Angels (Open SSL) and D(a)emons
Checkpoint 3

(1) SSL
(2) CGI
(3) Daemonize
Extras

ssl_example.c
ssl_client.py
daemonize.c

(on course website)
SSL
Implementing an SSL Server
What is SSL?

- Standard behind secure communication on the Internet.
- Provides confidentiality & integrity
- Sits between transport & application

![Diagram showing SSL between transport and application layers]
OpenSSL Toolkit

- Command line tools, **SSL library**, and crypto library
- Can do a lot more than SSL
  - Message digests
  - Encryption and decryption of files
  - Digital certificates
  - Digital signatures
  - Random number generation
SSL Server In a Nutshell

- Use the OpenSSL library, here is a link to their documentation.
- Create a second server socket in addition to the first one, use the passed in SSL port from the command line arguments.
- Add this socket to the select() loop just like your normal HTTP server socket.
- Whenever you accept connections, wrap them with the SSL wrapping functions.
- Use the special read() and write() SSL functions to read and write to these special connected clients.
- In the select() loop, you need to know if a socket you are dealing with is SSL wrapped or not.
- Use appropriate IO depending on the 'type' of socket---although use select() for all fd's.
- Use your private key and certificate file that you obtained earlier.
Open SSL headers

/* OpenSSL headers */
#include <openssl/ssl.h>
#include <openssl/err.h>
Initialization Steps

- Global System Initialize
  - SSL_library_init()
  - SSL_load_error_strings()

- Initialize SSL_METHOD and SSL_CTX
  - meth=SSLv23_method();
  - ctx=SSL_CTX_new(meth);

- Loading keys
  - SSL_CTX_use_certificate_file(...)
  - SSL_CTX_use_PrivateKey_file(...)

Global Initialization

- SSL_library_init()
  - registers the available SSL/TLS ciphers and digests.

- SSL_load_error_strings()
  - Provide readable error messages.
SSL_METHOD

- To describe protocol versions
- SSLv1, SSLv2 and TLSv1

```c
SSL_METHOD* meth = TLSv1_method();
```
SSL_CTX

- Data structure to store keying material
- Reused for all connections; make ONE for your server

```c
SSL_CTX* ctx = SSL_CTX_new(meth);
```
SSL_CTX_use_certificate_file()

- Loads the first certificate stored in file into ctx.
- The formatting type of the certificate must be specified from the known types
  - SSL_FILETYPE_PEM
  - SSL_FILETYPE_ASN1.
- Our CA generates files of PEM format

```c
int SSL_CTX_use_certificate_file(SSL_CTX *ctx, const char *file, int type);
```
SSL_CTX_use_PrivateKey_file()

- Adds the first private key found in file to ctx.
- The formatting type of the certificate must be specified from the known types:
  - SSL_FILETYPE_PEM
  - SSL_FILETYPE_ASN1.
- Our CA generates files of PEM format

```c
int SSL_CTX_use_PrivateKey_file(SSL_CTX *ctx, const char *file, int type);
```
Wrapping Connections

- Create new SSL structure using `SSL_new()`
- Connect it to the socket using `SSL_set_fd()`
- Perform handshake using `SSL_accept()`
- Read and write using `SSL_read()` and `SSL_write()`
- Perform shutdown at the end, also need to clear state and close underlying I/O socket etc.
- As always, check for return value and handle errors appropriately!
SSL_new()

- Creates a new SSL structure
- Create one per connection
- Inherits the settings of the underlying context.

```c
SSL* ssl = SSL_new(ctx);
```
SSL_set_fd()

- Tell the SSL object which socket it will wrap

```c
int SSL_set_fd(SSL *ssl, int fd);
```
SSL_accept

- SSL_accept - wait for a TLS/SSL client to initiate a TLS/SSL handshake

```c
int SSL_accept(SSL *ssl)
```

- (Do this after a standard `accept()`.)
SSL_read and SSL_write

- SSL_read to read bytes from a TLS/SSL connection
  ```c
  int SSL_read(SSL *ssl, void *buf, int num);
  ```
- SSL_write to write bytes to a TLS/SSL connection
  ```c
  int SSL_write(SSL *ssl, const void *buf, int num);
  ```

NOTE:
- The data are received in records (with a maximum record size of 16kB for SSLv3/TLSv1).
- Only when a record has been completely received, it can be processed (decryption and integrity check).
SSL_shutdown

• Shuts down an active TLS/SSL connection.

int SSL_shutdown(SSL *ssl);

• (Then do a standard close().)
Getting a... Certificate
15-441 Certificate Authority
http://gs11697.sp.cs.cmu.edu/keyserver
You Need 3 Things

1) CA certificate
2) Your private key
3) Your certificate
Add CA Cert to Your System/Browser

e.g., add to OSX Keychain
Getting a... Domain Name
Create a Domain Name

- Get a **free** domain name from **No-IP**

**No-IP Free**

No-IP Free is our entry level service. Use yourname.no-ip.org instead of a hard to remember IP address or URL. With No-IP Dynamic DNS, our free Dynamic Update Client keeps track of your changing IP address and updates your hostname, keeping your connection active.

[Sign Up Now] [More]

- Use your **Andrew ID** as the hostname

Hostname:

```
dnaylor.no-ip.biz
```
Get the Update Client

- You don't have root, so...
  - Just build (make), don't install (make install)
  - Run manually when your IP changes
Create No-IP Conf File

./noip2 -C -c noip.conf

[dnaylor@unix3 ~/noip-2.1.9-1]$ ./noip2 -C -c noip.conf

Auto configuration for Linux client of no-ip.com.

Please enter the login/email string for no-ip.com <username>

Please enter the password for user '<username>' ****************

Only one host [dnaylor.no-ip.biz] is registered to this account.

It will be used.

Please enter an update interval:[30]

Do you wish to run something at successful update?[N] (y/N)

New configuration file 'noip.conf' created.
Update Your IP Address

./noip2 -c noip.conf -i 108.17.82.243

[dnaylor@unix3 ~/noip-2.1.9-1]$ ./noip2 -c noip.conf -i 108.17.82.243
IP address detected on command line.
Running in single use mode.
SSL

Questions?
Daemonizing
Orphaning

- Fork the process to create a copy (child)
- Let parent exit!
- The child will become child of init process
  - Start operating in the background

```c
int pid = fork();
if (pid < 0) exit(EXIT_FAILURE); /* fork error */
if (pid > 0) exit(EXIT_SUCCESS); /* parent exits */
/* child (daemon) continues */
```
Process Independence

- Process inherits parent's controlling tty; need to detach
- Server should not receive signals from the process that started it
- Operate independently from other processes

setsid() /*obtain a new process group*/
Close File Descriptors

- Close all open descriptors inherited
  ```c
  int i;
  for (i = getdtablesize(); i >= 0; --i)
    close(i);
  ```
- Connect standard I/O descriptors (stdin 0, stdout 1, stderr 2) to /dev/null
  ```c
  i = open("/dev/null",O_RDWR); /* open stdin */
  dup(i) /* stdout */
  dup(i) /* stderr */
  ```
File Creation Mask

- Servers run as super-user
- Need to protect the files they create
- File creation mode is 750 (complement of 027)

   umask(027);
Mutual Exclusion

- We want only one copy of the server (file locking)
- Record pid of the running instance!
  - `cat lisod.lock` more efficient than `ps -ef | grep lisod`

```c
lfp = open(lock_file, O_RDWR|O_CREAT, 0640);
if (lfp < 0)
    exit(EXIT_FAILURE); /* cannot open */
if (lockf(lfp, F_TLOCK, 0) < 0)
    exit(EXIT_SUCCESS); /* cannot lock */
sprintf(str, "%d\n", getpid());
write(lfp, str, strlen(str)); /*record pid to lockfile */
```
Logging

• You sent stdout and stderr to /dev/null, so you need to log to a file!
Daemonizing
Questions?
CGI Parameters

http://www.cs.cmu.edu/~prs/15-441-F16/project1/CGI_Requirements
CGI Code

- Create a bi-directional pipe
- Fork to create a child process which will execute your script
- Execve() with your ENVP that you create using information of the request
- Write to the pipe to send data to the script
- Read from the pipe for the response
- Good Idea to use select so that you don’t block
- Which end of the pipe would go into readfds and which would go into writefds
Flaskr using WSGI wrapper

• Replace app.run() in the tutorial with the wrapper

```python
def run_with_cgi(application):
    # just copy all the code from the wrapper
if __name__ == '__main__':
    run_with_cgi(app)
    # app.run()
```

• Your Flaskr directory should contain

```
bash-4.2$ ls
flaskr.py schema.sql static templates
```