PV204 Security technologies

Hardware Security Modules (HSM), PKCS#

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Roadmap

1. Discussion of planned project fixes, ECC cards!
2. Principle of dynamically loaded libraries
3. Why PKCS#11 was introduced
4. Install and create own virtual SoftHSM token
5. Intro into PKCS#11 API (not covered at lecture)
6. Commented debug throw PKCS11Example code
7. Comparison between JavaCard API and PKCS#11
8. (VeraCrypt + PKCS#11 token)

Project – Phase III

- Distribution of cards supporting required algs
  - ECC support
- Be aware
  - if you have G&D Smartcarfe 6.0 card, you MUST use additional switch **–emv** for all GPPro commands
    - Different method for key derivation
- Discussion of planned code changes


SoftHSM

DLL/SO usage

- Windows: **`LoadLibrary()`,`GetProcAddress()`,`FreeLibrary()`**
- Unix/Linux: **`dlopen()`, `dlsym()`, `dlclose()`**

```
HINSTANCE dllHandle = NULL;
if ((dllHandle = LoadLibrary(our_dll_path)) != NULL) {
    FT_C_Initialize fInitialize = NULL;
    fInitialize = (FT_C_Initialize) GetProcAddress(dllHandle, "C_Initialize");
    if (fInitialize != NULL) {
        (fInitialize)(NULL);
    }
    else status = GetLastError();
}
else status = GetLastError();
```

Prepare SoftHSM (Windows/Linux)

- Download binary for your OS (prefer version from IS)
  - https://github.com/disig/SoftHSM2-for-Windows
  - Libsofthsm http://manpages.ubuntu.com/manpages/utopic/man1/softhsm.1.html
- Prepare system variables
  - set SOFTHSM2_CONF h:\Apps\SoftHSM2\etc\softhsm2.conf (in system variables)
- Try to create and initialize new software token (cmd in SoftHSM2\bin\ folder)
  - softhsm2-util.exe --init-token --slot 0 --label “pv204"
- Troubleshooting:
  - Softhsm2-util crash: dll is not available
    - PATH, try to put softhsm2.dll into current folder
    - Still crash, check if softhsm2.dll is used (NOT softhsm2-x64.dll)
  - Error: Could not initialize library (check your system variable SOFTHSM2_CONF – name of file should be also included)
    - Check also directories.tokendir inside softhsm2.conf
  - ERROR 30: Could not initialize the token (wrong path to software tokens in softhsm2.conf - check)

Software token(s)

```
>softhsm2-util.exe --init-token --slot 0 --label "pv204"
*** SO PIN (4-255 characters) ***
Please enter SO PIN: ******
Please reenter SO PIN: ******
*** User PIN (4-255 characters) ***
Please enter user PIN: ****
Please reenter user PIN: ****
The token has been initialized.
```

- New directory (GUID) with software token created in SoftHSM2\var\softhsm2\tokens\ folder
- Multiple tokens can be created
  - Change --slot 0 to --slot X for additional tokens
  - Otherwise token in slot 0 will be overwritten!

Management of software PKCS#11 token

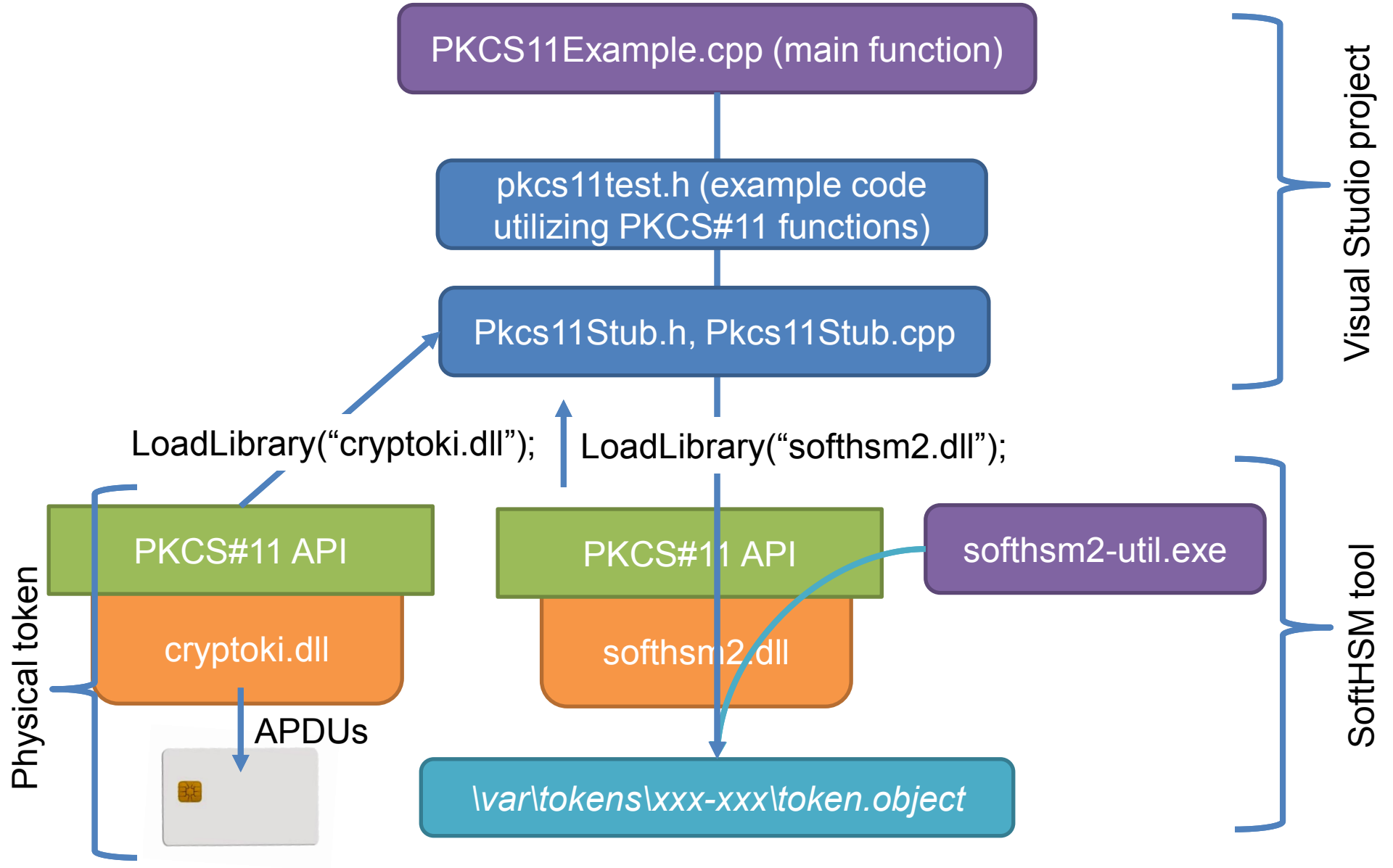
```
>softhsm2-util.exe
Support tool for PKCS#11
Usage: softhsm2-util [ACTION] [OPTIONS]
Action:
  -h              Shows this help screen.
  --help          Shows this help screen.
  --import <path>  Import a key pair from the given path.
                  The file must be in PKCS#8-format.
                  Use with --file-pin, --slot, --label, --id,
                  --no-public-key, and --pin.
  --init-token    Initialize the token at a given slot.
                  Use with --slot or --free, --label, --so-pin, and --pin.
                  WARNING: Any content in token token will be erased.
  --show-slots    Display all the available slots.
  -v              Show version info.
  --version       Show version info.
```

```
Options:
  --file-pin <PIN>  Supply a PIN if the file is encrypted.
  --force           Used to override a warning.
  --free            Initialize the first free token.
  --id <hex>        Defines the ID of the object. Hexadecimal characters.
                    Use with --force if multiple key pairs may share
                    the same ID.
  --label <text>    Defines the label of the object or the token.
  --module <path>   Use another PKCS#11 library than SoftHSM.
  --no-public-key   Do not import the public key.
  --pin <PIN>       The PIN for the normal user.
  --slot <number>   The slot where the token is located.
  --so-pin <PIN>    The PIN for the Security Officer (SO).
```

Before use of PKCS#11 – program API

- Delete all previously created software tokens
  - SoftHSM2\var\softhsm2\tokens\
- Create new token and make sure that
  - Token label is “pv204”
  - SO PIN is “123456”
  - User PIN “1234”

AT THIS MOMENT, WE HAVE AT LEAST ONE INITIALIZED TOKEN (HOPEFULLY ☺)


PKCS11Example.cpp (main function)
pkcs11test.h (example code utilizing PKCS#11 functions)
Pkcs11Stub.h, Pkcs11Stub.cpp
Visual Studio project
LoadLibrary("cryptoki.dll");
LoadLibrary("softhsm2.dll");
PKCS#11 API
cryptoki.dll
PKCS#11 API
softhsm2.dll
softhsm2-util.exe
Physical token
APDUs
\var\tokens\xxx-xxx\token.object
SoftHSM tool

Use of PKCS#11 – program API

- Pre-prepared project for Visual Studio
  - PKCS11Example inside 06_SoftHSM
  - Make sure token label is “pv204”!
- Example tests of functionality in PKCS11Test
  - List available tokens (slot, token)
  - List of supported cryptographic mechanisms
  - PIN login/change (user CKU_USER, admin CKU_SO)
  - Create and find objects (public, private)
  - Generate random data on token
- Compile, run and inspect in debug mode
- Try to understand what functions are doing

Own work – during this lab

1. Write own function, which will insert private object with label “VeraCrypt secret1” into token
   – Private object => user must be logged in (C_Login)
2. Write own function, which will list all private objects on token including values
   – C_FindObjectsInit, C_FindObjects, C_FindObjectsFinal
3. Change insert function so that value of objects will be randomly data generated by token itself
   – obtained previously via C_GenerateRandom() function

Use of PKCS#11 – TrueCrypt/VeraCrypt

- Use P#11 token to increase security of VeraCrypt password
- Settings→Security tokens→Select library
  - Point to softhsm2-x64.dll
- Important: at least one private object must exists on token
  - VeraCrypt will search for private objects on token and fail with GENERIC_ERROR if not found
  - Use your private object “VeraCrypt secret1”
- Volumes→Create new volume
  - (Set standard volume info in wizard)
  - Volume Password→Use keyfiles→Keyfiles →Add token files
  - New volume should be created and PIN required on mount

Assignments

- No homework this week
- Project
  - Phase III.: Improve code (GitHub), 10 points (19.4.2018)
  - Functionality and security tests (unit tests, integration)
  - Best practices, fix identified problems