Do security certification schemes improve security?

Analyzing artifacts of Common Criteria & FIPS 140 certifications

EurOpen 2022

Adam Janovsky | `adamjanovsky@mail.muni.cz`

MUNI
FI

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📤 Slideshow available from: ajanovsky.cz/europen.pdf

Joint work 👏

Petr Svenda, Jan Jancar, Jiri Michalik, Stanislav Bobon, Adam Janovsky, Vashek Matyas, and others…

Work in progress 🔧

2017 at CRoCS

- Return of the Coppersmith Attack: Practical Factorization of Widely Used RSA Moduli
- CVE-2017-15361

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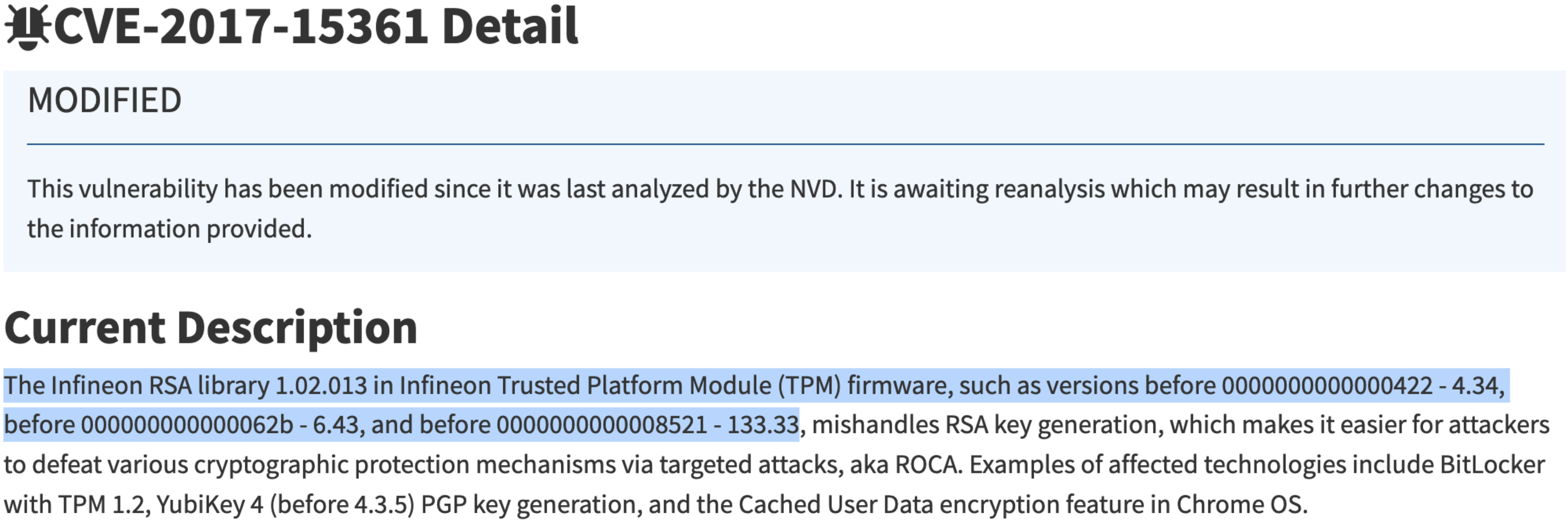
Which certified devices are affected?

Finding affected certified devices…



CVE-2017-15361 Detail

MODIFIED

This vulnerability has been modified since it was last analyzed by the NVD. It is awaiting reanalysis which may result in further changes to the information provided.

Current Description

The Infineon RSA library 1.02.013 in Infineon Trusted Platform Module (TPM) firmware, such as versions before 0000000000000422 - 4.34, before 000000000000062b - 6.43, and before 0000000000008521 - 133.33, mishandles RSA key generation, which makes it easier for attackers to defeat various cryptographic protection mechanisms via targeted attacks, aka ROCA. Examples of affected technologies include BitLocker with TPM 1.2, YubiKey 4 (before 4.3.5) PGP key generation, and the Cached User Data encryption feature in Chrome OS.

Excerpt from RoCA NVD record.

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Infineon Technologies Security Controller M7793 A12 and G12 with optional RSA2048/4096 v1.02.010
or v1.02.013, EC v1.02.010 or v1.02.013 and Toolbox v1.02.010 or v1.02.013 libraries and with
specific IC-dedicated software.
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What if this product is used in other certificated products?

So you browse all CC certificates again

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- And you find a fairly similar certificate `` `BSI-DSZ-CC-0926-2014` ``

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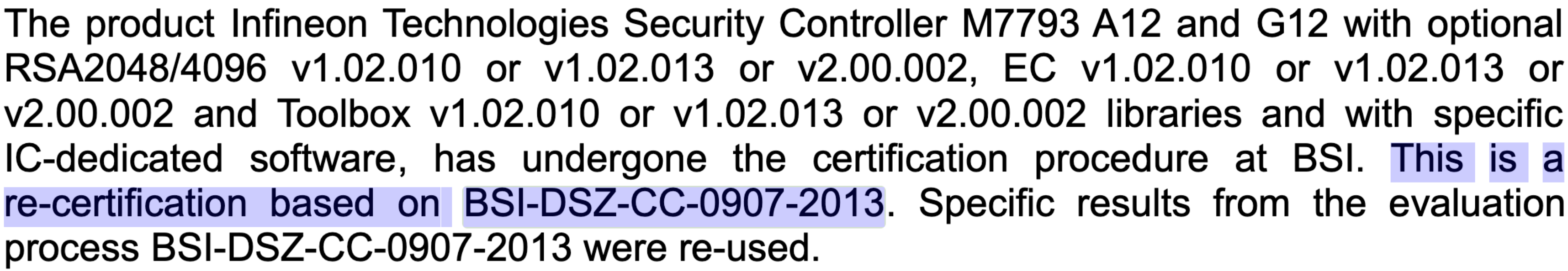

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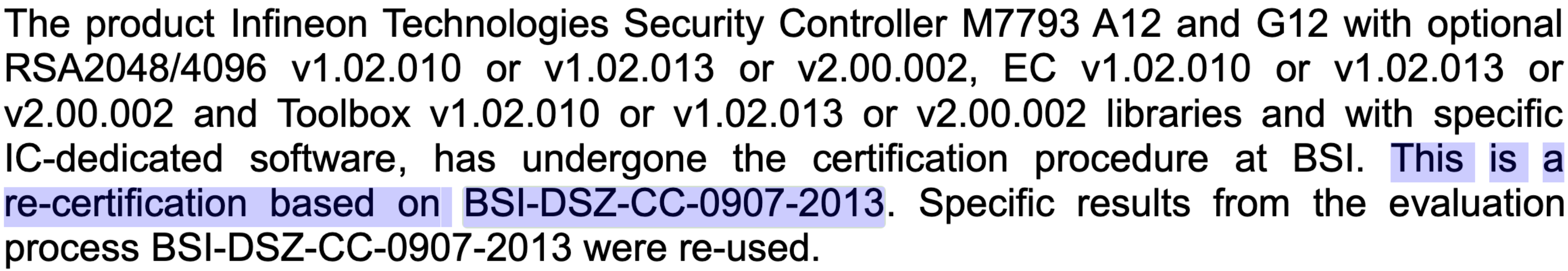

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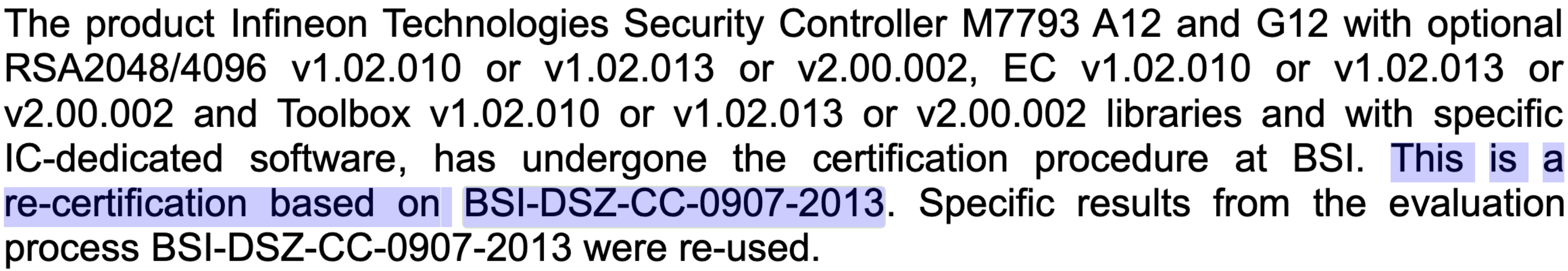

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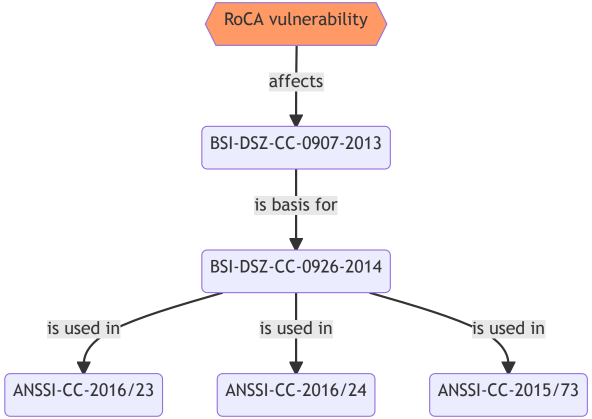
- Spoiler, it is: `ANSSI-CC-2016/23`, `ANSSI-CC-2016/24`, `ANSSI-CC-2015/73`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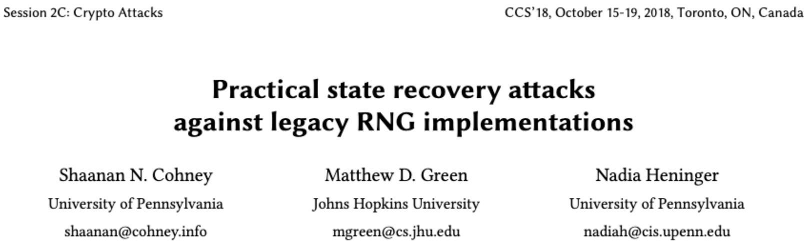
- State of `ANSI X9.17/X9.31` PRNG can be recovered if its internal key is not secret.



Session 2C: Crypto Attacks

CCS'18, October 15-19, 2018, Toronto, ON, Canada

Practical state recovery attacks against legacy RNG implementations

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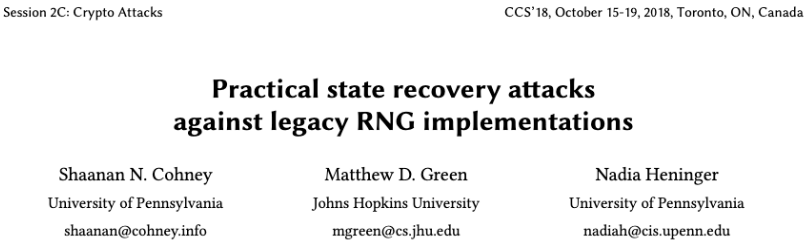

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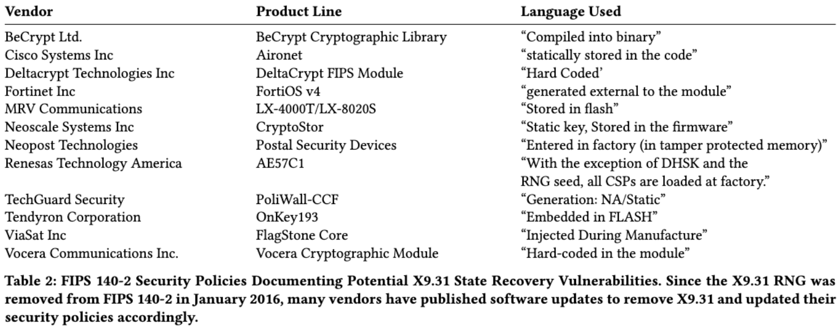
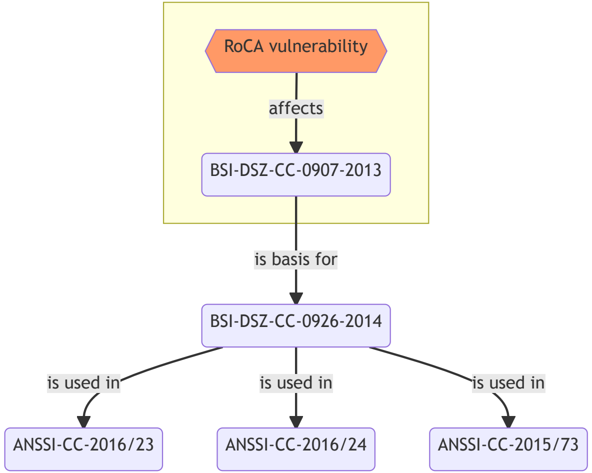
- After reviewing 1411 certificates, the authors conclude that



Vendor	Product Line	Language Used
BeCrypt Ltd.	BeCrypt Cryptographic Library	"Compiled into binary"
Cisco Systems Inc	Aironet	"statically stored in the code"
Deltacrypt Technologies Inc	DeltaCrypt FIPS Module	"Hard Coded'
Fortinet Inc	FortiOS v4	"generated external to the module"
MRV Communications	LX-4000T/LX-8020S	"Stored in flash"
Neoscale Systems Inc	CryptoStor	"Static key, Stored in the firmware"
Neopost Technologies	Postal Security Devices	"Entered in factory (in tamper protected memory)"
Renesas Technology America	AE57C1	"With the exception of DHSK and the RNG seed, all CSPs are loaded at factory."
TechGuard Security	PoliWall-CCF	"Generation: NA/Static"
Tendyron Corporation	OnKey193	"Embedded in FLASH"
ViaSat Inc	FlagStone Core	"Injected During Manufacture"
Vocera Communications Inc.	Vocera Cryptographic Module	"Hard-coded in the module"

Table 2: FIPS 140-2 Security Policies Documenting Potential X9.31 State Recovery Vulnerabilities. Since the X9.31 RNG was removed from FIPS 140-2 in January 2016, many vendors have published software updates to remove X9.31 and updated their security policies accordingly.



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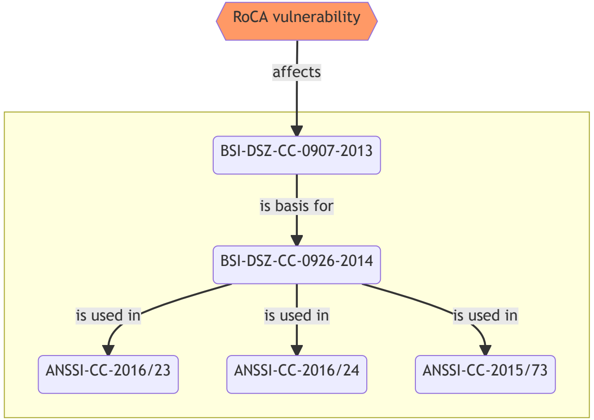
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A certificate is valid for ~3-6 years and can be partially updated with maintenance updates.

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They are not meant to be processed automatically.

Can we do better? 🤷‍♂️

Our approach

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- Build a tool capable of robust processing of certification artifacts.
- Automate all that we can.
- Build a frontend for it.
- Analyze interesting trends and write a paper about those.

CC certification artifacts

- The ECDH (ECC Diffie-Hellman) key exchange algorithm can be used to establish cryptographic keys. It can be also used as secure point multiplication.
- Provide secure point addition for Elliptic Curves over GF(p).

The TOE supports various key sizes for ECC over GF(p) up to a limit of 576 bits for signature generation, key pair generation and key exchange. For signature verification the TOE supports key sizes up to a limit of 576 bits . To fend off attackers with high attack potential an adequate key length must be used (references can be found in national and international documents and standards).

SHA

- The SHA-1, SHA-224, SHA-256, SHA-384 and SHA-512 algorithms can be used for different purposes such as computing hash values in the course of digital signature creation or key derivation.

To fend off attackers with high attack potential an adequate security level must be used (references can be found in national and international documents and standards). In particular this means that SHA-1 shall not be used.

Resistance of cryptographic algorithms against attacks

The cryptographic algorithms are resistant against attacks as described in JIL, Attack Methods for Smartcards and Similar Devices [32], which include Side Channel Attacks, Perturbation attacks, Differential Fault Analysis (DFA) and timing attacks, except for SHA, which is only resistant against Side Channel Attacks and timing attacks.

More details about conditions and restrictions for resistance against attacks are given in the user documentation of the Crypto Library [11][12].

Random number generation

- The TOE provides access to random numbers generated by a software (pseudo) random number generator and functions to perform a test of the hardware (true) random number generator at initialisation.

Processing pipeline

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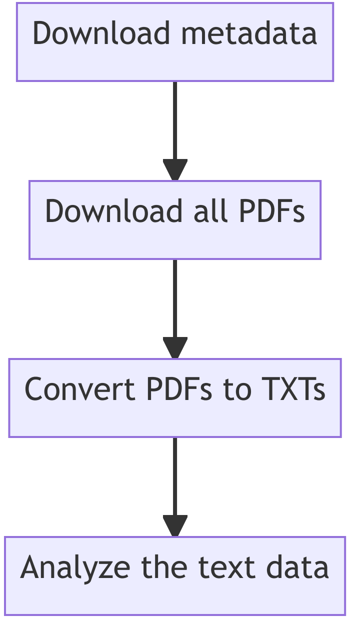

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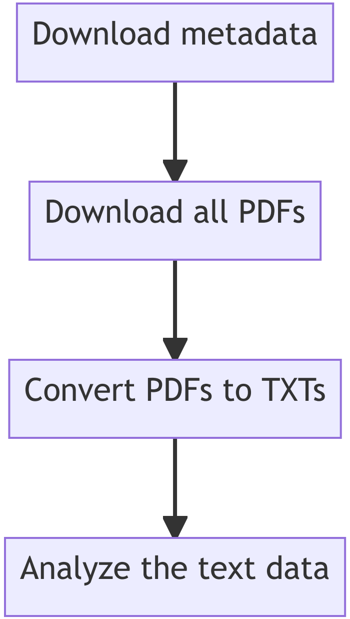


Download metadata

Download all PDFs

Convert PDFs to TXTs

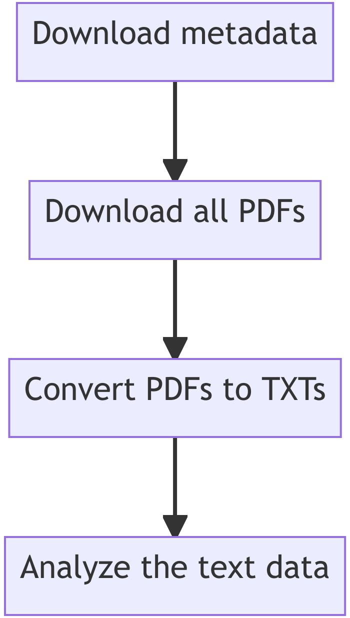
Analyze the text data

Run the pipeline

```
from sec_certs.dataset import CCDataset

dset = CCDataset()
dset.get_certs_from_web()
dset.process_protection_profiles()
dset.download_all_pdfs()
dset.convert_all_pdfs()
dset.analyze_certificates()
```

Processing pipeline



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dset.download_all_pdfs()
dset.convert_all_pdfs()
dset.analyze_certificates()
```

View the results

```
print(dset.to_pandas().head(n=3))
```

	cert_id	name	status	category	manufacturer	scheme	security_level
dgst							
8298c7814b3b2860	KECS-CR-22-11	KSignAccess V4.1	active	Access Control Devices and Systems	KSign Co., LTD.	KR	{}
9a1c767d358eee50	DXC-EFC-T092-ETR 1.0	VeroGuard HSM Digital ID for Open Networks v1.0	active	Access Control Devices and Systems	VeroGuard Systems Pty Ltd	AU	{ALC_FLR.1, EAL2+}
979e00ac7d3e229c	KECS-CR-21-63	SafeIdentity v5.1	active	Access Control Devices and Systems	Hancom With Inc.	KR	{}

Data extraction

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1. Read all text files and match regular expressions

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`"AES[-]*(?:128|192|256|)"`
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- National Vulnerability Database
- 🤝 Plug in your data source here

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Extracted data

- Certification IDs
- Security assurance requirements
- Security functional components
- References to other standards (FIPS, ISO/IEC, …)
- Security levels
- Javacard platform, API constants
- Cryptographic algorithms
- Utilized elliptic curves
- Cryptographic libraries
- Defenses
- Vulnerabilities

Data serialization

Data serialization

JSON or Pandas

```
from sec_certs.sample import CommonCriteriaCert
certificate = dset["5efe98a1ba4df4d7"]
certificate.to_json("./certificate.json")
other = CommonCriteriaCert.from_json("./certificate.json")
```

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```
"report_references": {
  "directly_referenced_by": ["BSI-DSZ-CC-0926-2014"],
  "directly_referencing": ["BSI-DSZ-CC-0757-2011"],
  "indirectly_referenced_by": [
      "BSI-DSZ-CC-0926-2014",
      "BSI-DSZ-CC-0926-V2-2017"
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  "indirectly_referencing": ["BSI-DSZ-CC-0757-2011"]
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  "indirectly_referencing": ["BSI-DSZ-CC-0757-2011"]
}
```

```
  "heuristics": {
    "cert_id": "BSI-DSZ-CC-0907-2013",
    "cert_lab": ["BSI"],
    "cpe_matches": ["cpe:2.3:a:infineon:rsa_library:1.02.01
    "related_cves": ["CVE-2017-15361"],
    …
```

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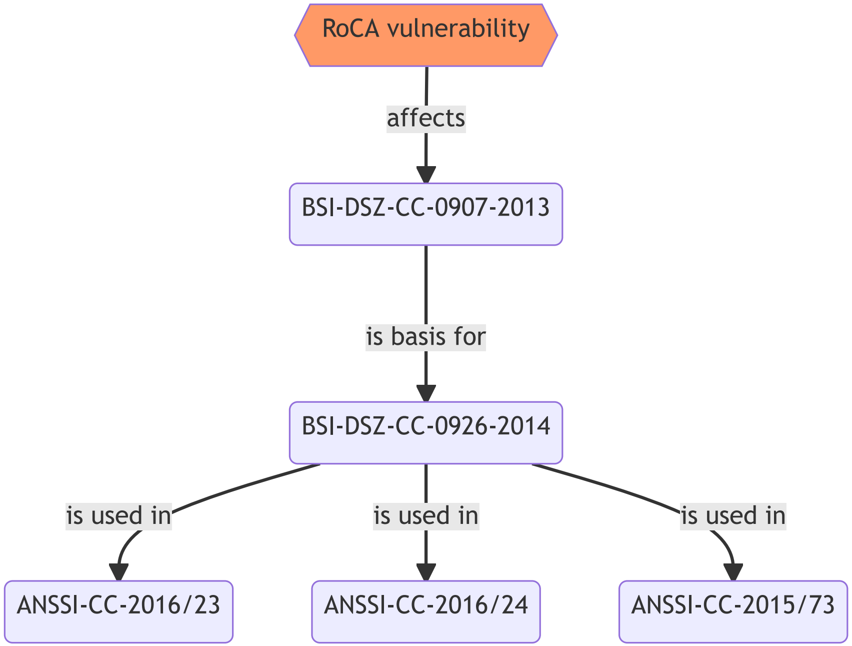
PDF data

```
"rules_crypto_algs": {
  "ECDSA": 7,
  "RNG": 10,
  "RSA-2048": 1,
  "RSA2048": 2,
  "RSA4096": 2,
  "TDES": 2,
  "TRNG": 4},
"rules_crypto_libs": {"v1.02.013": 28},
"rules_defenses": {
  "DFA": 5,
  "DPA": 6,
  "SPA": 5,
  "physical probing": 1,
  "physical tampering": 1},
"rules_ecc_curves": {"P-192": 2},
"rules_standard_id": {
  "AIS31": 3,
  "FIPS PUB 197": 1,
  "RFC 5639": 1,
  "RFC5639": 1},
"rules_vendor": {"Infineon": 40}
```

Linking certified products to vulnerabilities


RoCA vulnerability
affects
BSI-DSZ-CC-0907-2013
is basis for
BSI-DSZ-CC-0926-2014
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ANSSI-CC-2016/23
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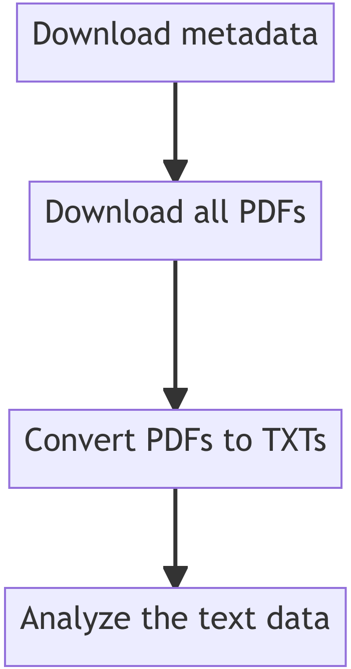
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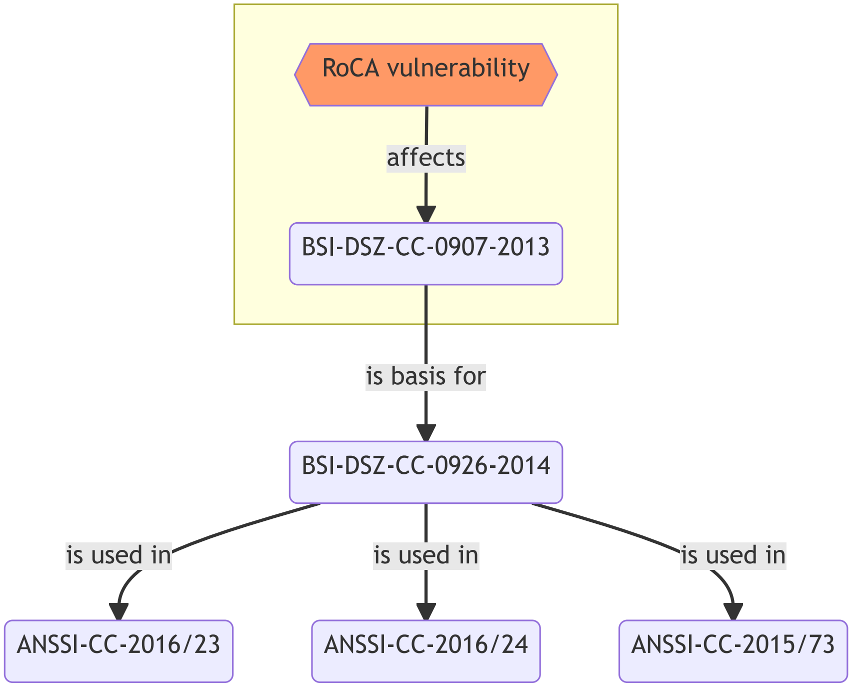
Analyze the text data



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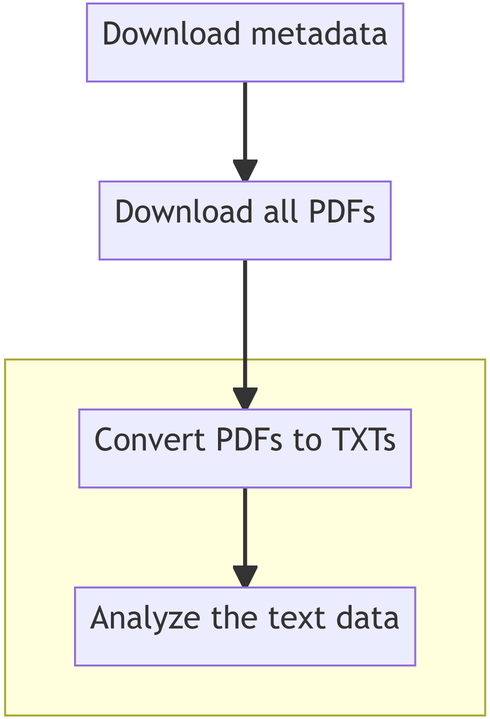

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Analyze the text data

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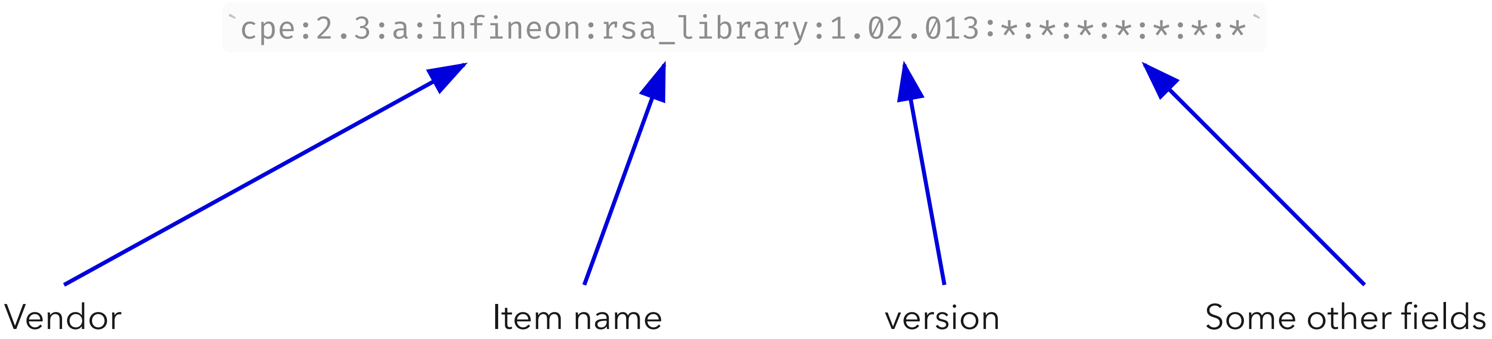

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Vendor

Item name

version

Some other fields

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DIRTY DATA YOU HAVE
CLEAN IT UP YOU MUST
memegenerator.net

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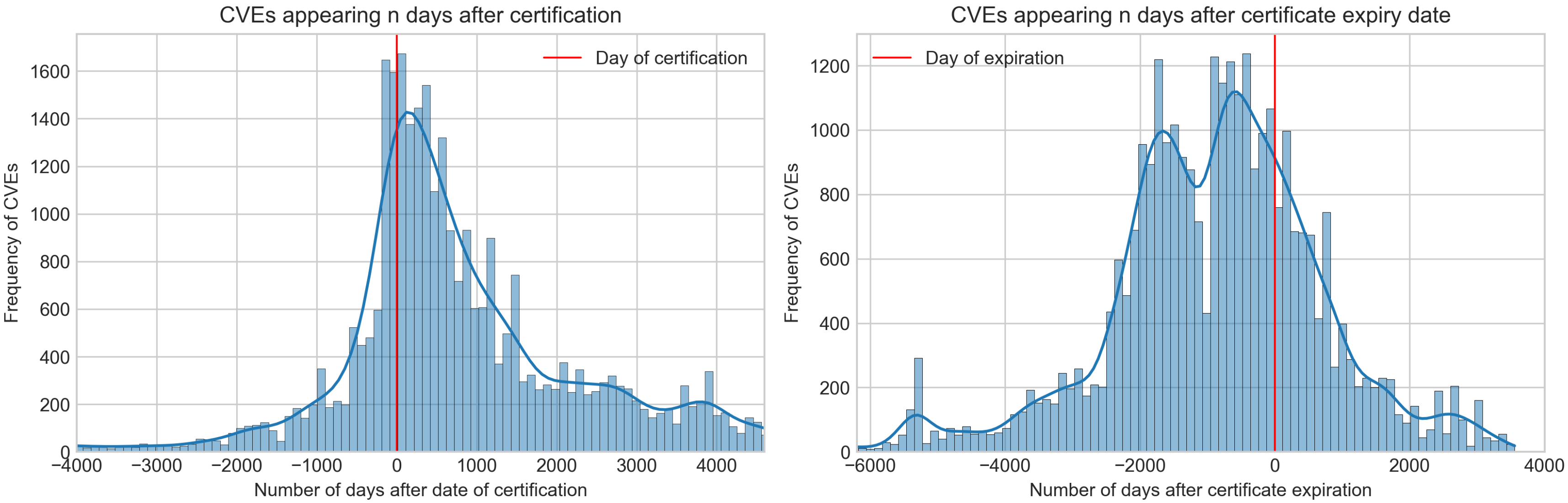
Very secure smartcards

When to watch out for vulnerabilities



Lifecycle of a product vs. its vulnerabilities

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- Only 25 SARs evaluated, so no "extreme by random" results expected

Live demo

Some links worth exploring

- CVE profile: seccerts.org/vuln/cve/CVE-2017-15361
- Certificate profile: seccerts.org/cc/5efe98a1ba4df4d7/
- Fulltext search: seccerts.org/cc/ftsearch/
- Notebook: seccerts.org/docs/notebooks/examples/common_criteria.html

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- Contributions are welcomed!

Learn More

Web | Documentation | GitHub Repo

Slides: ajanovsky.cz/europen.pdf

Open-source development at university

- Junior developers
- Prepare the project for your leave
  - So that issues can be fixed semi-automagically
- When they finally learn it, they leave for different project

Some advice

- Let them do what they want to do
- Constraint their space for errors as much as possible
  - Use linters, enforce code style, protect branches, enforce tests, …