CS 35L

Software Construction Laboratory

Lecture 8.2

28th February, 2019

Logistics

- Hardware requirement for Week 8
  - Seeed Studio BeagleBone Green Wireless Development Board
- Presentations for Assignment 10
  - https://docs.google.com/spreadsheets/d/1o6r6CKCaB2du3klPflHiquymhBvbn7oP0wkHHMz_q1E/edit?usp=sharing
- Assignment 7 is due on 3rd March, 2018 at 11:55pm

Review - Previous Lab

- Static Linking
- Dynamic Linking
- Dynamic Loading

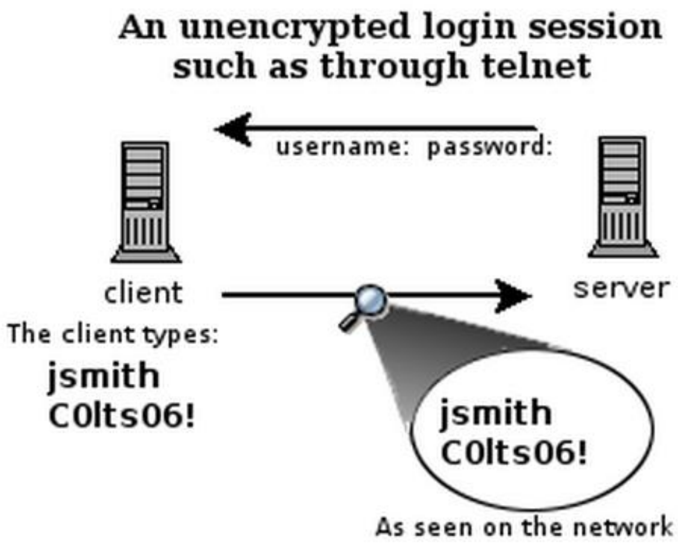
SSH

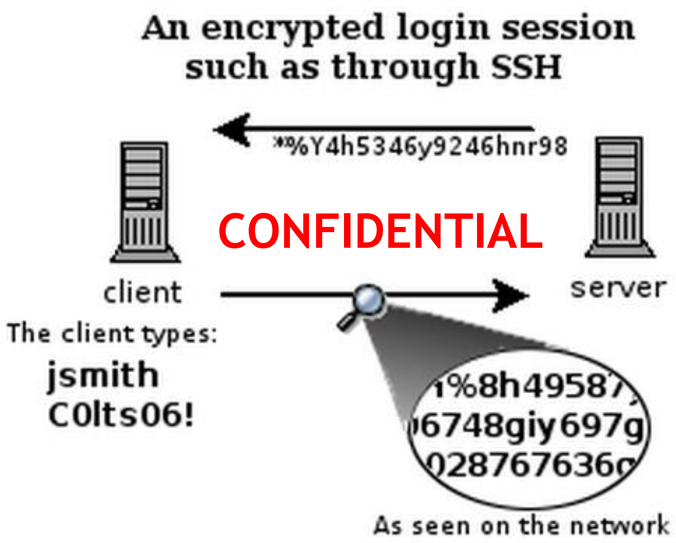
Communication Over the Internet

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

What is SSH?

- Secure Shell
- Used to remotely access shell
- Successor of telnet
- Encrypted and better authenticated session

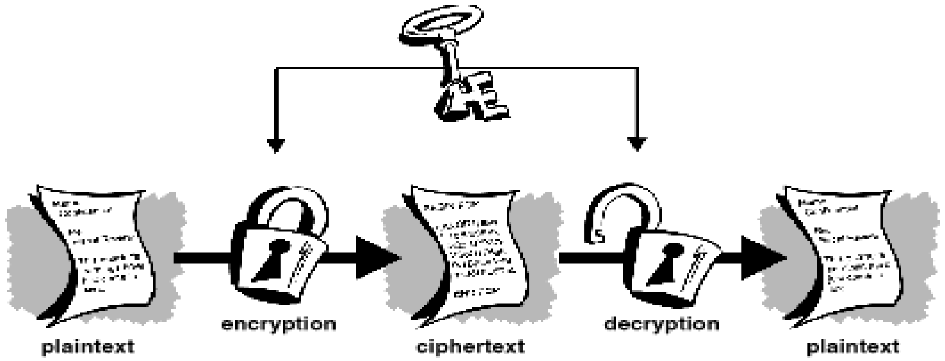




Encryption Types

- 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!!!

Symmetric-key Encryption



- Also called Shared Key/Shared Secret encryption
- 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)
- Key distribution is a problem
  - The secret key has to be delivered in a safe way to the recipient
  - Chance of key being compromised

Public Key Encryption (Asymmetric)

- Uses a pair of keys for encryption
  - Public Key – Published and known to everyone
  - Private Key – Secret key known only to the owner
- Encryption
  - Use public key to encrypt messages
  - Anyone can encrypt message, but cannot decrypt the ciphertext
- Decryption
  - Use private key to decrypt messages
  - Example: RSA – Rivest, Shamir and Adleman
  - Property used: - Difficulty of factoring large integers to prime numbers

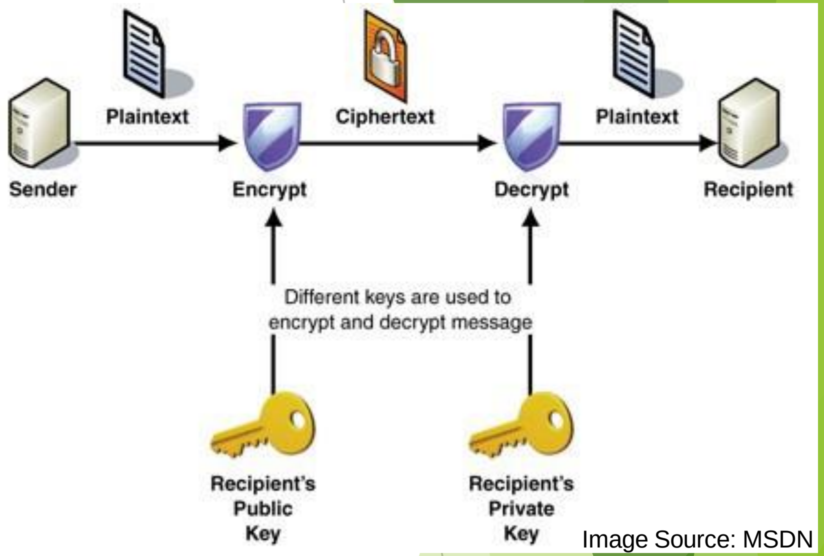


Image Source: MSDN

High-Level SSH Protocol

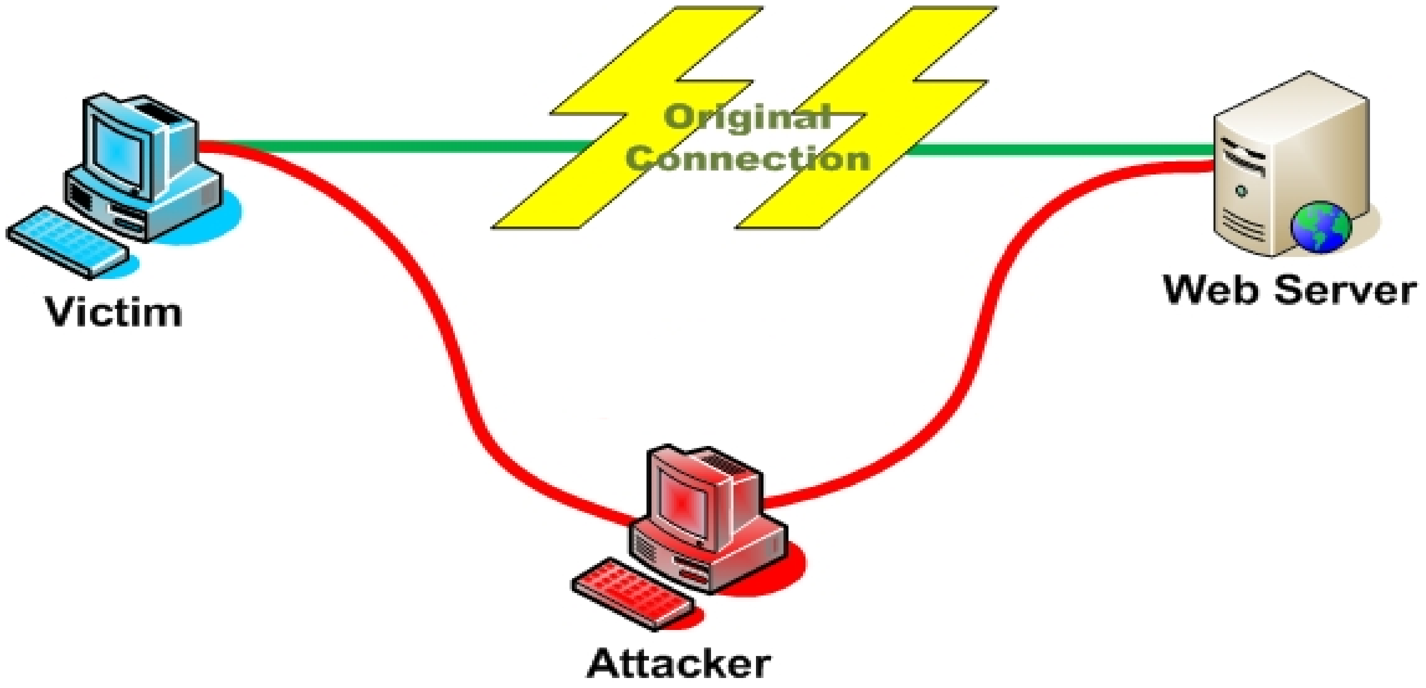
- Client ssh’s to remote server
  - $ ssh username@somehost
  - If first time talking to server -> host validation

```
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

Server Validation

- Next time client connects to server
  - Check server’s public key against saved public key
  - If they don’t match



Server Validation (cont’d)

- Client asks server to prove that it is the owner of the public key using asymmetric encryption
  - Encrypt a message with public key
  - If server is true owner, it can decrypt the message with private key
- If everything works, server is successfully validated

User Authentication

- **Password-based authentication**
  - Prompt for password on remote server
  - If username specified exists and remote password for it is correct then the system lets you in
- **Key-based authentication**
  - Generate a key pair on the client
  - Copy the public key to the server (~/.ssh/authorized_keys)
  - Server authenticates client if it can demonstrate that it has the private key
  - The private key can be protected with a passphrase
  - Every time you ssh to a host, you will be asked for the passphrase (inconvenient!)

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

ssh-agent (passphrase-less ssh)

- A program used with OpenSSH that provides a secure way of storing the private key
- ssh-add prompts user for the passphrase once and adds it to the list maintained by ssh-agent
- Once passphrase is added to ssh-agent, the user will not be prompted for it again when using SSH
- OpenSSH will talk to the local ssh-agent daemon and retrieve the private key from it automatically

X Window System

- Windowing system that forms the basis for most GUIs on UNIX
- 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 (X Session Forwarding)

Assignment 7 - Laboratory

- Securely log in 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

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 Address

- $ ifconfig
  - configure or display the current network interface configuration information (IP address, etc.)
- $ hostname –I
  - gives the IP address of your machine directly
- $ ping <ip_addr>(packet internet groper)
  - 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

Presentations

- Today’s Presentation:
  - Renee Hsu
  - Nathan Chen
- Next up:
  - Zhenghao Sun
  - Yu Yang

Questions?