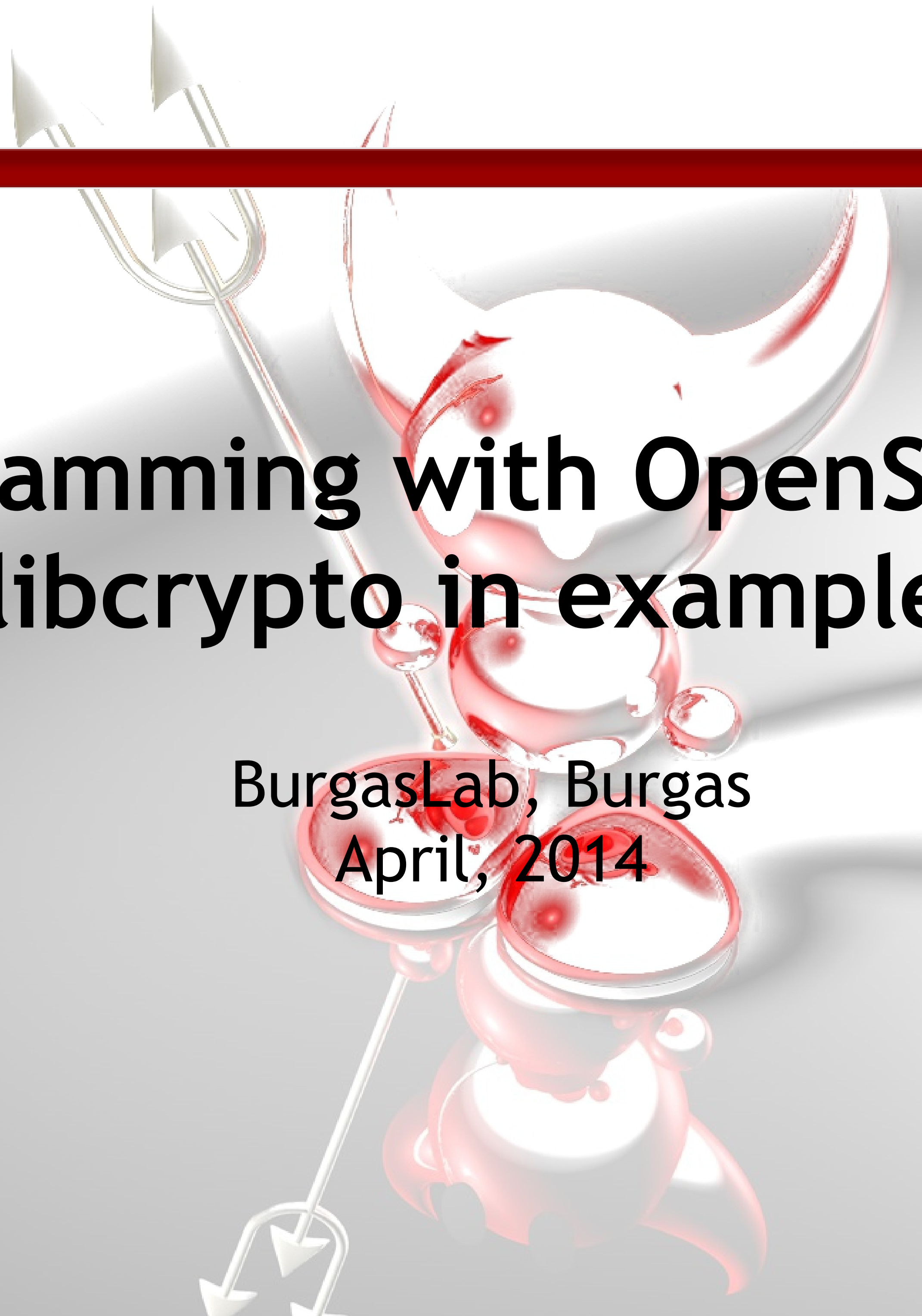
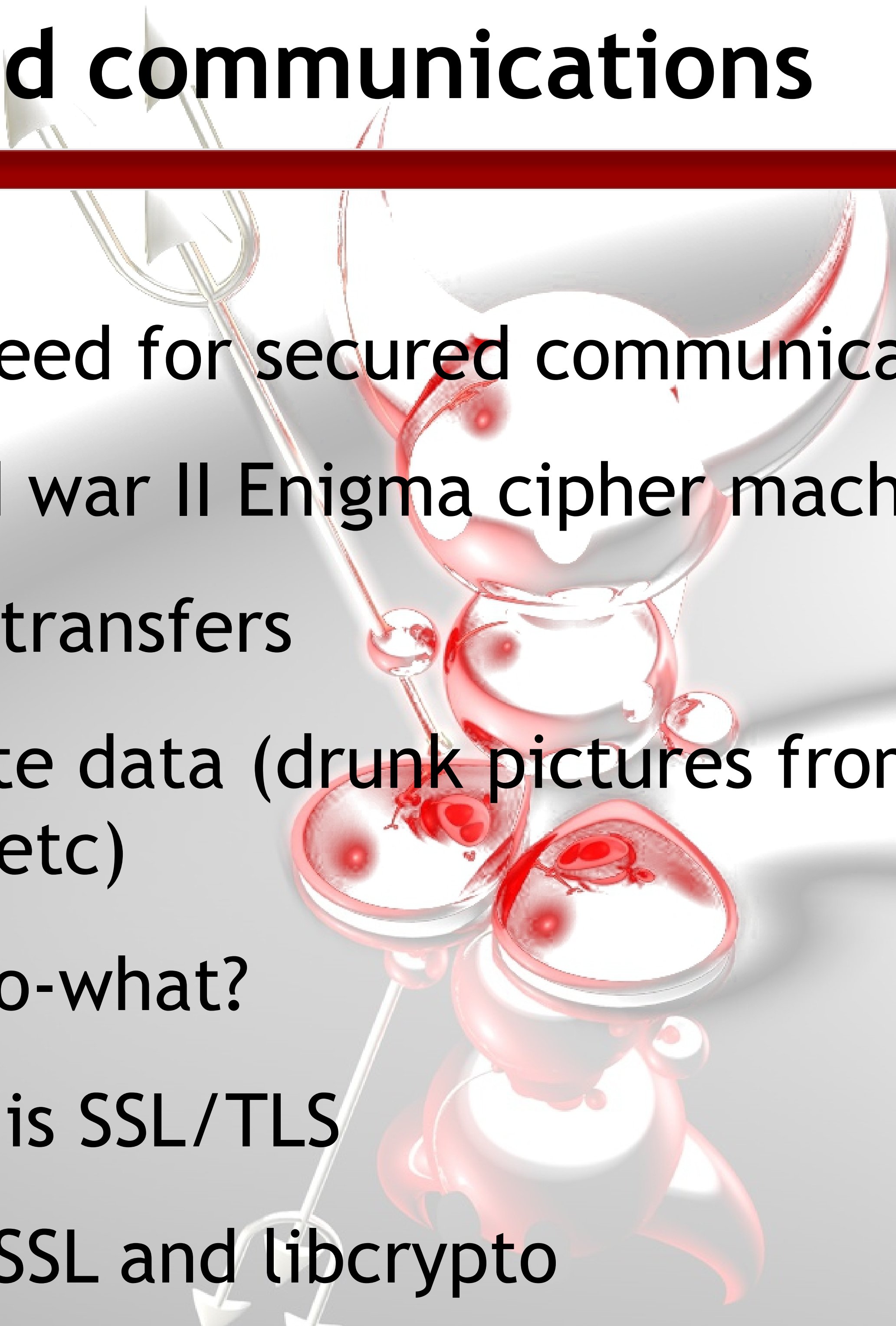
Shteryana Shopova,
syrinx@FreeBSD.org



Programming with OpenSSL and libcrypto in examples

BurgasLab, Burgas
April, 2014

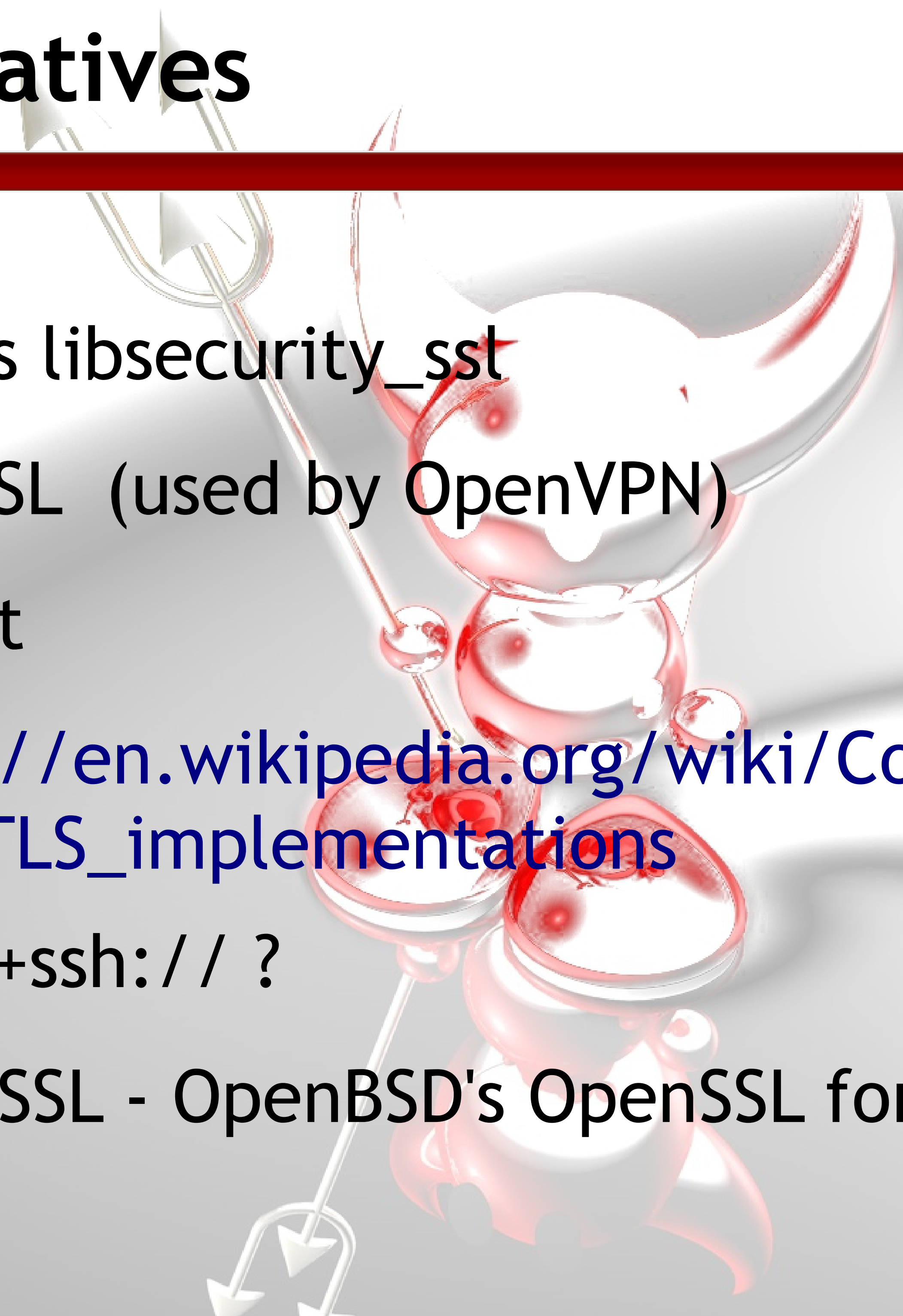
secured communications



- the need for secured communications
- world war II Enigma cipher machine
- bank transfers
- private data (drunk pictures from that party, etc)
- crypto-what?
- what is SSL/TLS
- OpenSSL and libcrypto

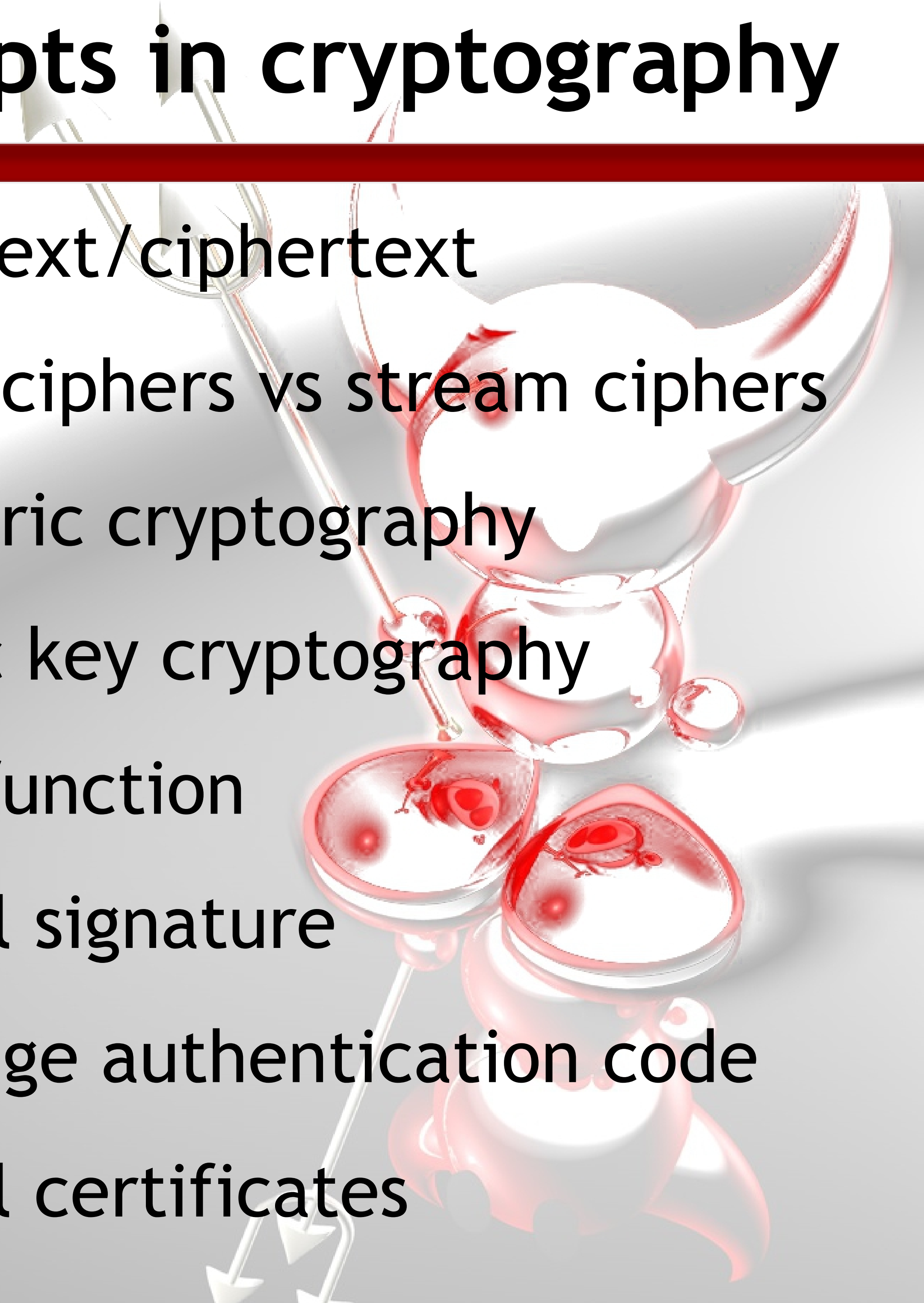
alternatives

- Apple's libsecurity_ssl
- PolarSSL (used by OpenVPN)
- full list
  - http://en.wikipedia.org/wiki/Comparison_of_TLS_implementations
  - http+ssh:// ?
  - LibreSSL - OpenBSD's OpenSSL fork

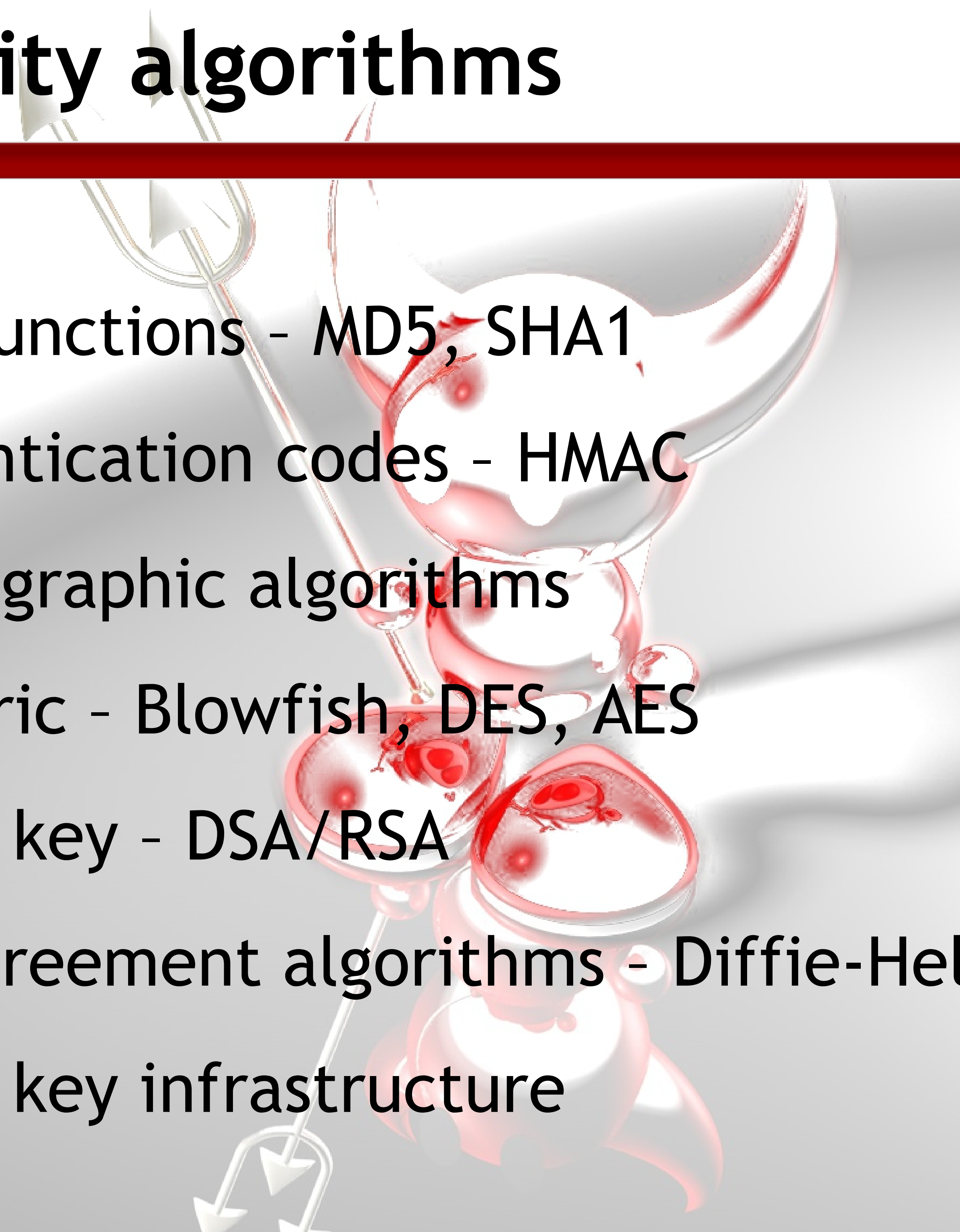


concepts in cryptography

- plaintext/ciphertext
- block ciphers vs stream ciphers
- symetric cryptography
- public key cryptography
- hash function
- digital signature
- message authentication code
- digital certificates

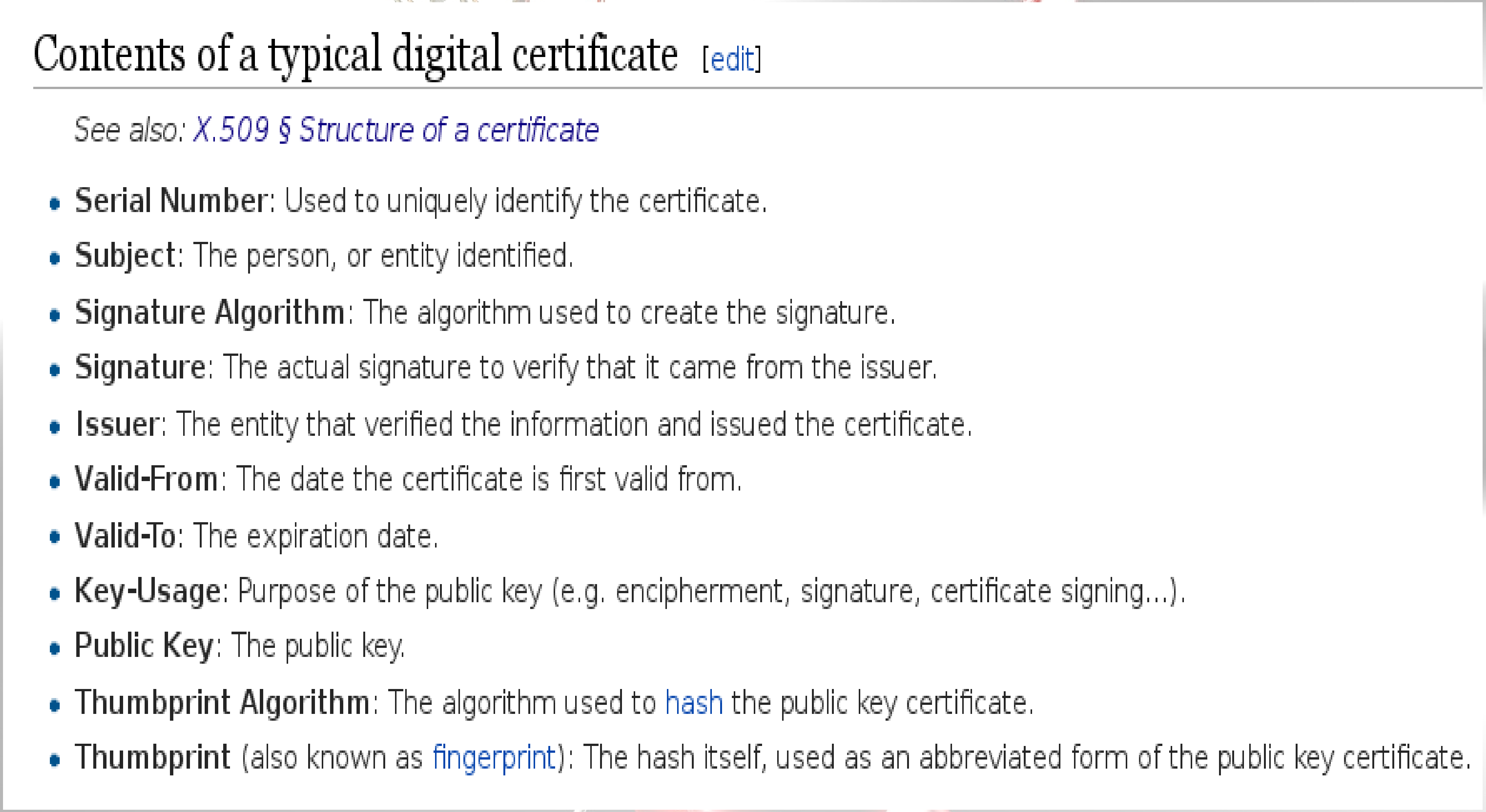


security algorithms



- hash functions – MD5, SHA1
- authentication codes – HMAC
- cryptographic algorithms
- symetric – Blowfish, DES, AES
- public key – DSA/RSA
- key agreement algorithms – Diffie-Hellman
- public key infrastructure

contents of a X.509 certificate



Contents of a typical digital certificate [edit]

See also: X.509 § Structure of a certificate

- **Serial Number**: Used to uniquely identify the certificate.
- **Subject**: The person, or entity identified.
- **Signature Algorithm**: The algorithm used to create the signature.
- **Signature**: The actual signature to verify that it came from the issuer.
- **Issuer**: The entity that verified the information and issued the certificate.
- **Valid-From**: The date the certificate is first valid from.
- **Valid-To**: The expiration date.
- **Key-Usage**: Purpose of the public key (e.g. encipherment, signature, certificate signing...).
- **Public Key**: The public key.
- **Thumbprint Algorithm**: The algorithm used to hash the public key certificate.
- **Thumbprint** (also known as fingerprint): The hash itself, used as an abbreviated form of the public key certificate.

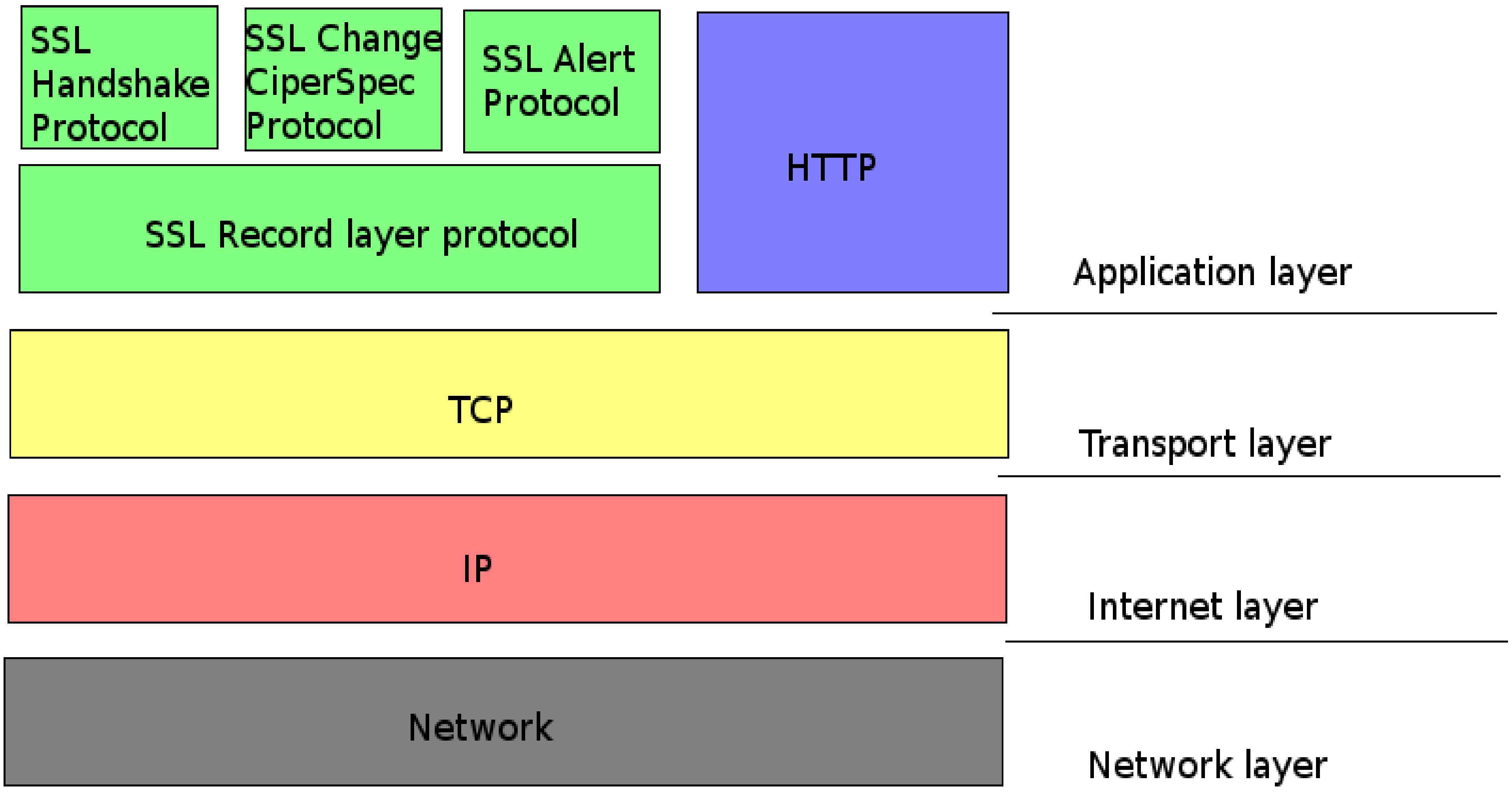
what is SSL/TLS

- cryptographic protocols, designed to provide communication security over unsecured network
- provide connection security by
- privacy – encrypt connection
- authentication – prove identity through certificates
- reliability – maintenance of secure connection through message integrity checking

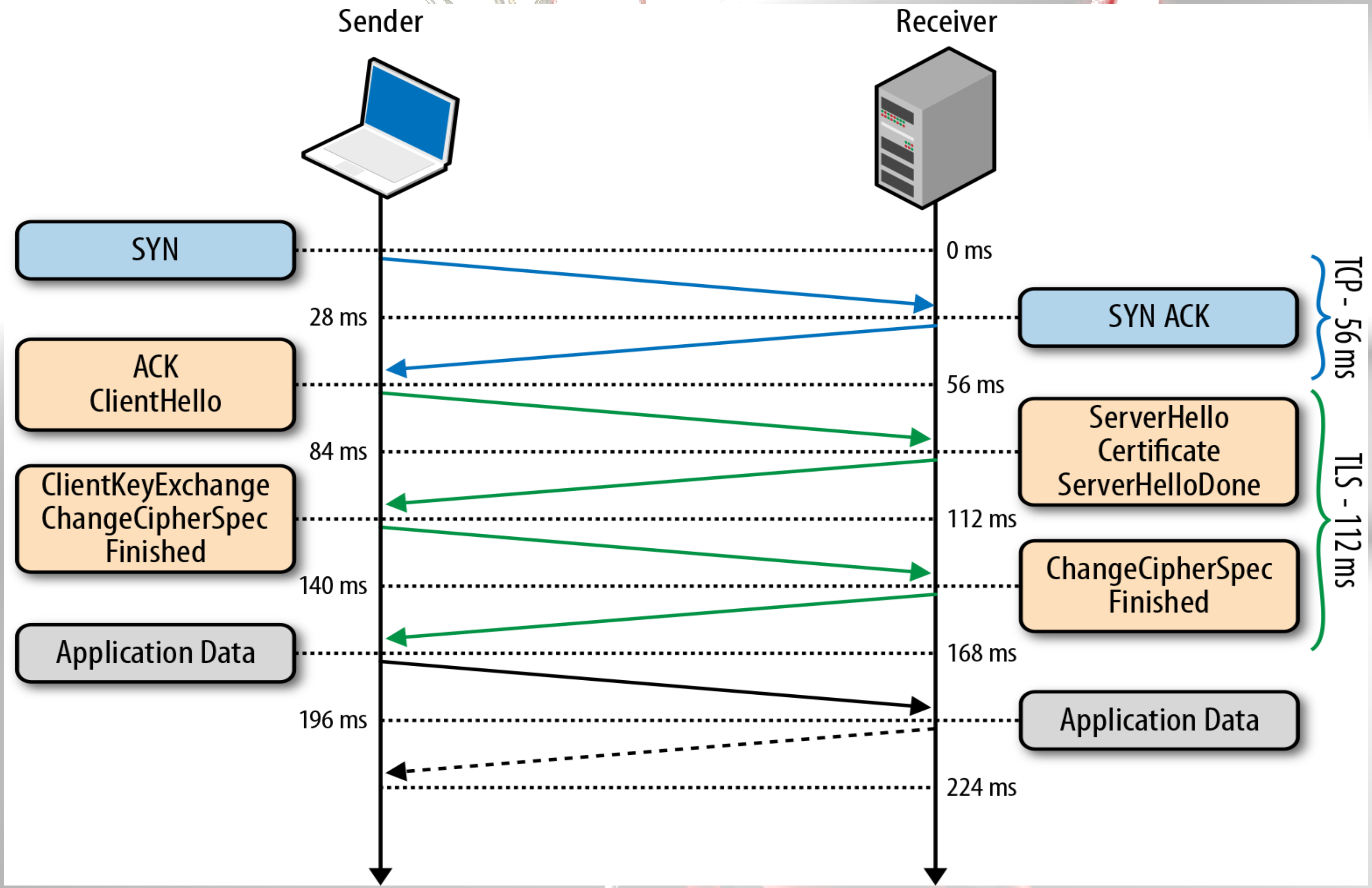
how SSL works

- four protocol layers
- record layer – formats messages, incl. Generated HMAC at the end
- ChangeCipherSpec protocol layer – one message that signals the beginning of secure communication
- alert protocol – sends errors, problems or warnings about the connection
- handshake protocol – establish a handshake that begins secure connection

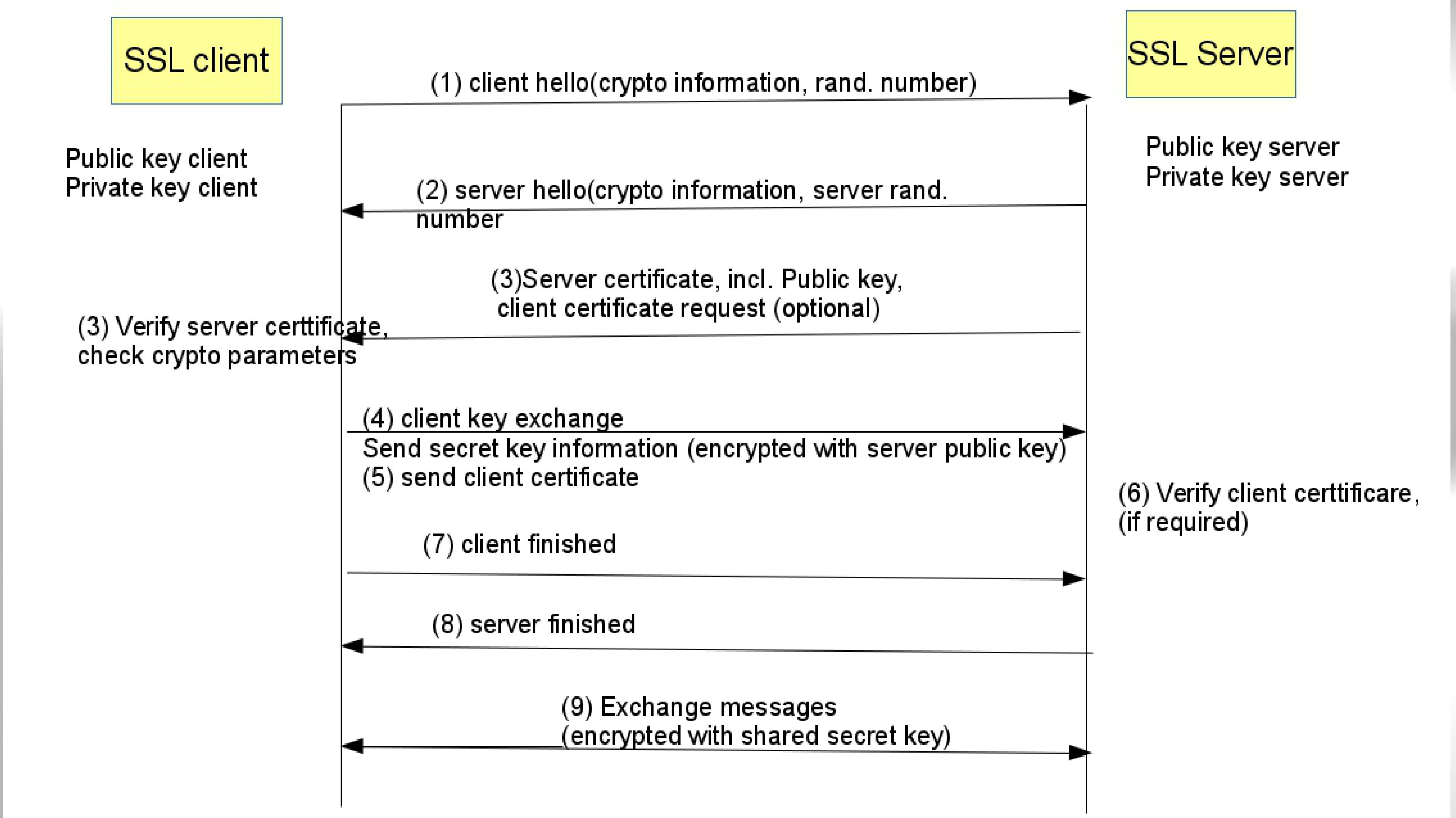
how SSL works (2)



SSL handshake



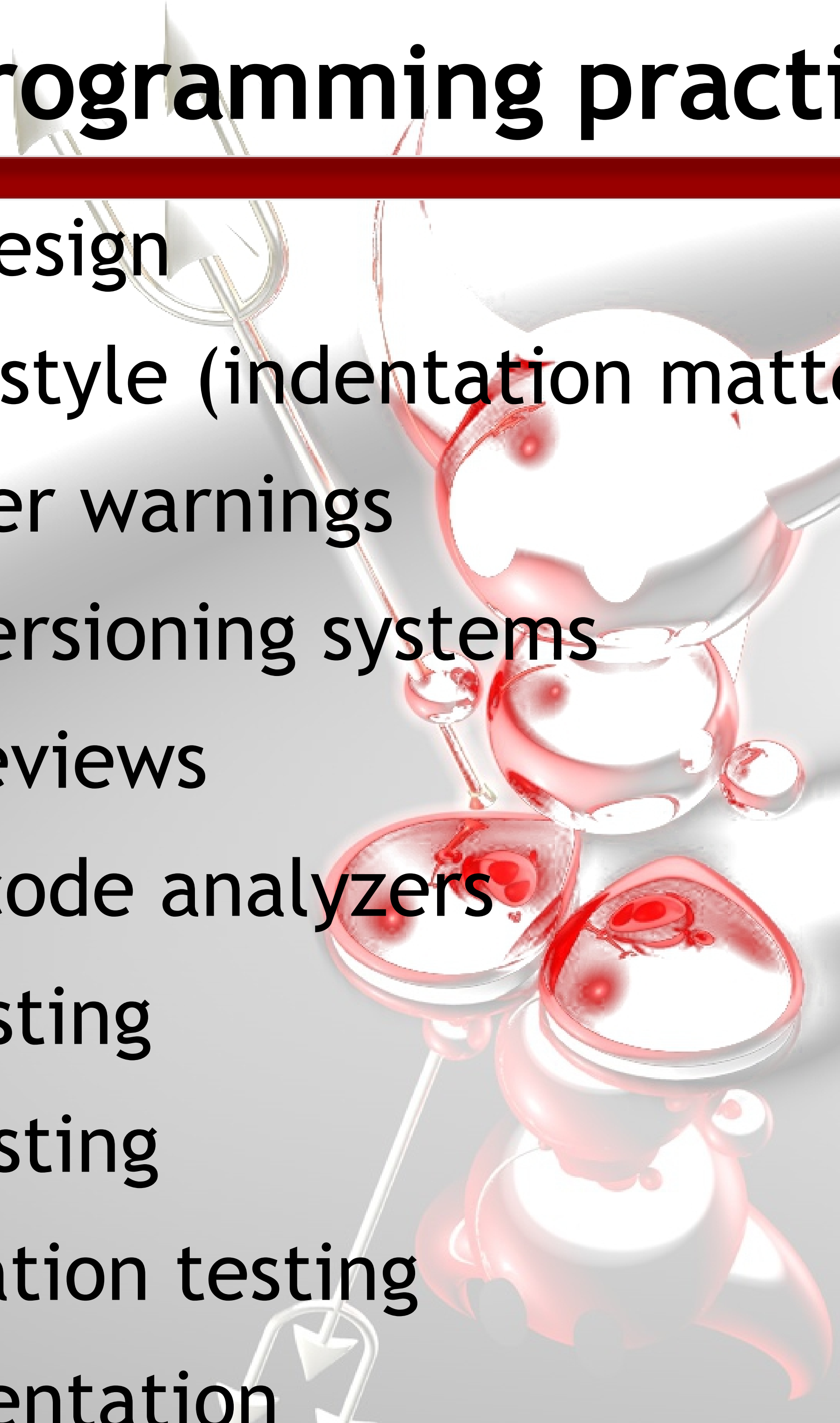
SSL handshake,2-way authentication


SSL client
SSL Server
(1) client hello(crypto information, rand. number)
Public key client
Private key client
Public key server
Private key server
(2) server hello(crypto information, server rand. number
(3)Server certificate, incl. Public key,
client certificate request (optional)
(3) Verify server certtificate,
check crypto parameters
(4) client key exchange
Send secret key information (encrypted with server public key)
(5) send client certificate
(6) Verify client certtificare,
(if required)
(7) client finished
(8) server finished
(9) Exchange messages
(encrypted with shared secret key)

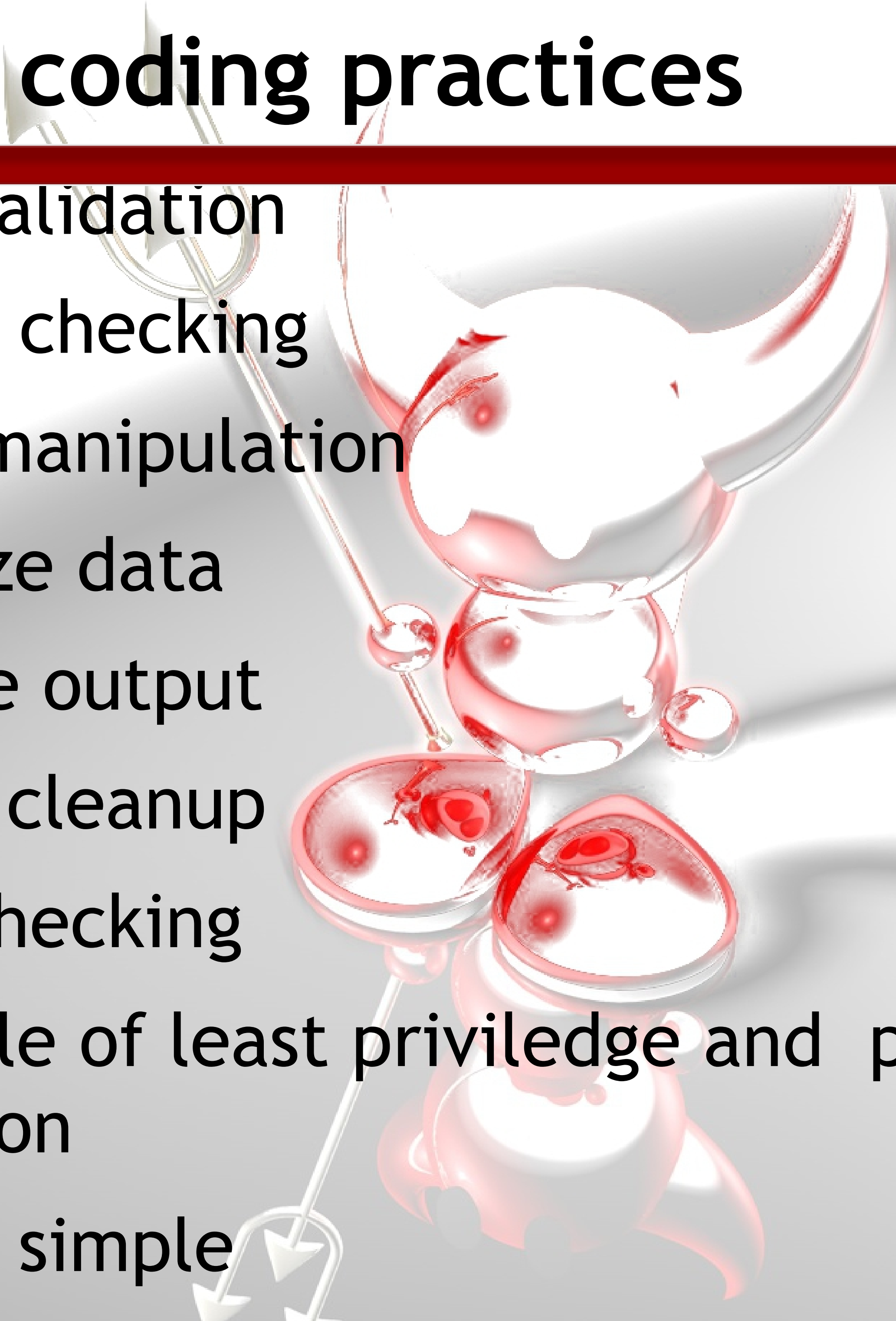
before we start programming

Learn to code C properly !!!

good programming practices



- clear design
- coding style (indentation matters too!)
- compiler warnings
- code versioning systems
- code reviews
- static code analyzers
- unit testing
- fuzz testing
- automation testing
- documentation



good C coding practices

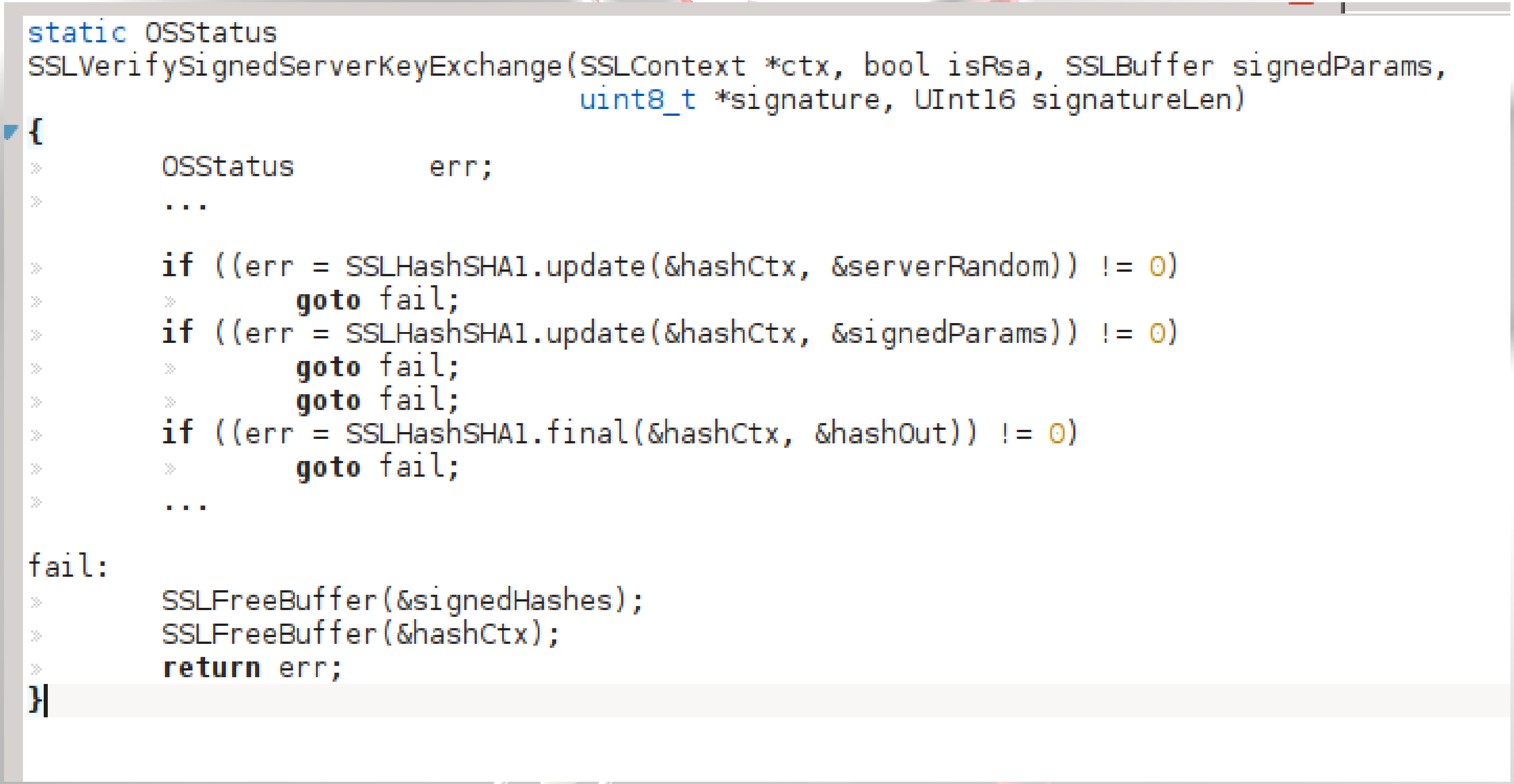
- input validation
- bounds checking
- string manipulation
- initialize data
- sanitize output
- proper cleanup
- error checking
- principle of least priviledge and priviledge separation
- keep it simple

good C coding practices (2)

- Build a habit of applying those!
- All of them!
- Always!

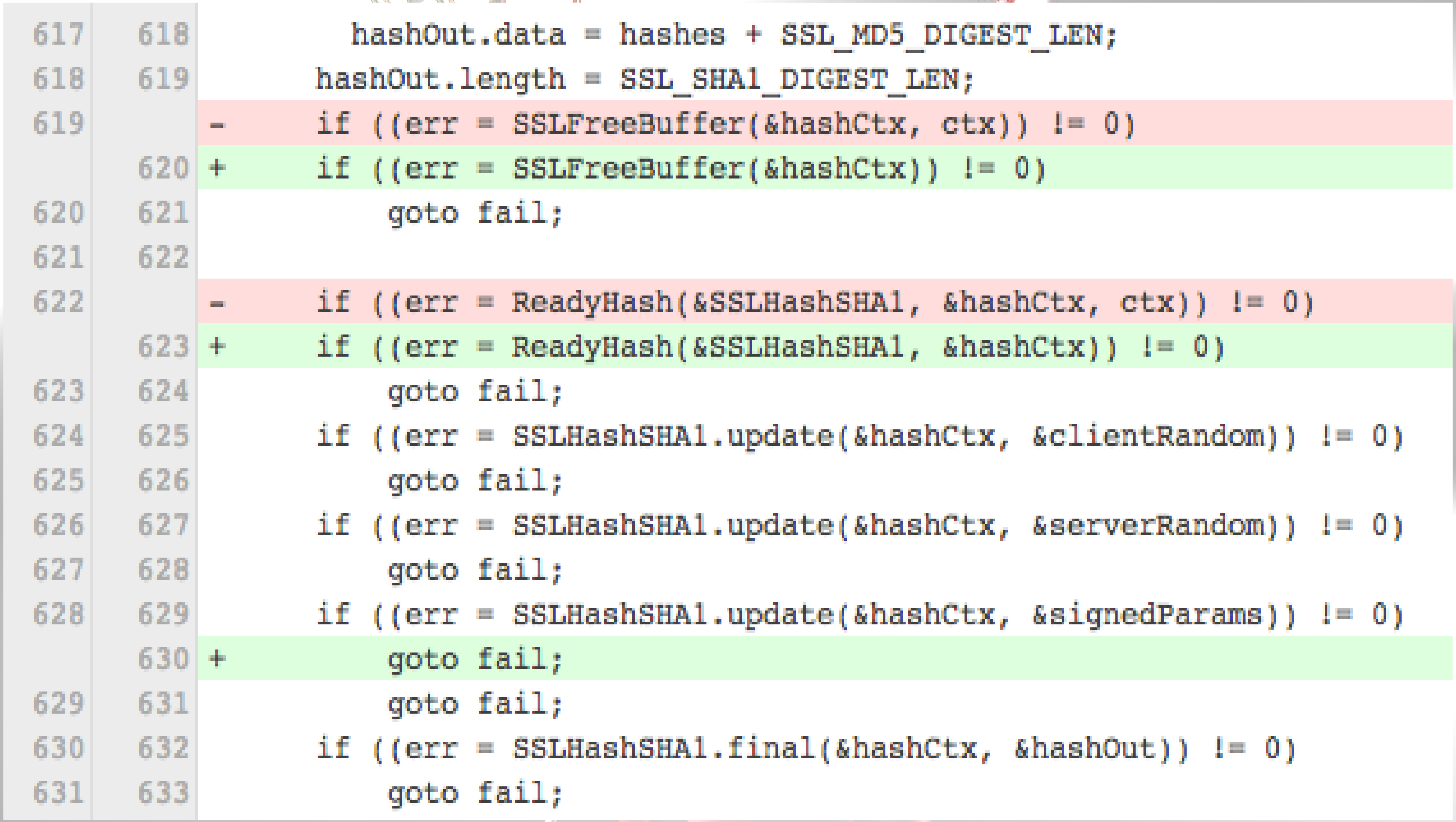
Apple's gotofail bug

- http://opensource.apple.com/source/Security/Security-55471/libsecurity_ssl/lib/sslKeyExchange.c



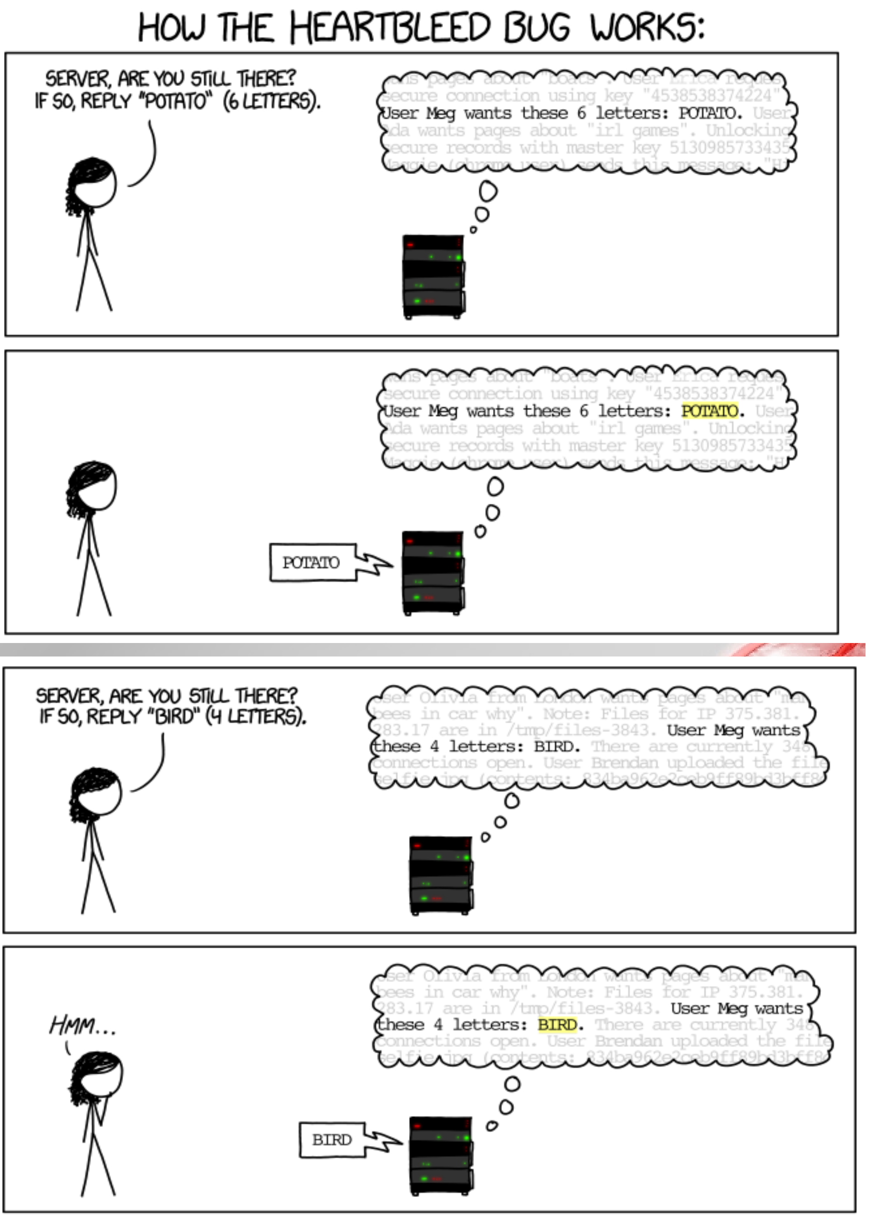
```
static OSStatus
SSLVerifySignedServerKeyExchange(SSLContext *ctx, bool isRsa, SSLBuffer signedParams,
                                 uint8_t *signature, UInt16 signatureLen)
{
        OSStatus        err;
        ...

        if ((err = SSLHashSHA1.update(&hashCtx, &serverRandom)) != 0)
                goto fail;
        if ((err = SSLHashSHA1.update(&hashCtx, &signedParams)) != 0)
                goto fail;
                goto fail;
        if ((err = SSLHashSHA1.final(&hashCtx, &hashOut)) != 0)
                goto fail;
        ...

fail:
        SSLFreeBuffer(&signedHashes);
        SSLFreeBuffer(&hashCtx);
        return err;
}
```

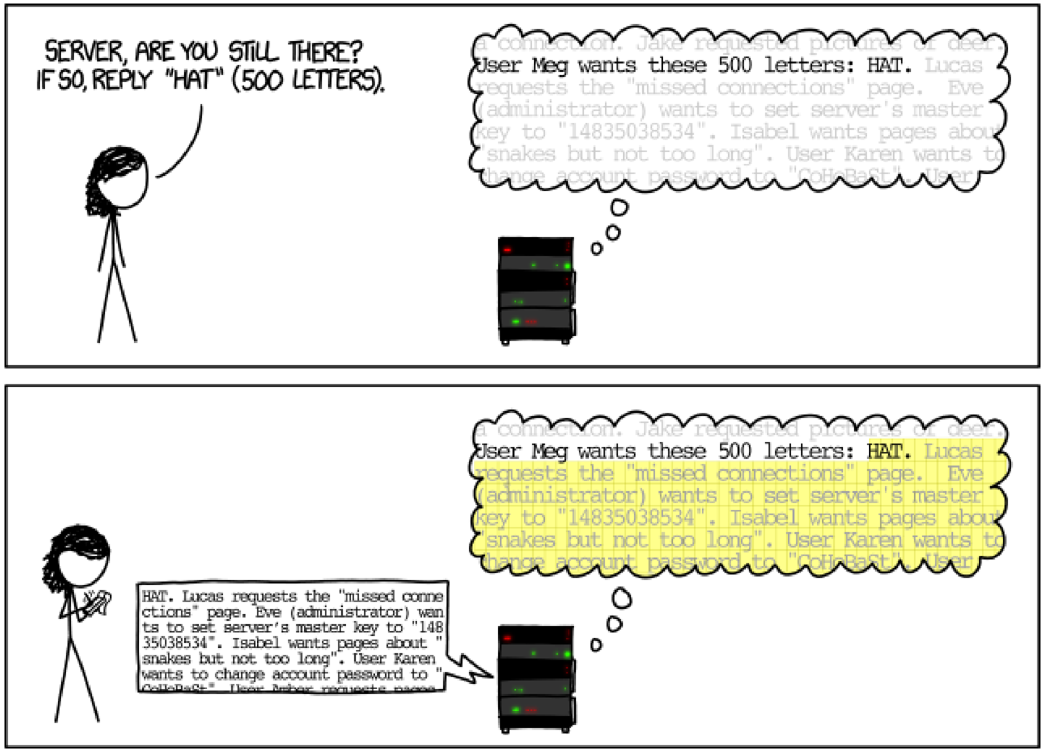
Apple's gotofail bug (2)



```diff
         hashOut.data = hashes + SSL_MD5_DIGEST_LEN;
       hashOut.length = SSL_SHA1_DIGEST_LEN;
-      if ((err = SSLFreeBuffer(&hashCtx, ctx)) != 0)
+      if ((err = SSLFreeBuffer(&hashCtx)) != 0)
           goto fail;

-      if ((err = ReadyHash(&SSLHashSHA1, &hashCtx, ctx)) != 0)
+      if ((err = ReadyHash(&SSLHashSHA1, &hashCtx)) != 0)
           goto fail;
       if ((err = SSLHashSHA1.update(&hashCtx, &clientRandom)) != 0)
           goto fail;
       if ((err = SSLHashSHA1.update(&hashCtx, &serverRandom)) != 0)
           goto fail;
       if ((err = SSLHashSHA1.update(&hashCtx, &signedParams)) != 0)
+          goto fail;
           goto fail;
       if ((err = SSLHashSHA1.final(&hashCtx, &hashOut)) != 0)
           goto fail;
```

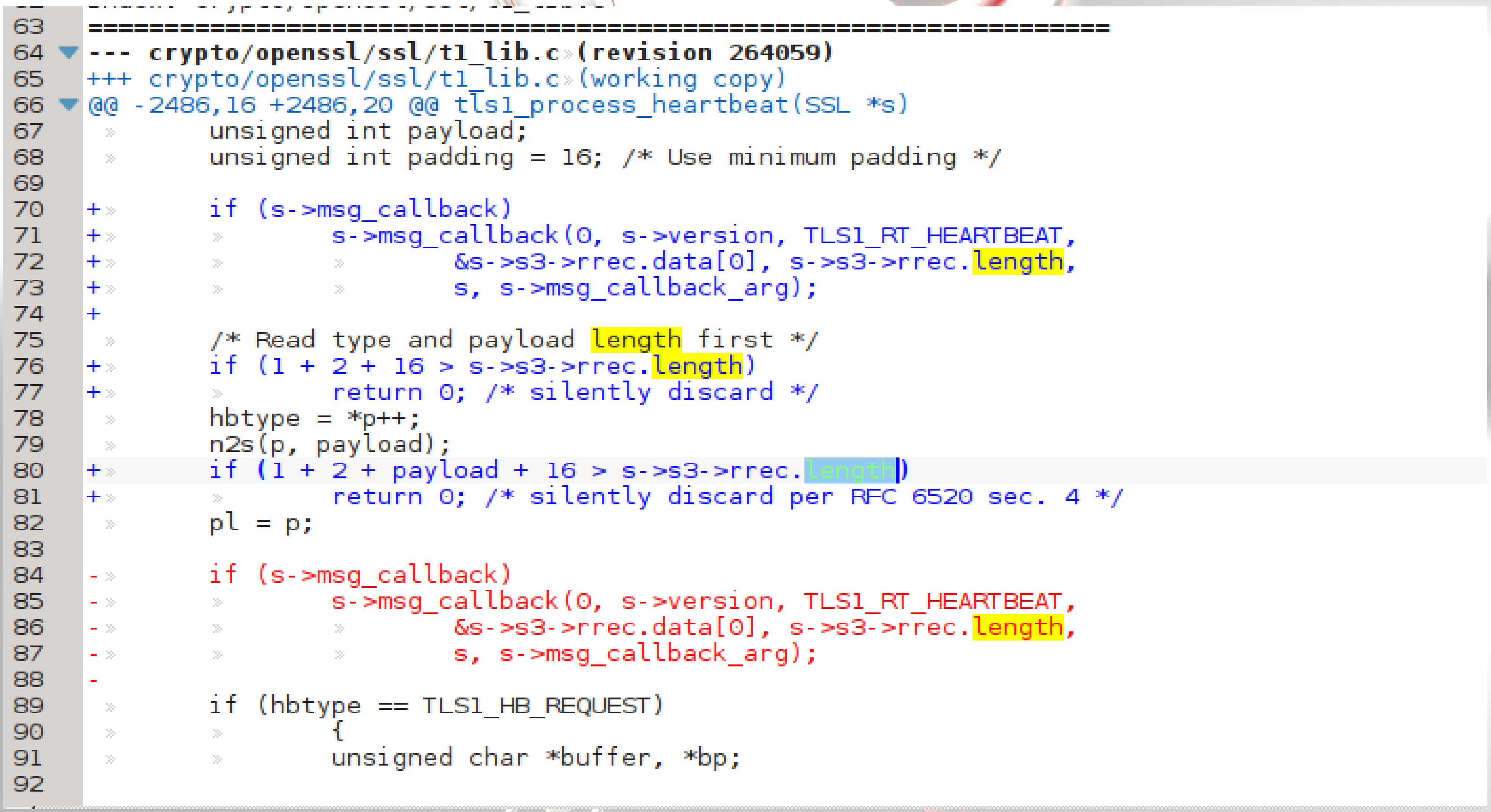
OpenSSL's heartbleed


HOW THE HEARTBLEED BUG WORKS:
SERVER, ARE YOU STILL THERE? IF SO, REPLY "POTATO" (6 LETTERS).
secure connection using key "4538538374224". User Meg wants these 6 letters: POTATO. User Ada wants pages about "irl games". Unlocking secure records with master key 5130985733435
POTATO
SERVER, ARE YOU STILL THERE? IF SO, REPLY "BIRD" (4 LETTERS).
bees in car why". Note: Files for IP 375.381.283.17 are in /tmp/files-3843. User Meg wants these 4 letters: BIRD. There are currently 346 connections open. User Brendan uploaded the file selfie.jpg (contents: 834ba962e2ceb9ff89bd3bff8
HMM...
BIRD


SERVER, ARE YOU STILL THERE? IF SO, REPLY "HAT" (500 LETTERS).
a connection. Jake requested pictures of deer. User Meg wants these 500 letters: HAT. Lucas requests the "missed connections" page. Eve (administrator) wants to set server's master key to "14835038534". Isabel wants pages about "snakes but not too long". User Karen wants to change account password to "CoHoBaSt". User
HAT. Lucas requests the "missed connections" page. Eve (administrator) wants to set server's master key to "14835038534". Isabel wants pages about "snakes but not too long". User Karen wants to change account password to "CoHoBaSt". User Amber requests pages

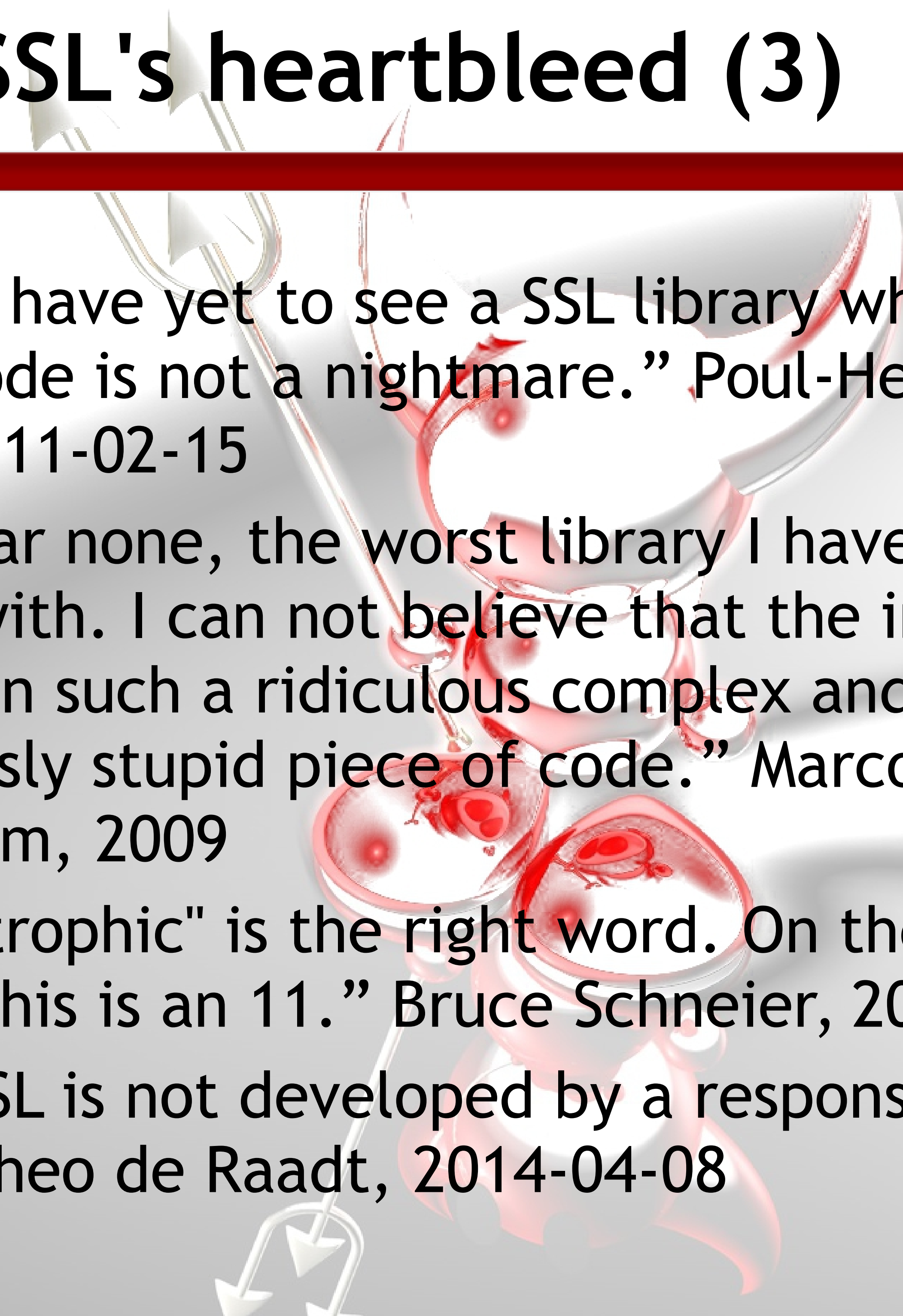
OpenSSL's heartbleed (2)

- http://git.openssl.org/gitweb/?p=openssl.git;a=commitdiff;h=4817504



```
===================================================================
--- crypto/openssl/ssl/t1_lib.c (revision 264059)
+++ crypto/openssl/ssl/t1_lib.c (working copy)
@@ -2486,16 +2486,20 @@ tls1_process_heartbeat(SSL *s)
        unsigned int payload;
        unsigned int padding = 16; /* Use minimum padding */

+       if (s->msg_callback)
+               s->msg_callback(0, s->version, TLS1_RT_HEARTBEAT,
+                       &s->s3->rrec.data[0], s->s3->rrec.length,
+                       s, s->msg_callback_arg);
+
        /* Read type and payload length first */
+       if (1 + 2 + 16 > s->s3->rrec.length)
+               return 0; /* silently discard */
        hbtype = *p++;
        n2s(p, payload);
+       if (1 + 2 + payload + 16 > s->s3->rrec.length)
+               return 0; /* silently discard per RFC 6520 sec. 4 */
        pl = p;

-       if (s->msg_callback)
-               s->msg_callback(0, s->version, TLS1_RT_HEARTBEAT,
-                       &s->s3->rrec.data[0], s->s3->rrec.length,
-                       s, s->msg_callback_arg);
-
        if (hbtype == TLS1_HB_REQUEST)
                {
                unsigned char *buffer, *bp;

```

OpenSSL's heartbleed (3)



- “First, I have yet to see a SSL library where the source code is not a nightmare.” Poul-Henning Kamp, 2011-02-15
- “It is, bar none, the worst library I have ever worked with. I can not believe that the internet is running on such a ridiculous complex and gratuitously stupid piece of code.” Marco Peereboom, 2009
- “"Catastrophic" is the right word. On the scale of 1 to 10, this is an 11.” Bruce Schneier, 2014-04-09
- “OpenSSL is not developed by a responsible team.” Theo de Raadt, 2014-04-08

OpenSSL's heartbleed (4)

- “I'm writing this on the third day after the "Heartbleed" bug in OpenSSL devasted internet security, and while I have been very critical of the OpenSSL source code since I first saw it, I have nothing but admiration for the OpenSSL crew and their effort.

  In particular considering what they're paid for it.

  …

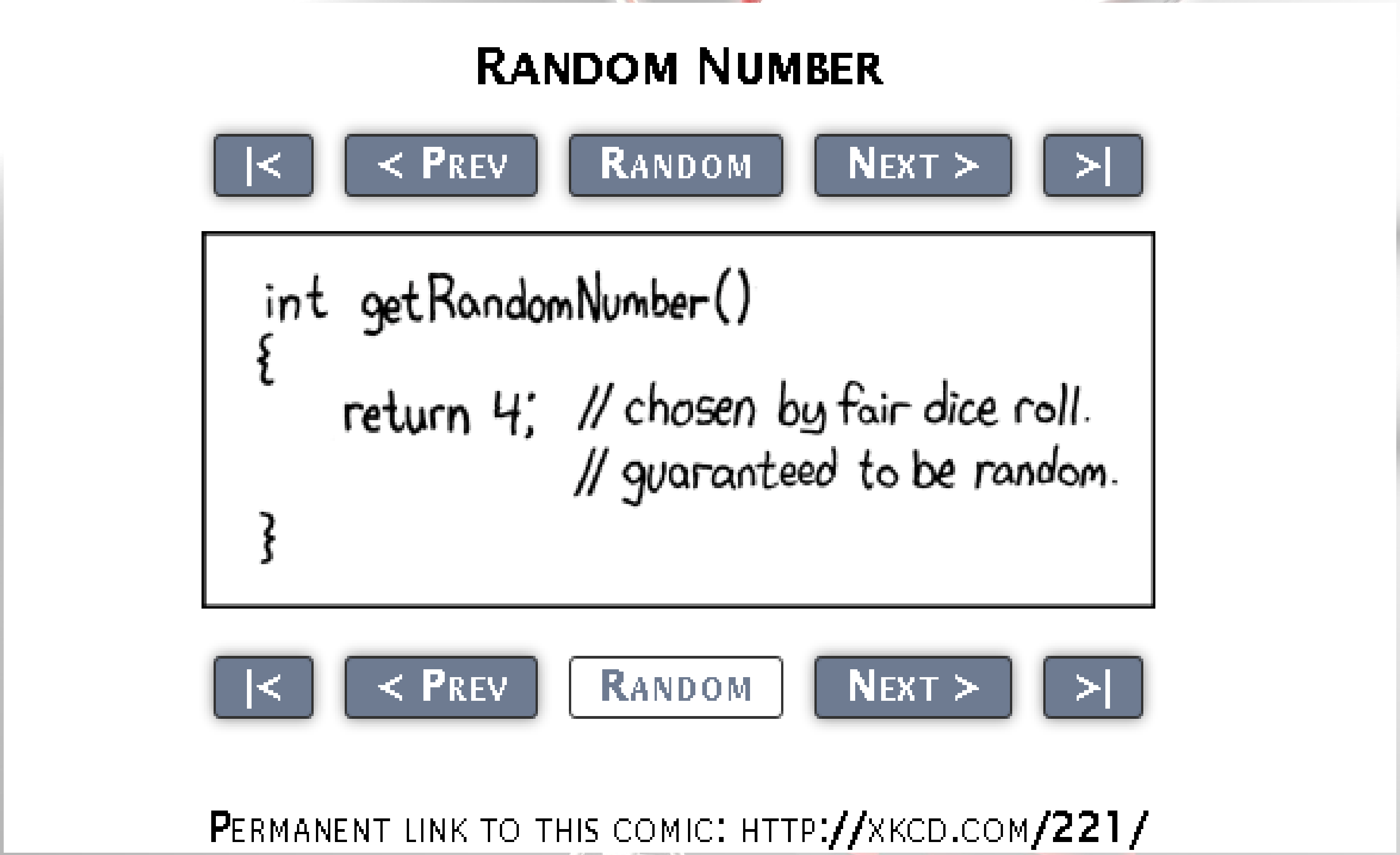
  But software is written by people, real people with kids, cars, mortgages, leaky roofs, sick pets, infirm parents and all other kinds of perfectly normal worries of an adult human being.” Poul-Henning Kamp, 2014-04-11

test! test! test!

- "Every time I think “this change is so simple, it doesn't need any tests,” it breaks in some horrible, unpredictable way. EVERY. TIME." Mislav Marohnić, 21-12-2013

Debian Random generator bug, 2008

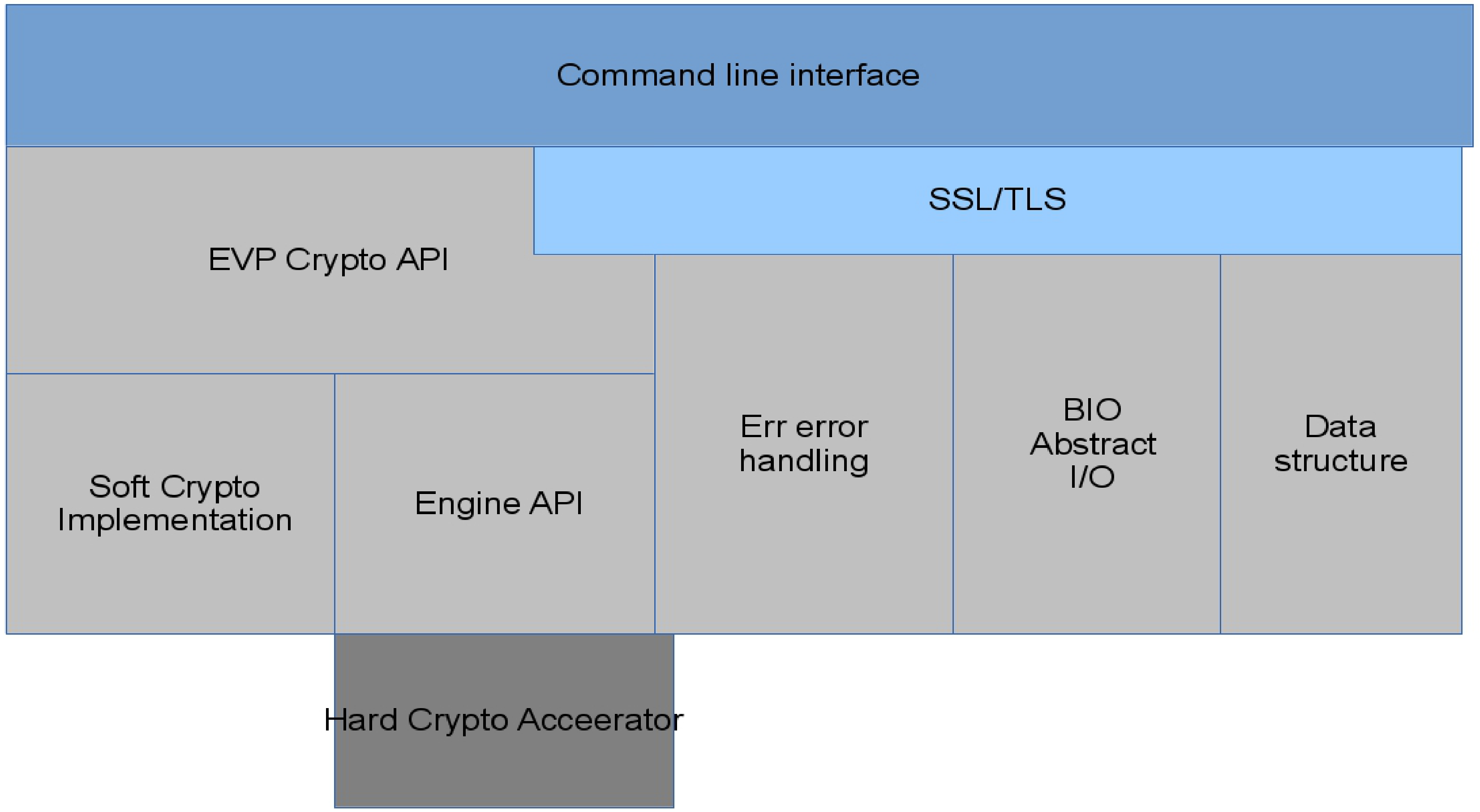
- Know what your code is doing


RANDOM NUMBER
|< < PREV RANDOM NEXT > >|

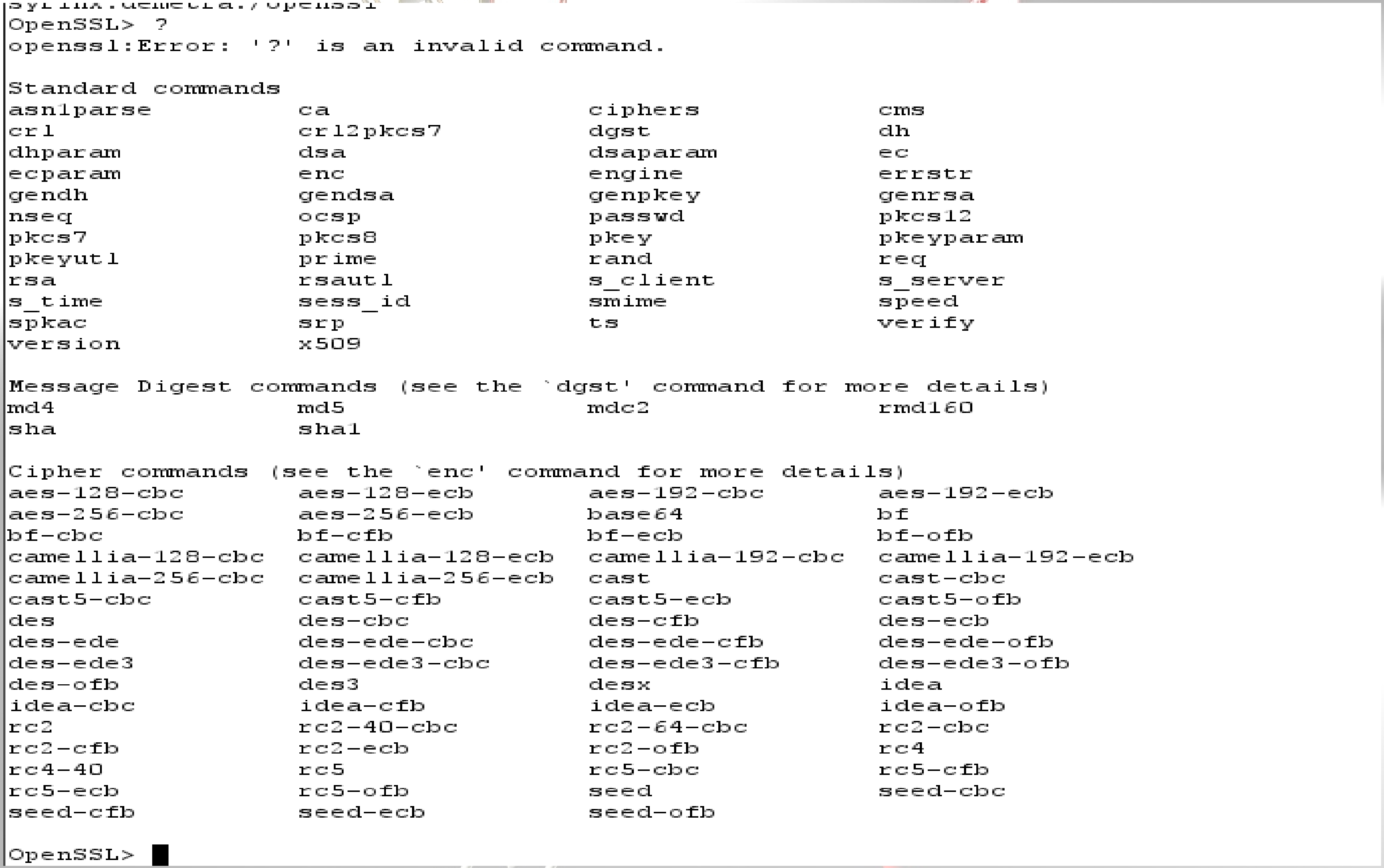
```
int getRandomNumber()
{
    return 4;  // chosen by fair dice roll.
               // guaranteed to be random.
}
```

|< < PREV RANDOM NEXT > >|
PERMANENT LINK TO THIS COMIC: HTTP://XKCD.COM/221/

OpenSSL architecture

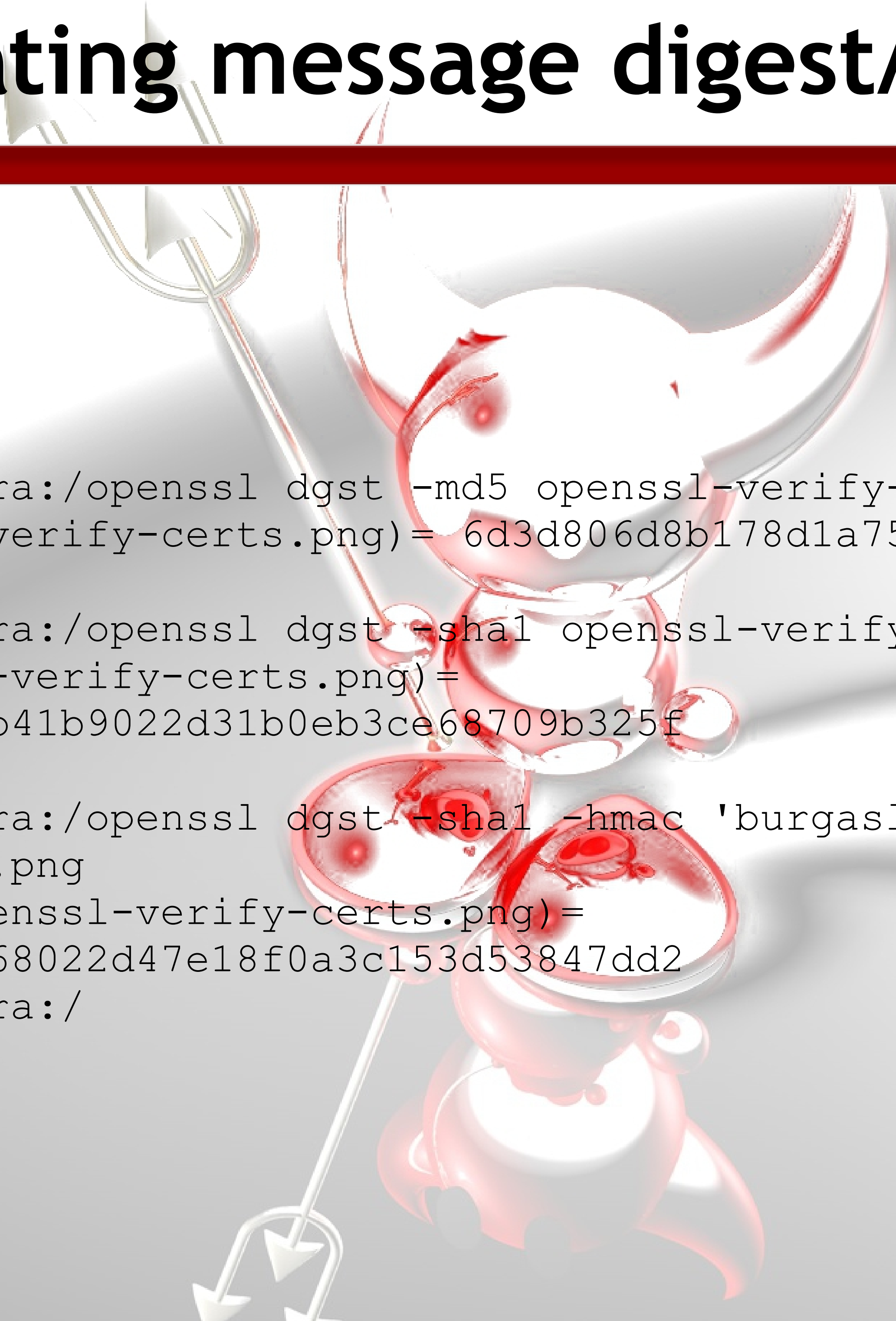


OpenSSL command-line interface



```
OpenSSL> ?
openssl:Error: '?' is an invalid command.

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

Message Digest commands (see the `dgst' command for more details)
md4               md5               mdc2              rmd160
sha               sha1

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       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

OpenSSL>
```

generating message digest/HMAC

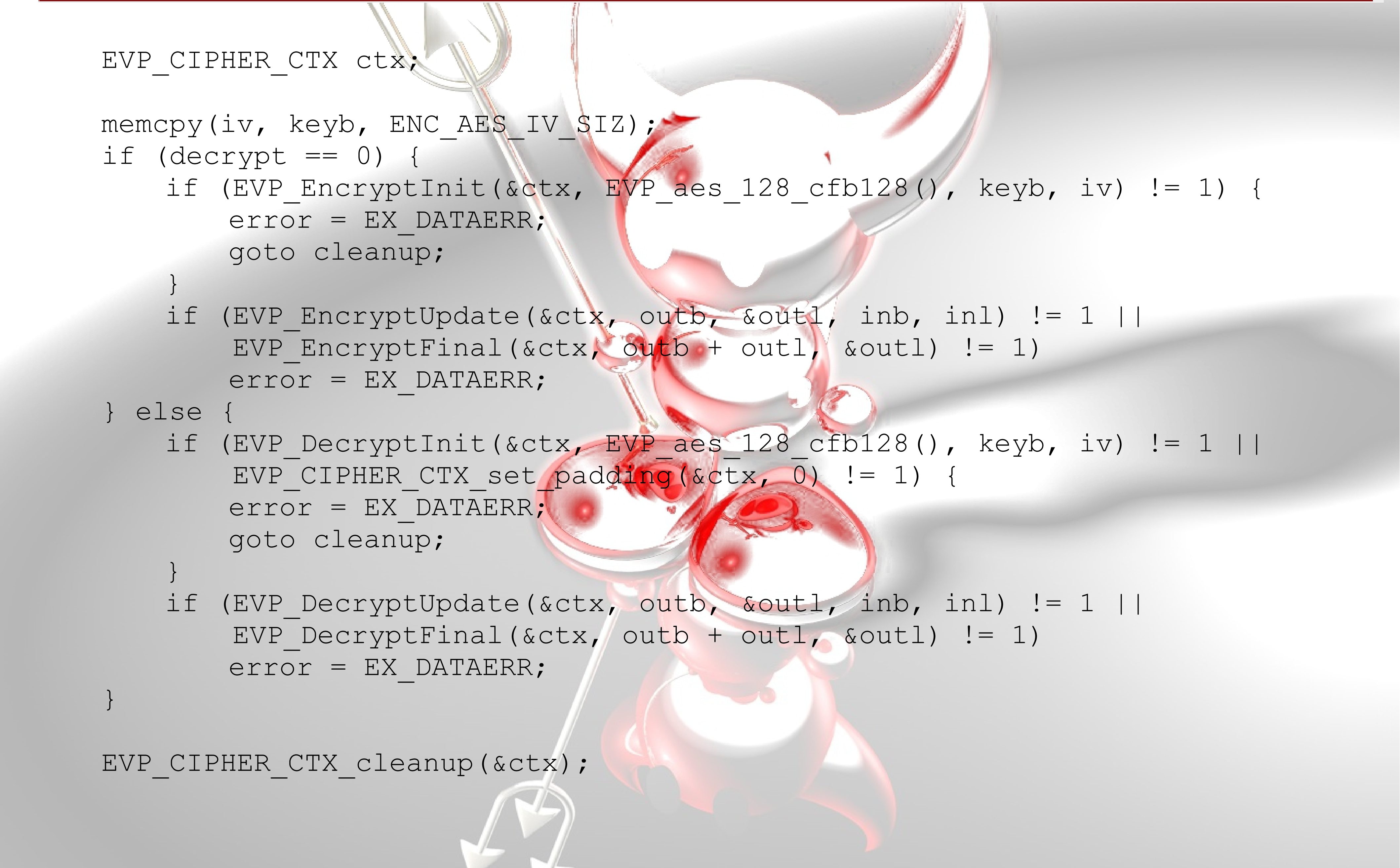


```
syrinx:demetra:/openssl dgst -md5 openssl-verify-certs.png
MD5(openssl-verify-certs.png)= 6d3d806d8b178d1a753ed6786fe51ffd

syrinx:demetra:/openssl dgst -sha1 openssl-verify-certs.png
SHA1(openssl-verify-certs.png)=
dbf8ff0ea8f6b41b9022d31b0eb3ce68709b325f

syrinx:demetra:/openssl dgst -sha1 -hmac 'burgaslab' openssl-
verify-certs.png
HMAC-SHA1(openssl-verify-certs.png)=
6eb5396d098a68022d47e18f0a3c153d53847dd2
syrinx:demetra:/
```

encryption/decryption

```
syrinx:demetra:/echo "This is plaintext!" > plaintext.txt

syrinx:demetra:/openssl enc -e -aes-256-cbc -in plaintext.txt -out plaintext.bin
enter aes-256-cbc encryption password:
Verifying - enter aes-256-cbc encryption password:

syrinx:demetra:/openssl enc -d -aes-256-cbc -in plaintext.bin -out plaintext2.txt
enter aes-256-cbc decryption password:
syrinx:demetra:/cat plaintext2.txt
This is plaintext!

syrinx:demetra:/openssl enc -d -aes-256-cbc -in plaintext.bin -out plaintext2.txt
enter aes-256-cbc decryption password:
bad decrypt
34379021208:error:06065064:digital envelope routines:EVP_DecryptFinal_ex:bad
decrypt:/usr/home/syrinx/freebsd-current-20131115-
01/head/secure/lib/libcrypto/../../../crypto/openssl/crypto/evp/evp_enc.c:546:
syrinx:demetra:/

syrinx:demetra:/openssl base64 -e -aes-256-cbc -in plaintext.bin -out plaintext.asc
enter aes-256-cbc encryption password:
Verifying - enter aes-256-cbc encryption password:
syrinx:demetra:/cat plaintext.asc
U2FsdGVkX1/Eg+RX++d7VhWEAI8HgyP7WpR341iOnxadwVlSzsvzy4ef2XKydpzU
8SWpieTUOLE7TKJiI3N8ICzlqlh+H6pgK/95KsDPUkU=
```

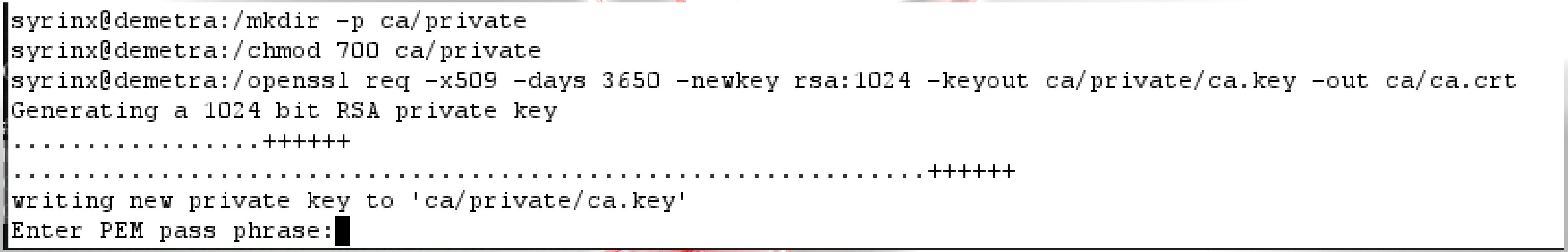
OpenSSL programming - encrypt/decrypt



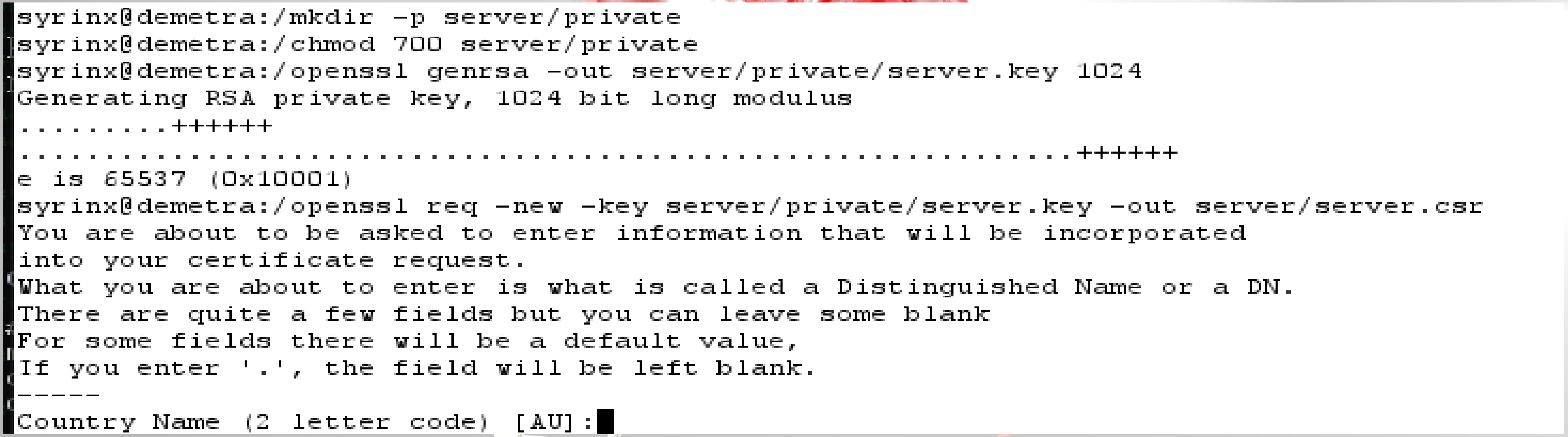
```
EVP_CIPHER_CTX ctx;

memcpy(iv, keyb, ENC_AES_IV_SIZ);
if (decrypt == 0) {
    if (EVP_EncryptInit(&ctx, EVP_aes_128_cfb128(), keyb, iv) != 1) {
        error = EX_DATAERR;
        goto cleanup;
    }
    if (EVP_EncryptUpdate(&ctx, outb, &outl, inb, inl) != 1 ||
        EVP_EncryptFinal(&ctx, outb + outl, &outl) != 1)
        error = EX_DATAERR;
} else {
    if (EVP_DecryptInit(&ctx, EVP_aes_128_cfb128(), keyb, iv) != 1 ||
        EVP_CIPHER_CTX_set_padding(&ctx, 0) != 1) {
        error = EX_DATAERR;
        goto cleanup;
    }
    if (EVP_DecryptUpdate(&ctx, outb, &outl, inb, inl) != 1 ||
        EVP_DecryptFinal(&ctx, outb + outl, &outl) != 1)
        error = EX_DATAERR;
}

EVP_CIPHER_CTX_cleanup(&ctx);
```

OpenSSL programming - create keys

- create CA cert, server &client certificate request/keys, sign csr

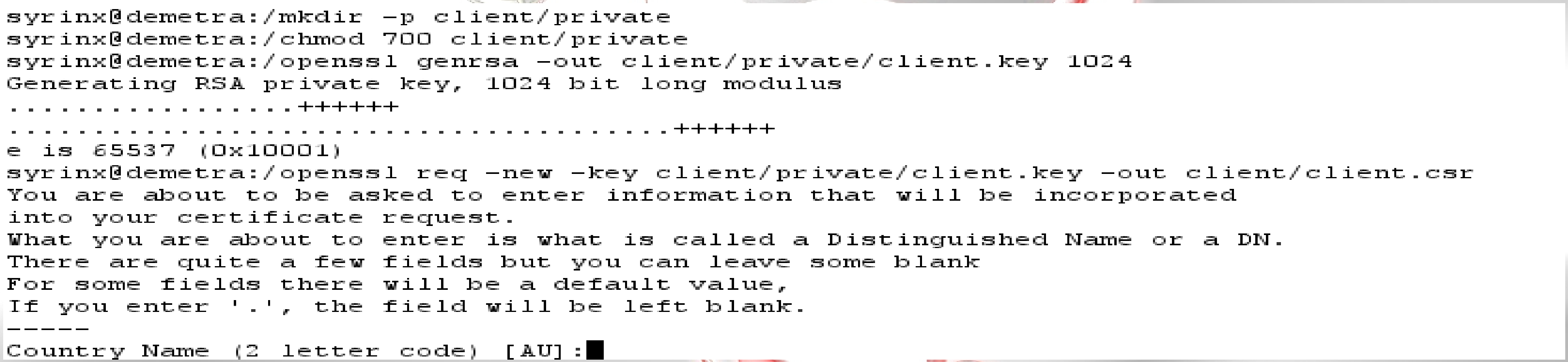


```
syrinx@demetra:/mkdir -p ca/private
syrinx@demetra:/chmod 700 ca/private
syrinx@demetra:/openssl req -x509 -days 3650 -newkey rsa:1024 -keyout ca/private/ca.key -out ca/ca.crt
Generating a 1024 bit RSA private key
.................++++++
.............................................................++++++
writing new private key to 'ca/private/ca.key'
Enter PEM pass phrase:
```

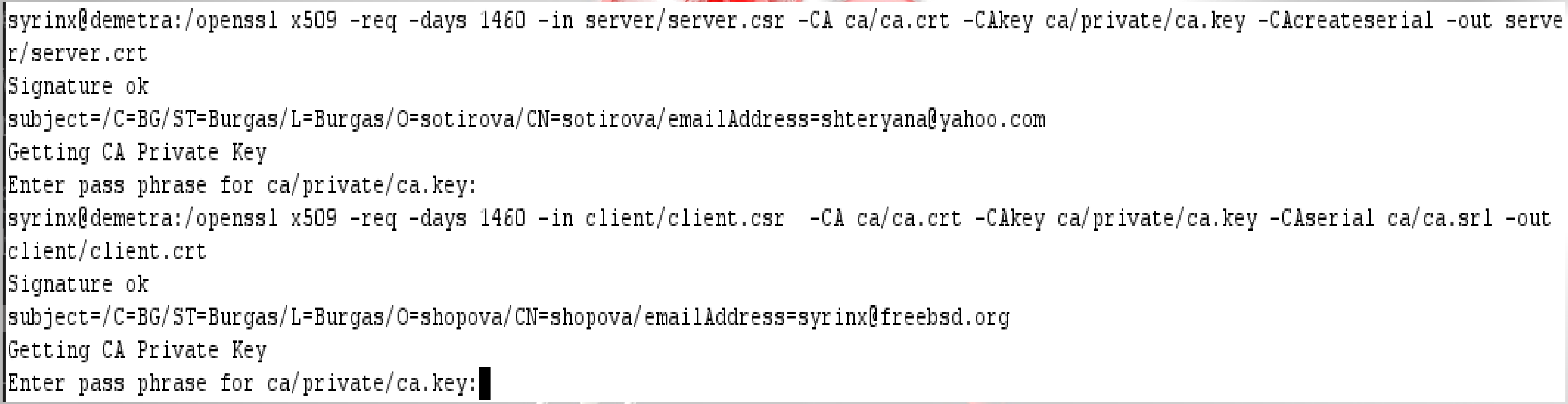


```
syrinx@demetra:/mkdir -p server/private
syrinx@demetra:/chmod 700 server/private
syrinx@demetra:/openssl genrsa -out server/private/server.key 1024
Generating RSA private key, 1024 bit long modulus
.........++++++
..............................................................++++++
e is 65537 (0x10001)
syrinx@demetra:/openssl req -new -key server/private/server.key -out server/server.csr
You are about to be asked to enter information that will be incorporated
into your certificate request.
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]:
```

OpenSSL - create keys(2)

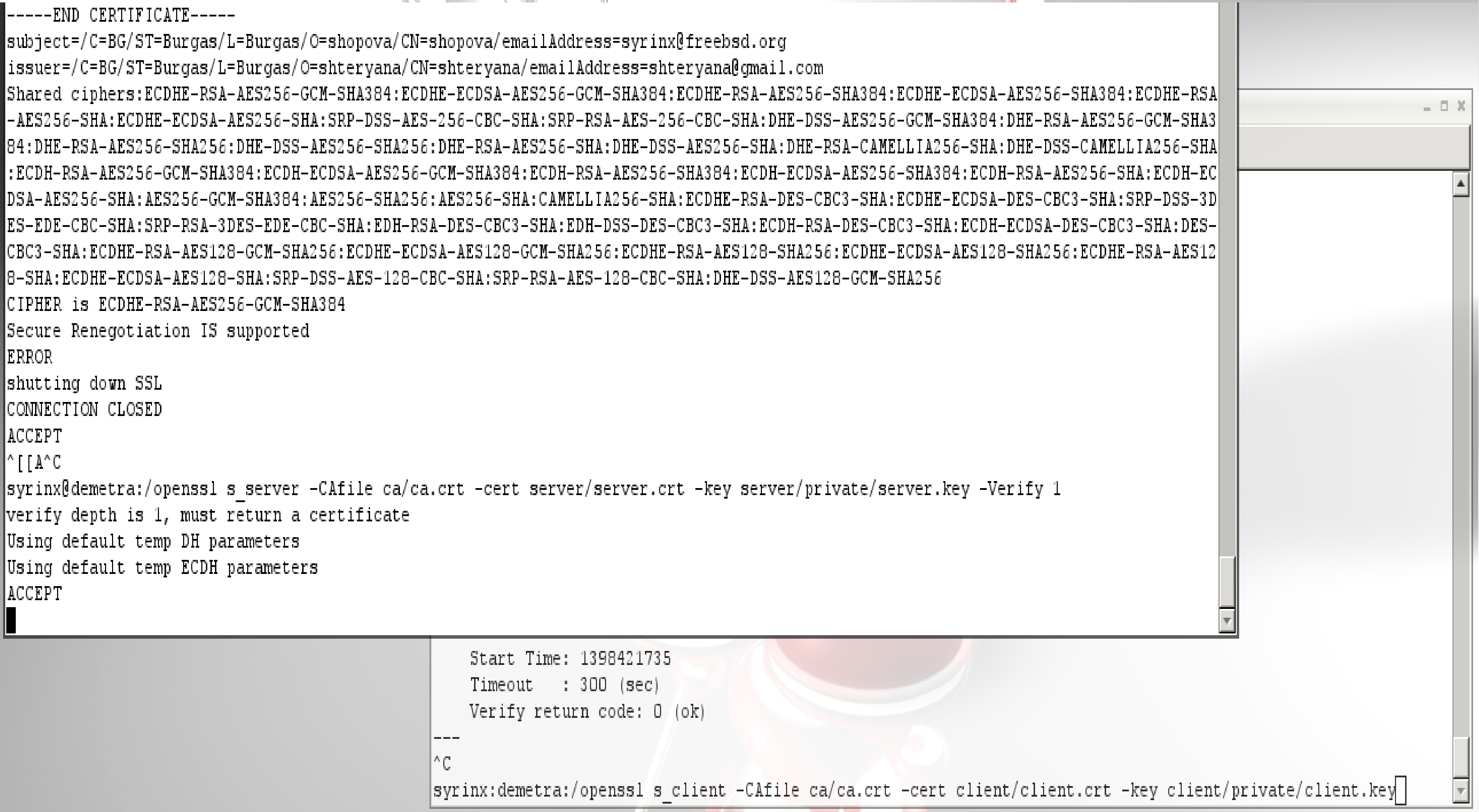


```
syrinx@demetra:/mkdir -p client/private
syrinx@demetra:/chmod 700 client/private
syrinx@demetra:/openssl genrsa -out client/private/client.key 1024
Generating RSA private key, 1024 bit long modulus
...................++++++
.........................................++++++
e is 65537 (0x10001)
syrinx@demetra:/openssl req -new -key client/private/client.key -out client/client.csr
You are about to be asked to enter information that will be incorporated
into your certificate request.
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]:
```



```
syrinx@demetra:/openssl x509 -req -days 1460 -in server/server.csr -CA ca/ca.crt -CAkey ca/private/ca.key -CAcreateserial -out serve
r/server.crt
Signature ok
subject=/C=BG/ST=Burgas/L=Burgas/O=sotirova/CN=sotirova/emailAddress=shteryana@yahoo.com
Getting CA Private Key
Enter pass phrase for ca/private/ca.key:
syrinx@demetra:/openssl x509 -req -days 1460 -in client/client.csr  -CA ca/ca.crt -CAkey ca/private/ca.key -CAserial ca/ca.srl -out
client/client.crt
Signature ok
subject=/C=BG/ST=Burgas/L=Burgas/O=shopova/CN=shopova/emailAddress=syrinx@freebsd.org
Getting CA Private Key
Enter pass phrase for ca/private/ca.key:
```

OpenSSL – test certificates

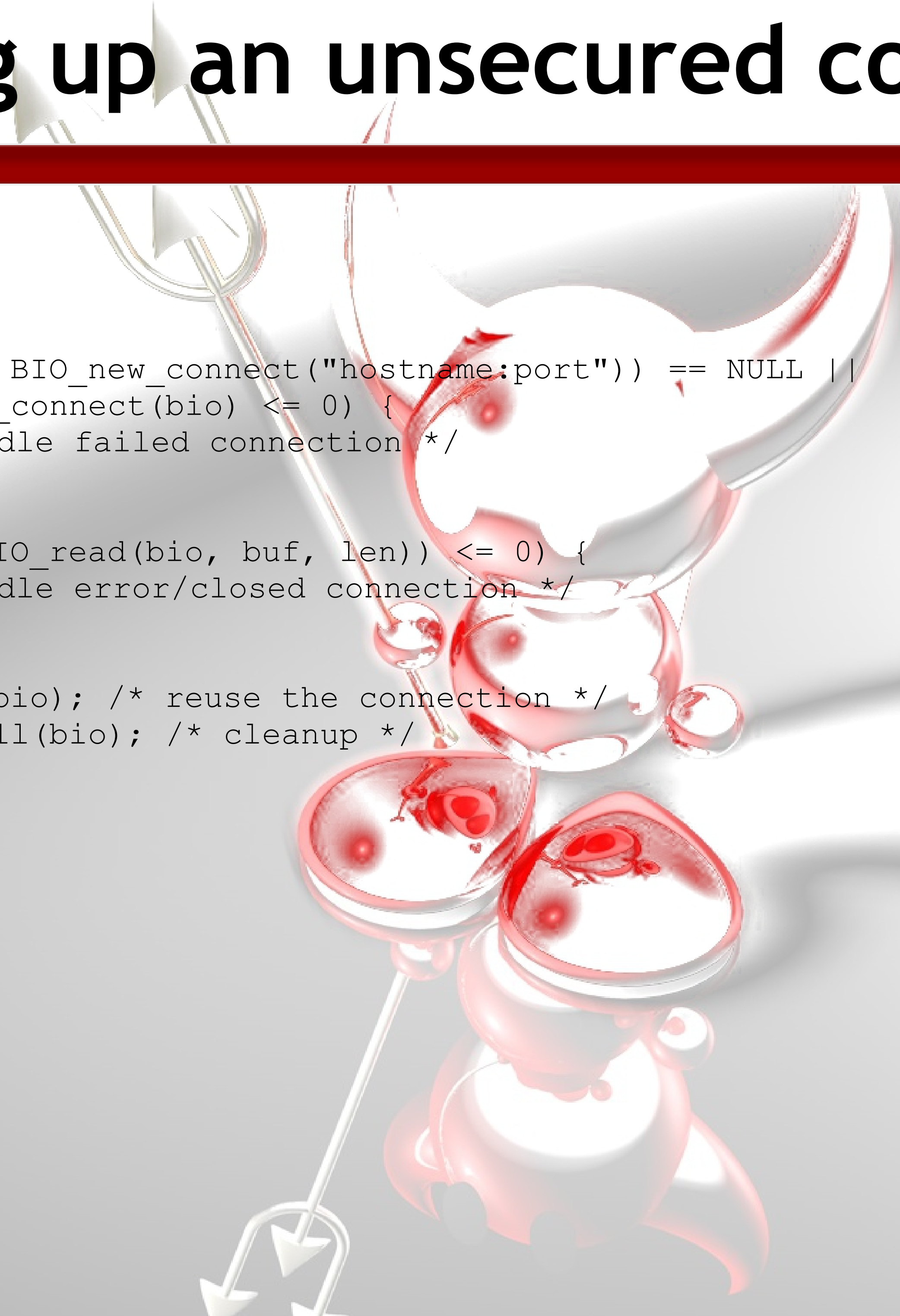


```
-----END CERTIFICATE-----
subject=/C=BG/ST=Burgas/L=Burgas/O=shopova/CN=shopova/emailAddress=syrinx@freebsd.org
issuer=/C=BG/ST=Burgas/L=Burgas/O=shteryana/CN=shteryana/emailAddress=shteryana@gmail.com
Shared ciphers:ECDHE-RSA-AES256-GCM-SHA384:ECDHE-ECDSA-AES256-GCM-SHA384:ECDHE-RSA-AES256-SHA384:ECDHE-ECDSA-AES256-SHA384:ECDHE-RSA
-AES256-SHA:ECDHE-ECDSA-AES256-SHA:SRP-DSS-AES-256-CBC-SHA:SRP-RSA-AES-256-CBC-SHA:DHE-DSS-AES256-GCM-SHA384:DHE-RSA-AES256-GCM-SHA3
84:DHE-RSA-AES256-SHA256:DHE-DSS-AES256-SHA256:DHE-RSA-AES256-SHA:DHE-DSS-AES256-SHA:DHE-RSA-CAMELLIA256-SHA:DHE-DSS-CAMELLIA256-SHA
:ECDH-RSA-AES256-GCM-SHA384:ECDH-ECDSA-AES256-GCM-SHA384:ECDH-RSA-AES256-SHA384:ECDH-ECDSA-AES256-SHA384:ECDH-RSA-AES256-SHA:ECDH-EC
DSA-AES256-SHA:AES256-GCM-SHA384:AES256-SHA256:AES256-SHA:CAMELLIA256-SHA:ECDHE-RSA-DES-CBC3-SHA:ECDHE-ECDSA-DES-CBC3-SHA:SRP-DSS-3D
ES-EDE-CBC-SHA:SRP-RSA-3DES-EDE-CBC-SHA:EDH-RSA-DES-CBC3-SHA:EDH-DSS-DES-CBC3-SHA:ECDH-RSA-DES-CBC3-SHA:ECDH-ECDSA-DES-CBC3-SHA:DES-
CBC3-SHA:ECDHE-RSA-AES128-GCM-SHA256:ECDHE-ECDSA-AES128-GCM-SHA256:ECDHE-RSA-AES128-SHA256:ECDHE-ECDSA-AES128-SHA256:ECDHE-RSA-AES12
8-SHA:ECDHE-ECDSA-AES128-SHA:SRP-DSS-AES-128-CBC-SHA:SRP-RSA-AES-128-CBC-SHA:DHE-DSS-AES128-GCM-SHA256
CIPHER is ECDHE-RSA-AES256-GCM-SHA384
Secure Renegotiation IS supported
ERROR
shutting down SSL
CONNECTION CLOSED
ACCEPT
^[[A^C
syrinx@demetra:/openssl s_server -CAfile ca/ca.crt -cert server/server.crt -key server/private/server.key -Verify 1
verify depth is 1, must return a certificate
Using default temp DH parameters
Using default temp ECDH parameters
ACCEPT
```

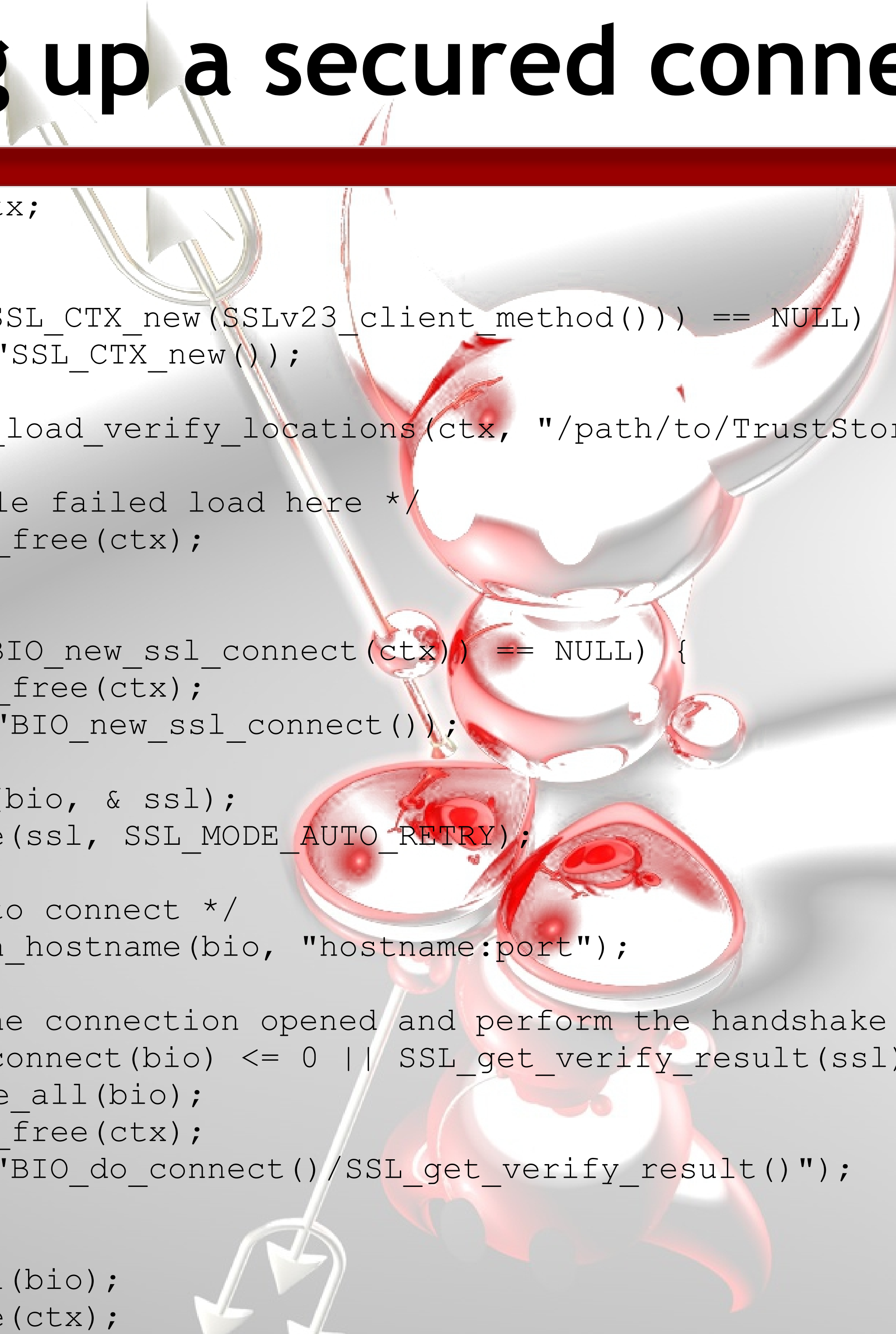
```
    Start Time: 1398421735
    Timeout   : 300 (sec)
    Verify return code: 0 (ok)
---
^C
syrinx:demetra:/openssl s_client -CAfile ca/ca.crt -cert client/client.crt -key client/private/client.key
```

setting up an unsecured connection

```
BIO * bio;
int x;

if ((bio = BIO_new_connect("hostname:port")) == NULL ||
    BIO_do_connect(bio) <= 0) {
     /* Handle failed connection */
}

if ((x = BIO_read(bio, buf, len)) <= 0) {
     /* Handle error/closed connection */
}

BIO_reset(bio); /* reuse the connection */
BIO_free_all(bio); /* cleanup */
```

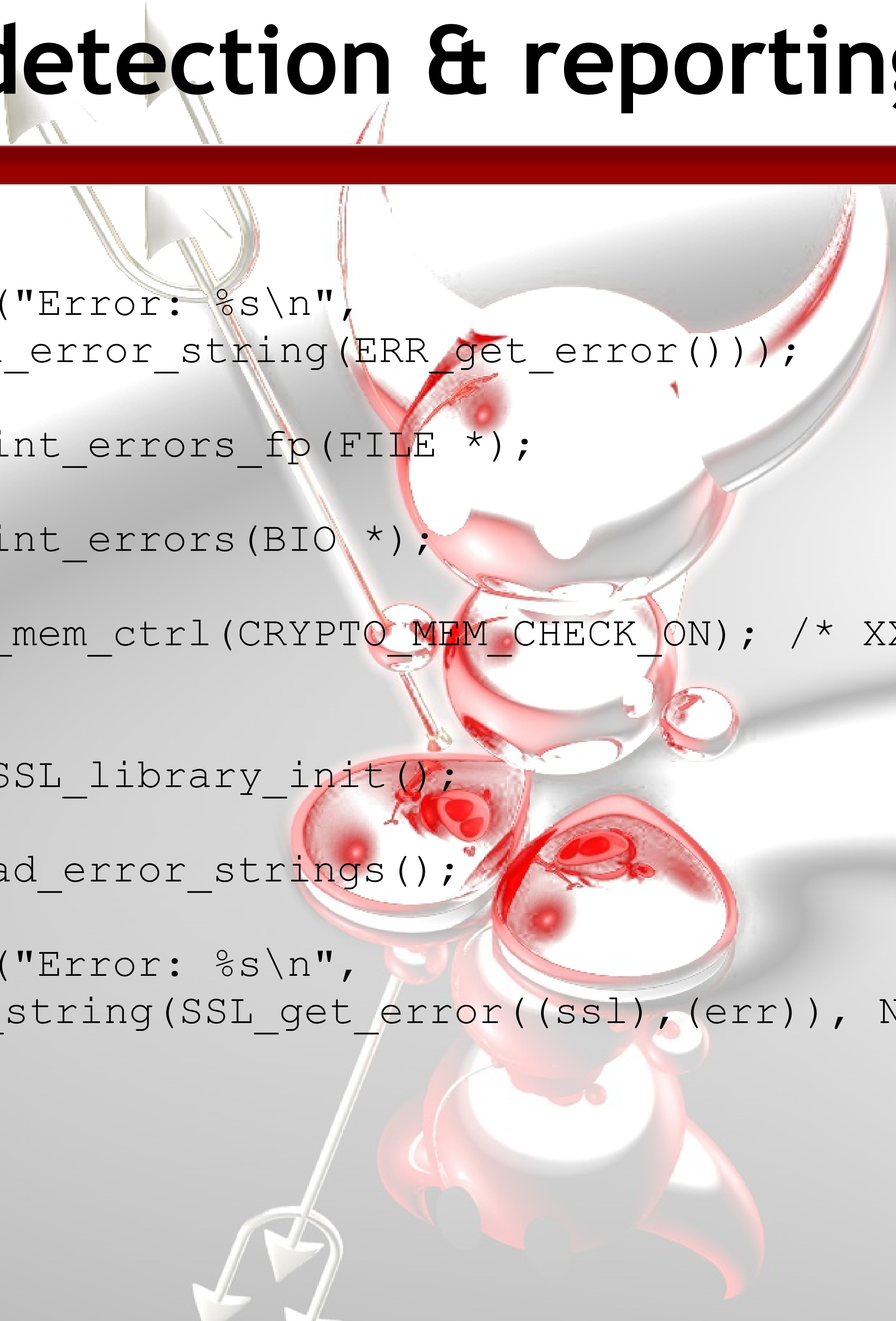


setting up a secured connection



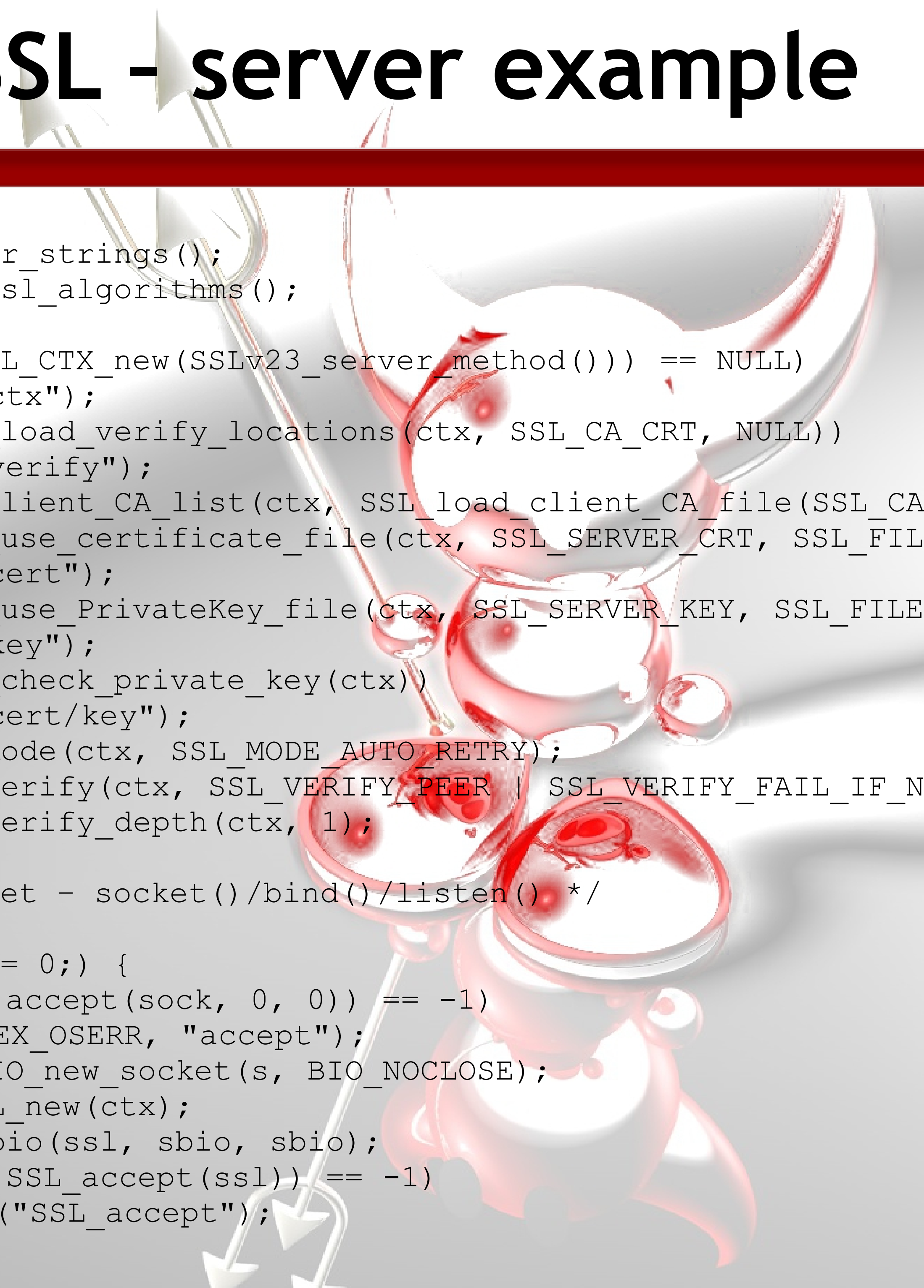
```
    SSL_CTX * ctx;
    SSL * ssl;

    if ((ssl = SSL_CTX_new(SSLv23_client_method())) == NULL)
        err(1, "SSL_CTX_new());

    if (SSL_CTX_load_verify_locations(ctx, "/path/to/TrustStore.pem", NULL) !=
0) {
        /* Handle failed load here */
        SSL_CTX_free(ctx);
    }

    if ((bio = BIO_new_ssl_connect(ctx)) == NULL) {
        SSL_CTX_free(ctx);
        err(1, "BIO_new_ssl_connect());
    }
    BIO_get_ssl(bio, & ssl);
    SSL_set_mode(ssl, SSL_MODE_AUTO_RETRY);

    /* Attempt to connect */
    BIO_set_conn_hostname(bio, "hostname:port");

    /* Verify the connection opened and perform the handshake */
    if (BIO_do_connect(bio) <= 0 || SSL_get_verify_result(ssl) != X509_V_OK) {
        BIO_free_all(bio);
        SSL_CTX_free(ctx);
        err(1, "BIO_do_connect()/SSL_get_verify_result()");
    }

    BIO_free_all(bio);
    SSL_CTX_free(ctx);
```

error detection & reporting



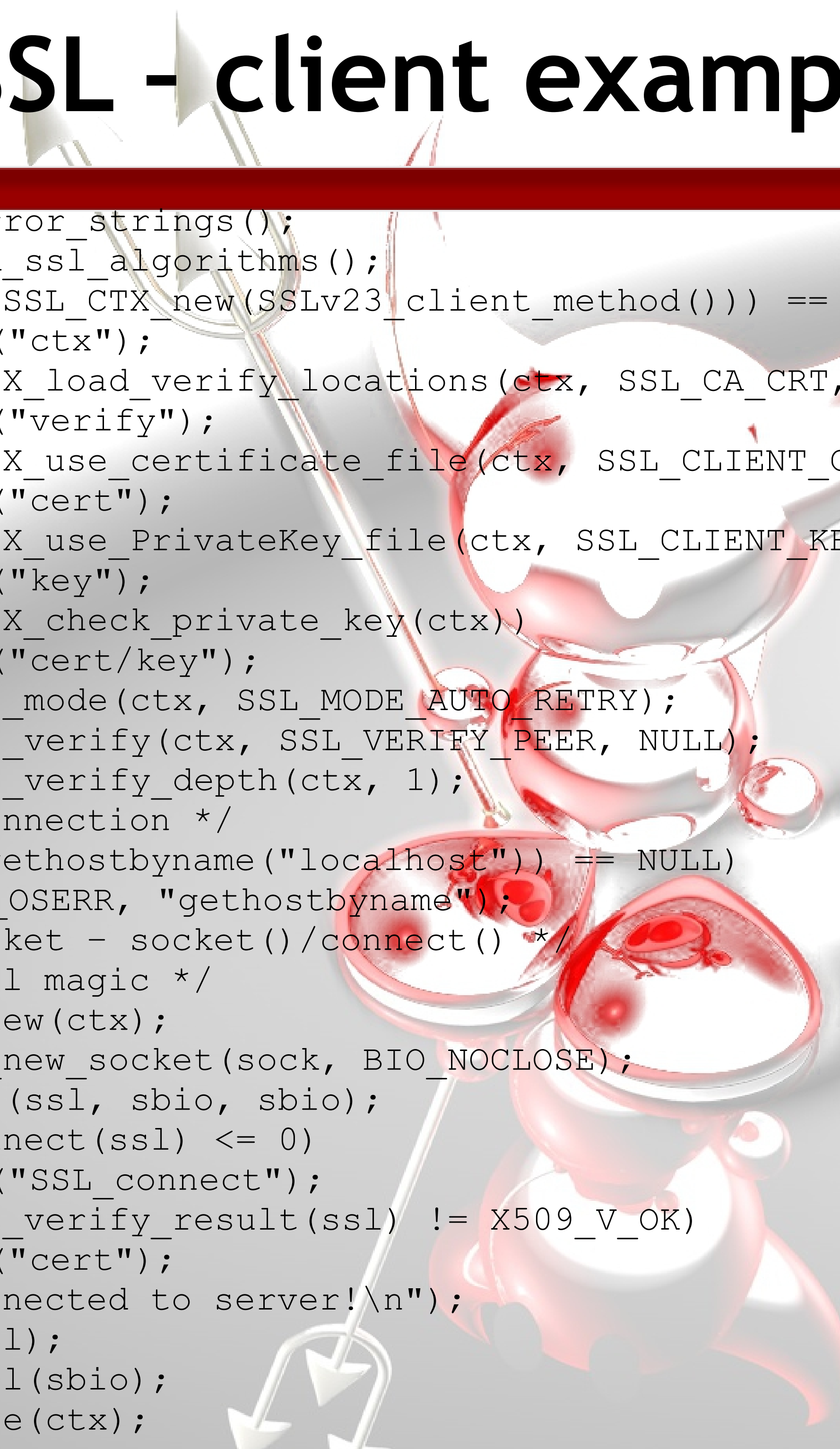
```
    printf("Error: %s\n",
ERR_reason_error_string(ERR_get_error()));

    ERR_print_errors_fp(FILE *);

    ERR_print_errors(BIO *);

    CRYPTO_mem_ctrl(CRYPTO_MEM_CHECK_ON); /* XXX: really
needed? */

    (void)SSL_library_init();

    SSL_load_error_strings();

    printf("Error: %s\n",
ERR_error_string(SSL_get_error((ssl),(err)), NULL);
```

OpenSSL - server example



```
SSL_load_error_strings();
OpenSSL_add_ssl_algorithms();

if ((ctx = SSL_CTX_new(SSLv23_server_method())) == NULL)
    fatalx("ctx");
if (!SSL_CTX_load_verify_locations(ctx, SSL_CA_CRT, NULL))
    fatalx("verify");
SSL_CTX_set_client_CA_list(ctx, SSL_load_client_CA_file(SSL_CA_CRT));
if (!SSL_CTX_use_certificate_file(ctx, SSL_SERVER_CRT, SSL_FILETYPE_PEM))
    fatalx("cert");
if (!SSL_CTX_use_PrivateKey_file(ctx, SSL_SERVER_KEY, SSL_FILETYPE_PEM))
    fatalx("key");
if (!SSL_CTX_check_private_key(ctx))
    fatalx("cert/key");
SSL_CTX_set_mode(ctx, SSL_MODE_AUTO_RETRY);
SSL_CTX_set_verify(ctx, SSL_VERIFY_PEER | SSL_VERIFY_FAIL_IF_NO_PEER_CERT, NULL);
SSL_CTX_set_verify_depth(ctx, 1);

/* setup socket - socket()/bind()/listen() */

for (; work != 0;) {
    if ((s = accept(sock, 0, 0)) == -1)
        err(EX_OSERR, "accept");
    sbio = BIO_new_socket(s, BIO_NOCLOSE);
    ssl = SSL_new(ctx);
    SSL_set_bio(ssl, sbio, sbio);
    if ((r = SSL_accept(ssl)) == -1)
        warn("SSL_accept");
}
```

OpenSSL - client example



```
SSL_load_error_strings();
OpenSSL_add_ssl_algorithms();
if ((ctx = SSL_CTX_new(SSLv23_client_method())) == NULL)
     fatalx("ctx");
if (!SSL_CTX_load_verify_locations(ctx, SSL_CA_CRT, NULL))
     fatalx("verify");
if (!SSL_CTX_use_certificate_file(ctx, SSL_CLIENT_CRT, SSL_FILETYPE_PEM))
     fatalx("cert");
if (!SSL_CTX_use_PrivateKey_file(ctx, SSL_CLIENT_KEY, SSL_FILETYPE_PEM))
     fatalx("key");
if (!SSL_CTX_check_private_key(ctx))
     fatalx("cert/key");
SSL_CTX_set_mode(ctx, SSL_MODE_AUTO_RETRY);
SSL_CTX_set_verify(ctx, SSL_VERIFY_PEER, NULL);
SSL_CTX_set_verify_depth(ctx, 1);
/* setup connection */
if ((hp = gethostbyname("localhost")) == NULL)
     err(EX_OSERR, "gethostbyname");
/* init socket - socket()/connect() */
/* go do ssl magic */
ssl = SSL_new(ctx);
sbio = BIO_new_socket(sock, BIO_NOCLOSE);
SSL_set_bio(ssl, sbio, sbio);
if (SSL_connect(ssl) <= 0)
     fatalx("SSL_connect");
if (SSL_get_verify_result(ssl) != X509_V_OK)
     fatalx("cert");
printf("connected to server!\n");
SSL_free(ssl);
BIO_free_all(sbio);
SSL_CTX_free(ctx);
```

compiling and running the code

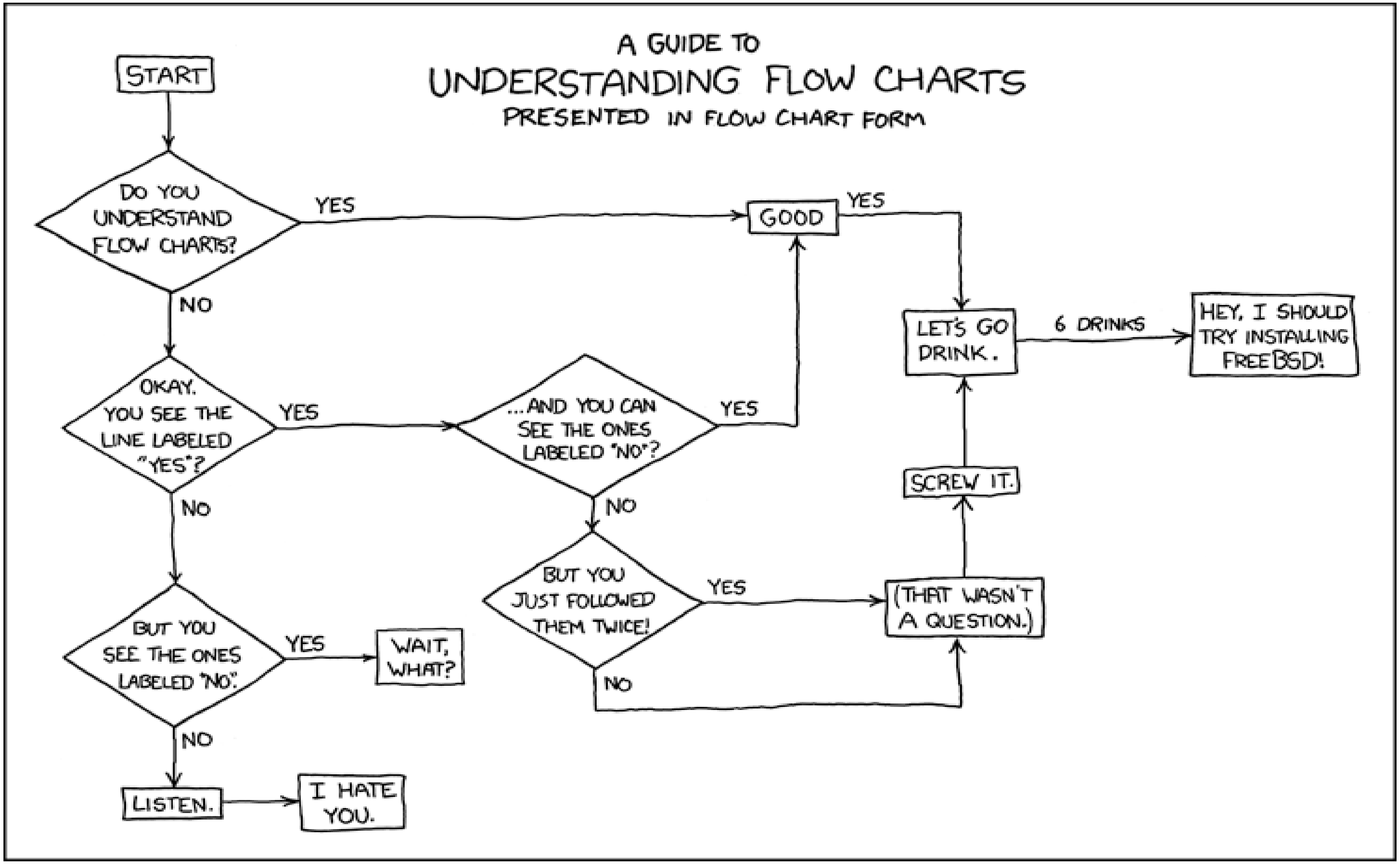
- http://people.freebsd.org/~syrinx/presentations/openssl/
- download, untar & make
- needs libbsd for Linux/Ubuntu

references

https://www.openssl.org/
http://www.libressl.org/
http://www.ietf.org/rfc/rfc2246.txt
http://www.ietf.org/rfc/rfc3546.txt
http://tools.ietf.org/html/rfc6347
http://tools.ietf.org/html/rfc6083
https://tools.ietf.org/html/rfc6520
http://www.open-std.org/jtc1/sc22/wg14/www/docs/n1255.pdf
http://cacr.uwaterloo.ca/hac/
https://www.peereboom.us/assl/assl/html/openssl.html
https://www.owasp.org/index.php/Guide_to_Cryptography
https://www.cs.utexas.edu/~shmat/shmat_oak14.pdf
https://www.ssllabs.com/
https://www.howsmyssl.com/
https://we.riseup.net/riseuplabs+paow/openpgp-best-practices#openpgp-key-checks
http://www.secureconsulting.net/2008/03/the_key_management_lifecycle_1.html

questions?

|<
< PREV
RANDOM
NEXT >
>|


A GUIDE TO
UNDERSTANDING FLOW CHARTS
PRESENTED IN FLOW CHART FORM
START
DO YOU UNDERSTAND FLOW CHARTS?
YES
GOOD
YES
NO
LET'S GO DRINK.
6 DRINKS
HEY, I SHOULD TRY INSTALLING FREEBSD!
OKAY. YOU SEE THE LINE LABELED "YES"?
YES
...AND YOU CAN SEE THE ONES LABELED "NO"?
YES
NO
NO
SCREW IT.
BUT YOU JUST FOLLOWED THEM TWICE!
YES
(THAT WASN'T A QUESTION.)
BUT YOU SEE THE ONES LABELED "NO".
YES
WAIT, WHAT?
NO
NO
LISTEN.
I HATE YOU.

thank you!