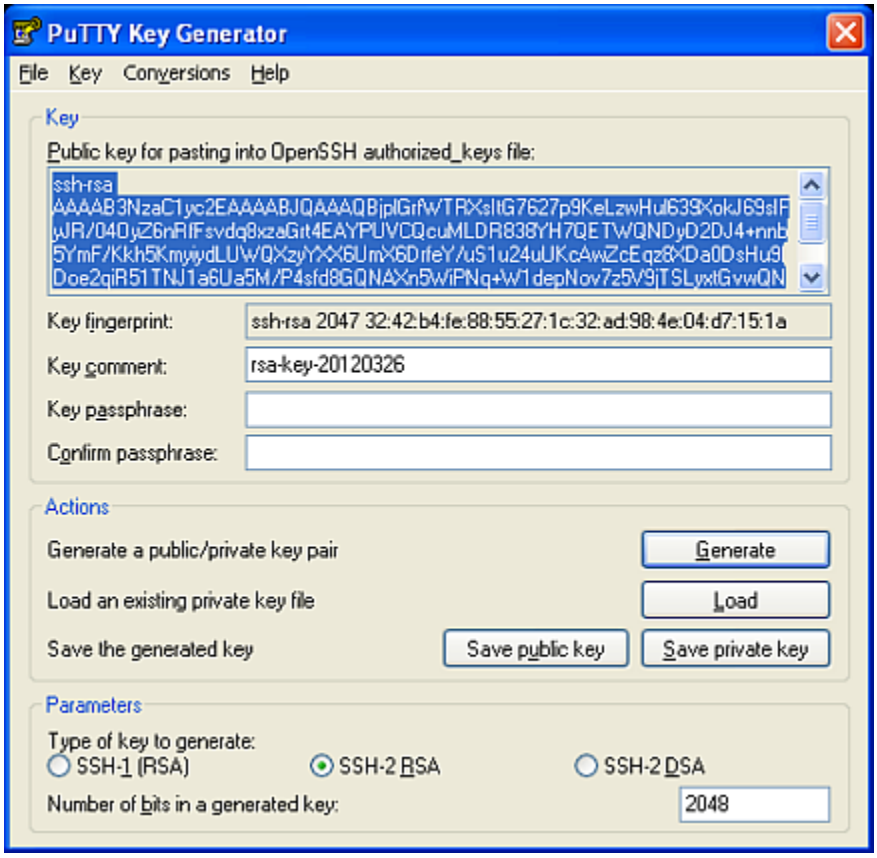


Figure 2-16 Save private key into OpenSSH format key file using “Export OpenSSH key

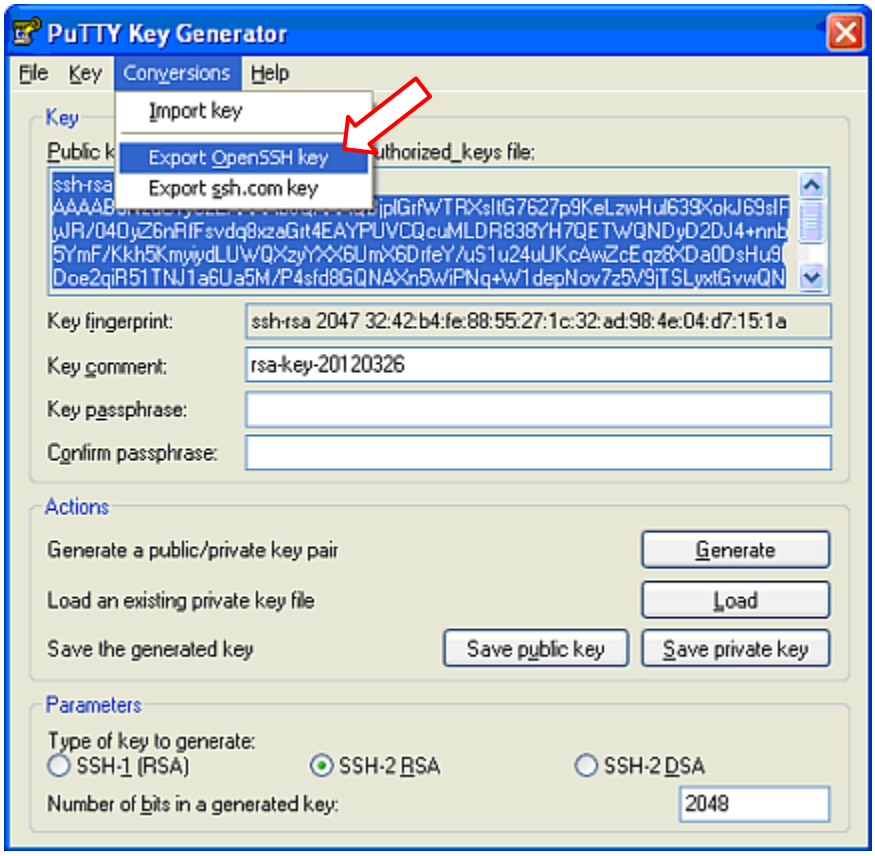


Figure 2-17 RTU private key must NOT be passphrase protected

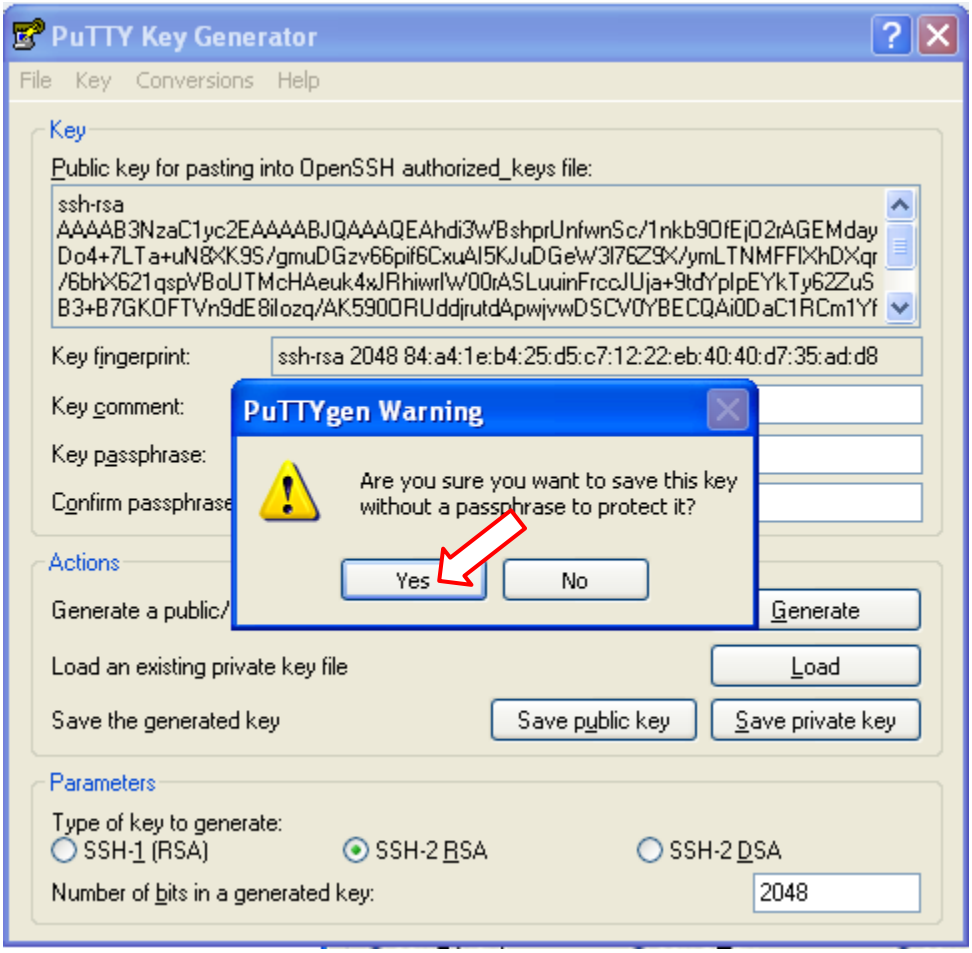


Figure 2-18 Name the RTU private key "rsa_pvt.key"

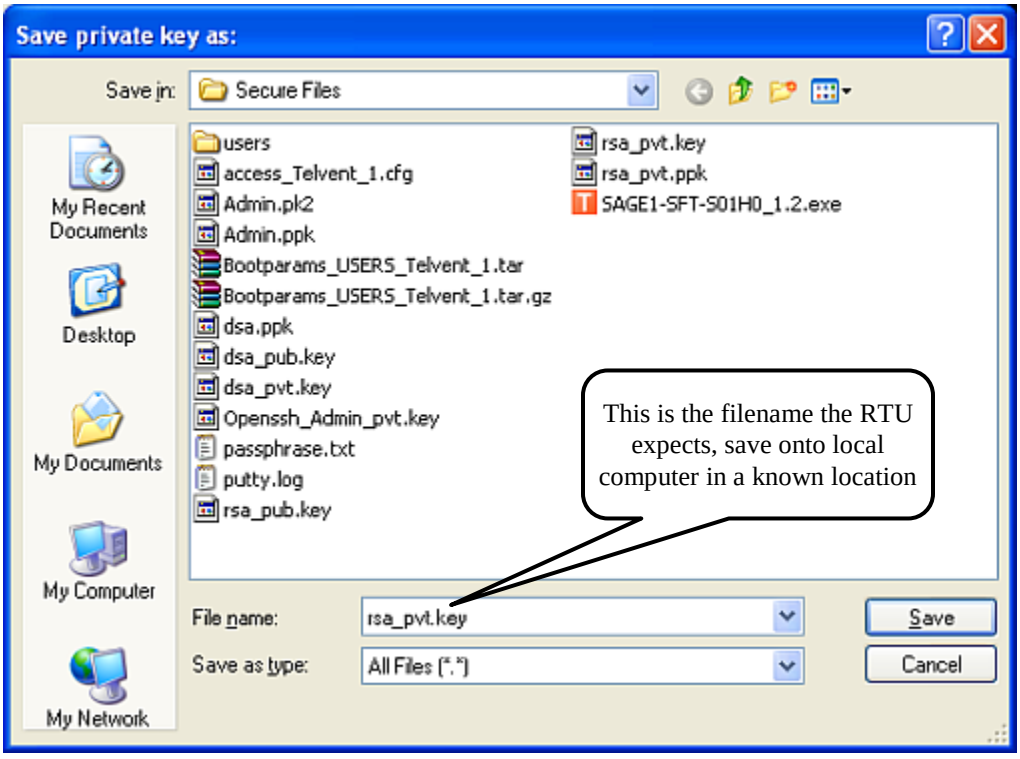
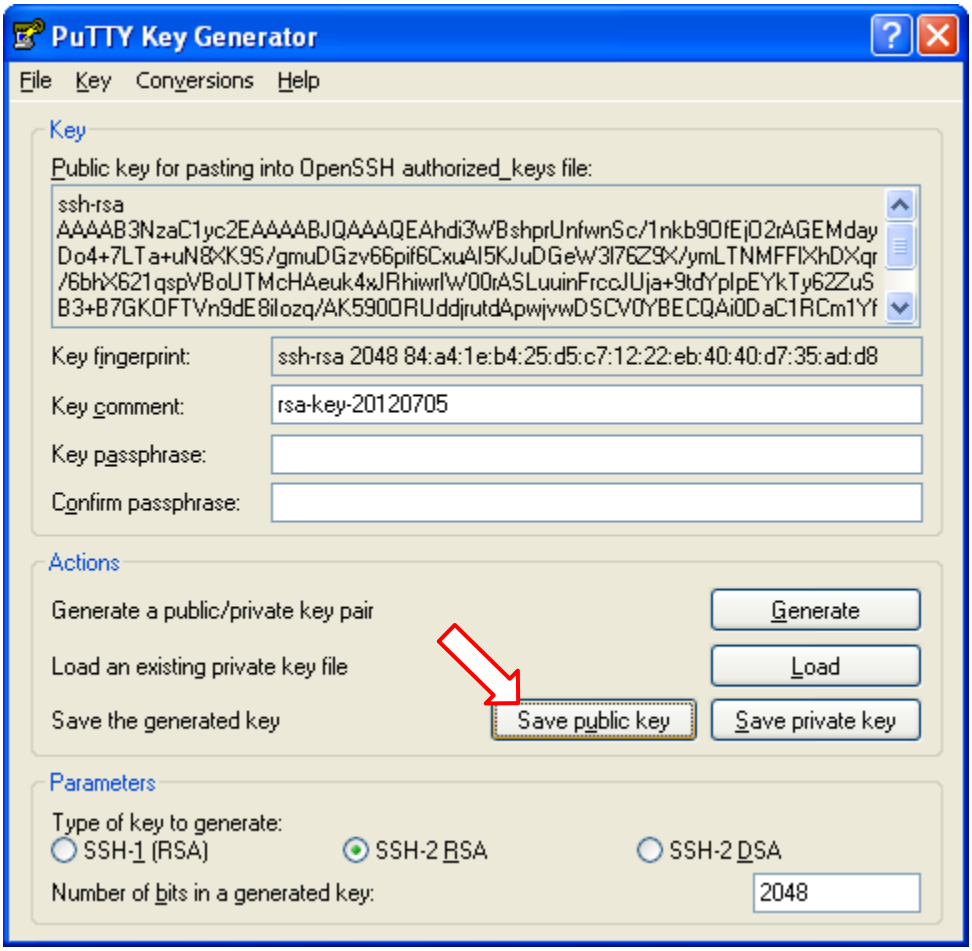
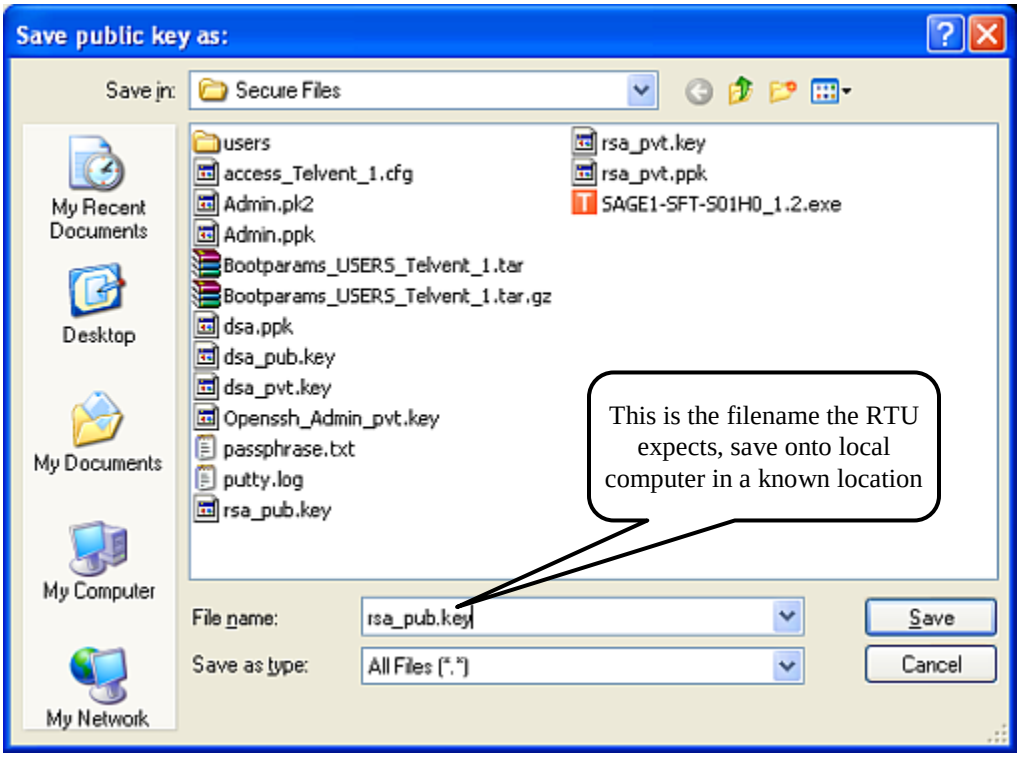


Figure 2-19 Click “Save public key” button to save the RTU public key



Do Not Click Generate Before Saving the Public Key!

Figure 2-20 Name RTU public key “rsa_pub.key” so it is easy to identify



The RTU server RSA Private and Public key pair generation is complete. To upload the RTU **Public** key and **Private** key into the RTU, use the User_Manager_YZ_YZ.exe program to create the secure upload file. See the "Secure Administration" chapter of the "config@WEB Secure Software Users Guide" for instructions on using this program.

2.6 Server DSA Key Example

Launch PuTTYGen Key Generator.

Figure 2-21 Set “Type of key to generate:” to “SSH-2 DSA”

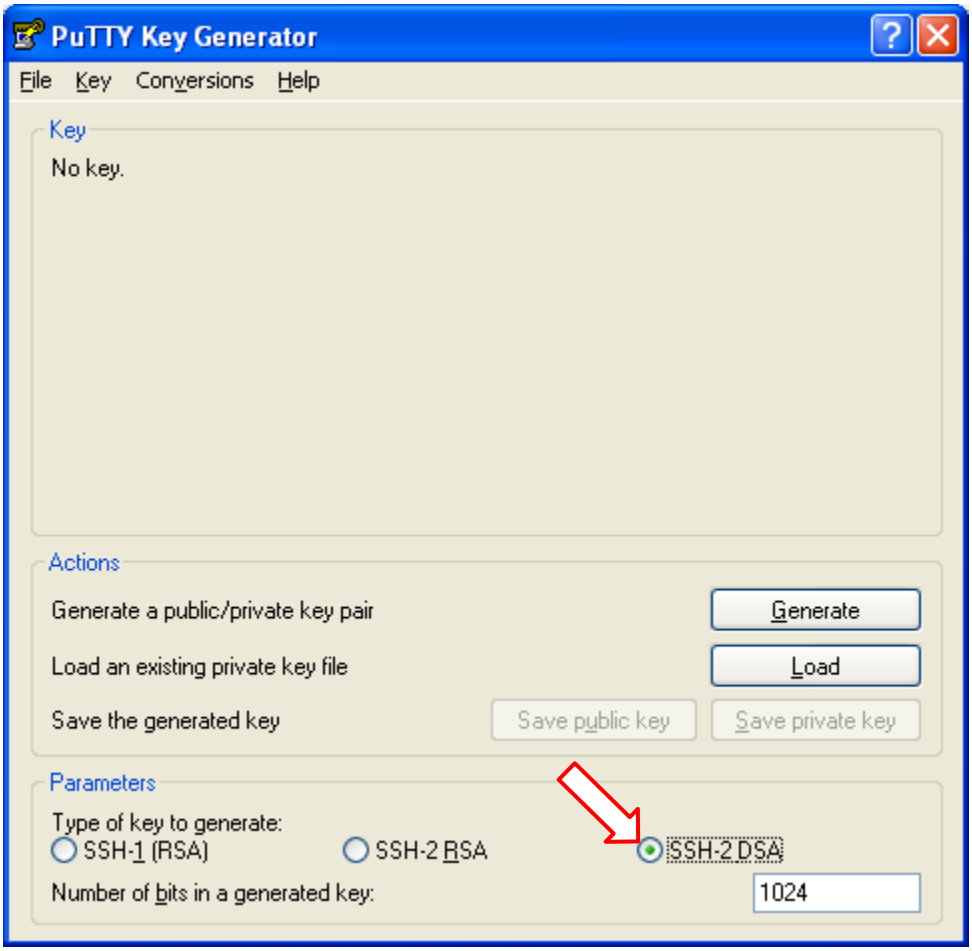


Figure 2-22 Set the "Number of bits in a generated key:" to 2048 as shown

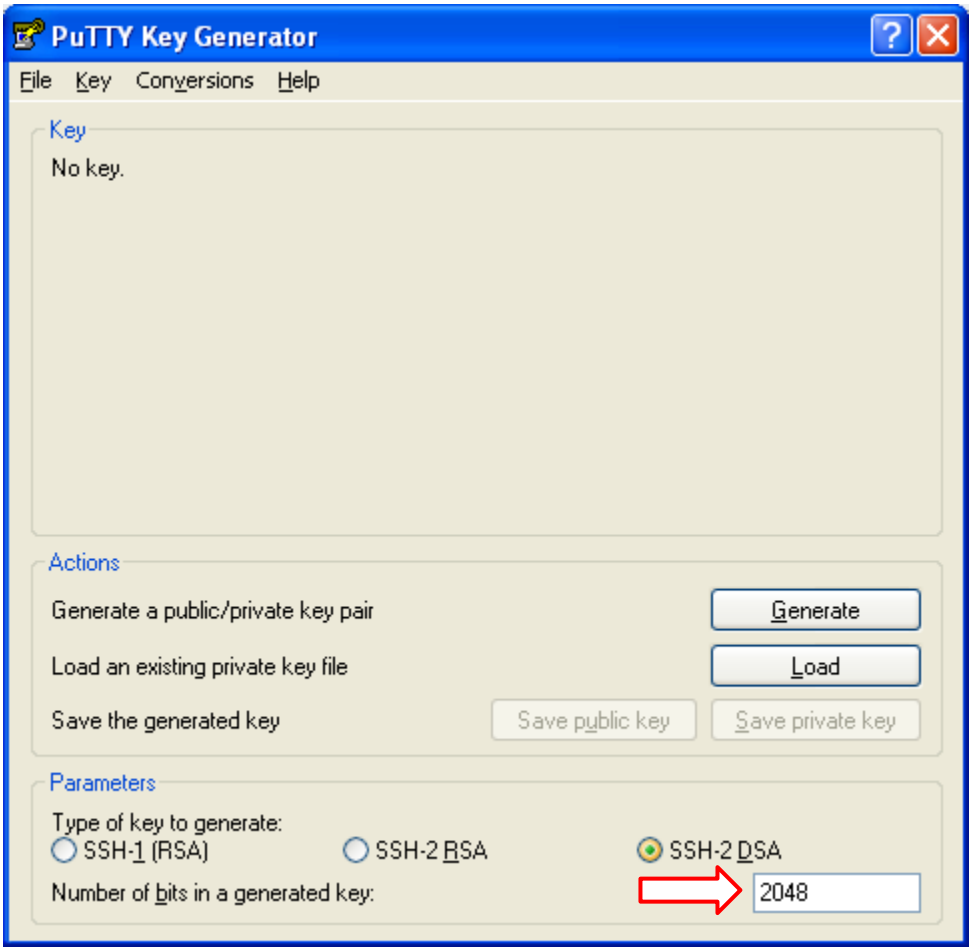


Figure 2-23 Click the “Generate” button

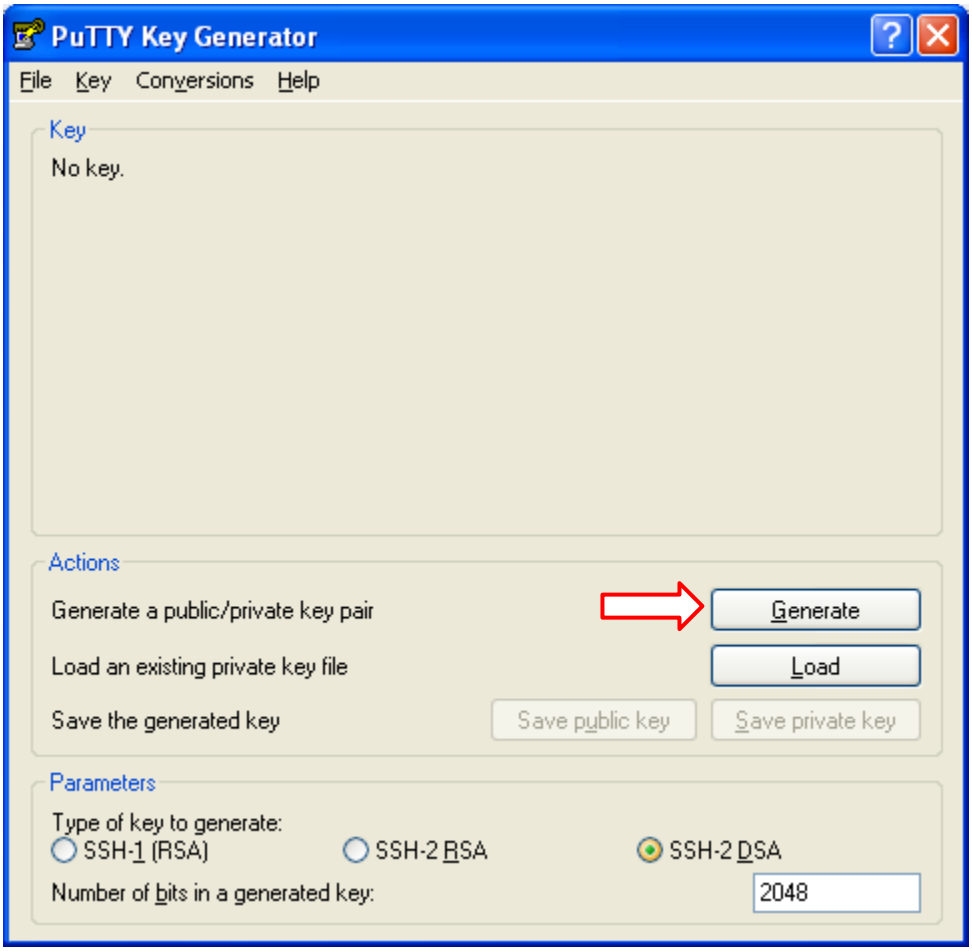
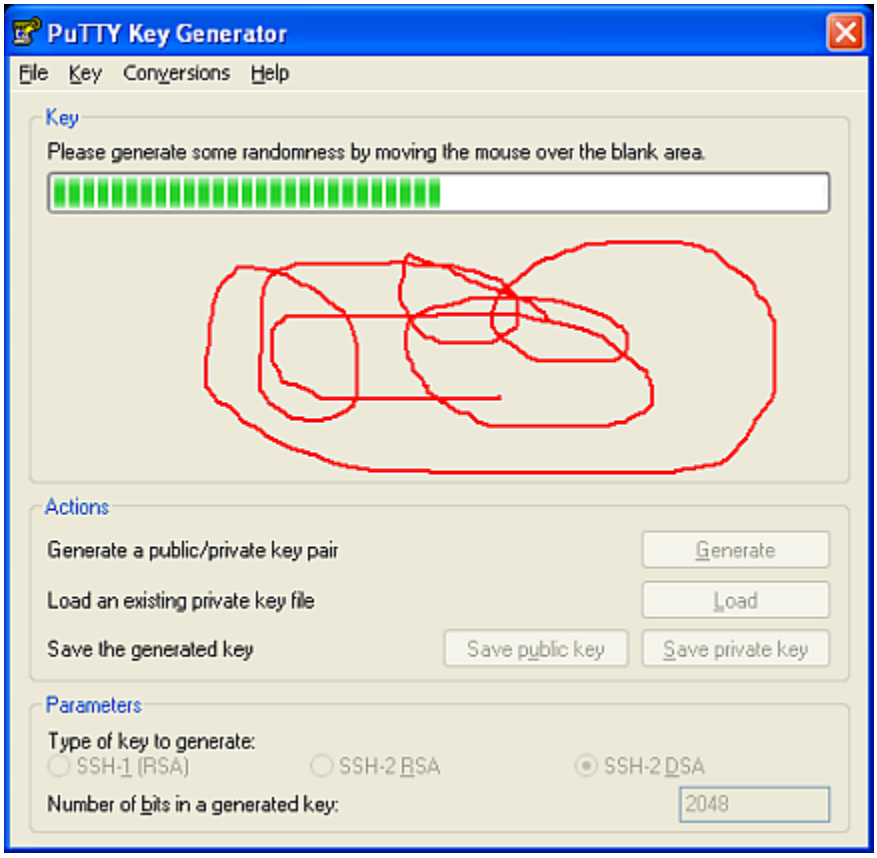


Figure 2-24 Moving the mouse in the blank area generates the progress bar



Keep moving the mouse until the program completes the key.

Figure 2-25 DSA key generation is complete

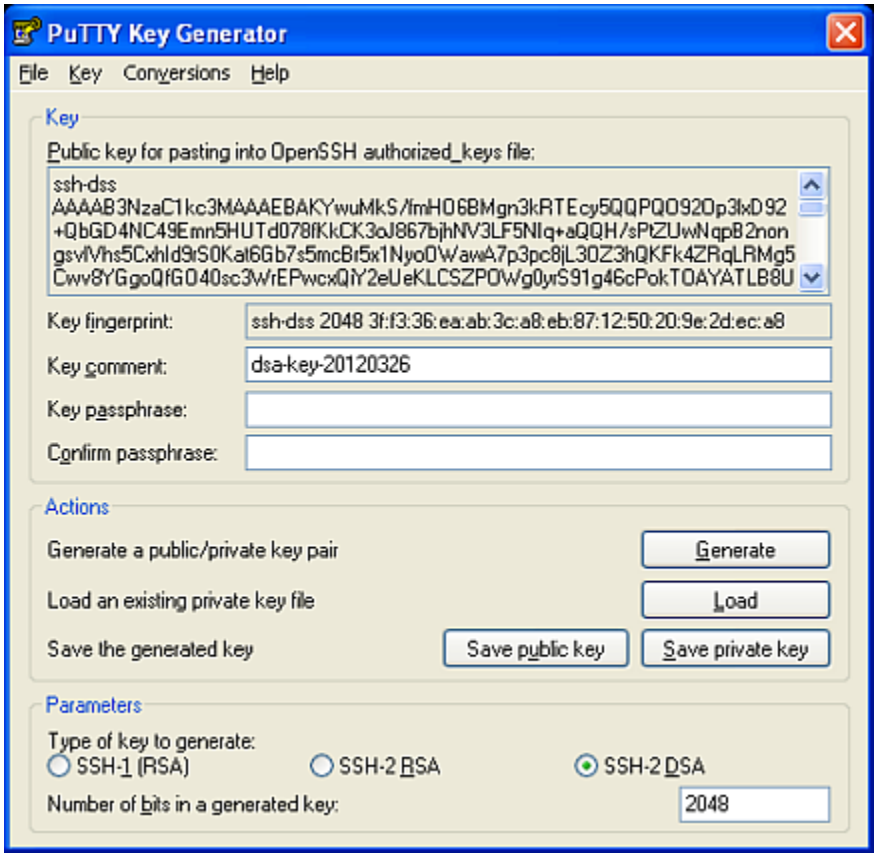


Figure 2-26 Save private key into OpenSSH format key file using “Export OpenSSH key"

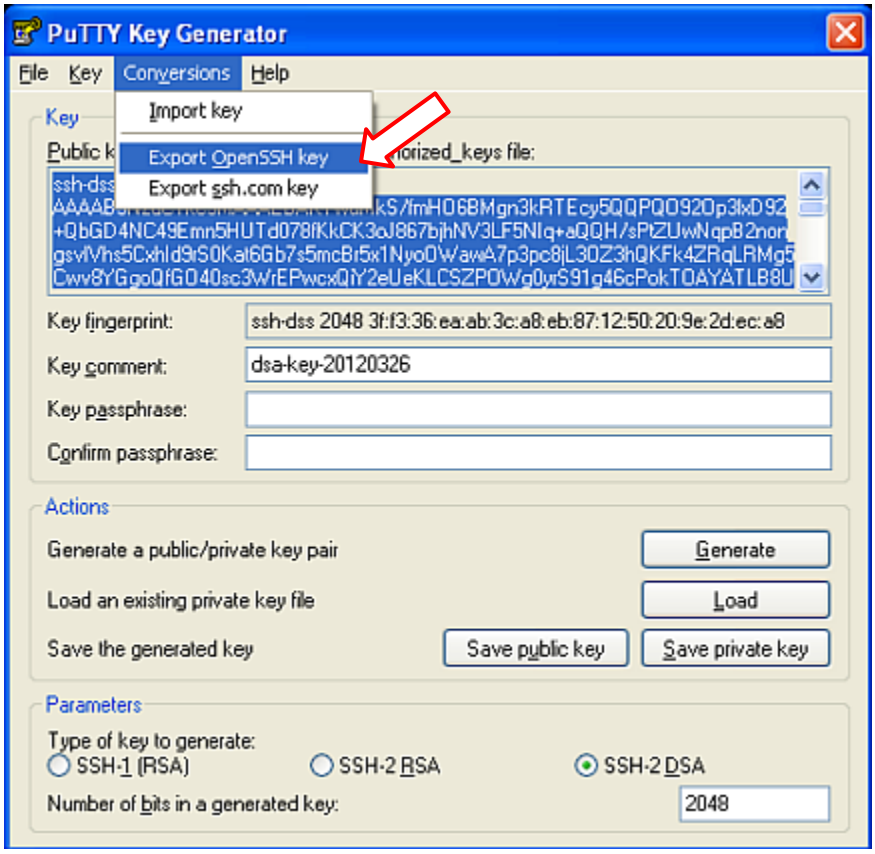


Figure 2-27 RTU private key must NOT be passphrase protected

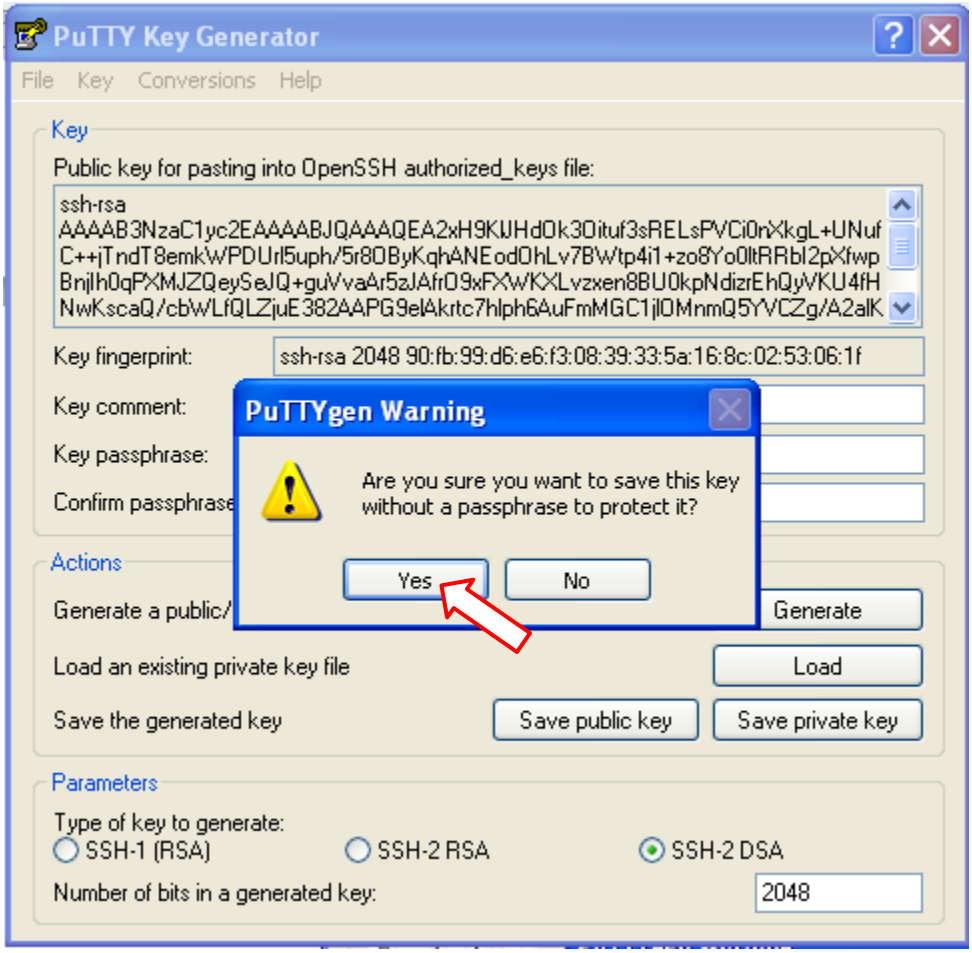


Figure 2-28 Name the RTU private key “dsa_pvt.key”

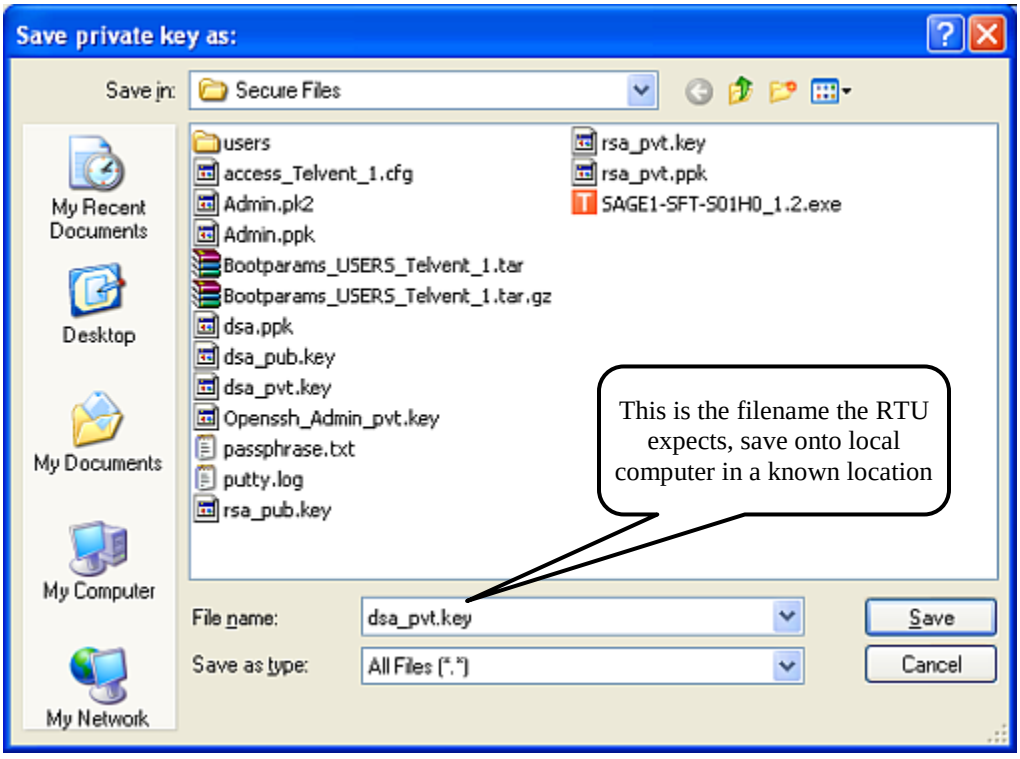
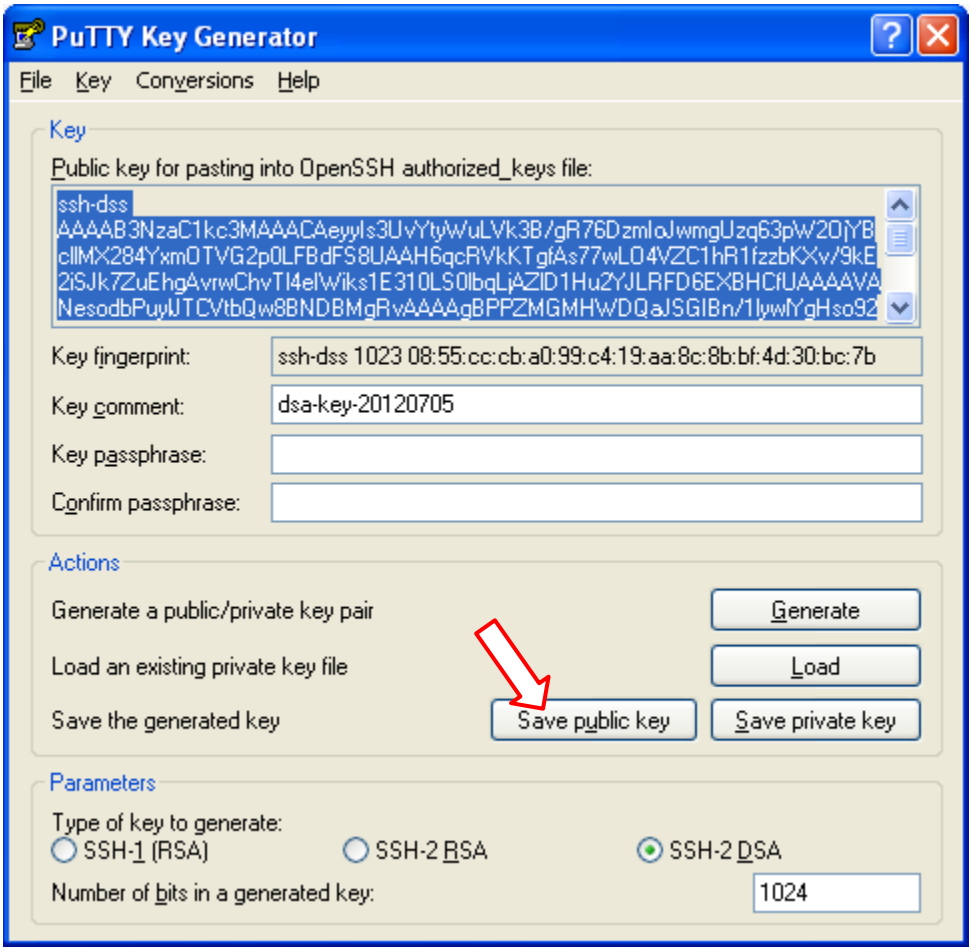
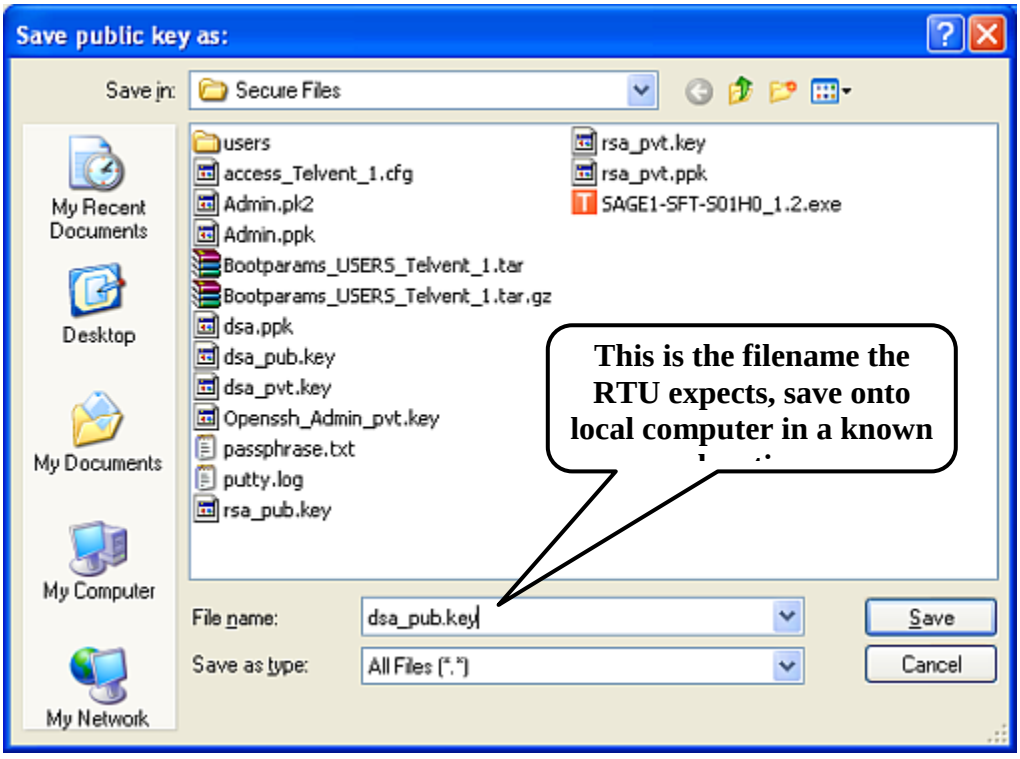


Figure 2-29 Click “Save public key” button to save the RTU public key



Do Not Click Generate Before Saving the Public Key!

Figure 2-30 Name RTU public key “dsa_pub.key” so it is easy to identify



The RTU server DSA Private and Public key pair generation is complete. To upload the RTU private key and public key into the RTU, use the User_Manager_YZ_YZ.exe program to create the secure upload file. See the "Secure Administration" chapter of the "config@WEB Secure Software Users Guide" for instructions on using this program.

3 SSL Keys and Certificates

3.1 Introduction

This document explains how to build a self-signed SSL Certificate and a server (RTU) private key using a program called OpenSSL-Win32 (or Win64) from Shining Light Productions. Some experience with MS DOS is helpful, although this document goes through the process step-by-step.

Note: Use either Win 32 or Win64 according to compatibility with your computing environment.

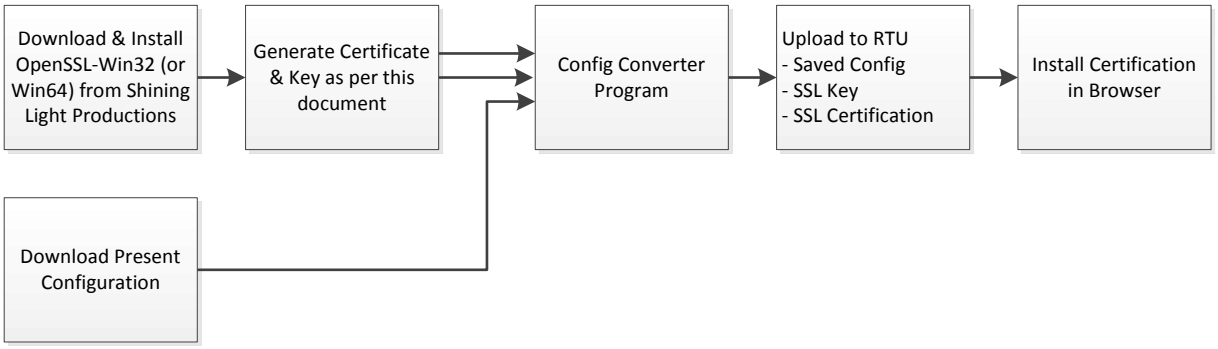
After the certificate and the server key are generated (instructions to follow), they must be loaded into the RTU. The only way to do this is by uploading to the RTU the C3414-500-S02YZ_Config.tar.gz package using the Config Converter. This package also replaces the configuration, so you must offload your present configuration from the RTU (if you want to save it).

For specific information on the Up/Download process and the Config Converter, refer to the config@WEB Secure Software Users Guide.

When it comes time to upload the certificate and server key to the RTU, you will do this using a minimum of three different fields in the Config Converter program:

1) Configuration (browse for your saved configuration)
2) SSL Key (browse; instructions to follow)
3) SSL Certificate (browse; instructions to follow)

The overall process is illustrated below.



3.2 Present Configuration

Save your present configuration (if desired) by downloading to a known location. See the config@WEB Secure Software Users Guide.

3.3 OpenSSL-Win32/64 Program

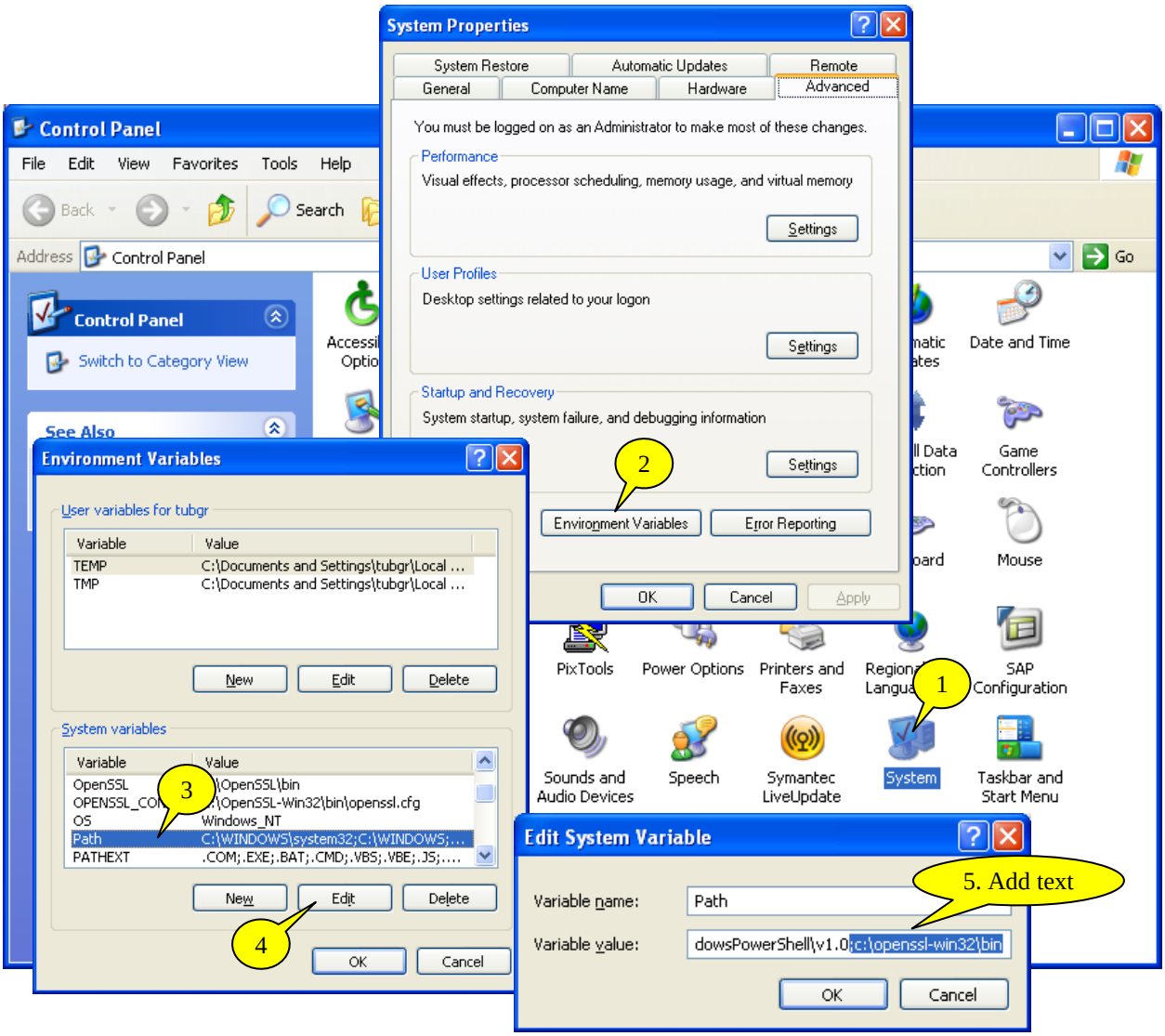
Note: The private key for the server (the RTU) must be the "OpenSSL" format.

Go to the Shining Light Productions website and download and install the OpenSSL-Win32/64 Program. Follow the defaults so that it installs in a folder at the root level called C:\OpenSSL-Win32/64.

3.4 Generating the Certificate & Key

3.4.1 Setting Paths

From the Start menu, open the Control Panel and do the sequence shown below.



3.4.2 Starting a Command Window

Click Start -> Run -> Type “cmd”

Change directory to where you would like the certificates to be saved.

3.5 Which Certificate is Right for You?

3.5.1 Self-signed

Self-signed certificates are good to test with or build a few certificates.

3.5.2 Certificate Authority (CA)

More secure. Certificates verified by trusted company. (Verisign, Thawte, etc.) See Figure 3-1 for a screen visual

3.6 Self-Signed Certificate & Key Creation

3.6.1 Creating a Private Key

This command generates 1024 bit RSA key with Triple-DES encryption.

openssl genrsa -des3 -out server.key 1024

3.6.2 Creating a CSR

This command creates a Certificate Signing Request.

openssl req -new -key server.key -out server.csr

The server.csr file contains all the information needed to make a certificate. These are sent to CA (Certification Authority) or Self signed to make a valid certificate.

3.6.3 Remove Passphrase from Key

To make the private key secure, the passphrase must be removed.

copy server.key server.key.org

openssl rsa -in server.key.org -out server.key

3.6.4 Creating a Self-Signed Certificate

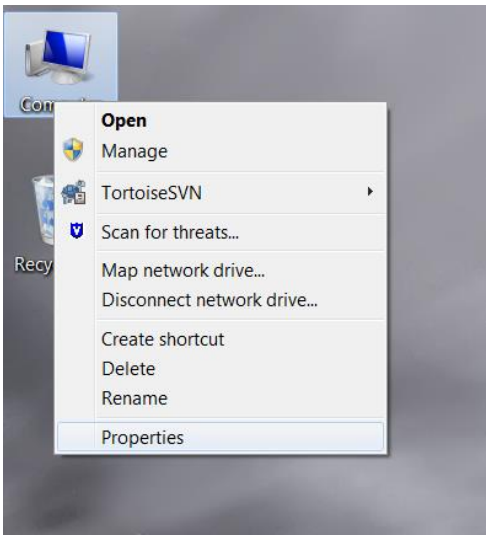
Sign the Certificate request using the server private key.

openssl x509 -req -days 365 -in server.csr -signkey server.key -out server.crt

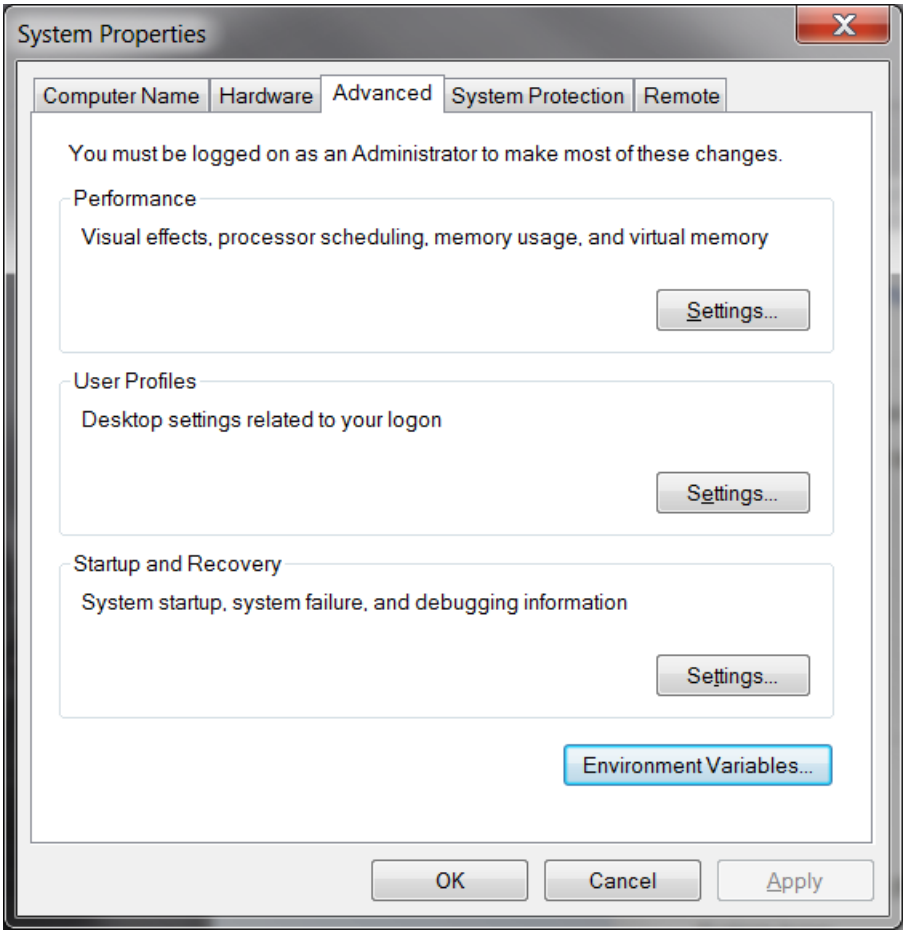
Note: In the event of an error stating "unable to write random state," create an environmental variable RAND and set it equal to `".rnd"`. This may be done with the following steps.

If you do not get this error, proceed to **Section 3.8**

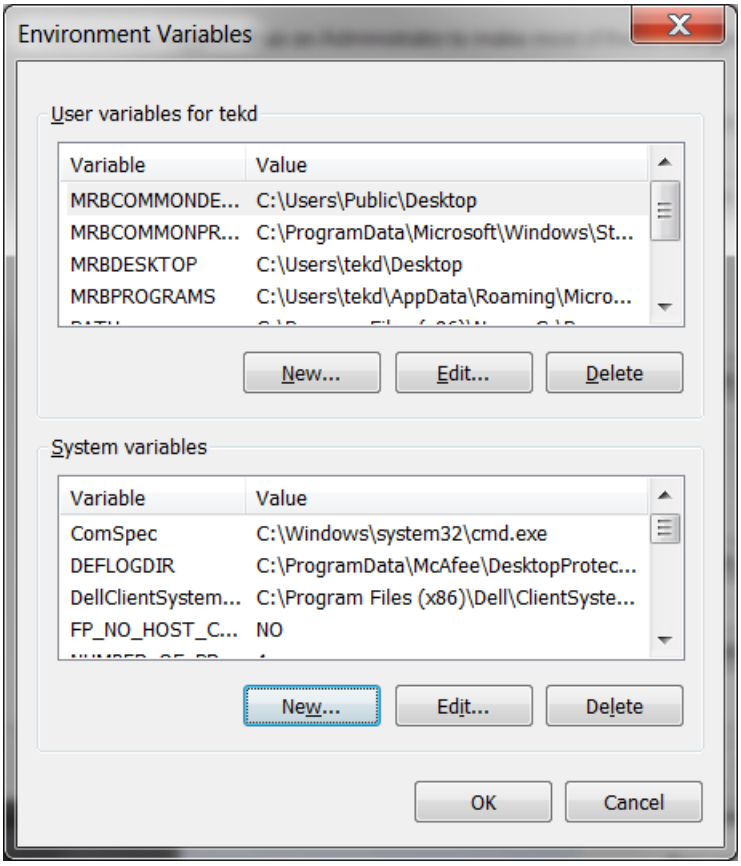
1. Right click on My Computer



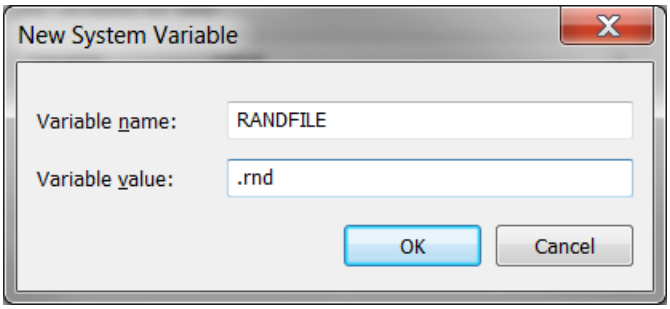
2. Click on Properties to get:



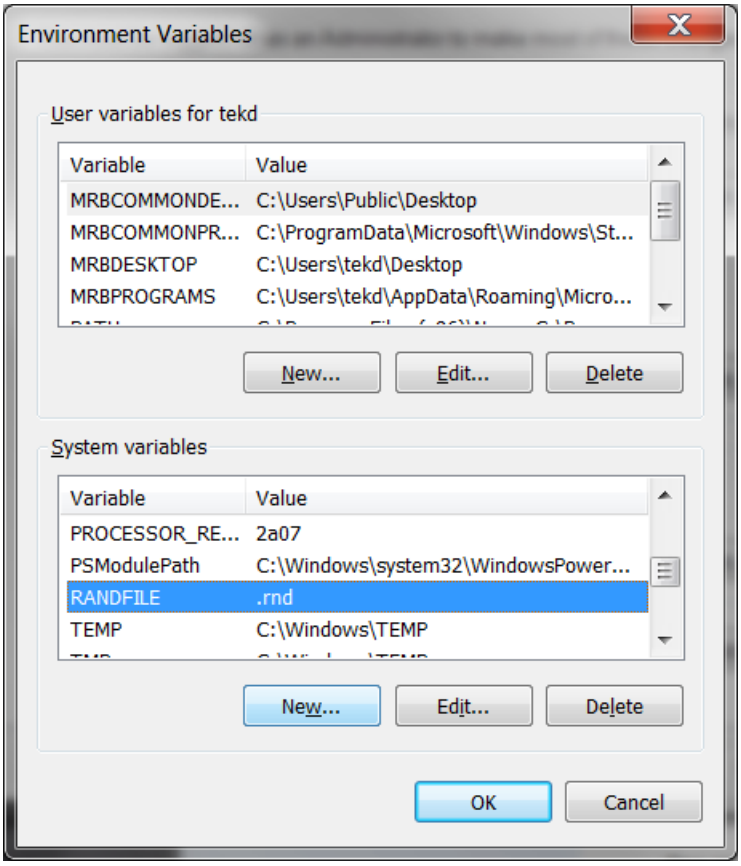
3. Click on Environmental Variables:



4. Click on System Variables, New to get the following. Enter RANDFILE and .rnd as shown, then OK.



5. Your entry will appear in the list:

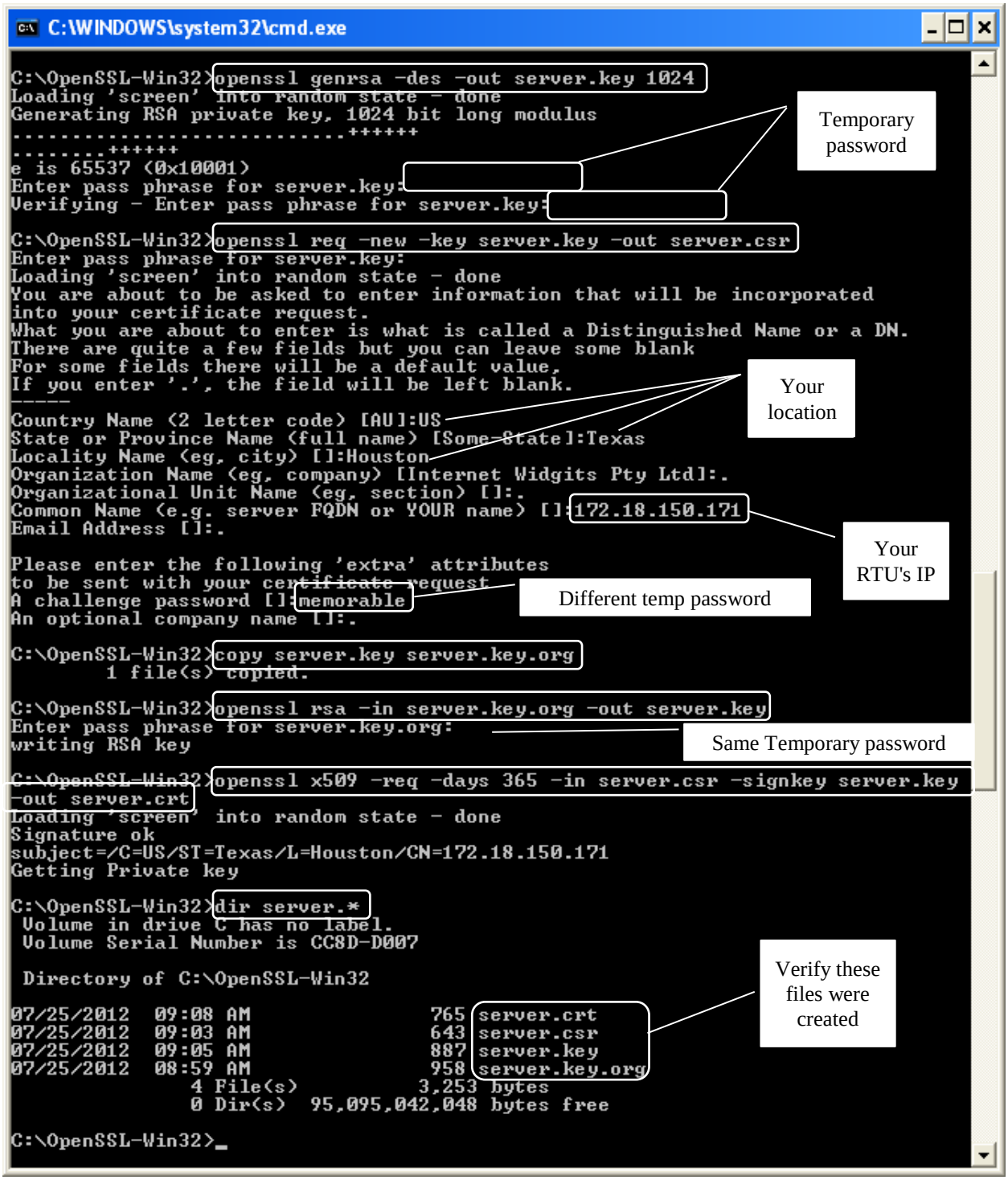


6. Click OK to complete the operation.

7. Repeat the cmd line shown in **Section 3.6.4.**

The purpose of the commands in the window below is explained in the previous section. You must type in commands exactly as shown, except as noted otherwise. Some requests following a colon (**:**) are optional; type in a period, as shown below.

Figure 3-1 Step by Step Window



At the end of this process, the files shown above must exist. You will use two of them in the Config Converter.

3.7 CA Certificate & Key Creation

3.7.1 Creating a Server Key and a Certificate Signing Request (CSR)

Command to generate server key:

openssl genrsa -des3 -out server.key 4096

Command to generate server certificate request:

openssl req -new -key server.key -out server.csr

3.7.2 Remove Passphrase from Key

copy server.key server.key.org

openssl rsa -in server.key.org -out server.key

3.7.3 Command to generate a CA Signed Certificate

openssl x509 -req -days 365 -in server.csr -CA ca.crt -CAkey ca.key -set_serial 01 -out server.crt

Note: Every time a new certificate is signed using the CA.key the serial number must be incremented.

The CA Certificate and Key will become part of your configuration to be uploaded to the RTU.

3.8 Uploading New Configuration to the RTU

Upload **C3414-500-S02YZ_Config.tar.gz** to the RTU. If you need help, see the config@WEB Secure Software Users Guide. Be sure to reset the RTU after upload.

3.9 Installing a Certificate in Browser

Please see the config@WEB Secure Software Users Guide.