Network Administration/System Administration Homework #9

B10202012 劉仲楷

1 系統環境與 NFS 基礎安裝

ref: lab slides

在 server 執行

```
sudo mkdir -p /srv/nfs-share
sudo chown 1000:1000 /srv/nfs-share
sudo chmod 755 /srv/nfs-share
```

在 /etc/exports 新增

```
/srv/nfs-share  192.150.9.1(rw,sync,no_subtree_check)
192.150.9.2(rw,sync,no_subtree_check)
```

執行

```
sudo exportfs -arv
sudo systemctl enable --now nfs-server
sudo systemctl restart nfs-kernel-server
sudo systemctl status nfs-kernel-server
```

```
inituser@nfs-server:~$ sudo systemctl status nfs-kernel-server
● nfs-server.service - NFS server and services
     Loaded: loaded (/usr/lib/systemd/system/nfs-server.service; enabled; preset: enabled)
    Drop-In: /run/systemd/generator/nfs-server.service.d
             └─order-with-mounts.conf
     Active: active (exited) since Mon 2025-11-24 05:13:07 UTC; 13s ago
    Process: 1152 ExecStartPre=/usr/sbin/exportfs -r (code=exited, status=0/SUCCESS)
    Process: 1154 ExecStart=/usr/sbin/rpc.nfsd (code=exited, status=0/SUCCESS)
   Main PID: 1154 (code=exited, status=0/SUCCESS)
        CPU: 12ms

Nov 24 05:13:07 nfs-server systemd[1]: Starting nfs-server.service - NFS server and services...
Nov 24 05:13:07 nfs-server systemd[1]: Finished nfs-server.service - NFS server and services.
```

在兩個 clients 上執行

```
sudo apt install nfs-common
sudo mkdir -p /mnt/nfs-share
sudo mount -t nfs 192.150.9.3:/srv/nfs-share /mnt/nfs-share
mount | grep nfs
df -h | grep nfs
```

```
inituser@hpc1:~$ mount | grep nfs
df -h | grep nfs
192.150.9.3:/srv/nfs-share on /mnt/nfs-share type nfs4 (rw,relatime,vers=4.2
,rsize=1048576,wsize=1048576,namlen=255,hard,proto=tcp,timeo=600,retrans=2,s
ec=sys,clientaddr=192.150.9.1,local_lock=none,addr=192.150.9.3)
192.150.9.3:/srv/nfs-share          15G  4.8G  9.2G  35% /mnt/nfs-share
inituser@hpc1:~$
```

```
inituser@hpc2:~$ mount | grep nfs
df -h | grep nfs
192.150.9.3:/srv/nfs-share on /mnt/nfs-share type nfs4 (rw,relatime,vers=4.2
,rsize=1048576,wsize=1048576,namlen=255,hard,proto=tcp,timeo=600,retrans=2,s
ec=sys,clientaddr=192.150.9.2,local_lock=none,addr=192.150.9.3)
192.150.9.3:/srv/nfs-share          15G  4.8G  9.2G  35% /mnt/nfs-share
inituser@hpc2:~$
```

接在兩個 clients 的 `/mnt/nfs-share/` 分別新增兩個檔案 `from_hpc1.txt`、`from_hpc2.txt`

```
inituser@nfs-server:~$ ls -la /srv/nfs-share/
total 16
drwxr-xr-x 2 inituser inituser 4096 Nov 24 05:24 .
drwxr-xr-x 3 root     root     4096 Nov 24 05:04 ..
-rw-rw-r-- 1 inituser inituser   16 Nov 24 05:24 from_hpc1.txt
-rw-rw-r-- 1 inituser inituser   16 Nov 24 05:24 from_hpc2.txt
```

```
inituser@hpc1:~$ ls -la /mnt/nfs-share/
total 16
drwxr-xr-x 2 inituser inituser 4096 Nov 24 05:24 .
drwxr-xr-x 3 root     root     4096 Nov 24 05:19 ..
-rw-rw-r-- 1 inituser inituser   16 Nov 24 05:24 from_hpc1.txt
-rw-rw-r-- 1 inituser inituser   16 Nov 24 05:24 from_hpc2.txt
inituser@hpc1:~$
```

```
inituser@hpc2:~$ ls -la /mnt/nfs-share/
total 16
drwxr-xr-x 2 inituser inituser 4096 Nov 24 05:24 .
drwxr-xr-x 3 root     root     4096 Nov 24 05:19 ..
-rw-rw-r-- 1 inituser inituser   16 Nov 24 05:24 from_hpc1.txt
-rw-rw-r-- 1 inituser inituser   16 Nov 24 05:24 from_hpc2.txt
inituser@hpc2:~$
```

2 多使用者帳號與權限控管

ref: 上次作業 在 server 上執行

```
sudo apt install -y slapd ldap-utils
sudo dpkg-reconfigure slapd
```

然後填入以下內容：

1. Omit OpenLDAP server configuration? No
2. DNS domain name: nasa.local
3. Organization name: NASA
4. Administrator password: nasa2025
5. Remove database when slapd is purged? No
6. Move old database? Yes

用 `slappasswd` 產生密碼後，用後面附件執行

```
ldapadd -x -D "cn=admin,dc=nasa,dc=local" -W -f users.ldif
ldapadd -x -D "cn=admin,dc=nasa,dc=local" -W -f groups.ldif
```

接在 clients 上執行

```
sudo apt-get update
sudo apt install -y libnss-ldap libpam-ldap ldap-utils nscd sssd sssd-tools libnss-ss
```

填入以下內容（沒寫都填預設）：

1. LDAP server Uniform Resource Identifier: ldap://192.150.9.3
2. Distinguished name of the search base: dc=nasa,dc=local
3. LDAP version to use: 3
4. LDAP account for root: cn=admin,dc=nasa,dc=local
5. LDAP root account password: nasa2025

在 `/etc/sssd/sssd.conf` 寫入

```
[sssd]
services = nss, pam
config_file_version = 2
domains = nasa.local

[domain/nasa.local]
```

```
id_provider = ldap
auth_provider = ldap
chpass_provider = ldap
ldap_uri = ldap://192.150.9.3
ldap_search_base = dc=nasa,dc=local
ldap_default_bind_dn = cn=admin,dc=nasa,dc=local
ldap_default_authtok_type = password
ldap_default_authtok = nasa2025
cache_credentials = True
ldap_id_use_start_tls = False
enumerate = True
```

執行

```
sudo chmod 600 /etc/sssd/sssd.conf
sudo systemctl restart sssd
sudo systemctl enable sssd
```

```
inituser@hpc1:~$ id astro1
uid=10001(astro1) gid=10001 groups=10001
inituser@hpc1:~$ id astro2
uid=10002(astro2) gid=10002 groups=10002
inituser@hpc1:~$ id astro3
uid=10003(astro3) gid=10003 groups=10003
inituser@hpc1:~$
```

```
inituser@hpc2:~$ id astro1
uid=10001(astro1) gid=10001 groups=10001
inituser@hpc2:~$ id astro2
uid=10002(astro2) gid=10002 groups=10002
inituser@hpc2:~$ id astro3
uid=10003(astro3) gid=10003 groups=10003
inituser@hpc2:~$
```

和上面類似，也在 server 上設定 ldap client，執行

```
sudo apt-get update
sudo apt install -y sssd sssd-tools libnss-sss libpam-sss
```

和上面一樣寫入 `/etc/sssd/sssd.conf` （ldap uri 要換成 `ldap://127.0.0.1`）並設定權限並重啓 sssd。接修改 Server 的 `/etc/exports` 加入 root squash

```
/srv/nfs-share 192.150.9.1(rw,sync,no_subtree_check,root_squash)
192.150.9.2(rw,sync,no_subtree_check,root_squash)
```

在 server 上重新匯出

```
sudo exportfs -arv
```

在 clients 上重新掛載

```
sudo umount /mnt/nfs-share
sudo mount -t nfs 192.150.9.3:/srv/nfs-share /mnt/nfs-share
```

接在 server 上建立目錄並設定權限

```
sudo mkdir -p /srv/nfs-share/{astro1_dir,astro2_dir,astro3_dir}

sudo chown astro1:astro1 /srv/nfs-share/astro1_dir
sudo chown astro2:astro2 /srv/nfs-share/astro2_dir
sudo chown astro3:astro3 /srv/nfs-share/astro3_dir

sudo chmod 700 /srv/nfs-share/astro1_dir
sudo chmod 700 /srv/nfs-share/astro2_dir
sudo chmod 700 /srv/nfs-share/astro3_dir
```

```
inituser@nfs-server:~$ ll /srv/nfs-share/
total 28
drwxr-xr-x 5 inituser inituser 4096 Nov 24 12:34 ./
drwxr-xr-x 3 root     root     4096 Nov 24 05:04 ../
drwx------ 2 astro1   astro1   4096 Nov 24 12:34 astro1_dir/
drwx------ 2 astro2   astro2   4096 Nov 24 12:34 astro2_dir/
drwx------ 2 astro3   astro3   4096 Nov 24 12:34 astro3_dir/
-rw-rw-r-- 1 inituser inituser   16 Nov 24 05:24 from_hpc1.txt
-rw-rw-r-- 1 inituser inituser   16 Nov 24 05:24 from_hpc2.txt
```

```
astro1@hpc1:/home/inituser$ echo "test" > /mnt/nfs-share/astro1_dir/test.txt
astro1@hpc1:/home/inituser$ ls /mnt/nfs-share/astro1_dir/
test.txt
astro1@hpc1:/home/inituser$ su - astro2
Password:
su: warning: cannot change directory to /home/astro2: No such file or directory
astro2@hpc1:/home/inituser$ cd /mnt/nfs-share/astro1_dir
-bash: cd: /mnt/nfs-share/astro1_dir: Permission denied
astro2@hpc1:/home/inituser$ exit
logout
astro1@hpc1:/home/inituser$ exit
logout
inituser@hpc1:~$ sudo ls /mnt/nfs-share/astro1_dir
[sudo] password for inituser:
ls: cannot open directory '/mnt/nfs-share/astro1_dir': Permission denied
```

```
# users.ldif
dn: ou=people,dc=nasa,dc=local
objectClass: organizationalUnit
ou: people

dn: uid=astro1,ou=people,dc=nasa,dc=local
objectClass: inetOrgPerson
objectClass: posixAccount
objectClass: shadowAccount
uid: astro1
cn: Astro One
sn: One
uidNumber: 10001
gidNumber: 10001
homeDirectory: /home/astro1
loginShell: /bin/bash
# userPassword: astro1
userPassword: {SSHA}FiUnfIRxAzW0HBhoa0iaIUaTiJlN6eq9

dn: uid=astro2,ou=people,dc=nasa,dc=local
objectClass: inetOrgPerson
objectClass: posixAccount
objectClass: shadowAccount
uid: astro2
cn: Astro Two
sn: Two
uidNumber: 10002
gidNumber: 10002
homeDirectory: /home/astro2
loginShell: /bin/bash
# userPassword: astro2
userPassword: {SSHA}mCb69mOWptuz1znV/PYGa9gNwbefGHJv

dn: uid=astro3,ou=people,dc=nasa,dc=local
objectClass: inetOrgPerson
objectClass: posixAccount
objectClass: shadowAccount
uid: astro3
cn: Astro Three
sn: Three
uidNumber: 10003
gidNumber: 10003
homeDirectory: /home/astro3
loginShell: /bin/bash
# userPassword: astro3
userPassword: {SSHA}iiqgZLGq2OxHc3WOAXheA7uKQCIUF28t
```

```
# groups.ldif
dn: ou=groups,dc=nasa,dc=local
objectClass: organizationalUnit
ou: groups

dn: cn=astro1,ou=groups,dc=nasa,dc=local
objectClass: posixGroup
cn: astro1
gidNumber: 10001

dn: cn=astro2,ou=groups,dc=nasa,dc=local
objectClass: posixGroup
cn: astro2
gidNumber: 10002

dn: cn=astro3,ou=groups,dc=nasa,dc=local
objectClass: posixGroup
cn: astro3
gidNumber: 10003
```

3 效能與大規模檔案測試

ref: Gemini Transcript

和上面類似在 `/etc/exports` 修改 sync/async：

```
/srv/nfs-share 192.150.9.1(rw,sync,no_subtree_check,root_squash)
192.150.9.2(rw,sync,no_subtree_check,root_squash)
```

在 server 上重新匯出、重啓

```
sudo exportfs -arv
sudo systemctl restart nfs-kernel-server
```

在 clients 上重新掛載，並設定 rsize, wsize，舉例：

```
sudo umount /mnt/nfs-share
sudo mount -t nfs -o rsize=8192,wsize=8192 \
192.150.9.3:/srv/nfs-share /mnt/nfs-share
```

讀寫中間可能需要刪除快取

```
echo 3 | sudo tee /proc/sys/vm/drop_caches > /dev/null 2>&1
```

測試腳本說明 ：使用 `dd` 指令產生 1GB 的全零檔案 (`/dev/zero`) 。`oflag=direct` 能讓寫入繞過作業系統的 Page Cache，直接傳輸到 NFS Server，測出真實的網路與磁碟效能。這個腳本最後利用 `/proc/loadavg` 抓取系統負載 Load Average。 使用方法：

```
nfs_test_b10202012.sh [read|write|all] [1|2]
```

多使用者的情況我寫了多一支小 shell script，用法與前一支相同

```
MODE="${1:-all}"
HPC="$2"
USERS=("astro1" "astro2" "astro3")
for user in "${USERS[@]}"; do
    sudo -u "$user" /mnt/nfs-share/nfs_test_b10202012.sh $MODE $HPC &
done
wait
echo "Multi-user test completed."
```

參數		時間 (s)		平均速率 (MB/s)		CPU 負載	
測試情境		寫入	讀取	寫入	讀取	寫入	讀取
A	單	99	45	10.8	23.8	2.35	2.87
	多	543	258	2.0	4.2	4.31	4.50
B	單	34	17	31.6	60.8	0.53	1.17
	多	182	65	5.9	16.4	4.03	4.04
C	單	110	50	9.7	21.5	1.83	3.20
	多	743	262	1.4	4.1	3.79	4.96
D	單	32	19	33.5	56.6	0.91	1.27
	多	198	67	5.5	15.9	4.17	3.16

問答題 可以觀察到多使用者同時讀寫的情況下，效能顯著下降。 原因可能有

- 競爭鎖：多個 client 同時存取相同資料夾，則需要 lock 來保證 consistent，沒有 lock 就只能等
- 網路頻寬：六倍的傳輸量可能導致 server 端頻寬不足、壅塞
- Disk I/O 頻寬：和網路頻寬類似，瓶頸也可能是 disk I/O

解決方法：

- 增加 NFS threads：提升頻寬
- 使用 RAID：增加磁碟 I/O 效能
- 使用多台 NFS server：做 load balancing