Project 2 – openSSL
Name: Muhfat Alam, Pennapa Aekaram, Ahmed M Shehab
Professor: Dr. Matluba Khodjaeva
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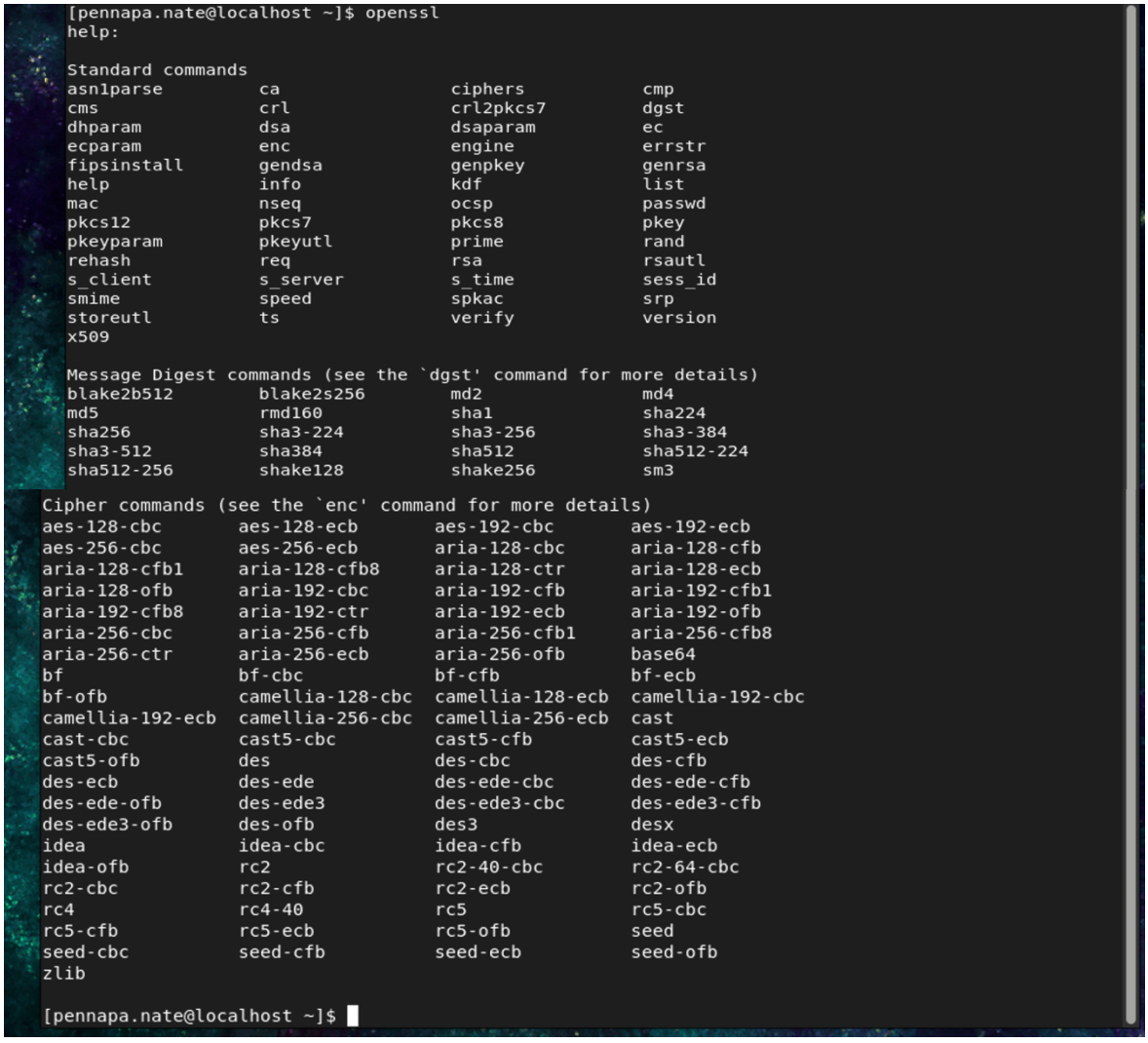
Project 2 (OpenSSL)

OpenSSL is an open-source command line tool that is commonly used to generate private keys, create CSRs, install your SSL/TLS certificate, and identify certificate information.

Task 1, Getting started: Start your PC (Windows or Linux) with an OpenSSL installation

a. **Start the OpenSSL command line.** We used the commands "**openssl**" to open the source commands. The openssl program provides a rich variety of commands each of which often has a wealth of options and arguments



b. List commands by type

Now we see that all the standard commands, massage digest commands, and cipher command after we use openssl. Next is we will use **openssl list -commands** to see all the list commands

```
[pennapa.nate@localhost ~]$ openssl list -commands
asn1parse         ca                ciphers           cmp
cms               crl               crl2pkcs7         dgst
dhparam           dsa               dsaparam          ec
ecparam           enc               engine            errstr
fipsinstall       gendsa            genpkey           genrsa
help              info              kdf               list
mac               nseq              ocsp              passwd
pkcs12            pkcs7             pkcs8             pkey
pkeyparam         pkeyutl           prime             rand
rehash            req               rsa               rsautl
s_client          s_server          s_time            sess_id
smime             speed             spkac             srp
storeutl          ts                verify            version
x509

[pennapa.nate@localhost ~]$
```

Then next we will use **openssl list -cipher-commands** to see all the list of ciphertext that you have on your operating system

```
[pennapa.nate@localhost ~]$ openssl list -cipher-commands
aes-128-cbc       aes-128-ecb       aes-192-cbc       aes-192-ecb
aes-256-cbc       aes-256-ecb       aria-128-cbc      aria-128-cfb
aria-128-cfb1     aria-128-cfb8     aria-128-ctr      aria-128-ecb
aria-128-ofb      aria-192-cbc      aria-192-cfb      aria-192-cfb1
aria-192-cfb8     aria-192-ctr      aria-192-ecb      aria-192-ofb
aria-256-cbc      aria-256-cfb      aria-256-cfb1     aria-256-cfb8
aria-256-ctr      aria-256-ecb      aria-256-ofb      camellia-128-cbc
camellia-128-ecb  camellia-192-cbc  camellia-192-ecb  camellia-256-cbc
camellia-256-ecb  des-ede           des-ede-cbc       des-ede-cfb
des-ede-ofb       des-ede3          des-ede3-cbc      des-ede3-cfb
des-ede3-ofb      des3
```

Next is using **openssl list -digest-commands** to see all list all digest commands. These commands are used to generate as well as verify signatures.

```
[pennapa.nate@localhost ~]$ openssl list -digest-commands
blake2b512        blake2s256        md5               sha1
sha224            sha256            sha3-224          sha3-256
sha3-384          sha3-512          sha384            sha512
sha512-224        sha512-256        shake128          shake256
sm3
```

c. Use the help to find out more about OpenSSL

Next, we will be using **openssl help.** This command helps to find out the further details.

```
[pennapa.nate@localhost ~]$ openssl help
help:

Standard commands
asn1parse         ca                ciphers           cmp
cms               crl               crl2pkcs7         dgst
dhparam           dsa               dsaparam          ec
ecparam           enc               engine            errstr
fipsinstall       gendsa            genpkey           genrsa
help              info              kdf               list
mac               nseq              ocsp              passwd
pkcs12            pkcs7             pkcs8             pkey
pkeyparam         pkeyutl           prime             rand
rehash            req               rsa               rsautl
s_client          s_server          s_time            sess_id
smime             speed             spkac             srp
storeutl          ts                verify            version
x509

Message Digest commands (see the `dgst' command for more details)
blake2b512        blake2s256        md2               md4
md5               rmd160            sha1              sha224
sha256            sha3-224          sha3-256          sha3-384
sha3-512          sha384            sha512            sha512-224
sha512-256        shake128          shake256          sm3

Cipher commands (see the `enc' command for more details)
aes-128-cbc       aes-128-ecb       aes-192-cbc       aes-192-ecb
aes-256-cbc       aes-256-ecb       aria-128-cbc      aria-128-cfb
aria-128-cfb1     aria-128-cfb8     aria-128-ctr      aria-128-ecb
aria-128-ofb      aria-192-cbc      aria-192-cfb      aria-192-cfb1
aria-192-cfb8     aria-192-ctr      aria-192-ecb      aria-192-ofb
aria-256-cbc      aria-256-cfb      aria-256-cfb1     aria-256-cfb8
aria-256-ctr      aria-256-ecb      aria-256-ofb      base64
bf                bf-cbc            bf-cfb            bf-ecb
bf-ofb            camellia-128-cbc  camellia-128-ecb  camellia-192-cbc
camellia-192-ecb  camellia-256-cbc  camellia-256-ecb  cast
cast-cbc          cast5-cbc         cast5-cfb         cast5-ecb
cast5-ofb         des               des-cbc           des-cfb
des-ecb           des-ede           des-ede-cbc       des-ede-cfb
des-ede-ofb       des-ede3          des-ede3-cbc      des-ede3-cfb
des-ede3-ofb      des-ofb           des3              desx
idea              idea-cbc          idea-cfb          idea-ecb
idea-ofb          rc2               rc2-40-cbc        rc2-64-cbc
rc2-cbc           rc2-cfb           rc2-ecb           rc2-ofb
rc4               rc4-40            rc5               rc5-cbc
rc5-cfb           rc5-ecb           rc5-ofb           seed
seed-cbc          seed-cfb          seed-ecb          seed-ofb
zlib
```

Task2, Performance of OpenSSL

a. **Make a speed test on your PC-platform with the speed command.** We use the "**openssl speed**" command to shows the speed test

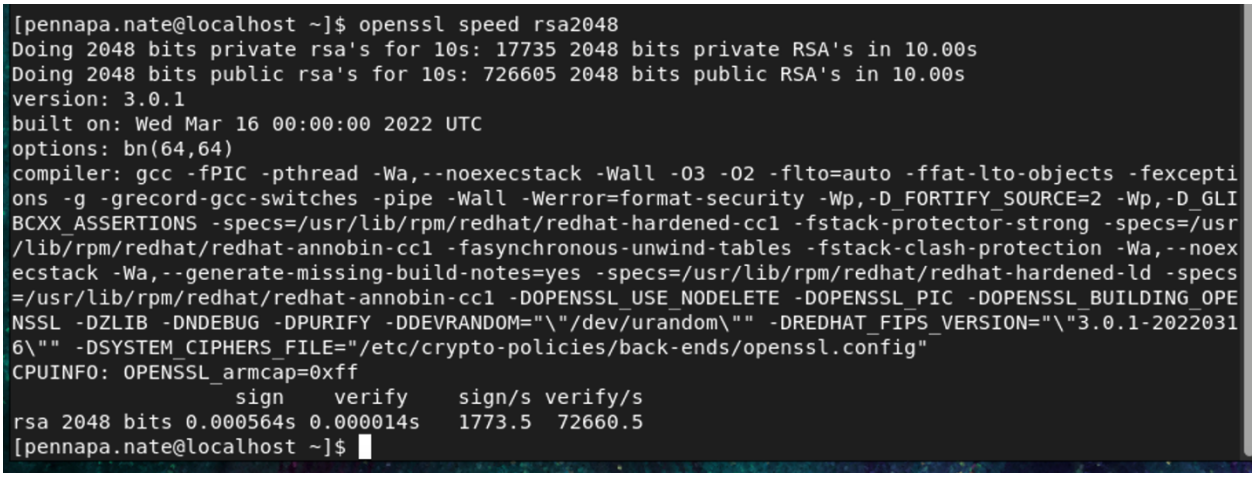
```
[pennapa.nate@localhost ~]$ openssl speed
Doing md5 for 3s on 16 size blocks: 17517910 md5's in 2.99s
Doing md5 for 3s on 64 size blocks: 10304113 md5's in 3.00s
Doing md5 for 3s on 256 size blocks: 4574525 md5's in 3.00s
Doing md5 for 3s on 1024 size blocks: 1426212 md5's in 3.00s
Doing md5 for 3s on 8192 size blocks: 191421 md5's in 3.00s
Doing md5 for 3s on 16384 size blocks: 95685 md5's in 3.00s
Doing sha1 for 3s on 16 size blocks: 29939961 sha1's in 3.00s
Doing sha1 for 3s on 64 size blocks: 24879372 sha1's in 3.00s
Doing sha1 for 3s on 256 size blocks: 15635723 sha1's in 3.00s
Doing sha1 for 3s on 1024 size blocks: 5870292 sha1's in 2.99s
Doing sha1 for 3s on 8192 size blocks: 864789 sha1's in 3.00s
Doing sha1 for 3s on 16384 size blocks: 438620 sha1's in 3.00s
Doing sha256 for 3s on 16 size blocks: 31383242 sha256's in 3.00s
Doing sha256 for 3s on 64 size blocks: 26154422 sha256's in 3.00s
Doing sha256 for 3s on 256 size blocks: 15586933 sha256's in 3.00s
Doing sha256 for 3s on 1024 size blocks: 5977675 sha256's in 3.00s
Doing sha256 for 3s on 8192 size blocks: 878309 sha256's in 3.00s
Doing sha256 for 3s on 16384 size blocks: 444903 sha256's in 3.00s
Doing sha512 for 3s on 16 size blocks: 16718389 sha512's in 3.00s
Doing sha512 for 3s on 64 size blocks: 16797653 sha512's in 3.00s
Doing sha512 for 3s on 256 size blocks: 8558683 sha512's in 3.00s
Doing sha512 for 3s on 1024 size blocks: 3350119 sha512's in 3.00s
Doing sha512 for 3s on 8192 size blocks: 509089 sha512's in 3.00s
Doing sha512 for 3s on 16384 size blocks: 258928 sha512's in 3.00s
Doing hmac(md5) for 3s on 16 size blocks: 10064181 hmac(md5)'s in 3.00s
Doing hmac(md5) for 3s on 64 size blocks: 7513435 hmac(md5)'s in 3.00s
Doing hmac(md5) for 3s on 256 size blocks: 3969048 hmac(md5)'s in 3.00s
Doing hmac(md5) for 3s on 1024 size blocks: 1352173 hmac(md5)'s in 3.00s
Doing hmac(md5) for 3s on 8192 size blocks: 189733 hmac(md5)'s in 3.00s
Doing hmac(md5) for 3s on 16384 size blocks: 95822 hmac(md5)'s in 3.00s
Doing des-ede3 for 3s on 16 size blocks: 6234953 des-ede3's in 3.00s
Doing des-ede3 for 3s on 64 size blocks: 1595647 des-ede3's in 3.00s
Doing des-ede3 for 3s on 256 size blocks: 395467 des-ede3's in 3.00s
Doing des-ede3 for 3s on 1024 size blocks: 99669 des-ede3's in 3.00s
Doing des-ede3 for 3s on 8192 size blocks: 12325 des-ede3's in 3.00s
Doing des-ede3 for 3s on 16384 size blocks: 6161 des-ede3's in 3.00s
Doing aes-128-cbc for 3s on 16 size blocks: 126893909 aes-128-cbc's in 3.00s
Doing aes-128-cbc for 3s on 64 size blocks: 67939697 aes-128-cbc's in 3.00s
Doing aes-128-cbc for 3s on 256 size blocks: 17851817 aes-128-cbc's in 3.00s
Doing aes-128-cbc for 3s on 1024 size blocks: 4610737 aes-128-cbc's in 3.00s
Doing aes-128-cbc for 3s on 8192 size blocks: 579428 aes-128-cbc's in 3.00s
Doing aes-128-cbc for 3s on 16384 size blocks: 291390 aes-128-cbc's in 3.00s
Doing aes-192-cbc for 3s on 16 size blocks: 113680440 aes-192-cbc's in 3.00s
Doing aes-192-cbc for 3s on 64 size blocks: 56242598 aes-192-cbc's in 3.00s
Doing aes-192-cbc for 3s on 256 size blocks: 14856878 aes-192-cbc's in 3.00s
Doing aes-192-cbc for 3s on 1024 size blocks: 3779178 aes-192-cbc's in 3.00s
Doing aes-192-cbc for 3s on 8192 size blocks: 478608 aes-192-cbc's in 3.00s
Doing aes-192-cbc for 3s on 16384 size blocks: 239465 aes-192-cbc's in 3.00s
Doing aes-256-cbc for 3s on 16 size blocks: 104676853 aes-256-cbc's in 3.00s
Doing aes-256-cbc for 3s on 64 size blocks: 49454751 aes-256-cbc's in 3.00s
Doing aes-256-cbc for 3s on 256 size blocks: 12964720 aes-256-cbc's in 3.00s
Doing aes-256-cbc for 3s on 1024 size blocks: 3257592 aes-256-cbc's in 3.00s
Doing aes-256-cbc for 3s on 8192 size blocks: 409670 aes-256-cbc's in 3.00s
Doing aes-256-cbc for 3s on 16384 size blocks: 207147 aes-256-cbc's in 3.00s
```

```
Doing camellia-128-cbc for 3s on 16 size blocks: 31081993 camellia-128-cbc's in 3.00s
Doing camellia-128-cbc for 3s on 64 size blocks: 8035999 camellia-128-cbc's in 3.00s
Doing camellia-128-cbc for 3s on 256 size blocks: 2050957 camellia-128-cbc's in 3.00s
Doing camellia-128-cbc for 3s on 1024 size blocks: 516554 camellia-128-cbc's in 3.00s
Doing camellia-128-cbc for 3s on 8192 size blocks: 64528 camellia-128-cbc's in 3.00s
Doing camellia-128-cbc for 3s on 16384 size blocks: 32111 camellia-128-cbc's in 3.00s
Doing camellia-192-cbc for 3s on 16 size blocks: 24260512 camellia-192-cbc's in 3.00s
Doing camellia-192-cbc for 3s on 64 size blocks: 6196333 camellia-192-cbc's in 3.00s
Doing camellia-192-cbc for 3s on 256 size blocks: 1530614 camellia-192-cbc's in 3.00s
Doing camellia-192-cbc for 3s on 1024 size blocks: 384417 camellia-192-cbc's in 3.00s
Doing camellia-192-cbc for 3s on 8192 size blocks: 48289 camellia-192-cbc's in 3.00s
Doing camellia-192-cbc for 3s on 16384 size blocks: 23887 camellia-192-cbc's in 3.00s
Doing camellia-256-cbc for 3s on 16 size blocks: 23835174 camellia-256-cbc's in 3.00s
Doing camellia-256-cbc for 3s on 64 size blocks: 6082269 camellia-256-cbc's in 3.00s
Doing camellia-256-cbc for 3s on 256 size blocks: 1522761 camellia-256-cbc's in 2.99s
Doing camellia-256-cbc for 3s on 1024 size blocks: 385474 camellia-256-cbc's in 3.00s
Doing camellia-256-cbc for 3s on 8192 size blocks: 48407 camellia-256-cbc's in 3.00s
Doing camellia-256-cbc for 3s on 16384 size blocks: 23885 camellia-256-cbc's in 3.00s
Doing ghash for 3s on 16 size blocks: 232878193 ghash's in 3.00s
Doing ghash for 3s on 64 size blocks: 218374046 ghash's in 3.00s
Doing ghash for 3s on 256 size blocks: 77264851 ghash's in 3.00s
Doing ghash for 3s on 1024 size blocks: 20517089 ghash's in 3.00s
Doing ghash for 3s on 8192 size blocks: 2581362 ghash's in 3.00s
Doing ghash for 3s on 16384 size blocks: 1309961 ghash's in 3.00s
Doing rand for 3s on 16 size blocks: 6222793 rand's in 2.61s
Doing rand for 3s on 64 size blocks: 6171383 rand's in 2.51s
Doing rand for 3s on 256 size blocks: 5876957 rand's in 2.47s
Doing rand for 3s on 1024 size blocks: 5040039 rand's in 2.59s
Doing rand for 3s on 8192 size blocks: 1998884 rand's in 2.82s
Doing rand for 3s on 16384 size blocks: 1178064 rand's in 2.95s
Doing 512 bits private rsa's for 10s: 545331 512 bits private RSA's in 10.00s
Doing 512 bits public rsa's for 10s: 6838351 512 bits public RSA's in 10.00s
Doing 1024 bits private rsa's for 10s: 111203 1024 bits private RSA's in 10.00s
Doing 1024 bits public rsa's for 10s: 2469542 1024 bits public RSA's in 10.00s
Doing 2048 bits private rsa's for 10s: 17679 2048 bits private RSA's in 9.99s
Doing 2048 bits public rsa's for 10s: 727947 2048 bits public RSA's in 10.00s
Doing 3072 bits private rsa's for 10s: 6078 3072 bits private RSA's in 10.00s
Doing 3072 bits public rsa's for 10s: 338124 3072 bits public RSA's in 10.00s
Doing 4096 bits private rsa's for 10s: 2773 4096 bits private RSA's in 10.00s
Doing 4096 bits public rsa's for 10s: 192225 4096 bits public RSA's in 10.00s
Doing 7680 bits private rsa's for 10s: 337 7680 bits private RSA's in 10.03s
Doing 7680 bits public rsa's for 10s: 55865 7680 bits public RSA's in 10.00s
Doing 15360 bits private rsa's for 10s: 64 15360 bits private RSA's in 10.11s
Doing 15360 bits public rsa's for 10s: 14314 15360 bits public RSA's in 10.00s
Doing 512 bits sign dsa's for 10s: 286813 512 bits DSA signs in 9.98s
Doing 512 bits verify dsa's for 10s: 505377 512 bits DSA verify in 10.00s
Doing 1024 bits sign dsa's for 10s: 147387 1024 bits DSA signs in 9.97s
Doing 1024 bits verify dsa's for 10s: 193175 1024 bits DSA verify in 10.00s
Doing 2048 bits sign dsa's for 10s: 51637 2048 bits DSA signs in 9.94s
Doing 2048 bits verify dsa's for 10s: 55531 2048 bits DSA verify in 9.97s
Doing 224 bits sign ecdsa's for 10s: 326412 224 bits ECDSA signs in 9.95s
Doing 224 bits verify ecdsa's for 10s: 151064 224 bits ECDSA verify in 10.00s
Doing 256 bits sign ecdsa's for 10s: 577926 256 bits ECDSA signs in 9.90s
Doing 256 bits verify ecdsa's for 10s: 186511 256 bits ECDSA verify in 9.99s
Doing 384 bits sign ecdsa's for 10s: 17328 384 bits ECDSA signs in 10.00s
Doing 384 bits verify ecdsa's for 10s: 20769 384 bits ECDSA verify in 9.99s
Doing 521 bits sign ecdsa's for 10s: 47996 521 bits ECDSA signs in 9.98s
Doing 521 bits verify ecdsa's for 10s: 25420 521 bits ECDSA verify in 9.99s
Doing 224 bits  ecdh's for 10s: 224933 224-bits ECDH ops in 10.00s
Doing 256 bits  ecdh's for 10s: 244389 256-bits ECDH ops in 10.00s
Doing 384 bits  ecdh's for 10s: 18073 384-bits ECDH ops in 10.00s
Doing 521 bits  ecdh's for 10s: 43264 521-bits ECDH ops in 10.00s
Doing 253 bits  ecdh's for 10s: 311897 253-bits ECDH ops in 9.99s
Doing 448 bits  ecdh's for 10s: 63021 448-bits ECDH ops in 10.00s
Doing 253 bits sign Ed25519's for 10s: 330077 253 bits Ed25519 signs in 9.99s
Doing 253 bits verify Ed25519's for 10s: 119166 253 bits Ed25519 verify in 10.00s
Doing 456 bits sign Ed448's for 10s: 54637 456 bits Ed448 signs in 10.00s
Doing 456 bits verify Ed448's for 10s: 62884 456 bits Ed448 verify in 10.00s
Doing 2048 bits  ffdh's for 10s: 5698 2048-bits FFDH ops in 9.98s
Doing 3072 bits  ffdh's for 10s: 1816 3072-bits FFDH ops in 10.00s
```

```
version: 3.0.1
built on: Wed Mar 16 00:00:00 2022 UTC
options: bn(64,64)
compiler: gcc -fPIC -pthread -Wa,--noexecstack -Wall -O3 -O2 -flto=auto -ffat-lto-objects -fexcepti
ons -g -grecord-gcc-switches -pipe -Wall -Werror=format-security -Wp,-D_FORTIFY_SOURCE=2 -Wp,-D_GLI
BCXX_ASSERTIONS -specs=/usr/lib/rpm/redhat/redhat-hardened-cc1 -fstack-protector-strong -specs=/usr
/lib/rpm/redhat/redhat-annobin-cc1 -fasynchronous-unwind-tables -fstack-clash-protection -Wa,--noex
ecstack -Wa,--generate-missing-build-notes=yes -specs=/usr/lib/rpm/redhat/redhat-hardened-ld -specs
=/usr/lib/rpm/redhat/redhat-annobin-cc1 -DOPENSSL_USE_NODELETE -DOPENSSL_PIC -DOPENSSL_BUILDING_OPE
NSSL -DZLIB -DNDEBUG -DPURIFY -DDEVRANDOM="\"/dev/urandom\"" -DREDHAT_FIPS_VERSION="\"3.0.1-2022031
6\"" -DSYSTEM_CIPHERS_FILE="/etc/crypto-policies/back-ends/openssl.config"
CPUINFO: OPENSSL_armcap=0xff
The 'numbers' are in 1000s of bytes per second processed.
type             16 bytes     64 bytes    256 bytes   1024 bytes   8192 bytes  16384 bytes
md5              93741.32k   219821.08k   390359.47k   486813.70k   522706.94k   522567.68k
sha1            159679.79k   530759.94k  1334248.36k  2010427.76k  2361450.50k  2395450.03k
sha256          167377.29k   557961.00k  1330084.95k  2040379.73k  2398369.11k  2429763.58k
sha512           89164.74k   358349.93k   730340.95k  1143507.29k  1390152.36k  1414092.12k
hmac(md5)        53675.63k   160286.61k   338692.10k   461541.72k   518097.58k   523315.88k
des-ede3         33253.08k    34040.47k    33746.52k    34020.35k    33655.47k    33647.27k
aes-128-cbc     676767.51k  1449380.20k  1523355.05k  1573798.23k  1582224.73k  1591377.92k
aes-192-cbc     606295.68k  1199842.09k  1267786.92k  1289959.42k  1306918.91k  1307798.19k
aes-256-cbc     558276.55k  1055034.69k  1106322.77k  1111924.74k  1118672.21k  1131298.82k
camellia-128-cbc   165770.63k   171434.65k   175015.00k   176317.10k   176204.46k   175368.87k
camellia-192-cbc   129389.40k   132188.44k   130612.39k   131214.34k   131861.16k   130454.87k
camellia-256-cbc   127120.93k   129755.07k   130376.86k   131575.13k   132183.38k   130443.95k
ghash          1242017.03k  4658646.31k  6593267.29k  7003166.38k  7048839.17k  7154133.67k
rand             38147.39k   157357.97k   609109.71k  1992664.07k  5806687.14k  6542847.65k
                  sign    verify    sign/s verify/s
rsa  512 bits 0.000018s 0.000001s  54533.1 683835.1
rsa 1024 bits 0.000090s 0.000004s  11120.3 246954.2
rsa 2048 bits 0.000565s 0.000014s   1769.7  72794.7
rsa 3072 bits 0.001645s 0.000030s    607.8  33812.4
rsa 4096 bits 0.003606s 0.000052s    277.3  19222.5
rsa 7680 bits 0.029763s 0.000179s     33.6   5586.5
rsa 15360 bits 0.157969s 0.000699s      6.3   1431.4
                  sign    verify    sign/s verify/s
dsa  512 bits 0.000035s 0.000020s  28738.8  50537.7
dsa 1024 bits 0.000068s 0.000052s  14783.0  19317.5
dsa 2048 bits 0.000192s 0.000180s   5194.9   5569.8
                              sign    verify    sign/s verify/s
 224 bits ecdsa (nistp224)   0.0000s   0.0001s  32805.2  15106.4
 256 bits ecdsa (nistp256)   0.0000s   0.0001s  58376.4  18669.8
 384 bits ecdsa (nistp384)   0.0006s   0.0005s   1732.8   2079.0
 521 bits ecdsa (nistp521)   0.0002s   0.0004s   4809.2   2544.5
                              op      op/s
 224 bits ecdh (nistp224)   0.0000s  22493.3
 256 bits ecdh (nistp256)   0.0000s  24438.9
 384 bits ecdh (nistp384)   0.0006s   1807.3
 521 bits ecdh (nistp521)   0.0002s   4326.4
 253 bits ecdh (X25519)   0.0000s  31220.9
 448 bits ecdh (X448)   0.0002s   6302.1
                              sign    verify    sign/s verify/s
 253 bits EdDSA (Ed25519)   0.0000s   0.0001s  33040.7  11916.6
 456 bits EdDSA (Ed448)   0.0002s   0.0002s   5463.7   6288.4
                         op     op/s
2048 bits ffdh   0.0018s    570.9
3072 bits ffdh   0.0055s    181.6
4096 bits ffdh   0.0125s     80.3
6144 bits ffdh   0.0402s     24.9
8192 bits ffdh   0.0945s     10.6
[pennapa.nate@localhost ~]$
```

b. Compare the results for symmetric encryption (e.g., AES-CBC) and RSA signature.

Next is we will use **openssl speed rsa2048** to Compare the results for symmetric encryption and RSA signature.



Taks3, Using **OpenSSL from the command line interface**

Now, our goal is to create a text file that can be encrypted in three different types. For this, I have to create a directory for this project and access this directory. So, I used my terminal and went to my desire folder, and type

```
mkdir Project 2 – openssl
cd Project 2 - openssl
```

Then for the text file created, we used nano editor and named as “textFile”

```
nano textFile
```

Here we typed our text, “Hi everyone, This is a group project about OpenSSL. Our goal is to encrypt and decrypt using OpenSSL.”
Then press ctrl + X, then y, and press enter to save this text.

a. **Create a text file with some input and encrypt it using**
   I. **AES-128 CBC**
   II. **AES-256 CTR**
   III. **DES**

Now, we are going to encrypt with three following different types of encryption methods.

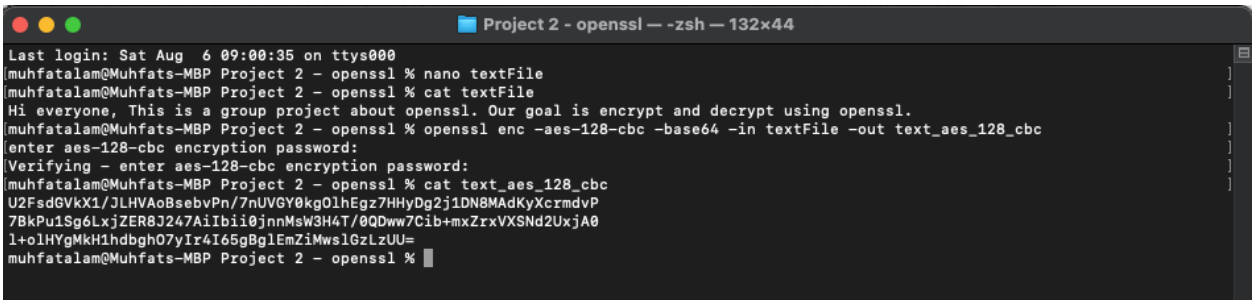
i. AES-128 CBC
ii. AES-256 CTR
iii. DES

To do this encryption, In the terminal, we used three commands that are similar to each other and just changed the encryption method.

i. For AES-128 CBC

```
openssl enc -aes-128-cbc -base64 -in textFile -out text_aes_128_cbc
```

Here are “textFile” will encrypted and it will save as “text_aes_128_cbc”. Besides terminal is required for the password for extra security. For the password we used “password.” We also need to verify our password with our given password.



ii. For AES-256 CTR

```
openssl enc -aes-256-ctr -base64 -in textFile -out text_aes_128_cbc
```

Here “textFile” will be encrypted and it will save as “text_aes_256_ctr” and password we used “password”. We also need to verify our password with our given password.

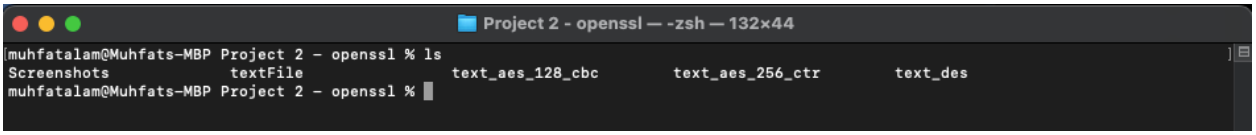
iii. For AES-256 CTR

```
openssl enc -des -base64 -in textFile -out text_des
```

Here “textFile” will be encrypted and it will save as “text_des” and password we used “password”. We also need to verify our password with our given password.

Now, we need to verify we will have 3 different encrypted file and one original files.

```
ls
```



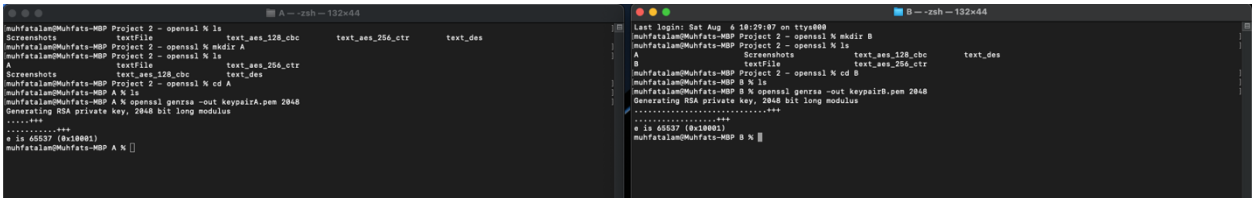
b. Create a 2048 bit RSA public and private key.

After we verify there are three different encrypted files, and one original file are this directory now we will create a 2048-bit RSA public and private key. For this, we need to create directories for two people where they will have each other’s public key and they can share encrypted text file. After getting an encrypted file they will decrypt it with their own private key. Assume one is Alice and the other one is Bob. They both need private and public keys for RSA encryption. We can follow the following commands:

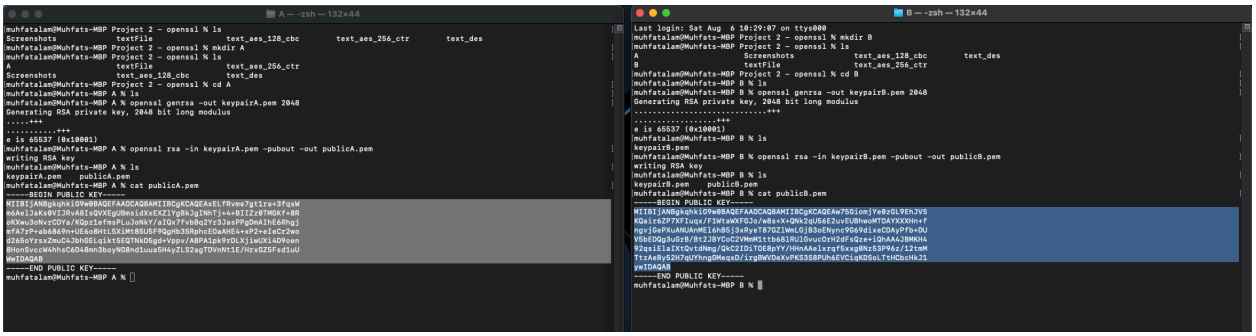
For Alice,

```
mkdir A
ls
cd A
openssl genrsa -out keypairA.pem 2048
```

For Bob
```
mkdir B
ls
cd B
openssl genrsa -out keypairB.pem 2048
```
Here, for the last command genrsa is generate an RSA key and it will save as “keypairA” and “keypairB”, which will contain private and public keys.



Now, we are going to separate our public key from keypairA and keypairB.

For Alice,
```
openssl rsa -in keypairA.pem -pubout -out publicA.pem
cat publicA.pem
```
**Notice that after OpenSSL we do not generate the key, we are using this RSA key to separate the file. So we used RSA after OpenSSL.
For Bob,
```
openssl rsa -in keypairB.pem -pubout -out publicB.pem
cat publicB.pem
```


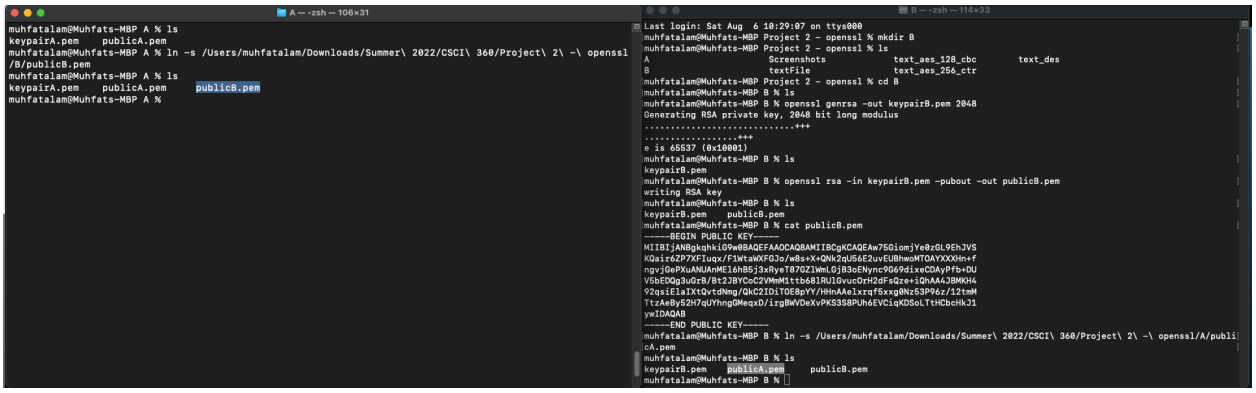
Task4, Exchange of encrypted data.

a. Encrypt a file (e.g., a text file) with an algorithm and key length of your choice.

To exchange data, we will need to create a link between Alice and Bob to access each other's public keys by

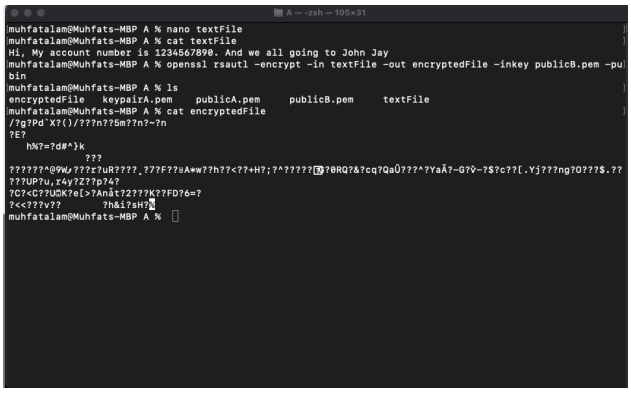
For Alice,
```
ln -s /Users/muhfatalam/Downloads/Summer\ 2022/CSCI\ 360/Project\ 2\ -\ openssl/B/publicB.pem
ls
```

For Bob,
```
ln -s /Users/muhfatalam/Downloads/Summer\ 2022/CSCI\ 360/Project\ 2\ -\ openssl/A/publicA.pem
ls
```



Now for demonstration purposes, we will make an encrypted text file with bob's public key in the Alice directory. In the text file, we typed "Hi, My account number is 1234567890. And we all going to John Jay" and saved it as "textFile"
```
nano textFile
cat textFile
```
Now we are going to encrypt our "textFile" with Bob's public key "public.pem" and save it as "encryptedFile".

```
openssl rsautl -encrypt -in textFile -out encrptedFile -inkey publicB.pem -pubin
ls
cat encryptedFile
```



b. Exchange the file and the necessary credentials for decryption (i.e., algorithm, key) with your neighbor.

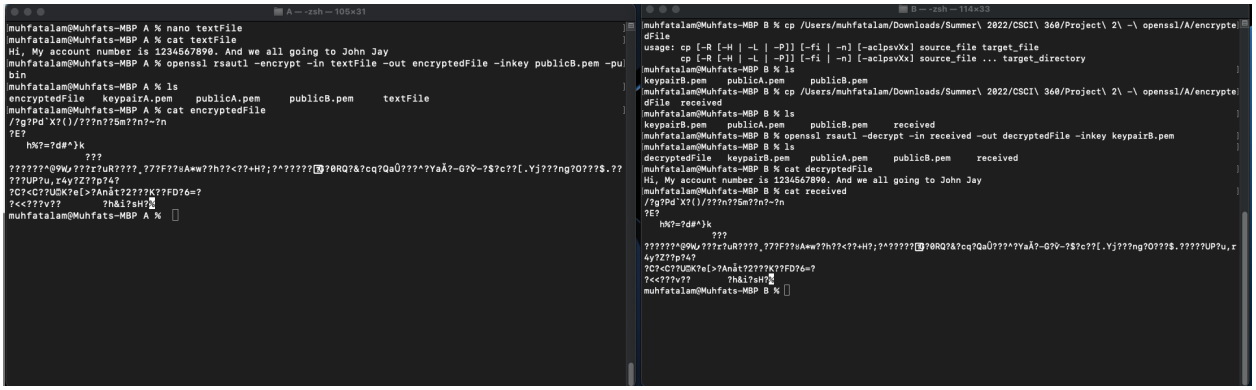
Now, Bob, it is going to copy this encrypted file from Alice and save his directory with the name “received.”

```
cp /Users/muhfatalam/Downloads/Summer\ 2022/CSCI\ 360/Proiect\ 2\ -\openssl/A/encrypte
dFile received
```

c. Decrypt the secret of your neighbor.

For decryption, Bob will use his own private key and save it as “decryptedFile.”

```
openssl rsautl -decrypt -in received -out decryptedFile -inkey keypairB.pem
ls
cat decryptedFile
```



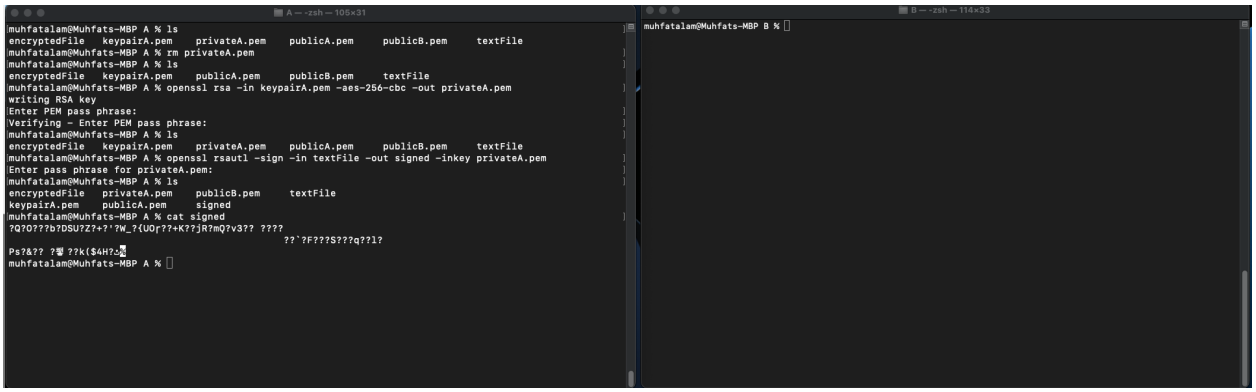
For security purposes, before Alice encrypts the file with Bob's public key, we can separate our private key with any kind of encryption methods like AES or DES from "keypairA.pem" to save it with "privateA.pem." Here we are using "AES-256-CBC". For passwords, we are using "password."

```
openssl rsa -in keypairA.pem -aes-256-cbc -out privateA.pem
```

After verifying the password, we will sign our "textFile", and save it as a "signed" name using the inkey "privateA.pem."

```
openssl rsautl -sign -in textFile -out signed -inkey privateA.pem
```

From now every time, we used our private key we need to use password.



Now Bob needs to copy this file and saved it as a "singed" name.

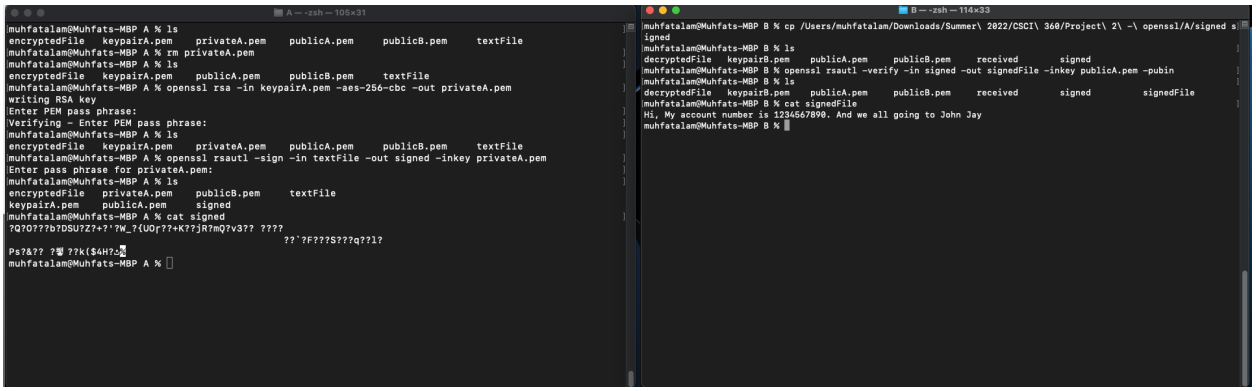
```
cp /Users/muhfatalam/Downloads/Summer\ 2022/CSCI\ 360/Project\ 2\ -\ openssl/A/signed signed
ls
```

After copying the file Bob needs to verify this signed file and save it as "signedFile" using the public key of Alice "publicA.pem."

```
openssl rsautl -verify -in signed -out signedFile -inkey publicA.pem -pubin
```

Now we can open this file:

```
ls
cat signedFile
```



When we used any encryption method for RSA it will become more secure besides the public and private keys.