Cryptography: Assignment 1

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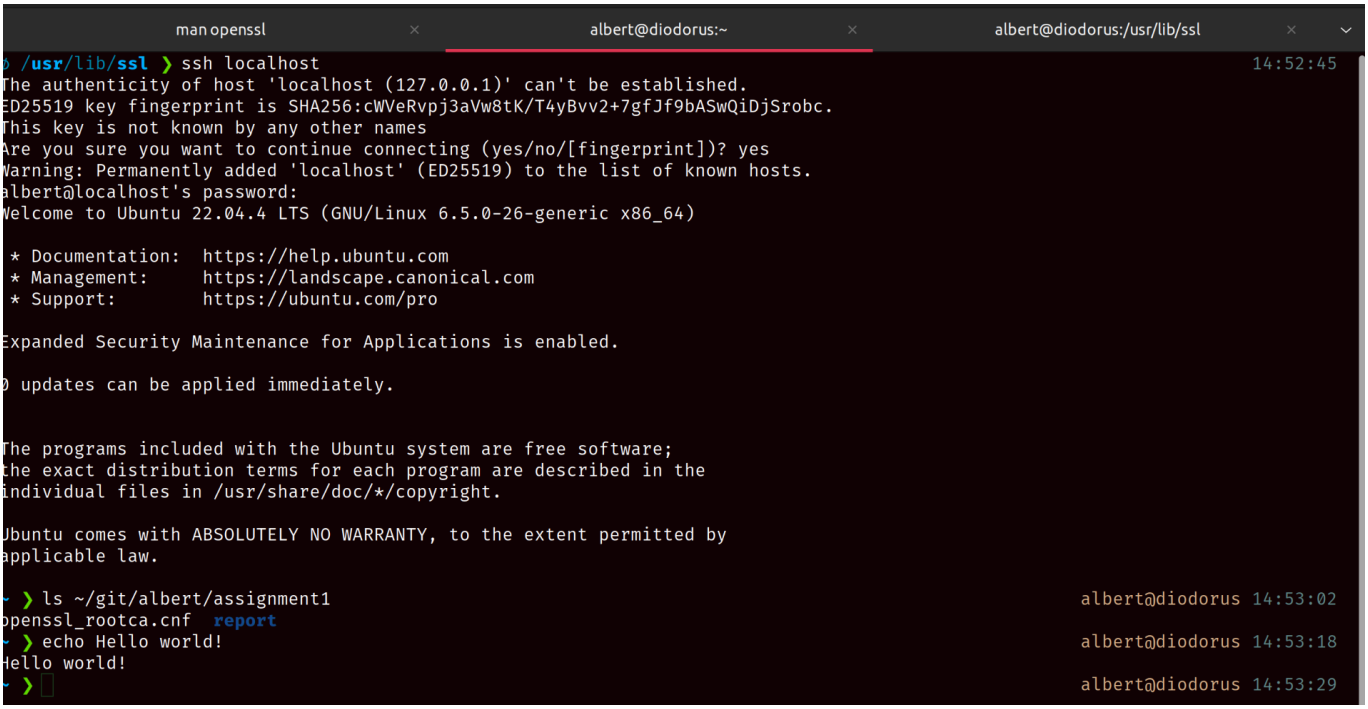
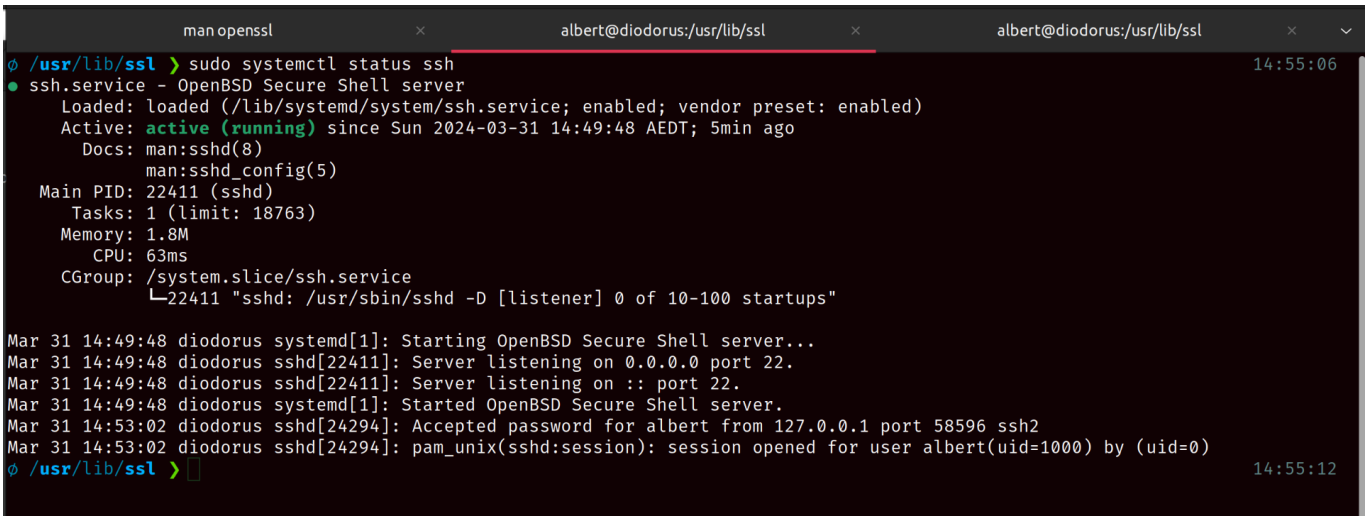
Part I: Setting up SSH

Firstly, there's a few dependencies to check. Namely, I don't have the SSH server configured installed on my system. So I go ahead and install that and connect to localhost as a test,



You can tell I haven't connected to localhost before as the client prompts me to add it my list of known hosts. After logging in, you can also see that I'm running Ubuntu 22.04.4 LTS and can browse to the directory where I'm editing this assignment.

Exiting out of this and checking the openssh server service shows it working as expected,



The daemon is running successfully without issue and shows my previous connection in the logs. You can also spot my hostname and the date here (happy easter).

I haven't configured pubkey auth to localhost, but I have done so to other hosts already. To add the localhost config, I'll edit my existing config file.

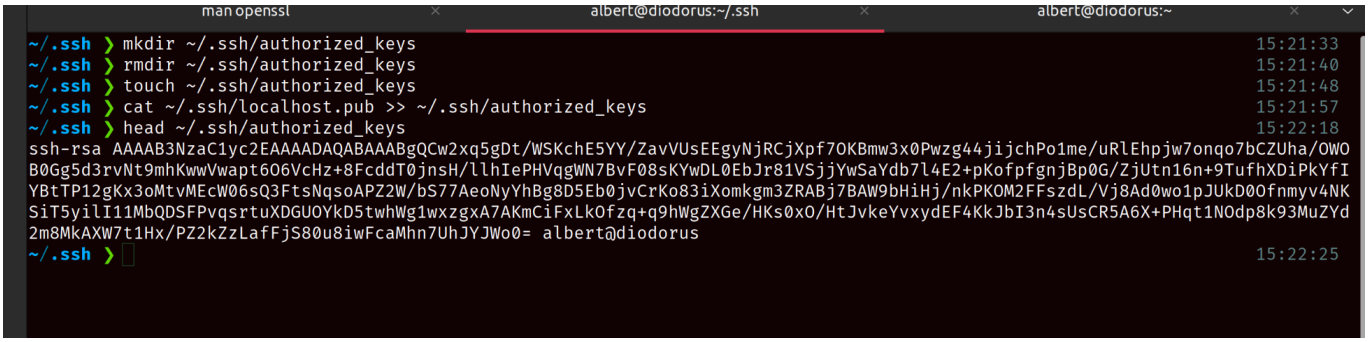
```
ForwardX11 no

Host localhost
Hostname localhost
User albert
PubKeyAuthentication yes
IdentityFile /home/albert/.ssh/localhost
ForwardX11 no
```

Then I generate a new RSA keypair with the password ABC123,

```
man openssl                                    albert@diodorus:~/.ssh
~/.ssh ❯ ssh-keygen -t rsa
Generating public/private rsa key pair.
Enter file in which to save the key (/home/albert/.ssh/id_rsa): localhost
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in localhost
Your public key has been saved in localhost.pub
The key fingerprint is:
SHA256:E6v795gu2CO4tsZ0zNw4r+L6yB6qkqbIIzrNUCuRPOk albert@diodorus
The key's randomart image is:
+---[RSA 3072]----+
|                 |
|                 |
|...     .        |
|o+.      o       |
|.o.. + oS        |
|oE. . B...       |
| *.o o.=         |
|B=oo* o.= .o     |
|&+**=+o+.=+..    |
+----[SHA256]-----+
~/.ssh ❯
```

This is then added as an authorised key, which lets me ssh to localhost without using my account password,



Notice I didn't provide the identity file in this command, as the config already set it.

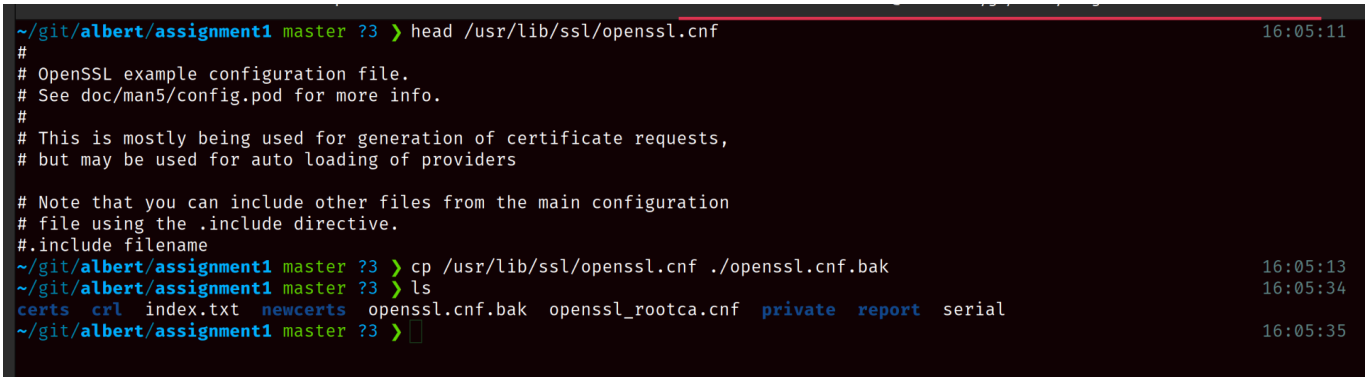
Part II: Creating and Configuring a Root CA

> For this part, the root CA directory will be this assignment's directory `/git/albert/assignment1`. The CA full config used is in the appendix for reference

To setup the CA, I start by configuring the cwd,

```
mkdir certs crl newcerts private
chmod 700 private
touch index.txt serial
echo 1000 > serial
```

Then I created a configuration file by copying and modfiying the demo one installed with OpenSSL,



I trimmed down some sections and configure the root cert and key directories,

```
# root key and cert
```

```
private_key = $dir/private/ca.key.pem
certificate = $dir/certs/ca.cert.pem
```

The sample file also recommended,

```
# recommended from docs/sample file

name_opt = ca_default
cert_opt = ca_default
```

I then configured a policy to match the assignment requirements, as we will always require these details,

```
[ policy ]
stateOrProvinceName = match
countryName = match
organizationName = match
organizationalUnitName = match
localityName = match
commonName = supplied
emailAddress = supplied
```

Finally, I configure the defaults for requested certs. Some notable parts,

- X509 extensions are enabled,
- a challenge password is required,
- the cert

```
[ req ]
default_bits = 2048
distinguished_name = req_distinguished_name
string_mask = utf8only
default_md = sha256
attributes = req_attributes

# Extension to add when the -x509 option is used.

x509_extensions = v3_ca

[ req_distinguished_name ]

# See <https://en.wikipedia.org/wiki/Certificate_signing_request>.

countryName = Country Name (2 letter code)
stateOrProvinceName = State or Province Name (full name) [Some-State]
localityName = Locality Name (eg, city)
0.organizationName = Organization Name (eg, company)
organizationalUnitName = Organizational Unit Name (eg, section)
```

```
commonName = Common Name (e.g. server FQDN or YOUR name)
emailAddress = Email Address

# specify defaults for this example

countryName_default = AU
stateOrProvinceName_default = NSW
localityName_default = SYD
0.organizationName_default = UTS
organizationalUnitName_default = FEIT
commonName_default = utscrypto.com.au
emailAddress_default = root@utscrypto.com.au

[ req_attributes ]
challengePassword = A challenge password
challengePassword_min = 4
challengePassword_max = 20

# an optional company name as requested in the assignment details

unstructuredName = An optional company name
```

As an extra I applied the default `[server_cert]` extension, as we're about to create a server cert for the next part.

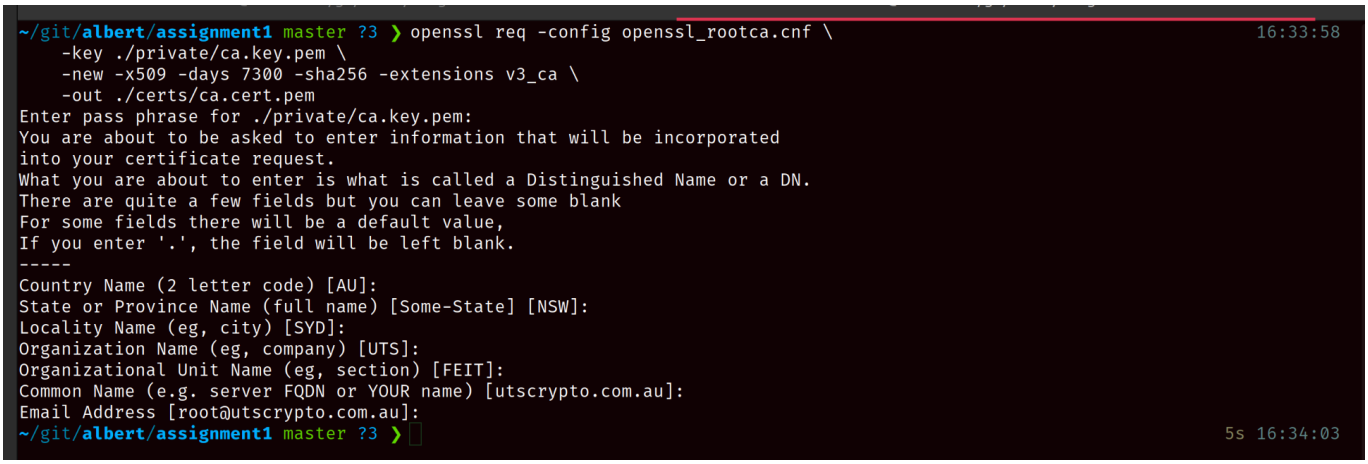
Next, I create a 4096-bit root key with password `ABC123` and lock down its permissions as readonly,

```
openssl genrsa -aes256 -out ./private/ca.key.pem 4096
chmod 400 ./private/ca.key.pem
```

With that complete, then I create the root cert, ensuring to specify my custom config file. I set the expiry to some large amount of time in the future (7300 days = 20 years). I also set its password to `ABC123`,

```
openssl req -config openssl_rootca.cnf \
    -key ./private/ca.key.pem \
    -new -x509 -days 7300 -sha256 -extensions v3_ca \
    -out ./certs/ca.cert.pem
```

This then prompts for the cert information, which defaults to the expected configuration,



I then lock this down to readonly for all and verify it with another openssl command,

```
chmod 444 certs/ca.cert.pem
openssl x509 -noout -text -in ./certs/ca.cert.pem
```

```
~/git/albert/assignment1 master ?3 ❯ openssl x509 -noout -text -in ./certs/ca.cert.pem                                16:36:13
Certificate:
    Data:
        Version: 3 (0x2)
        Serial Number:
            28:aa:0d:60:64:16:34:46:1e:f8:78:50:7f:ac:35:2c:b8:6c:98:ee
        Signature Algorithm: sha256WithRSAEncryption
        Issuer: C = AU, ST = NSW, L = SYD, O = UTS, OU = FEIT, CN = utscrypto.com.au, emailAddress = root@utscrypto.com.au
        Validity
            Not Before: Mar 31 05:34:03 2024 GMT
            Not After : Mar 26 05:34:03 2044 GMT
        Subject: C = AU, ST = NSW, L = SYD, O = UTS, OU = FEIT, CN = utscrypto.com.au, emailAddress = root@utscrypto.com.au
        Subject Public Key Info:
            Public Key Algorithm: rsaEncryption
                Public-Key: (4096 bit)
                Modulus:
                    00:9f:a8:66:56:74:06:42:42:8a:42:2a:de:94:b1:
                    b7:a5:c5:8e:7c:e4:63:af:b9:25:fa:20:8b:0b:b8:
                    6b:45:57:86:b6:cd:26:b6:c8:27:bb:cf:b9:4b:5e:
                    87:55:d9:66:04:35:cc:cb:76:95:bd:9e:2c:4c:2b:
                    b7:36:be:7a:61:69:95:2a:ed:49:1a:b6:4c:6c:81:
                    03:5f:0a:d8:d0:d1:96:68:23:88:d9:c6:71:25:b7:
                    ca:ea:f9:07:af:73:13:e4:b7:80:96:e5:a1:de:4f:
                    30:f5:56:3a:50:86:26:4a:26:5c:79:f0:bd:f1:75:
                    77:51:ad:98:b0:67:a7:5a:e8:50:dd:80:f2:8d:40:
                    97:f6:a1:ef:0e:da:94:09:3f:0e:97:b9:19:db:ef:
                    8f:2d:a4:09:57:07:d3:9d:d3:37:61:5b:5c:cf:37:
                    fb:15:7b:1e:ba:8d:3b:d7:7f:63:23:7d:46:ac:7f:
                    0a:51:24:6e:56:6c:b6:62:4f:9c:f3:85:11:3d:54:
                    3f:6c:45:23:85:79:ac:34:4f:44:84:02:53:77:6d:
                    dc:32:d7:dd:56:56:cd:30:8a:25:0f:1a:93:f1:ef:
                    2f:95:0c:6c:d3:62:80:b3:1d:d7:e3:cd:02:51:5c:
                    48:6c:f3:84:ef:59:e1:11:39:0c:c9:3f:49:c8:8e:
                    76:9e:87:6d:2a:d3:df:24:11:c4:38:fd:7f:a5:e3:
                    95:04:7e:a5:9e:6c:57:64:51:f9:39:a1:9f:99:40:
                    ee:3f:cd:83:55:42:11:44:70:42:86:e5:2b:6f:33:
                    91:cd:14:8d:62:fa:b3:5c:f9:cb:1e:7d:b8:f4:8b:
                    84:6c:46:32:55:06:b8:2b:9a:f5:44:06:03:d2:8e:
                    b5:44:84:e8:d3:b3:d8:2a:d7:58:1b:6e:f9:05:7c:
                    39:51:bd:92:bf:c7:6a:53:89:3a:fd:6b:1a:6f:d7:
                    91:f1:e2:bf:e0:88:2d:87:c5:30:9f:18:8d:09:3c:
                    38:e0:32:3b:a7:79:15:cb:34:ea:38:b7:ce:38:c2:
                    c5:94:2e:2e:dc:91:fa:d6:44:ae:99:69:c8:aa:2d:
                    ad:20:df:af:f4:3e:35:85:fd:b5:4c:c6:96:8f:4d:
                    14:b0:c2:b2:5a:57:37:a4:59:fa:c4:36:8d:7a:c7:
                    f2:73:2b:21:da:4f:3f:b9:aa:24:1a:17:a8:3f:91:
                    b4:28:48:b5:e1:6f:ff:b8:c0:c9:49:89:d4:cb:2b:
                    33:6b:20:be:29:c2:dd:e9:83:5d:6e:77:56:0d:bf:
                    46:65:81:ce:05:9b:60:72:3a:8e:2f:26:9b:a8:18:
                    a4:a2:17:e0:10:ce:54:3c:d1:7e:e4:91:96:ea:d3:
                    73:7b:e1
                Exponent: 65537 (0x10001)
        X509v3 extensions:
            X509v3 Subject Key Identifier:
                A3:9A:F6:14:02:DB:C9:04:08:07:D3:B6:8F:6D:63:35:8F:CF:C1:1F
            X509v3 Authority Key Identifier:
                A3:9A:F6:14:02:DB:C9:04:08:07:D3:B6:8F:6D:63:35:8F:CF:C1:1F
            X509v3 Basic Constraints: critical
                CA:TRUE
            X509v3 Key Usage: critical
                Digital Signature, Certificate Sign, CRL Sign
    Signature Algorithm: sha256WithRSAEncryption
    Signature Value:
        8b:31:89:bc:0a:62:ef:dc:3a:fa:1b:88:8f:73:71:86:8d:20:
        d6:73:b9:57:be:32:21:0d:19:38:5e:bb:c9:99:45:83:a9:22:
        bd:88:01:7b:06:71:dd:5b:4c:6a:2a:50:c7:1e:d2:c0:a7:fd:
```

The working directory now looks like so,

```
~/git/albert/assignment1 master ?3 ❯ tree -f -I "report"
.
├── ./certs
│   └── ./certs/ca.cert.pem
├── ./crl
├── ./index.txt
├── ./newcerts
├── ./openssl.cnf.bak
├── ./openssl_rootca.cnf
├── ./private
│   └── ./private/ca.key.pem
└── ./serial

4 directories, 6 files
~/git/albert/assignment1 master ?3 ❯
```

Part III: Generating an X.509 Cert for a Server

To generate an RSA private key and CSR in one go, I use the openssl command (again setting the key to readonly)

```
openssl req -config openssl_rootca.cnf \
    -new -newkey rsa:2048 \
    -keyout ./albertferguson.key \
    -out ./albertferguson.csr
chmod 400 ./albertferguson.key
```

Since I have omitted the `-nodes / -noenc` flags, the default private key encryption is DES. The command prompts a form as expected. I then verify the key,

```
What you are about to enter is what is called a Distinguished Name or a DN.
There are quite a few fields but you can leave some blank
For some fields there will be a default value,
If you enter '.', the field will be left blank.
-----
Country Name (2 letter code) [AU]:
State or Province Name (full name) [Some-State] [NSW]:
Locality Name (eg, city) [SYD]:
Organization Name (eg, company) [UTS]:
Organizational Unit Name (eg, section) [FEIT]:
Common Name (e.g. server FQDN or YOUR name) [utscrypto.com.au]:
Email Address [root@utscrypto.com.au]:

Please enter the following 'extra' attributes
to be sent with your certificate request
A challenge password []:
An optional company name []:
~/git/albert/assignment1 master ?3 ❯ openssl req -in albertferguson.csr -noout -text                    19s 17:12:49
Certificate Request:
    Data:
        Version: 1 (0x0)
        Subject: C = AU, ST = NSW, L = SYD, O = UTS, OU = FEIT, CN = utscrypto.com.au, emailAddress = root@utscrypto.com.au
        Subject Public Key Info:
            Public Key Algorithm: rsaEncryption
                Public-Key: (2048 bit)
                Modulus:
                    00:98:c2:e3:cd:b1:e2:d8:64:88:65:6a:43:19:e6:
                    fb:57:d7:60:4c:1c:2e:e6:04:d1:cf:42:ea:69:70:
                    fc:24:02:a5:36:bc:59:10:14:1d:60:67:ff:0b:1e:
                    e8:66:7b:7b:8a:ba:5b:7e:55:66:28:86:31:1c:04:
                    35:4a:0d:10:5a:56:a5:ad:3e:d5:d4:38:b3:aa:17:
                    ea:9d:09:bb:54:49:52:a1:64:b1:d0:20:b2:ec:f2:
                    52:ea:b3:d8:9a:65:a4:c8:51:c6:9b:86:c1:da:e5:
                    3f:8d:f6:1c:5d:2a:d8:20:d1:f0:d4:da:84:62:1f:
                    a9:00:8a:48:a3:14:6a:9e:93:dc:6f:81:d6:b4:0d:
                    a8:7d:a0:78:6b:ae:b8:63:6f:a9:dd:64:66:b8:bc:
                    a4:c1:1b:6a:91:d5:bc:c0:99:f7:7e:e2:e9:73:12:
                    18:59:3c:2b:0a:ed:fc:45:89:1a:0a:df:b2:2f:62:
                    28:59:ca:b4:9c:84:b5:c4:b8:33:1e:9b:eb:65:c2:
                    b4:dc:f0:09:69:03:b0:4e:05:a0:a9:75:7f:39:41:
                    b7:a8:4c:78:5b:7d:58:be:47:43:ad:65:28:49:c9:
                    2a:2a:67:c8:3e:93:18:08:7f:66:0c:7f:06:56:e5:
                    d2:af:b9:3f:b3:ce:c3:cf:b7:2f:b6:6e:e6:a2:ae:
                    0e:49
                Exponent: 65537 (0x10001)
        Attributes:
            (none)
            Requested Extensions:
    Signature Algorithm: sha256WithRSAEncryption
    Signature Value:
        33:09:9f:55:b9:b4:fd:fc:f0:51:ae:63:78:60:dd:25:45:2b:
        98:ef:0d:49:c7:35:6c:0b:53:f7:10:a1:e8:21:21:d5:c5:94:
        44:21:d5:85:50:2b:23:fd:33:2e:ee:ec:34:19:af:d4:46:86:
        0f:0f:94:f1:44:c8:65:44:fb:1d:74:93:b5:60:37:27:5d:5c:
        79:3e:41:18:a1:cd:1a:ea:02:bc:e9:64:bb:bb:64:77:03:48:
        db:93:1e:cc:d9:e5:5c:25:7b:b1:d5:15:0d:9d:a3:08:76:e6:
        b5:5d:a1:bb:9b:6b:a3:a6:5b:68:06:60:63:f3:8b:a0:79:98:
        48:e0:be:46:0d:26:f3:5c:91:ec:af:e6:df:f8:17:bb:c5:ae:
        13:25:69:55:a7:4b:a8:13:be:b7:6d:db:44:61:91:29:45:83:
        c0:d3:2a:d0:d6:3a:71:fe:b4:48:e7:14:fa:6c:5b:11:1b:fc:
        5c:b5:01:f5:a5:32:aa:ec:04:0b:27:b0:ab:26:bf:eb:8d:73:
        c4:bc:5b:8b:20:ec:25:df:aa:85:97:af:d2:30:1c:30:51:6c:
        75:e2:27:c5:e1:8e:a2:8b:5b:25:cd:60:26:24:8f:ed:ab:fd:
        79:1b:73:68:11:29:df:a1:c4:d5:79:ed:44:ea:00:fb:1d:63:
        68:e6:8d:05
~/git/albert/assignment1 master ?3 ❯                                                                   17:13:44
```

Next, I create a certificate for the local server using the above CSR. Notably, I'm invoking the server extensions

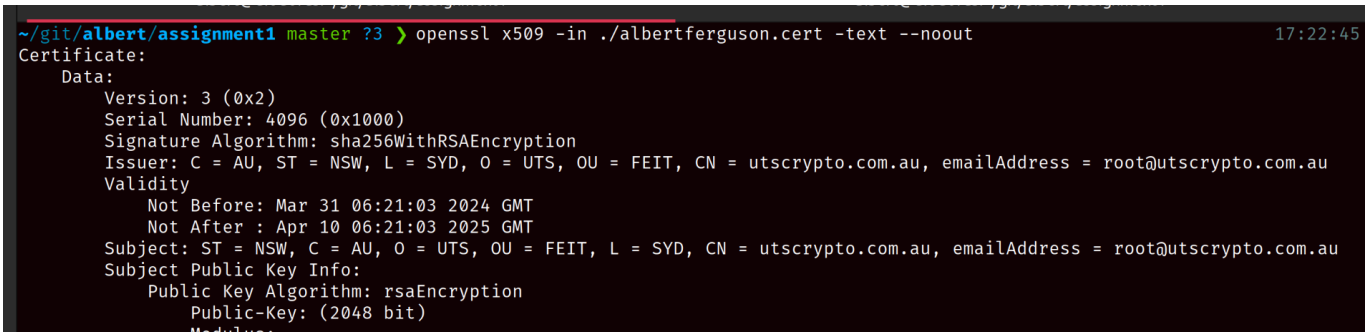
```
openssl ca -config openssl_rootca.cnf \
      -extensions server_cert -days 375 -notext -md sha256 \
      -in ./albertferguson.csr \
      -out ./albertferguson.cert
chmod 444 ./albertferguson.cert
```

Processing this and applying the chmod change,

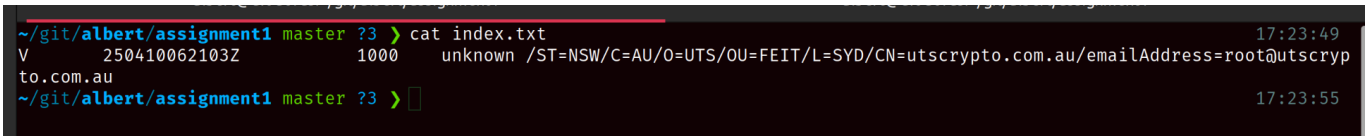
```
        Attributes:
            (none)
            Requested Extensions:
    Signature Algorithm: sha256WithRSAEncryption
    Signature Value:
        33:09:9f:55:b9:b4:fd:fc:f0:51:ae:63:78:60:dd:25:45:2b:
        98:ef:0d:49:c7:35:6c:0b:53:f7:10:a1:e8:21:21:d5:c5:94:
        44:21:d5:85:50:2b:23:fd:33:2e:ee:ec:34:19:af:d4:46:86:
        0f:0f:94:f1:44:c8:65:44:fb:1d:74:93:b5:60:37:27:5d:5c:
        79:3e:41:18:a1:cd:1a:ea:02:bc:e9:64:bb:bb:64:77:03:48:
        db:93:1e:cc:d9:e5:5c:25:7b:b1:d5:15:0d:9d:a3:08:76:e6:
        b5:5d:a1:bb:9b:6b:a3:a6:5b:68:06:60:63:f3:8b:a0:79:98:
        48:e0:be:46:0d:26:f3:5c:91:ec:af:e6:df:f8:17:bb:c5:ae:
        13:25:69:55:a7:4b:a8:13:be:b7:6d:db:44:61:91:29:45:83:
        c0:d3:2a:d0:d6:3a:71:fe:b4:48:e7:14:fa:6c:5b:11:1b:fc:
        5c:b5:01:f5:a5:32:aa:ec:04:0b:27:b0:ab:26:bf:eb:8d:73:
        c4:bc:5b:8b:20:ec:25:df:aa:85:97:af:d2:30:1c:30:51:6c:
        75:e2:27:c5:e1:8e:a2:8b:5b:25:cd:60:26:24:8f:ed:ab:fd:
        79:1b:73:68:11:29:df:a1:c4:d5:79:ed:44:ea:00:fb:1d:63:
        68:e6:8d:05
Check that the request matches the signature
Signature ok
Everything appears to be ok, creating and signing the certificate
Successfully added extensions from config
The subject name appears to be ok, checking data base for clashes
Certificate Details:
        Serial Number: 4096 (0x1000)
        Validity
            Not Before: Mar 31 06:21:03 2024 GMT
            Not After : Apr 10 06:21:03 2025 GMT
        Subject:
            stateOrProvinceName       = NSW
            countryName               = AU
            organizationName          = UTS
            organizationalUnitName    = FEIT
            localityName              = SYD
            commonName                = utscrypto.com.au
            emailAddress              = root@utscrypto.com.au
        X509v3 extensions:
            X509v3 Basic Constraints:
                CA:FALSE
            Netscape Cert Type:
                SSL Server
            Netscape Comment:
                OpenSSL Generated Server Certificate
            X509v3 Subject Key Identifier:
                69:F8:B8:EB:F9:9C:CE:6E:0E:04:9E:ED:CC:12:27:C5:2F:D4:A0:07
            X509v3 Authority Key Identifier:
                keyid:A3:9A:F6:14:02:DB:C9:04:08:07:D3:B6:8F:6D:63:35:8F:CF:C1:1F
                DirName:/C=AU/ST=NSW/L=SYD/O=UTS/OU=FEIT/CN=utscrypto.com.au/emailAddress=root@utscrypto.com.au
                serial:28:AA:0D:60:64:16:34:46:1E:F8:78:50:7F:AC:35:2C:B8:6C:98:EE
            X509v3 Key Usage: critical
                Digital Signature, Key Encipherment
            X509v3 Extended Key Usage:
                TLS Web Server Authentication
Certificate is to be certified until Apr 10 06:21:03 2025 GMT (375 days)
Sign the certificate? [y/n]:y


1 out of 1 certificate requests certified, commit? [y/n]y
Write out database with 1 new entries
writing new certificates
writing /home/albert/git/albert/assignment1/newcerts/1000.pem
Data Base Updated
~/git/albert/assignment1 master ?3 ❯ chmod 444 ./albertferguson.cert                                    11s 17:21:11
~/git/albert/assignment1 master ?3 ❯                                                                       17:21:46
```

Verifying this all,



The CA is also aware of the cert,

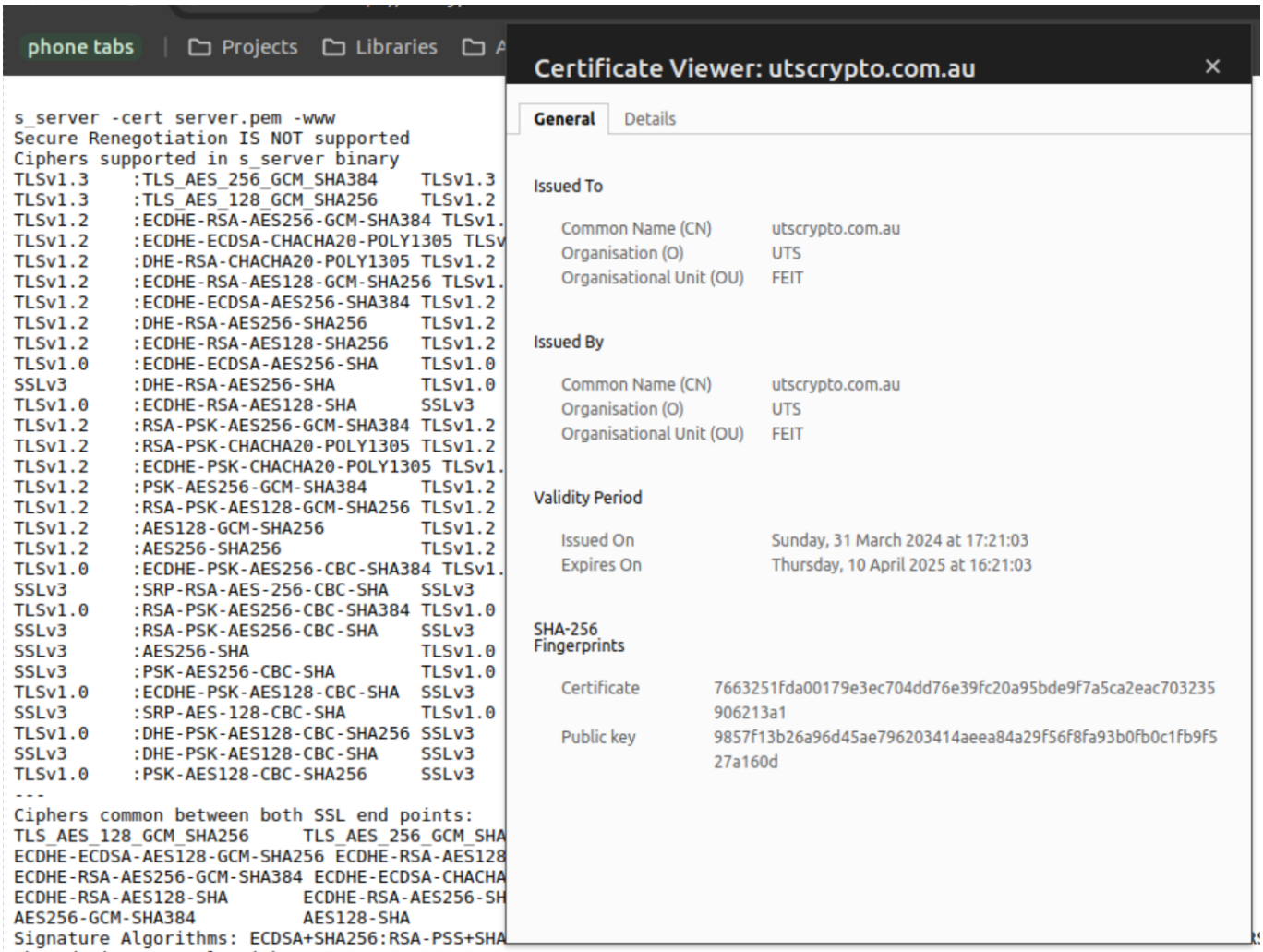


Part IV: Running a secure webserver

To run the webserver, first the `.cert` and `.key` files need to be merged into the PEM format,

```
cat albertferguson.key >> server.pem
cat albertferguson.cert >> server.pem
chmod 400 server.pem
```

Then I append a local domain in my host file that matches the cert (`utscrypto.com.au`) using openssl to launch a server with the created PEM file,

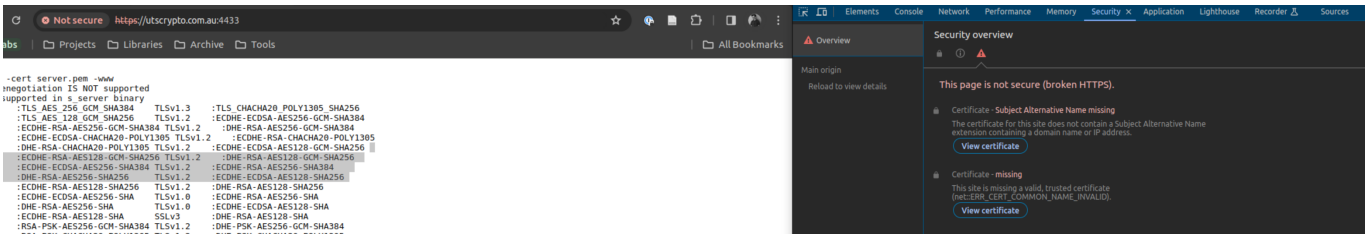



```
s_server -cert server.pem -www
Secure Renegotiation IS NOT supported
Ciphers supported in s_server binary
TLSv1.3    :TLS_AES_256_GCM_SHA384    TLSv1.3
TLSv1.3    :TLS_AES_128_GCM_SHA256    TLSv1.2
TLSv1.2    :ECDHE-RSA-AES256-GCM-SHA384 TLSv1.
TLSv1.2    :ECDHE-ECDSA-CHACHA20-POLY1305 TLSv
TLSv1.2    :DHE-RSA-CHACHA20-POLY1305 TLSv1.2
TLSv1.2    :ECDHE-RSA-AES128-GCM-SHA256 TLSv1.
TLSv1.2    :ECDHE-ECDSA-AES256-SHA384 TLSv1.2
TLSv1.2    :DHE-RSA-AES256-SHA256     TLSv1.2
TLSv1.2    :ECDHE-RSA-AES128-SHA256   TLSv1.2
TLSv1.0    :ECDHE-ECDSA-AES256-SHA    TLSv1.0
SSLv3      :DHE-RSA-AES256-SHA        TLSv1.0
TLSv1.0    :ECDHE-RSA-AES128-SHA      SSLv3
TLSv1.2    :RSA-PSK-AES256-GCM-SHA384 TLSv1.2
TLSv1.2    :RSA-PSK-CHACHA20-POLY1305 TLSv1.2
TLSv1.2    :ECDHE-PSK-CHACHA20-POLY1305 TLSv1.
TLSv1.2    :PSK-AES256-GCM-SHA384     TLSv1.2
TLSv1.2    :RSA-PSK-AES128-GCM-SHA256 TLSv1.2
TLSv1.2    :AES128-GCM-SHA256         TLSv1.2
TLSv1.2    :AES256-SHA256             TLSv1.2
TLSv1.0    :ECDHE-PSK-AES256-CBC-SHA384 TLSv1.
SSLv3      :SRP-RSA-AES-256-CBC-SHA   SSLv3
TLSv1.0    :RSA-PSK-AES256-CBC-SHA384 TLSv1.0
SSLv3      :RSA-PSK-AES256-CBC-SHA    SSLv3
SSLv3      :AES256-SHA                TLSv1.0
SSLv3      :PSK-AES256-CBC-SHA        TLSv1.0
TLSv1.0    :ECDHE-PSK-AES128-CBC-SHA  SSLv3
SSLv3      :SRP-AES-128-CBC-SHA       TLSv1.0
TLSv1.0    :DHE-PSK-AES128-CBC-SHA256 SSLv3
SSLv3      :DHE-PSK-AES128-CBC-SHA    SSLv3
TLSv1.0    :PSK-AES128-CBC-SHA256     SSLv3
---
Ciphers common between both SSL end points:
TLS_AES_128_GCM_SHA256     TLS_AES_256_GCM_SHA
ECDHE-ECDSA-AES128-GCM-SHA256 ECDHE-RSA-AES128
ECDHE-RSA-AES256-GCM-SHA384 ECDHE-ECDSA-CHACHA
ECDHE-RSA-AES128-SHA       ECDHE-RSA-AES256-SH
AES256-GCM-SHA384          AES128-SHA
Signature Algorithms: ECDSA+SHA256:RSA-PSS+SHA
Shared Signature Algorithms: ECDSA+SHA256:RSA-PSS+SHA256:RSA+SHA256:ECDSA+SHA384:RSA-PSS+SHA384:RSA+SHA384:RSA-PSS+SH
Supported groups: :x25519:secp256r1:secp384r1
Shared groups: x25519:secp256r1:secp384r1
---
New, TLSv1.3, Cipher is TLS_AES_128_GCM_SHA256
SSL-Session:
    Protocol  : TLSv1.3
    Cipher    : TLS_AES_128_GCM_SHA256
    Session-ID: 7BBA8C1904081C6A70916BAE40C13DB6EE39794B37EB0E2A5BFEF7C5548A4D7D
    Session-ID-ctx: 01000000
    Resumption PSK: 0278C2218495AF25A2936088DAF7F48DE29F2AD39C941E5E7EC4541EBC848E24
    PSK identity: None
    PSK identity hint: None
    SRP username: None
    Start Time: 1711867357
    Timeout   : 7200 (sec)
    Verify return code: 0 (ok)
    Extended master secret: no
    Max Early Data: 0
---
   0 items in the session cache
   0 client connects (SSL_connect())
   0 client renegotiates (SSL_connect())
   0 client connects that finished
  16 server accepts (SSL_accept())
   0 server renegotiates (SSL_accept())
   1 server accepts that finished
   0 session cache hits
   0 session cache misses
   0 session cache timeouts
   0 callback cache hits
   0 cache full overflows (128 allowed)
---
no client certificate available
```

The last part here would be to import the CA's certificate so that I can trust the site. Importing the root CA cert for Chrome under,

> Settings > Privacy and Security > Manage Certificates > Authorities

I expected this to work. However, I am missing Subject Alternative Name (SAN) configuration,



As of 2017, Chrome 58 removed support for common names and preferred SAN [1]. This missing config could be rectified by updating my root CA's config to include the `[ alt_names ]` extension. However, I think this is fine for the purpose of this assignment.

Bibliography

[1] “Deprecations and Removals in Chrome 58 | Blog,” Chrome for Developers. Accessed: Mar. 31, 2024. [Online]. Available: https://developer.chrome.com/blog/chrome-58-deprecations

Appendix Root CA Config

```
[ ca ]
default_ca = CA_default

[ CA_default ]
prompt            = no
dir               = /home/albert/git/albert/assignment1
certs             = $dir/certs
crl_dir           = $dir/crl
new_certs_dir     = $dir/newcerts
database          = $dir/index.txt
serial            = $dir/serial
RANDFILE          = $dir/private/.rand

# root key and cert
private_key       = $dir/private/ca.key.pem
certificate       = $dir/certs/ca.cert.pem

# for cert revocation lists
crlnumber         = $dir/crlnum
crl               = $dir/crl/mycrl.pem
default_crl_days  = 30

default_md          = sha256

# recommended from docs/sample file
name_opt = ca_default
cert_opt = ca_default

preserve          = no
# typicaly this would be used to create intermediate CAs (strict policy)
# but we're skipping a step here
policy            = policy
default_days      = 365

[ policy ]
stateOrProvinceName     = match
countryName             = match
organizationName        = match
organizationalUnitName  = match
localityName            = match
commonName              = supplied
emailAddress            = supplied

[ req ]
```

```
default_bits        = 2048
distinguished_name  = req_distinguished_name
string_mask         = utf8only
default_md          = sha256
attributes          = req_attributes

# Extension to add when the -x509 option is used.
x509_extensions     = v3_ca

[ req_distinguished_name ]
# See <https://en.wikipedia.org/wiki/Certificate_signing_request>.
countryName                     = Country Name (2 letter code)
stateOrProvinceName             = State or Province Name (full name) [Some-
State]
localityName                    = Locality Name (eg, city)
0.organizationName              = Organization Name (eg, company)
organizationalUnitName          = Organizational Unit Name (eg, section)
commonName                      = Common Name (e.g. server FQDN or YOUR
name)
emailAddress                    = Email Address

# specify defaults for this example
countryName_default                     = AU
stateOrProvinceName_default             = NSW
localityName_default                    = SYD
0.organizationName_default              = UTS
organizationalUnitName_default          = FEIT
commonName_default                      = utscrypto.com.au
emailAddress_default                    = root@utscrypto.com.au

[ req_attributes ]
challengePassword                       = A challenge password
challengePassword_min                   = 4
challengePassword_max                   = 20
# an optional company name as requested in the assignment details
unstructuredName                        = An optional company name

[ v3_ca ]
# Extensions for a typical CA (`man x509v3_config`).
subjectKeyIdentifier            = hash
authorityKeyIdentifier          = keyid:always,issuer
basicConstraints                = critical, CA:true
keyUsage                        = critical, digitalSignature, cRLSign,
keyCertSign

[ server_cert ]
# Extensions for server certificates (`man x509v3_config`).
basicConstraints                    = CA:FALSE
nsCertType                          = server
nsComment                           = "OpenSSL Generated Server
Certificate"
subjectKeyIdentifier                = hash
authorityKeyIdentifier              = keyid,issuer:always
keyUsage                            = critical, digitalSignature,
```

```
keyEncipherment
extendedKeyUsage                    = serverAuth
```