Crypto++: Past Validations and Future Directions

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Introductions

About Me

- Jeffrey Walton
  - Security Architect
  - Mobile Security Engineer
  - Library Maintainer
- Verticals
  - US DoD
  - US Federal
  - US Financial

About Crypto++

- C++ class library
- Originally written by Wei Dai
- Released in June 1995
- General purpose crypto library
- Given to community 2015
- https://www.cryptopp.com

About Crypto++ (continued)

- C++03 through C++17
  - Heavy use of templates
  - F-Bound quantification
  - Static polymorphism
  - Acquired taste

FIPS Validations

Validations

- Crypto++ 5.0.4
  - October 2002
  - Certificate 343
- Crypto++ 5.2.3
  - September 2005
  - Certificate 562
- Crypto++ 5.3.0
  - September 2006
  - Certificate 819

- Historical Validation list
  - Sometime around 2015 or 2016

Sponsor and Lab

- Benefactor
  - Groove Networks
  - Productivity & Collaboration
  - Purchased by Microsoft
- Testing Lab
  - Cygnacom

FIPS Module

Windows DLL

- NIST approved algorithms
  - RNG, AES, SHA, MAC, RSA, DH
- One set of #define's
  - DLL_EXPORT (et al)
- Artifacts
  - cryptopp.lib
  - cryptopp.dll

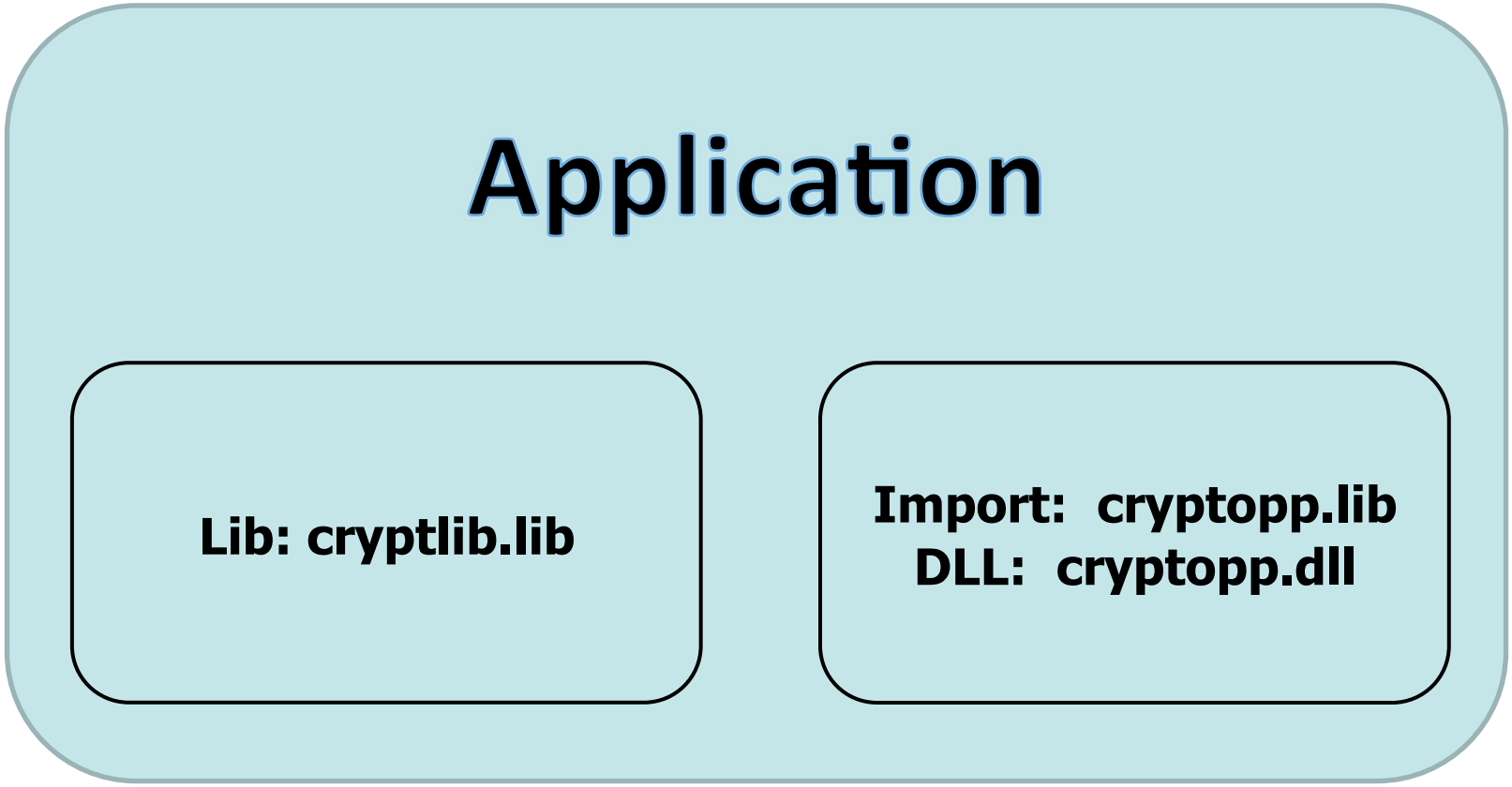
Windows Lib

- Non-FIPS routines
  - Non-approved algorithms
  - Encoders, Decoders
  - Sources, Filters, Sinks
- Another set of #define's
  - DLL_IMPORT (et al)
- Artifact
  - cryptlib.lib

Windows App

- Multiple libraries
  - Needed both cryptopp.lib and cryptlib.lib
  - cryptopp.lib import library
  - cryptlib.lib static archive
- Lots of confusion
  - Nightmare for users
  - Users think its a regular "Crypto++ DLL"
  - Three wiki pages covering them

App View


Application
Lib: cryptlib.lib
Import: cryptopp.lib
DLL: cryptopp.dll

Explicit Instantiations

- Pure C++ library
  - Everything in a header
  - Instantiated at call site

- FIPS DLL
  - Header (*.h) + source (*.cpp)
  - Source explicitly instantiates object
  - `template class X <Y>`

Future Directions

Improve Design (?)

- Add C interface
  - Avoid C++ ABI instability
- Flatten API
  - FIPS_rng_generate_block
  - FIPS_aes_gcm_128
  - Init-Update-Final pattern

Improve Design (?) (continued)

- C++ classes to wrap flattened API
  - OK to provide to users ...
  - … but we don't export the classes

- Add Engine-like interface
  - Already have object registry
  - Add provider strings
  - Additional namespace?

Another Validation

- Probably not
  - Need sponsor or benefactor
  - Need time and energy
- Already probed DHS and NSF
  - Looking for projects and grants

Native Services

- Use native services
  - Crypto++ wrapper for OS or external library
  - We already do this on a limited basis
    - RNGs, Pipes, Sockets, Timers
- Apple
  - CommonCrypto
- Linux/Mozilla
  - Network Services (NSS)
- Windows
  - CAPI or Bcrypt

OpenSSL Integration

- Utilize FIPS Object Module
  - Use it like external service
  - libcryptopp.a + fipcanister.o
  - Use fipsld++ to build fips_premain.c and link against fipscanister.o
  - fipsld++ available from OpenSSL wiki
- Platform not validated?
  - Crypto++ becomes an OpenSSL customer
  - $5K to $10K private label validation

Init struct/OpenSSL

ossl-init.h - Notepad

File Edit Format View Help

```
#include <sstream>
#include <cstddef>
#include <stdexcept>
#include "/usr/local/ssl/fips-2.0/include/openssl/opensslconf.h"
#include "/usr/local/ssl/fips-2.0/include/openssl/e_os2.h"
#include "/usr/local/ssl/fips-2.0/include/openssl/fipssyms.h"
#include "/usr/local/ssl/fips-2.0/include/openssl/evp.h"
#include "/usr/local/ssl/fips-2.0/include/openssl/fips.h"

struct OsslFipsInit
{
        OsslFipsInit()
        {
                const char password[] = "etaonrishdlcupfm";
                if (FIPS_module_mode_set(1, password) != 1)
                {
                        throw std::runtime_error("FIPS_module_mode_set failed.");
                }
                std::cout << "FIPS_module_mode_set succeeded." << std::endl;
        }
};
```

PIMPL class/OpenSSL

ossl-aes.cxx - Notepad

File Edit Format View Help

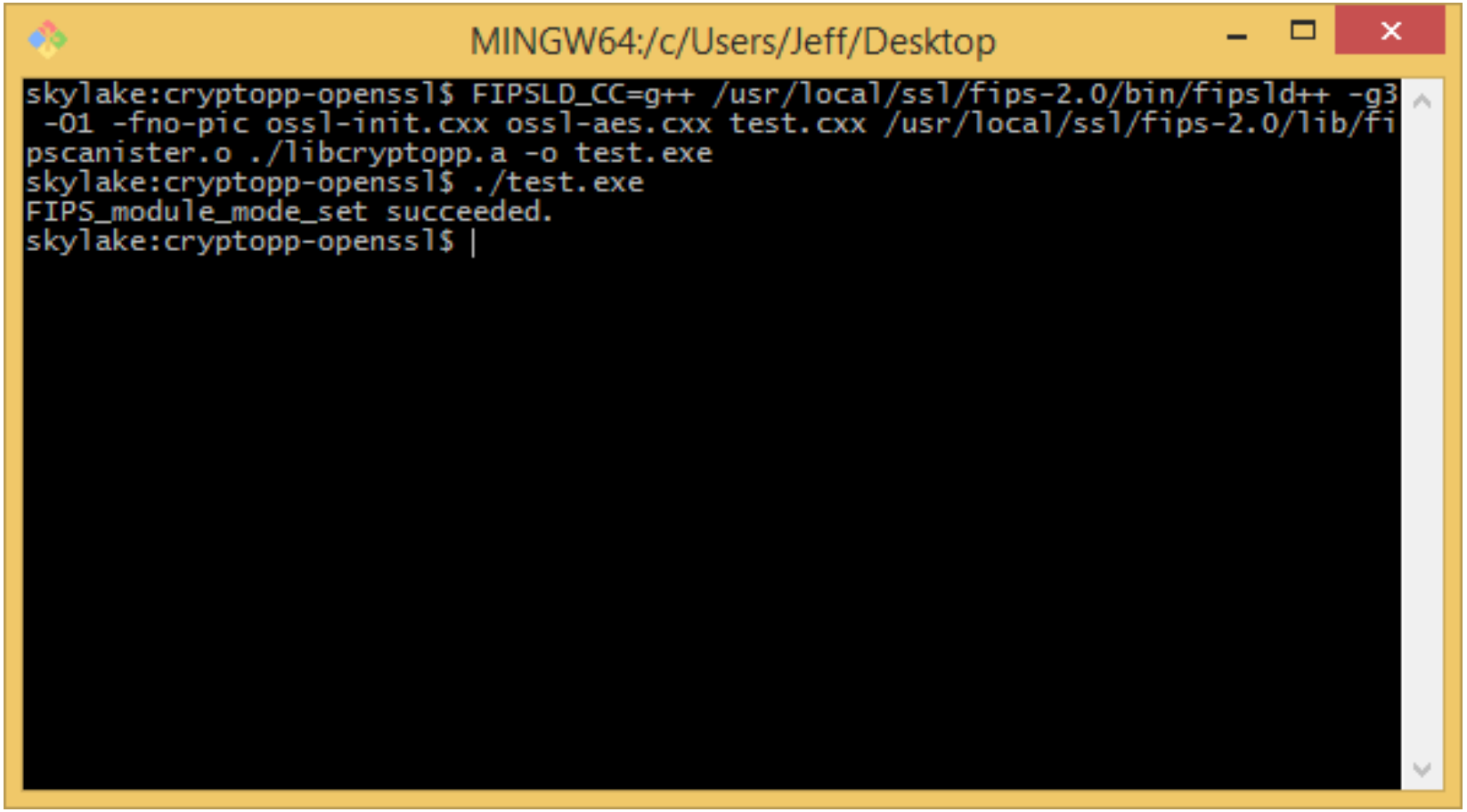
```
////////// The OpenSSL implementation //////////

using EVP_CIPHER_CTX_ptr = std::unique_ptr<EVP_CIPHER_CTX, decltype(&::EVP_CIPHER_CTX_free)>;

struct OsslAesImpl
{
        OsslAesImpl() : m_ctx(NULLPTR, ::EVP_CIPHER_CTX_free) {}

        void Init(const byte* key, size_t ksize, const byte* iv, size_t vsize, CipherDir direction)
        {
                m_ctx = EVP_CIPHER_CTX_ptr(EVP_CIPHER_CTX_new(), ::EVP_CIPHER_CTX_free);
                if (direction == ENCRYPTION)
                {
                        int rc = M_EVP_EncryptInit_ex(m_ctx.get(), EVP_aes_256_cbc(), NULL, key, iv);
                        if (rc != 1)
                          throw std::runtime_error("EVP_EncryptInit_ex failed");
                }
                else
                {
                        int rc = M_EVP_DecryptInit_ex(m_ctx.get(), EVP_aes_256_cbc(), NULL, key, iv);
                        if (rc != 1)
                          throw std::runtime_error("EVP_DecryptInit_ex failed");
                }
        }
```

Command Line/FOM linking



Questions?

- Hopefully useful answers

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- Credits
  - Wei Dai, who gave the world Crypto++
  - Cryptographers and researchers who make it happen