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

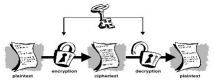


Image Source: gpgtools.org

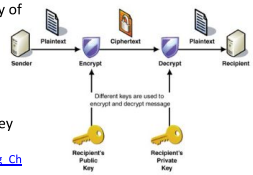
Public-Key Encryption (Asymmetric)

- 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



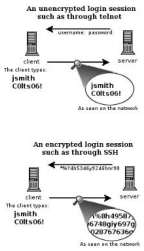
Encryption Types Comparison

- **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

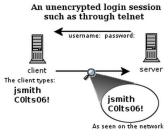
Secure Shell (SSH)

- 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



CONFIDENTIAL

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