SSH - Secure Shell

CS 35L
Spring 2018 - Lab 3

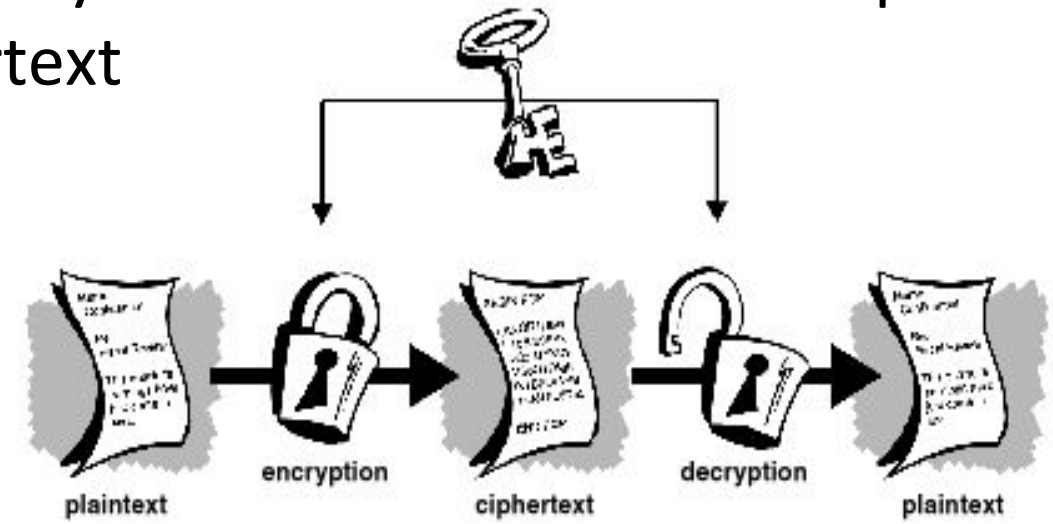
Simple Cryptography Crash Course

Communication Over the Internet

- What type of guarantees do we want?
  - **Confidentiality**
    - Message secrecy
  - **Data integrity**
    - Message consistency
  - **Authentication**
    - Identity confirmation
  - **Authorization**
    - Specifying access rights to resources

Cryptography

- Plaintext: actual message
- Ciphertext: encrypted message (unreadable to unintended recipients)
- Encryption: converting from plaintext to ciphertext
- Decryption: converting from ciphertext to plaintext
- Secret key
  - Part of the function used to encrypt\decrypt
  - Good key makes it hard to recover plaintext from ciphertext



Symmetric-key Encrption

- Same secret key used for encryption and decryption
- **Example** : Data Encryption Standard (**DES**)
- **Caesar's cipher**
  - Map the alphabet to a shifted version
    - ABCDEFGHIJKLMNOPQRSTUVWXYZ
    - DEFGHIJKLMNOPQRSTUVWXYZABC
  - Plaintext – SECRET.
  - Ciphertext – VHFUHW Key is 3 (number of shifts of the alphabet)
- **Key distribution** is a problem
  - The secret key has to be delivered in a safe way to the recipient
  - Chance of key being compromised

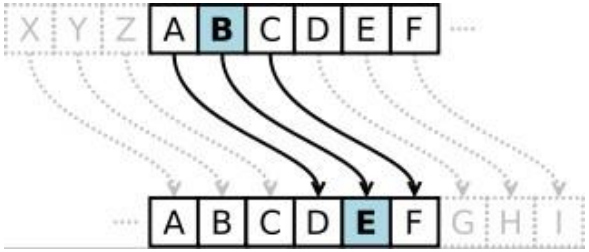


Image Source: wikipedia

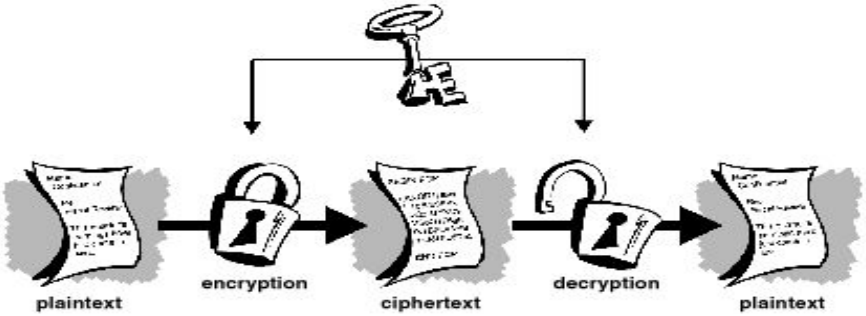


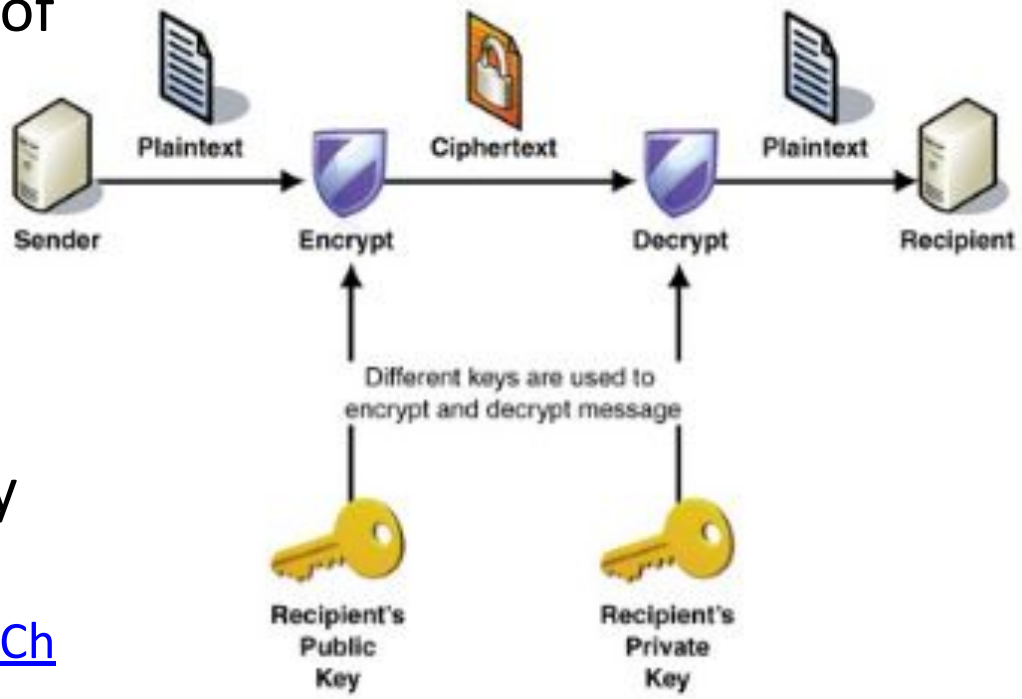
Image Source: gpgtools.org

Public-Key Encryption (Asymmetric)

- Uses a pair of keys for encryption
  - Public Key- published and well known to everyone
  - Private- secret key known only to the owner
- Encryption
  - Use public key to encrypt messages
  - Anyone can encrypt message, but they cannot decrypt the ciphertext
- Decryption
  - Use private key to decrypt messages
- In what scheme is this encryption useful?

Public-Key Encryption (Asymmetric)

- Example: RSA
  (Rivest, Shamir & Adelman)
  - Property used: Difficulty of factoring large integers to prime numbers
  - N = p * q
  - M is a large integer.
  - p,q are prime numbers
  - N is part of the public key



en.wikipedia.org/wiki/RSA_Factoring_Challenge

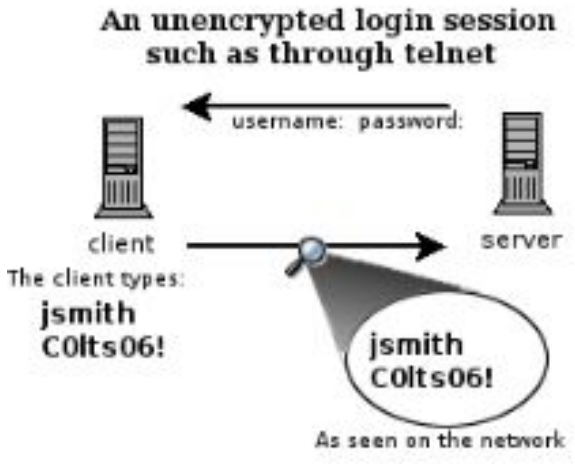
Encryption Types Comparison

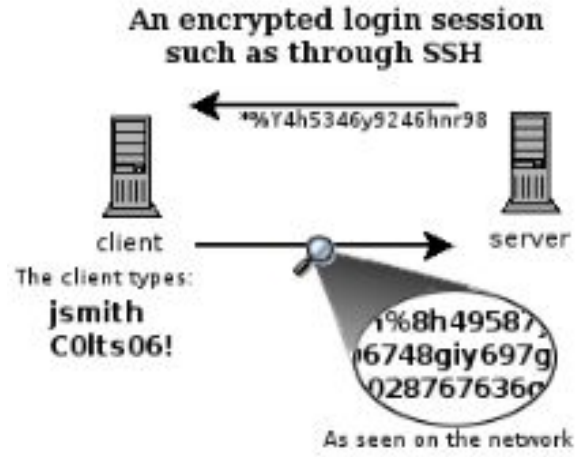
- **Symmetric Key Encryption**
  - a.k.a shared/secret key
  - Key used to encrypt is the same as key used to decrypt
- **Asymmetric Key Encryption: Public/Private**
  - 2 different (but related) keys: public and private
    - Only creator knows the relation. Private key cannot be derived from public key
  - Data encrypted with public key can only be decrypted by private key and vice versa
  - Public key can be seen by anyone
  - **Never** publish private key!!!

SSH

Secure Shell (SSH)

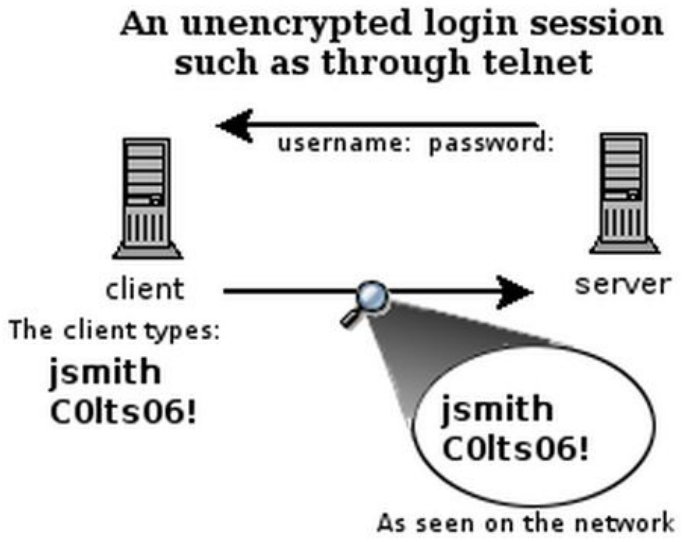
- Telnet
  - Remote access
  - Not encrypted
  - Packet sniffers can intercept sensitive information (username/password)
- SSH
  - run processes remotely
  - encrypted session
  - Session key (secret key) used for encryption during the session





What is SSH?

- **S**ecure **Sh**ell
- Used to remotely access shell
- Successor of telnet
- Encrypted and better authenticated session



SSH Initialization

High level description:

1. Negotiating the version of the protocol to use
2. Negotiating cryptographic algorithms, etc.
3. Negotiating a one-time session key for encrypting the rest of the session
4. Authenticating the server host using its host key
5. Authenticating the client using a password, public key authentication, or other means

Session Encryption

- Client and server agree on a **symmetric encryption key** (session key)
- All messages sent between client and server
  - encrypted at the sender with session key
  - decrypted at the receiver with session key
- anybody who doesn't know the session key (hopefully, no one but client and server) doesn't know any of the contents of those messages

High-Level SSH Protocol

- Client ssh's to remote server
  - `$ ssh username@somehost`
  - If first time talking to server -> host validation

The authenticity of host 'somehost (192.168.1.1)' can't be established.
RSA key fingerprint is 90:9c:46:ab:03:1d:30:2c:5c:87:c5:c7:d9:13:5d:75.
Are you sure you want to continue connecting (yes/no)? **yes**
Warning: Permanently added 'somehost' (RSA) to the list of known hosts.

  - ssh doesn't know about this host yet
  - shows hostname, IP address and fingerprint of the server's public key, so you can be sure you're talking to the correct computer
  - After accepting, public key is saved in ~/.ssh/known_hosts

Secure Shell (SSH) - Client Authentication

- **Password** login
  - `ssh username@ugrad.seas.ucla.edu`
  - `Enter password`

- **Passwordless** login with keys
  - Use private/public keys for authentication (server and client authentication)
  - ssh-keygen
    - Passphrase (longer version of a password/more secure)
    - Passphrase for protecting the private key
    - Passphrase needed whenever the keys are accessed
  - ssh-copy-id username@ugrad.seas.ucla.edu
    - Copies the public key to the server (~/.ssh/authorized_keys)
  - Login without password
    - ssh username@ugrad.seas.ucla.edu
    - Run scripts/commands on the remote machine
      - ssh username@ugrad.seas.ucla.edu ls
    - But you need to provide a passphrase to use a private key

Secure Shell (SSH) - Client Authentication

- **Passphrase-less** authentication
  - `ssh-agent` → authentication agent
  - Manages private key identities for SSH
  - To avoid entering the passphrase whenever the key is used
  - `ssh-add`
    - Registers the private key with the agent
    - Passphrase asked only once
    - `ssh` will ask the `ssh-agent` whenever the private keys are needed

Secure Shell (SSH) - Client Authentication

- **Session Encryption**
  - Symmetric encryption
  - Exchange secret key (Example - Diffie-Hellman)

- **Host/Client Validation**
  - Public-key Encryption
  - Challenge-Response
    - Host sends a “challenge” that has to be answered by the client
    - Similarly, client sends a “challenge” that has to be answered by the host

Account Administration

- Install OpenSSH (should be done on both server and client)
  - `sudo apt-get update`
  - `sudo apt-get install openssh-server`
  - `sudo apt-get install openssh-client`
- Server
  - `sudo useradd -d /home/<username> -m <UserName>`
  - `sudo passwd <username>`
  - `cd /home/<username>`
  - `sudo mkdir .ssh`
  - `sudo chown -R <username> .ssh`
  - `sudo chmod 700 .ssh`
  - `ifconfig` (this will give you the IP address of the server. Give this to your partner).
  - `ps aux | grep ssh`
    - This will give you the
    - or alternatively `pgrep -lf ssh`

Account Administration

- **Client**
  - **Password** login
    - `ping server_ip_addr` (just to check if the server responds)
    - `ssh <username>@server_ip_addr`
  - **Password-less** login
    - `ssh-keygen`
    - `ssh-copy-id -i <username>@server_ip_addr`
    - `ssh <username>@server_ip_addr` (should not ask for login password)
  - **Passphrase-less** login
    - `ssh-add`
    - `ssh -X <username>@server_ip_addr` (should not ask for key's passphrase)
  - **X session forwarding** - running programs with GUI
    - `ssh -X <UserName>@server_ip_addr`
    - `xterm`
    - `firefox`

X session forwarding

- **X** is the windowing system for GUI apps on linux
- **X** is a network-based system. It is based upon a network protocol such that a program can run on one computer but be displayed on another
  - i.e. you want to run such apps remotely, but the GUI should show up on the local machine

- Windowing system forms the basis for most GUIs on UNIX
  - ssh -X username@ugrad.seas.ucla.edu
  - gedit
  - gimp

Secure copy (scp)

- Based on secure shell (ssh)
- Used for transferring files between hosts in a secure way (encrypted)
- Usage similar to cp
  - `scp [source] [destination]`
- Transferring to remote host
  - `scp /home/username/doc.txt username@ugrad.seas.ucla.edu:/home/user/docs`
  - Transferring from remote host
    - `scp username@ugrad.seas.ucla.edu:/home/user/docs/foo.txt /home/username`

Lab 7

- **Securely login to each others' computers**
  - Use ssh (OpenSSH)
- **Use key-based authentication**
  - Generate key pairs
- **Make logins convenient**
  - type your passphrase once and be able to use ssh to connect to any other host without typing any passwords or passphrases
- **Use port forwarding** to run a command on a remote host that displays on your host

Lab Environment Setup

On your PC:

- Make sure X11 forwarding is enabled:
  - Putty: Connection -> SSH -> X11 -> “Enable X11 forwarding” should be checked
  - SSH command (Mac/Linux): -X or -Y flag
- Make sure an X11 windowing tool is installed:
  - Windows: Xming
  - Mac: XQuartz
  - (U|Li)nix: No extra software necessary!

Lab Environment Setup

On your board:

- Make sure you have openssh-server and openssh-client installed on the board
- $ `dpkg --get-selections | grep openssh` should output:
  - openssh-server install
  - openssh-client install
- If not:
  - $ `sudo apt-get install openssh-server`
  - $ `sudo apt-get install openssh-client`

Server Steps

- **Generate public and private keys**
  - $ `ssh-keygen` (by default saved to ~/.ssh/is_rsa and id_rsa.pub) – don't change the default location
- **Create an account for the client on the server**
  - $ `sudo useradd –d /home/<homedir_name> –m <username>`
  - $ `sudo passwd <username>`
- **Create .ssh directory for new user**
  - $ `cd /home/<homedir_name>`
  - $ `sudo mkdir .ssh`
- **Change ownership and permission on .ssh directory**
  - $ `sudo chown –R username .ssh`
  - $ `sudo chmod 700 .ssh`
- **Optional: disable password-based authentication**
  - $ `emcas /etc/ssh/sshd_config`
  - change PasswordAuthentication option to no

Client Steps

- **Generate public and private keys**
  - `$ ssh-keygen`
- **Copy your public key to the server for key-based authentication (~/.ssh/authorized_keys)**
  - `$ ssh-copy-id -i UserName@server_ip_addr`
- **Add private key to authentication agent (ssh-agent)**
  - `$ ssh-add`
- **SSH to server**
  - `$ ssh UserName@server_ip_addr`
  - `$ ssh -X UserName@server_ip_addr` (X11 session forwarding)
- **Run a command on the remote host**
  - `$ xterm`, `$ gedit`, `$ firefox`, etc.

How to Check IP Addresses

- $ `ifconfig`
  - configure or display the current network interface configuration information (IP address, etc.)
- $ `ping <ip_addr>`(**p**acket **in**ternet **g**roper)
  - Test the reachability of a host on an IP network
  - measure round-trip time for messages sent from a source to a destination computer
  - Example: $ ping 192.168.0.1, $ ping google.com

Lab 7

For instructions on how to initially setup your BeagleBone Green Wireless board, see:
https://piazza.com/class/jfinlsjb34f3vc?cid=282

Follow these instructions to reset a used board:

http://wiki.seeedstudio.com/BeagleBone_Green/#update-to-latest-software