Cryptography - SSH

bdNOG7

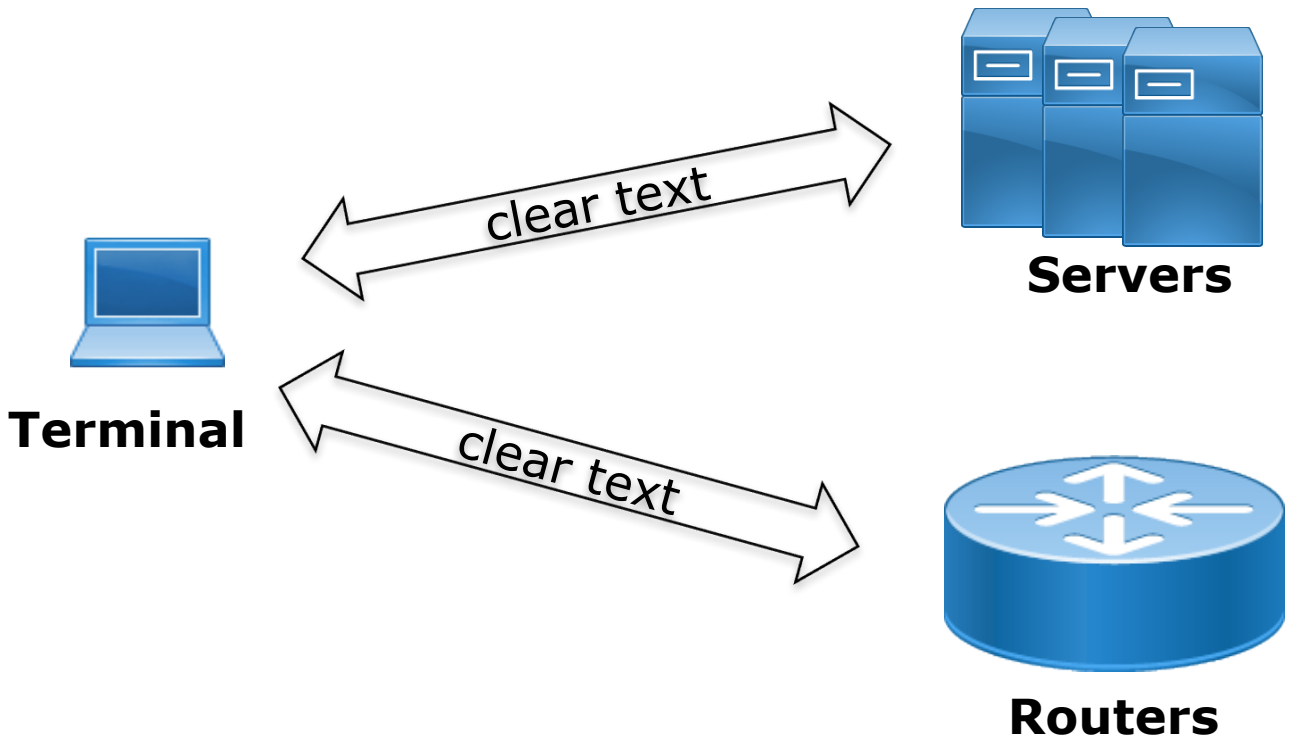
19-22 November 2017

Dhaka, Bangladesh

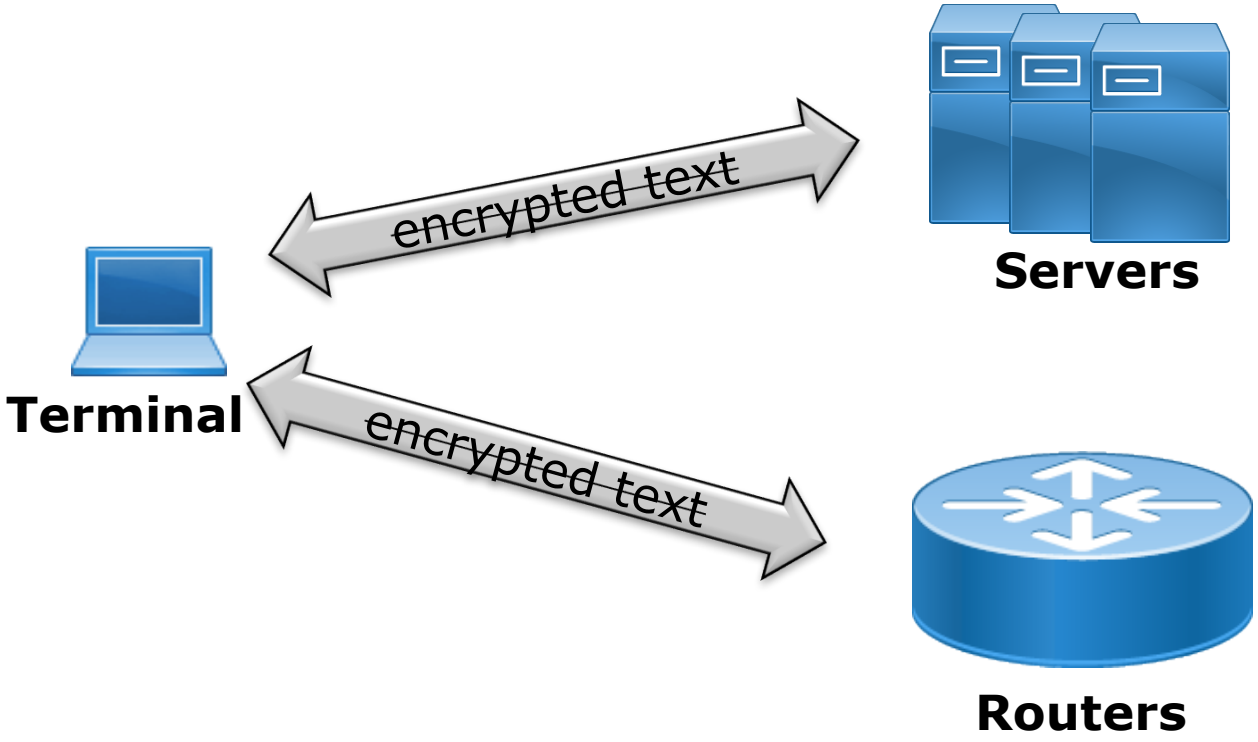
What is “Secure”

- **Authentication** – I know who I am talking to
- Our communication is **Encrypted**

Telnet



SSH – encrypted channel



Secure Shell (SSH)

- Authenticated and encrypted shell access to a remote host
- Client-server model
- TCP 22
- It is much more than a secure shell
  - Transport protocol (eg. SCP, SFTP)
  - Connection forwarder
    - You can use it to build custom tunnels

Secure Shell (SSH) process

- Client-server crypto handshake
- Generate a symmetric key to secure the transport
- Client authenticates to server securely
- Secure communication can begin

SSH – under the hood

CipherSuite Negotiation

The highest supported by both

- Encryption algorithm
- Hashing algorithm
- Key-exchange algorithm

Client generates random

C-random

Server generates random

- Hash [C-random and S-random]
- Sign hash with its private-key

S-random, signed hash, public-key (host-key)

- Client decrypts signed hash
- Compute and compare hashes (validate S-random)

Master Key

- Compute Master key using S-random and its own random

- Compute Master key using C-random and its own random

- Master key (shared-secret) used to encrypt all messages!
- The hash is used as SSH session ID

SSH Authentication

- Client sends its username to server over the secure channel
  - Encrypted using the "**shared master key**"
- Server checks if the username exists in the local database
  - If username not valid, tear down the SSH session!
  - If valid, the server sends back authentication method
    - Password based
    - Public-key based

SSH Authentication – Password

- Client sends its password
  - encrypted using the shared master secret
- Server decrypts, and checks the password
  - If match found, access is granted (shell access)

Password Authentication

- Password Authentication is simple to set up
  - usually the default

- But allows brute-force guessing ☹

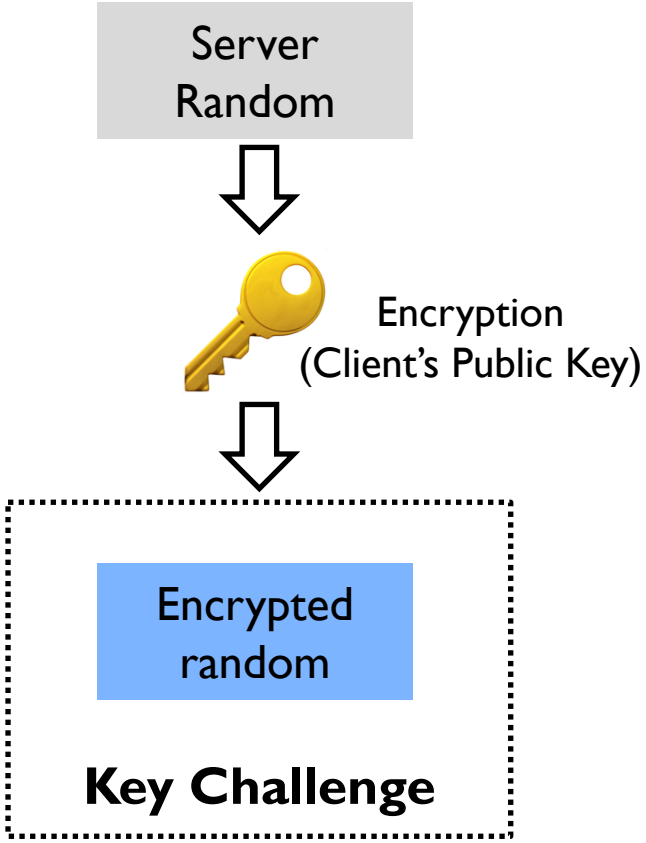
SSH Authentication - Public Key

- User creates a key pair
  - public and private
    - **public key** - nonsensitive information
    - **private key** - is protected on the local machine by a strong passphrase
- Installs the public key in `$HOME/.ssh/authorized_keys` file on the target server.
  - one time installation

How it works - Key Challenge

1. Client connects to server with a request to set up a key session
   - Sends KeyID for the key-pair it wants to use, and
   - Username/account-name

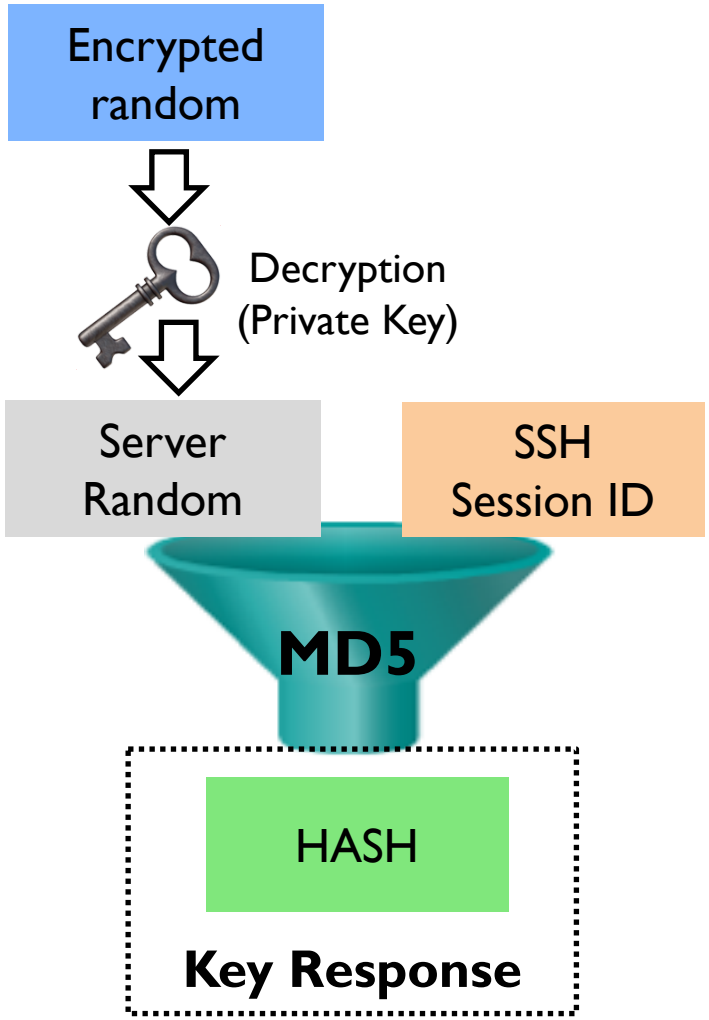
2. If there is a public key in the `authorized_keys`
   - server generates a random number
   - encrypts the random using client's public
   - sends the encrypted random as a key-challenge to client



How it works - Key Response

3. Client decrypts the random number with its private key

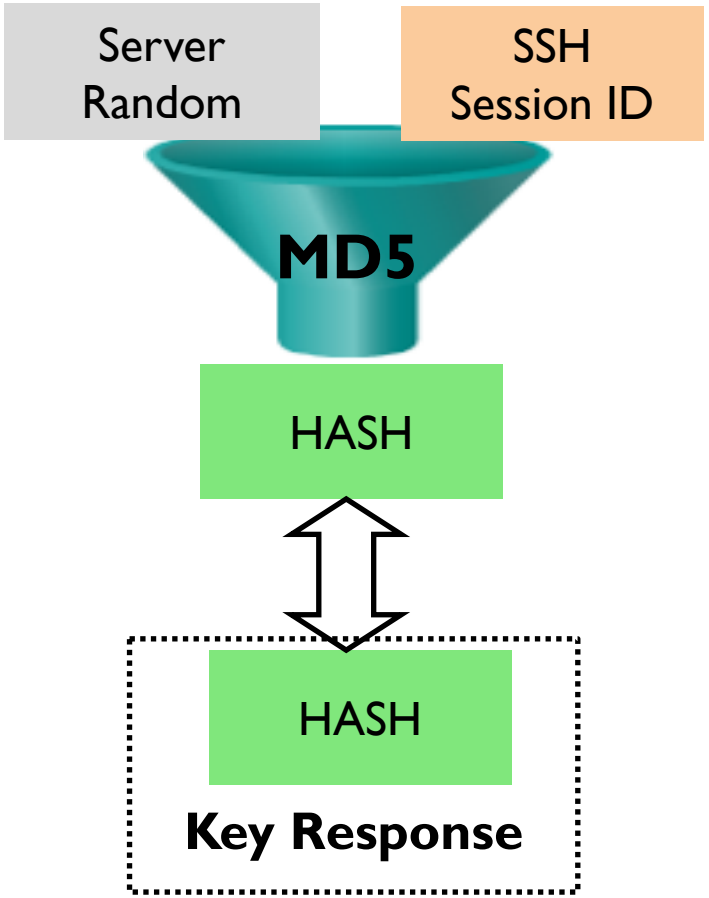
4. Creates an MD5 hash of the random and the session ID
   - sends back to the server as the key response
     - encrypted with shared Master key



How it works - Access

5. The server computes its own MD5 hash and compares it with the received hash
   - **random number + session ID**

6. If the hashes match, the user must be in possession of the private key
   - **access is granted!**



Public Key Authentication

- Cannot derive private key from public key!
  - Cannot brute force either
- Requires one-time setup of public key on target system
- Requires unlocking private key with secret passphrase upon each connection
  - If you have setup one

Public Key Access

- Never store Private Key on a multi-user host
- Store Private Key **ONLY** on your machine and protect
  - **Encrypt Disk!**
- It is OK to use SSH_AGENT to remember your key ONLY if your laptop/computer locks very quickly

SSH Keys on Unix /MacOS

- SSH is built-in
  - UNIX
  - Linux
  - MacOS X

Generate Key (Unix / MacOS)

```
$/usr/home/foo> ssh-keygen -t rsa -b 4096 -C your_email@example.com
Generating public/private rsa key pair.
Enter file in which to save the key (/usr/home/foo/.ssh/id_rsa):
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in /usr/home/foo/.ssh/id_rsa.
Your public key has been saved in /usr/home/foo/.ssh/id_rsa.pub.
The key fingerprint is:
27:99:35:e4:ab:9b:d8:50:6a:8b:27:08:2f:44:d4:20
your_email@example.com
```

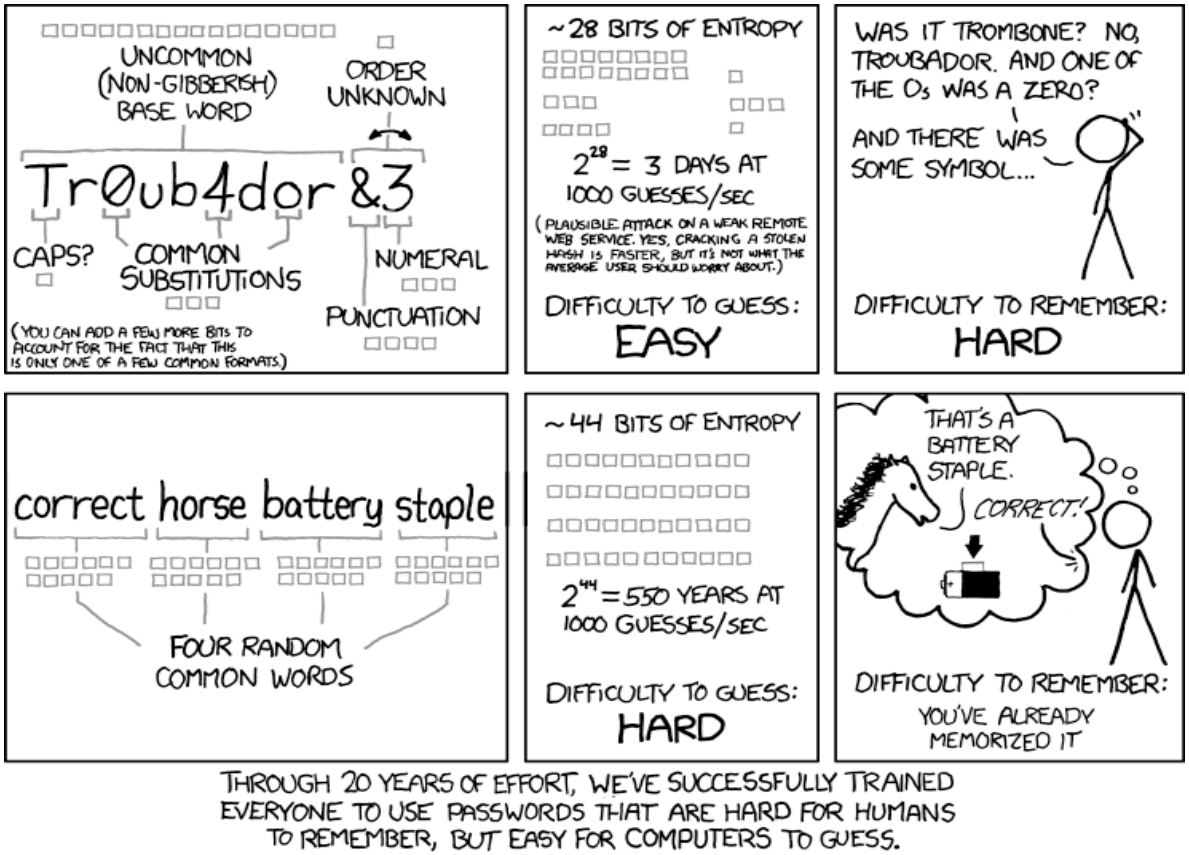
SSH Keys (Unix / MacOS)

`~/.ssh/id_rsa:` The private key

DO NOT SHARE THIS FILE!

`~/.ssh/id_rsa.pub:` The associated public key. This can be shared freely without consequence.

Password vs Passphrase



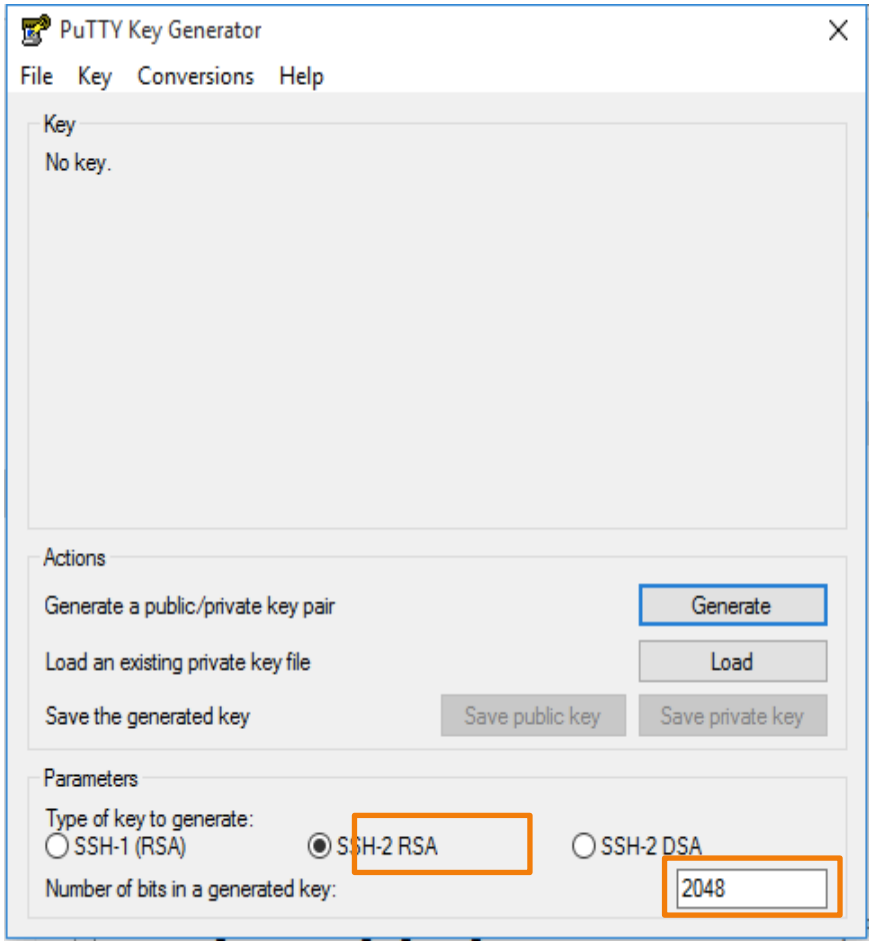
source : http://xkcd.com/936/

Private Key on Windows

- https://www.chiark.greenend.org.uk/~sgtatham/putty/latest.html
  - PuTTY (the Telnet and SSH client itself)
  - PuTTYgen (an RSA and DSA key generation utility)
  - Pageant (an SSH authentication agent for PuTTY, PSCP, PSFTP, and Plink)

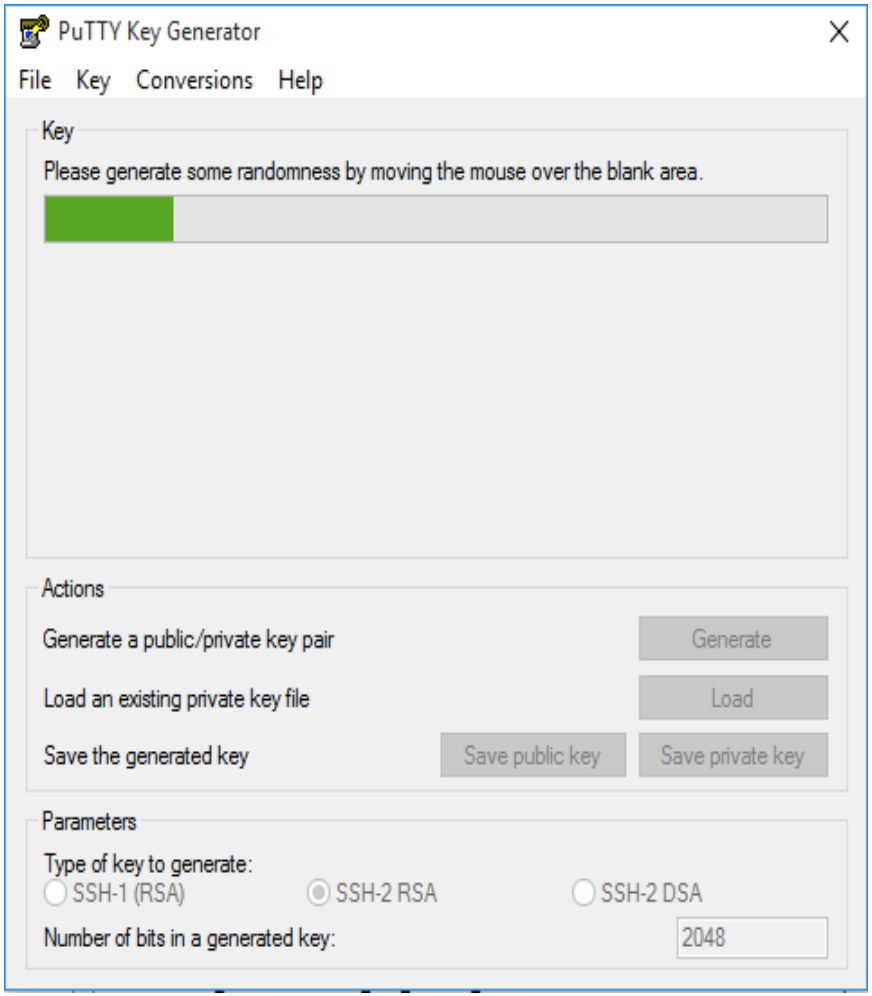
Generate Key (Windows)

1. Run PuttyGen



Generate Key (Windows)

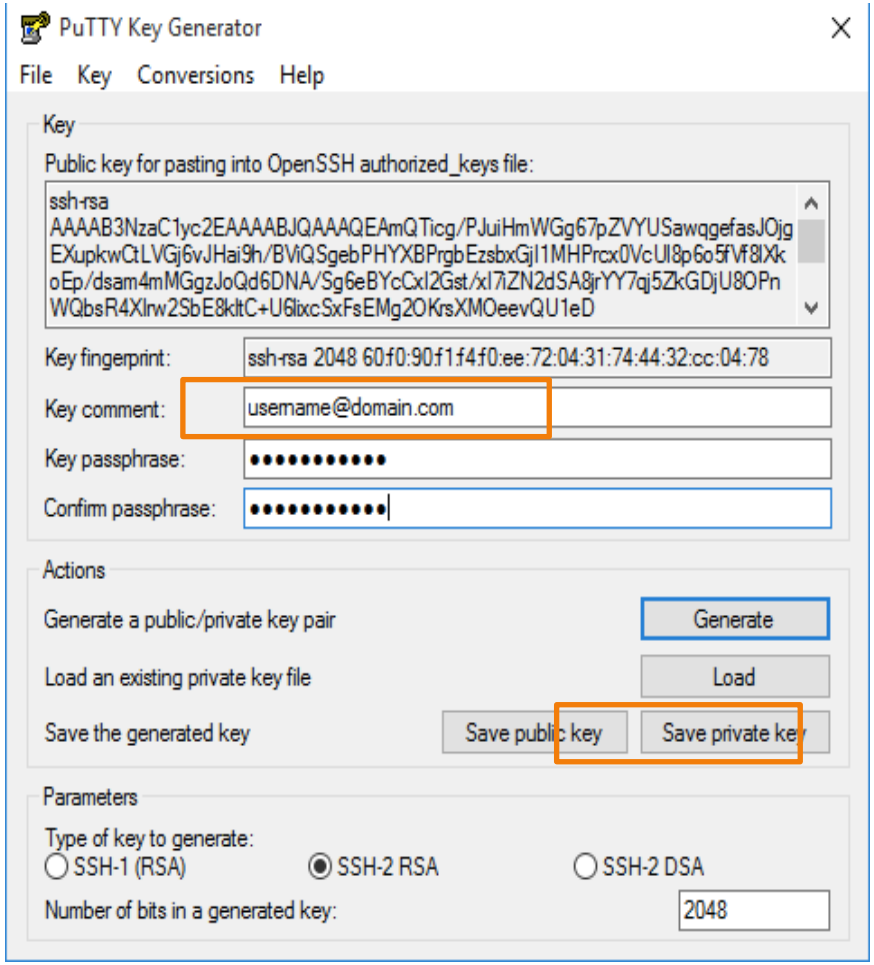
2. Generate Key



Generate Key (Windows)

3. Enter Passphrase & save Private Key

4. Right-click in the text field labeled Public key for pasting into OpenSSH authorized_keys file and choose Select All and copy the key



Saving Key on the Target Host

- You can copy the public key into the new machine's authorized_keys file with the **ssh-copy-id** command

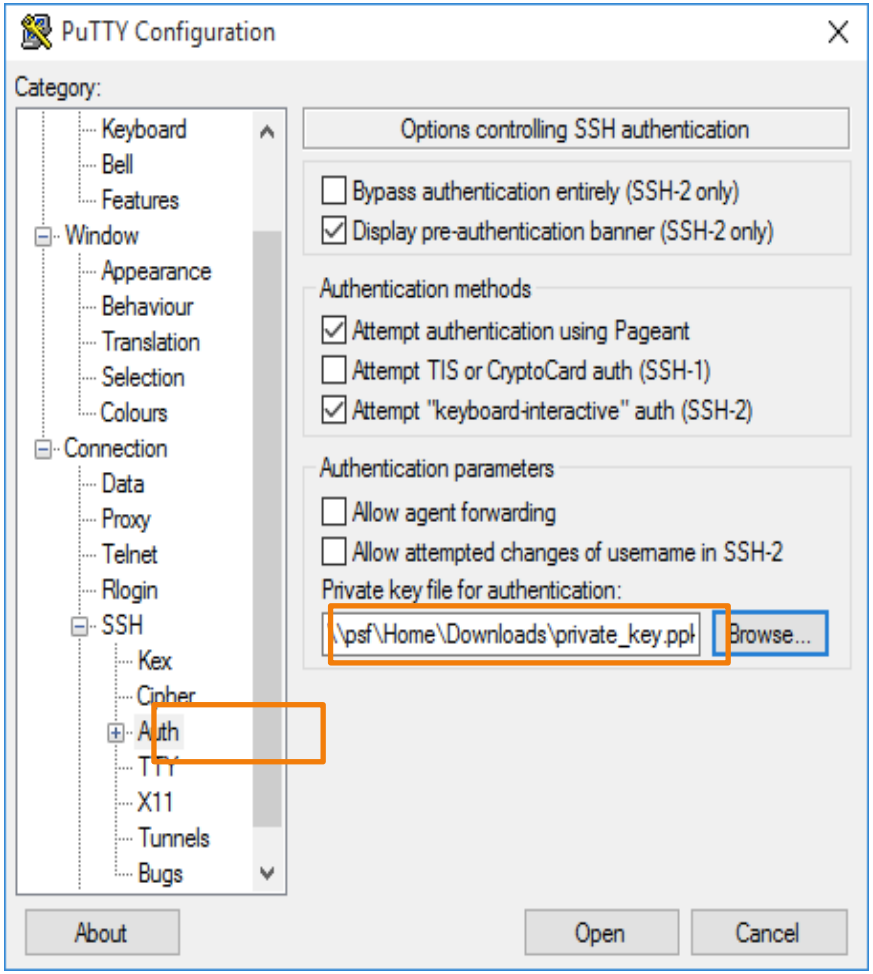
```
ssh-copy-id user@serverip
```

- Alternatively, you can paste in the keys using SSH:

```
cat ~/.ssh/id_rsa.pub | ssh user@serverip "mkdir -p
~/.ssh && cat >> ~/.ssh/authorized_keys”
```

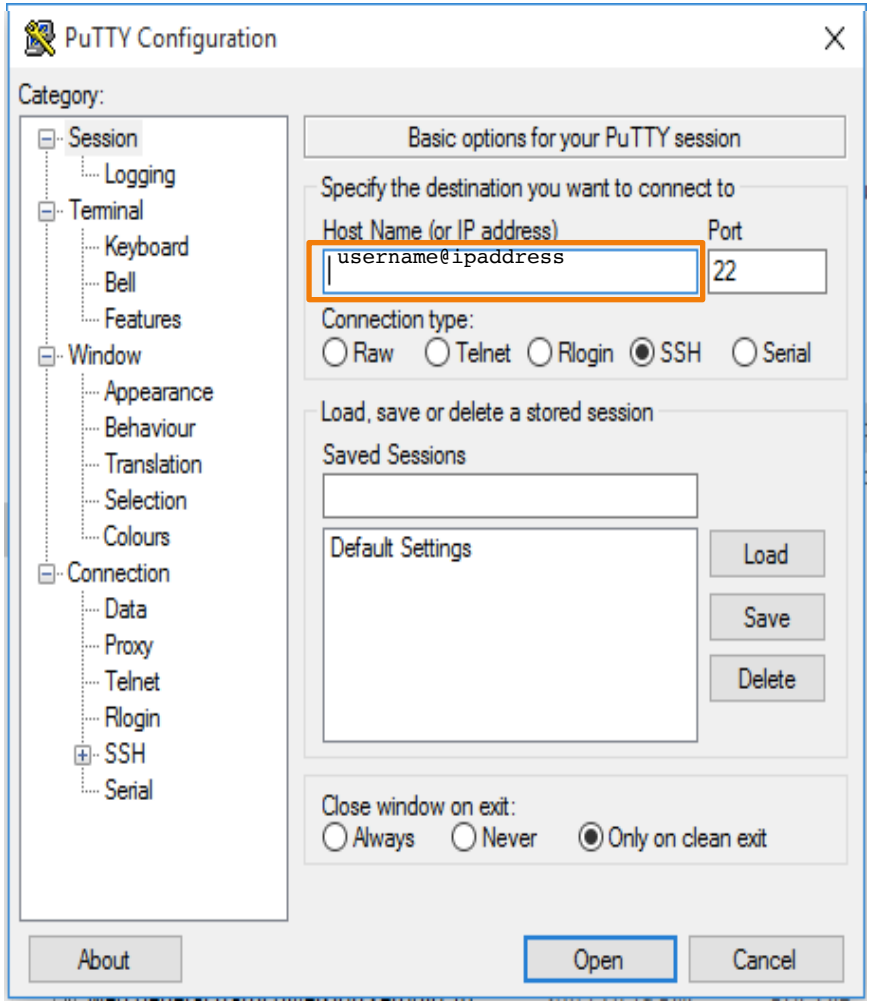
Saving Key on the Target Host - Windows

4. Load Key in Putty



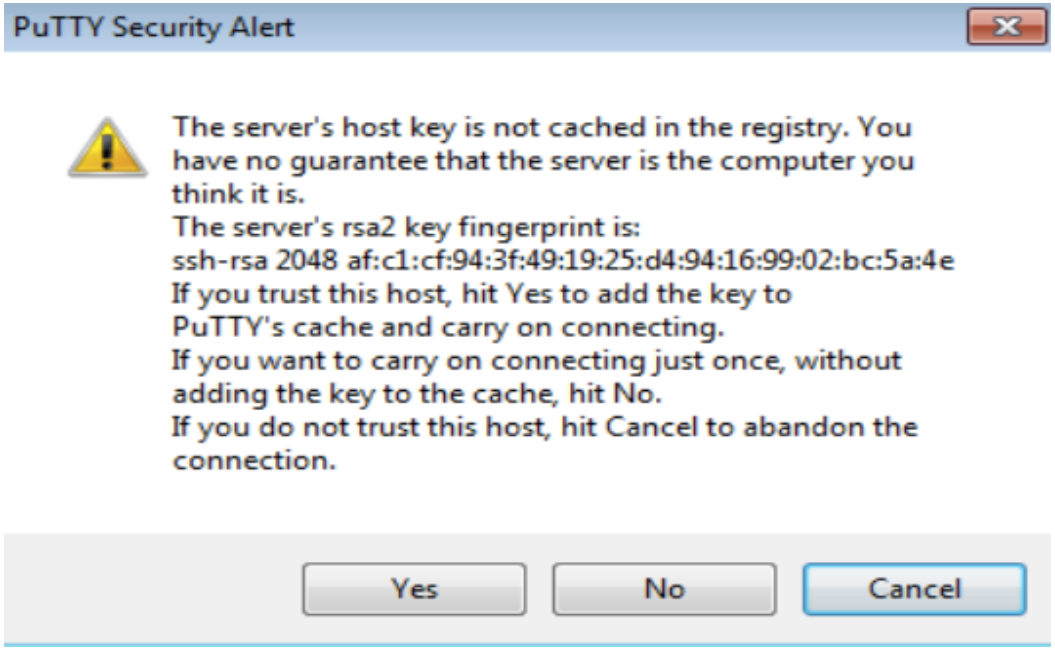
Saving Key on the Target Host - Windows

5. SSH to host



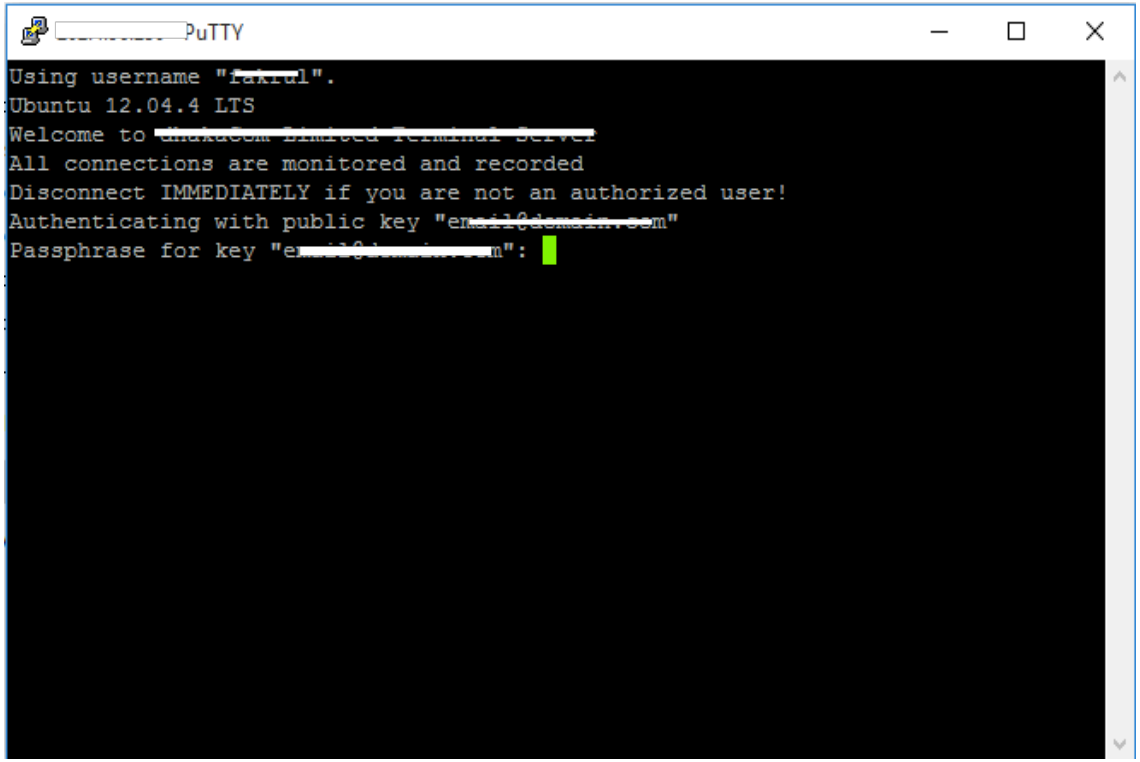
Saving Key on the Target Host - Windows

6. Accept Host’s Key



Saving Key on the Target Host - Windows

7. passphrase for Key



Lab Exercise

- Create your key
- Follow the lab manual **ssh-lab.pdf**