Crypto libraries
OpenSSL II (cont.)

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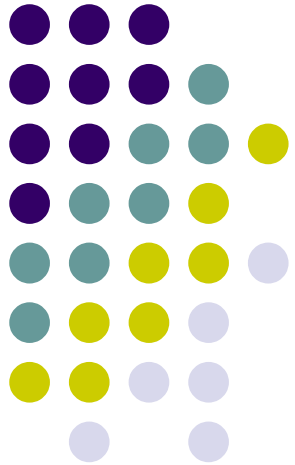
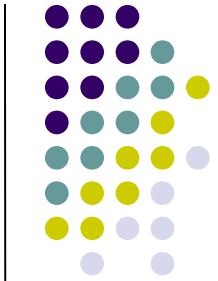
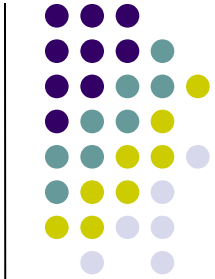


Today’s exercise



- Continue with OpenSSL on Linux
- OpenSSL I/O abstraction (BIO)
- OpenSSL3 ECC (elliptic curves) keygen
- Trivial TLS client
- (optional) some more advanced PKI example
- Bonus: OpenSSL3 providers

Example 7: OpenSSL BIO (I/O abstraction)

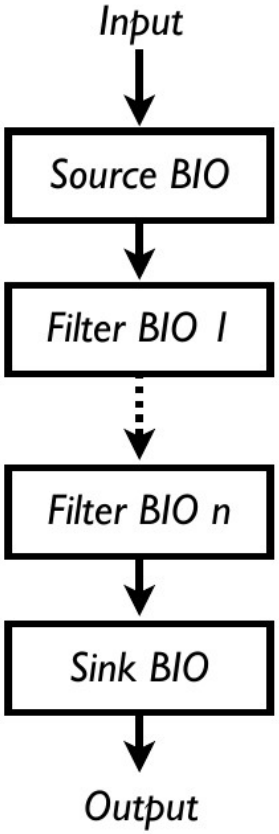


Source/sink BIOs:

BIO_s_mem() - memory I/O
BIO_s_file() - file I/O
BIO_s_fd() - file descriptor IO
BIO_s_socket() - sockets
BIO_s_accept()
BIO_s_connect()
BIO_s_null() - discard (like /dev/null)

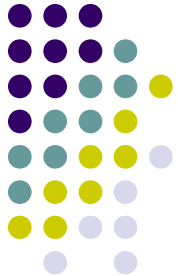
Filters

BIO_f_base64() - Base64 encoding
BIO_f_buffer() - buffering I/O
BIO_f_cipher() - encryption/decryption
BIO_f_md() - message digest
BIO_f_ssl() - SSL support for BIO



Example 7: the same encryption as in Example 4 using BIO interface.
*See **7_bio_openssl** directory**.*

Example 8:
TLS connection & certificates



BIO TLS connection

- `SSL_CTX_set_verify, SSL_get_peer_certificate, SSL_get_verify_result`
- `BIO_new_ssl_connect, BIO_get_ssl, BIO_do_connect, BIO_do_handshake`

X509

- `X509_STORE_CTX_get_current_cert, X509_print_ex_fp, X509_NAME_get_entry, …`

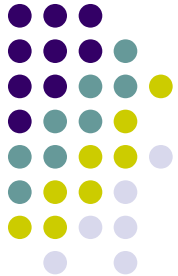
Connect to https://www.google.com.

Read and validate certificates.

Sent HTTP GET and receive /robots.txt through a secured connection.

*See **8_tls_client_openssl** directory.*

Example 9: ECC keys, sign & verify with ED25519



EC key (pair) generation

EVP_PKEY_CTX_new_from_name
EVP_PKEY_keygen_init
EVP_PKEY_CTX_set_params
EVP_PKEY_generate

// Also: EVP_EC_gen(), EVP_PKEY_Q_keygen()

Signature – there can be differences for different curves

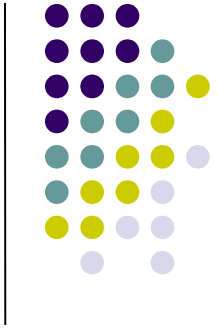
ED25519: EVP_DigestSign/EVP_DigestVerify (one-shot)

Export of keys and attributes

EVP_PKEY_get_* functions
PEM_write_bio_PrivateKey
PEM_write_bio_PUBKEY

*See **9_ecc_gen_openssl3** directory.*

(optional example) Signing and certificates



PKCS12

- `PKCS12_verify_mac, PKCS12_parse`

PKCS7

- `PKCS7_sign, PKCS7_verify`

X509

- `X509_STORE_add_lookup`

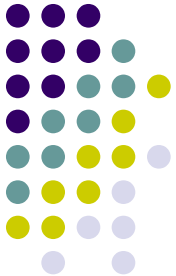
BIO

- `BIO_new, BIO_new_mem_buf, BIO_new_file`
- `BIO_push, BIO_f_cipher, BIO_set_cipher`
- `BIO_flush, BIO_free_all`
- `d2i_PKCS12_bio, d2i_PKCS7_bio`

*See **opt_cert_sign_openssl** directory.*

prepare CA signed cert.

script: opt_cert_sign_openssl/create_CA



```
#!/bin/bash

CA=ca
CA_SUBJ='/C=CZ/ST=Utopia/L=Brno/O=Test s.r.o./OU=Test CA'
SIGN=sub-ca
SIGN_SUBJ='/C=CZ/ST=Utopia/L=Brno/O=Test s.r.o./OU=Test sign'

PASSWORD="mypassword"

# Generate RSA key for root CA
openssl genrsa -out $CA.key 4096
# self-sign CA
openssl req -new -x509 -days 365 -key $CA.key -out $CA.crt -subj "$CA_SUBJ"

# Generate sub-ordinate CA signed by CA
openssl genrsa -out $SIGN.key 4096
openssl req -new -key $SIGN.key -out $SIGN.csr -subj "$SIGN_SUBJ"
# sign by root CA
openssl x509 -req -days 365 -in $SIGN.csr -CA $CA.crt -CAkey $CA.key -set_serial 01 -out $SIGN.crt

# Package it as PKCS12 file
openssl pkcs12 -export -out $SIGN.p12 -inkey $SIGN.key -in $SIGN.crt -chain -CAfile $CA.crt -password "pass:$PASSWORD"

for i in $(ls *.crt)
do
        h=$(openssl x509 -hash -noout -in $i)
        echo "$i => $h.o"
        ln -s $i $h.0
done
```

Bonus: OpenSSL3 providers

You can define you own library;
It is loaded and used through OpenSSL3 API

Provider Corner

A place for public OpenSSL provider modules, including demos and lessons. This is NOT part of the OpenSSL organization.

https://github.com/provider-corner

- **Toy example: Vigenere cipher** (historic 16th century cipher)
  git clone https://github.com/provider-corner/vigenere
  git submodule init
  git submodule update
  cmake .
  make
- Need to copy to ossl-modules dir or use config

```
$ echo ahoj | openssl enc -provider vigenere -e -vigenere -K 000102030405060708090a0b0c0d0e0f
aiqm
```