

# IN SΦVI3T ЯЦSSID SMДЯТСДЯD HDCKS ЧФЦ @DEF CON 26 - 2018

---

Eric Sesterhenn <eric.sesterhenn@x41-dsec.de>

2018

X41 D-SEC GmbH

- Eric Sesterhenn
- Principal Security Consultant
- Pentesting/Code Auditing at X41



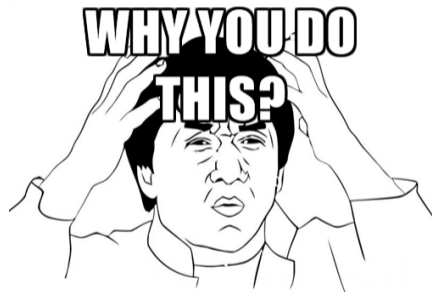
- The issues presented here have been reported and fixed!
- These are open source projects - help them!
- I am not interested in testing / debugging proprietary stuff in my spare time.



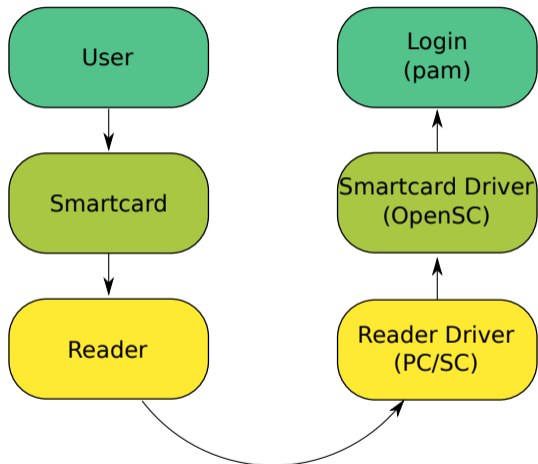
MOBILEPHONE ATM LOGIN ACCESSCONTROL COPYP  
ROTECTION PAYPHONES HEALTHCARE PAYMENT SI  
GNATURES PASSPORTS TRANSPORTATION TRANSP  
RTATION SIGNATURES ACCESSCONTROL DISKENC  
RYPTI **LINUX** IN PAYPHONES HEALTHCARE ATM MO  
BILEP **LOGIN** )OPYPROTECTION PASSPORTS HEALTHC  
ARE PAYMENT PAYPHONES PASSPORTS MOBILEPHO  
NE DISKENCRIPTION TRANSPORTATION LOGIN AT  
M COPYPROTECTIONACCESSCONTROL SIGNATURES  
PASSPORTS TRANSPORTATION MOBILEPHONE COPY  
PROTECTION LOGIN SIGNATURES PAYMENT ACCES  
SCONTROL PAYPHONES HEALTHCARE DISKENCRIPT

# Why?

- Smartcards control authentication!
- Authentication runs as root!
- Users and programmers subconsciously trust the smartcard!



memegenerator.net



# What is a Smartcard?

- Physical, tamper-proof device
- Designed to keep information secret
- Contains memory and a processor



[https://en.wikipedia.org/wiki/Smart\\_card#/media/File:SmartCardPinout.svg](https://en.wikipedia.org/wiki/Smart_card#/media/File:SmartCardPinout.svg)



- APDUs form the protocol to talk to smartcards
- ISO/IEC 7816-4 Identification cards
  - Integrated circuit cards
- T=0 is character oriented / T=1 is block-oriented
- Verify: 00 20 00 01 04 31323334

CLA	INS	P1	P2	L <sub>C</sub>	Data
1	1	1	1	0-3	N <sub>C</sub>



- PC/SC API can be used on win and \*nix
- Other libraries have a similar interface

---

```
LONG WINAPI SCardTransmit(  
    SCARDHANDLE          hCard,  
    LPCSCARD_IO_REQUEST pioSendPci,  
    LPCBYTE              pbSendBuffer,  
    DWORD                cbSendLength,  
    PSCARD_IO_REQUEST   pioRecvPci,  
    LPBYTE              pbRecvBuffer,  
    LPDWORD              pcbRecvLength  
);
```

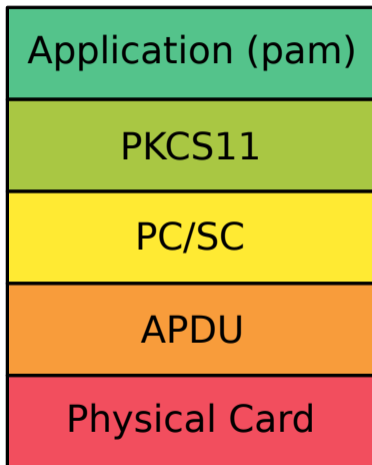
---

- PKCS11 is a platform independent API for cryptographic token
- Supported by OpenSSL, browsers,... (eg. via libp11)
- Windows uses smartcard Minidriver now
- Driver for each card, uses ATR to match

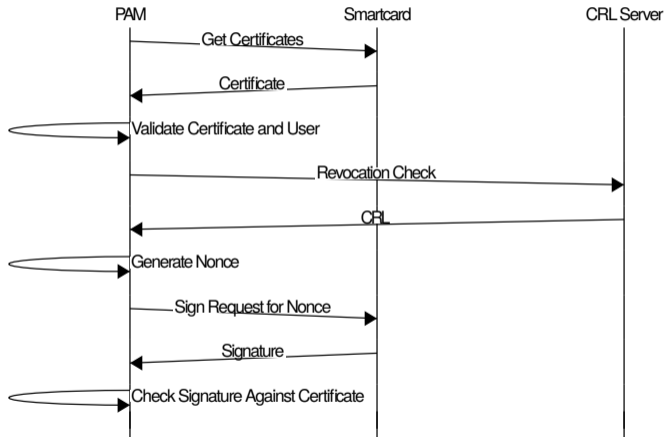
---

```
CK_RV C_FindObjectsInit(  
    CK_SESSION_HANDLE hSession,  
    CK_ATTRIBUTE_PTR pTemplate,  
    CK_ULONG ulCount  
);
```

---



# Smartcard for Sign-On



- Driver developers trust the smartcard!
- Let's abuse that
- Mess with the card responses



Project	# Bugs
libykneomgr	1
OpenSC	Over 9000 ;-)
pam_pkcs11	1
smartcardservices	2
Yubico-Piv	2

No, I did not fuzz the &\$#?@! out of it...

but guess which one I fuzzed the most ;-)  
Thanks to Frank Morgner for fixing!

```
do {
    cacreturn = cacToken.exchangeAPDU(command, sizeof(command), result,
    ↪ resultLength);
    if ((cacreturn & 0xFF00) != 0x6300)
        CACError::check(cacreturn);
    ...
    memcpy(certificate + certificateLength, result, resultLength - 2);
    certificateLength += resultLength - 2;
    // Number of bytes to fetch next time around is in the last byte
    // returned.
    command[4] = cacreturn & 0xFF;
} while ((cacreturn & 0xFF00) == 0x6300);
```



---

```
u8 buf[2048], *p = buf;
size_t bufsize, keysize;

sc_format_path("I1012", &path);
r = sc_select_file(card, &path, &file);
if (r)
    return 2;
bufsize = file->size;
sc_file_free(file);
r = sc_read_binary(card, 0, buf, bufsize, 0);
```

---



# Popping calcs...

```
snakebyte@smartcard:~$ cryptoflex-tool
Usage: cryptoflex-tool [OPTIONS]
Options:
  -l, --list-keys           Lists all keys in a public key file
  -c, --create-key-files <arg> Creates new RSA key files for <arg> keys
  -P, --create-pin-file <arg> Creates a new CHV<arg> file
  -g, --generate-key       Generates a new RSA key pair
  -R, --read-key           Reads a public key from the card
  -V, --verify-pin        Verifies CHV1 before issuing commands
  -k, --key-num <arg>     Selects which key number to operate on [1]
  -a, --app-df <arg>     Selects the DF to operate in
  -p, --prkey-file <arg> Private key file
  -u, --pubkey-file <arg> Public key file
  -e, --exponent <arg>   The RSA exponent to use in key generation [3]
  -m, --modulus-length <arg> Modulus length to use in key generation [1024]
  -r, --reader <arg>     Uses reader <arg>
  -w, --wait              Wait for card insertion
  -v, --verbose          Verbose operation. Use several times to enable debug output

snakebyte@smartcard:~$ cryptoflex-tool -R
Using reader with a card: libfuzzy
Using card driver: Schlumberger Multiflex/Cryptoflex
Unable to read public key file: Card command failed
bc 1.06.95
Copyright 1991-1994, 1997, 1998, 2000, 2004, 2006 Free Software Foundation, Inc.
This is free software with ABSOLUTELY NO WARRANTY.
For details type `warranty'.
3+4
7
:-) █
```



- Basiccard gives you nice control,...  
yes BASIC!
- Example exploit (Kevin) will be  
released to the public at beVX
- Other methods would be SIMtrace  
or certain Javacards





---

```
if(*out_len + recv_len - 2 > max_out) {
    fprintf(stderr,
        ↪ "Output buffer to small, wanted to write %lu, max was %lu.",
        ↪ *out_len + recv_len - 2, max_out);
}
if(out_data) {
    memcpy(out_data, data, recv_len - 2);
    out_data += recv_len - 2;
    *out_len += recv_len - 2;
}
```

---



```
Debian GNU/Linux 9 smartcard tty3  
Hint: Num Lock on  
smartcard login: _
```

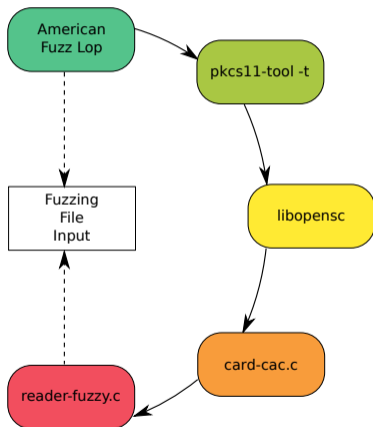


- Most modern fuzzers are file-oriented
- Radamsa: Generates a corpus of files
- Honggfuzz: passes a file (filename different each run)
- libfuzzer: passes a buffer and length
- AFL: passes a file



- SCardTransmit() tells us how much data it expects
- Read this from a file on each call and error out if EOF
- No complicated poll handling like for network sockets required

- reader-fuzzy.c
- Implements a (virtual) smartcard reader interface
- Responds with malicious data read from file (OPENSC\_FUZZ\_FILE)
- Have fun with AFL





- Wincard(.dll) on Linux and Unix
- For proprietary code
- Preload the library
- Have fun with non-feedback fuzzers (e.g. radamsa) or AFL in qemu mode





- Tavis loadlibrary
- Extended to support Wincard drivers
- Fuzz the windows drivers on linux without all the overhead



**Tavis Ormandy** ✓

@taviso

Folgen



Surprise, I ported Windows Defender to Linux. 😎



**tavis/loadlibrary**

Porting Windows Dynamic Link Libraries to Linux. Contribute to loadlibrary development by creating an account on GitHub.

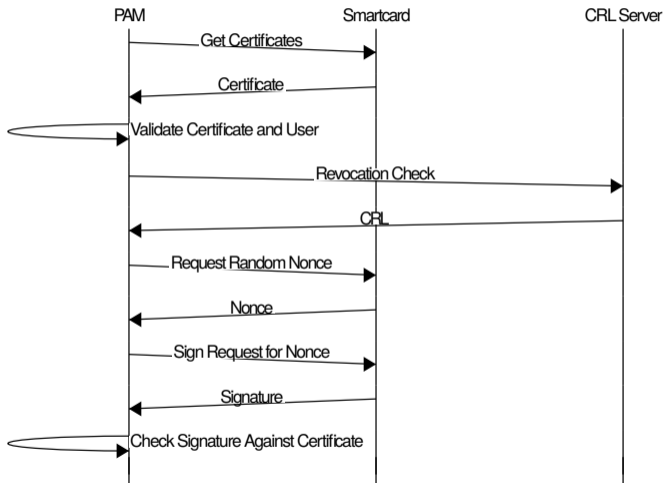
github.com

14:45 - 23. Mai 2017

- Released now!
- <https://github.com/x41sec/x41-smartcard-fuzzing>



# pam\_pkcs11: Replay an Authentication





- Channel back to card is quite limited
- Might need to use revocation list check for information leaks
- Interaction during exploitation not possible with basiccard, get SIMtrace for that
- But: A single bitflip from false to true during login can be enough :)



- Think about trust models!
- Some security measures increase your attack surface big time!
- Fuzz Everything!
- Limit attack surface by disabling certain drivers.
- Do not write drivers in C ;-)

- Q & A
- <https://github.com/x41sec/x41-smartcard-fuzzing>
- [eric.sesterhenn@x41-dsec.de](mailto:eric.sesterhenn@x41-dsec.de)
- Sorry no Twitter... stalk me on LinkedIn if you must ;-)

