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A Journey to Post-Quantum Cryptography: Crypto-Inventory

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Cryptographically Relevant Quantum Computers (CRQC) are a fundamental threat to cybersecurity

CRQCs exploit exponential speed-up for breaking universally used public key algorithms RSA and ECC.

Main threats:

- **“Intercepted now – decrypted later”**
  No confidentiality, e.g., “secret Coca Cola formula”, encrypted patient data

- **“Signed today – forged later”**
  No integrity and authentication: e.g., “signed malware”, manipulated audit trails

- **“Installed now – attacked later”**
  No availability, e.g., bypass of security measures, leading to disruption of critical infrastructures

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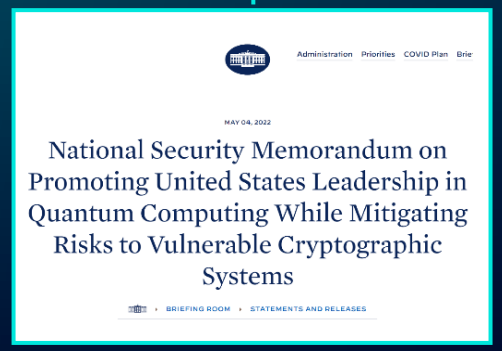
The transition to PQC must be prepared to meet upcoming regulatory requirements and customer demands, regardless of progress in the field of quantum computers

- US administration is pushing for the transition to post-quantum cryptography
- Initial focus on US NSS systems starting by 2025, e.g., armed forces, intelligence
- Private sector expected to follow soon afterwards
- Similar recommendations expected in other regions too, e.g., Europe, China, …
- US NIST have been published first PQC standards in August 2024

May 2022 — *National Security Memorandum*

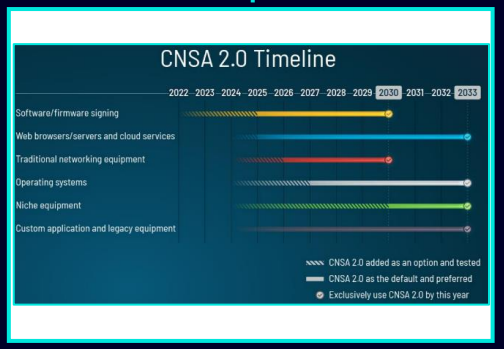


Mar 2023 — *US National Cybersecurity Strategy*

"… Federal Government will prioritize the transition of vulnerable public networks and systems to quantum-resistant cryptography [...] The ***private sector should follow the government's model*** *in preparing its own networks and systems for our post-quantum future"*

Apr 2024 — *EU: Recommendation on PQC*

Apr 2024 — *CNSA 2.0 Suite FAQ Update*



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The transition to PQC must be prepared to meet upcoming regulatory requirements and customer demands, regardless of progress in the field of quantum computers

A journey to post-quantum cryptography

Awareness

Establishment of a PQC Task Force and a PQC Community within the company

Crypto-Inventory

Identification of cryptographic assets and definition of transition priorities

Evaluation/PoC

Impact evaluation and design for PQC in IT/OT products, solutions, and infrastructures

Deployment

Deployment of PQC into products, solutions, and infrastructures

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Post-Quantum Cryptography Task Force @ Siemens Foundational Technologies

Cryptography lies at the foundation of cybersecurity. Products, solutions, and infrastructures must be transitioned to Post-Quantum Cryptography.

The **Challenge**

Regardless of when quantum computers will become available, the time to act is **now.**

- Experts predict cryptographically relevant quantum computers to be available by **2030**
- However, customer demand for PQC support will come in the near future, driven by upcoming **security standards and recommendations**
- A transition to post-quantum cryptography affects the **full ecosystem**

The **Offer**

A dedicated task force of technology experts, **supporting businesses** to

- **Identify** relevant elements within portfolio affected by the PQC transition
- **Prioritize** portfolio elements that need to be considered first in the PQC transition
- **Implement** comprehensive concepts for the transition of components, infrastructure, and processes to PQC

The **Benefits**

Time- & cost-efficient transition to PQC, by mitigating **capacity and know-how gaps.**

- **Guidance and best practice sharing** by technology experts
- Gain early experience on post-quantum cryptography from implemented proof-of-concepts
- **Quantum-safe** business portfolio

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What is a cryptographic inventory?

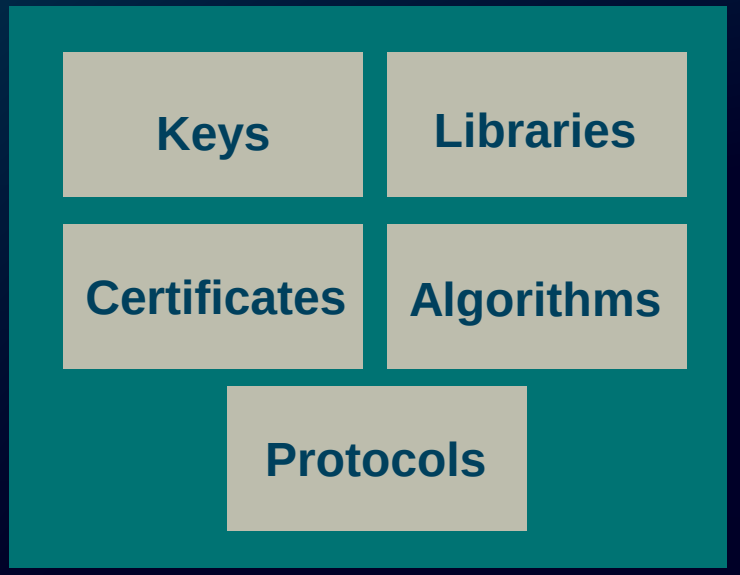
A cryptographic inventory is the record of the active cryptography included in a system or application.

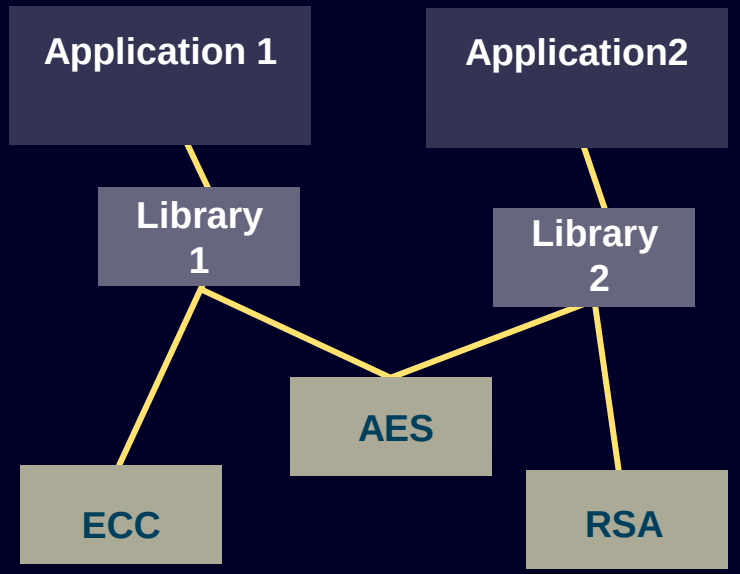
The cryptographic inventory:

- includes information on the **location and usages** of libraries, certificates, and keys.
- indicates **which protocols** and which algorithms is used.

A Cryptographic Inventory shows:

- the **dependencies** on the same libraries of different applications
- the parameters of an algorithm and its instances.





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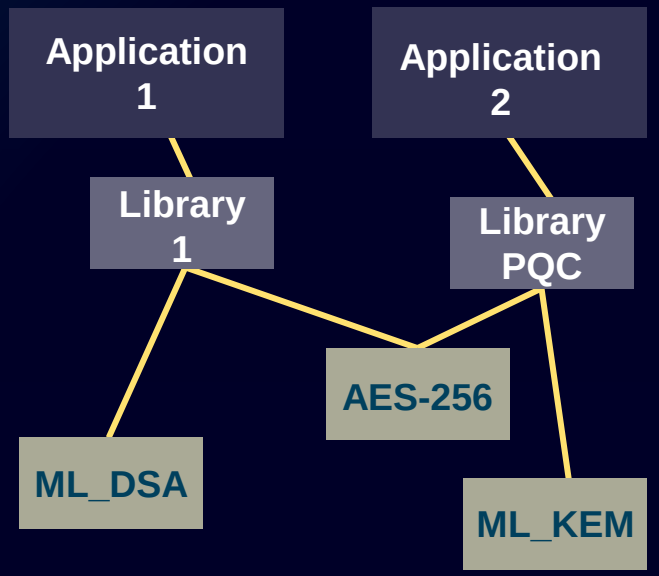
A cryptographic inventory for the transition to post-quantum cryptography

With a cryptographic inventory it is possible to:

- Define different **strategies** for algorithms, symmetric and asymmetric cryptography: to enable the **transition to PQC** and **crypto-agility**
- Define a timeline for the keys and certificates that must be updated, to address the harvest-now-decrypt-later attacks in time.
- Have an overview of libraries and be able to monitor their transition to post-quantum cryptography.

Further task to be performed before the transition to post-quantum cryptography:

- Monitor the transition plan of software providers to PQC;
- Monitor the status of libraries that implement PQC and their compliance with the standards.



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A cryptographic bill of materials for a cryptographic inventories

The Cryptographic Inventory format

- **C**ryptographic **B**ill **o**f **M**aterials (CBOM) is the format that describes cryptographic assets and their dependencies.
- The Cyclone DX 1.6 standard is the gold standard for the CBOMs.

The CBOM support:

- The CBOM is supported to generate the CI of a source code.
- A series of open-source tools can create a CBOM: cdxgen, sonar cube, CodeQL.

CDXGEN

sonarqube

CodeQL


```
"components": [ {
    "name": "RSA-2048",
    "type": "cryptographic-asset",
    "bom-ref": "crypto/key/rsa-2048@1.2.840.113549.1.1.1",
    "cryptoProperties": {
      "assetType": "related-crypto-material",
      "relatedCryptoMaterialProperties": {
        "type": "public-key",
        "id": "2e9ef09e-dfac-4526-96b4-d02f31af1b22",
        "state": "active",
        "size": 2048,
        "algorithmRef": "crypto/algorithm/rsa-2048@1.2.840.113549.1.1.1",
        "securedBy": {
          "mechanism": "Software",
          "algorithmRef": "crypto/algorithm/aes-128-gcm@2.16.840.1.101.3.4.1.6"
        },
        "creationDate": "2016-11-21T08:00:00Z",
        "activationDate": "2016-11-21T08:20:00Z"
      },
      "oid": "1.2.840.113549.1.1.1"
    }
```


Source: bom-examples/CBOM/Key at master · CycloneDX/bom-examples · GitHub

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PQC transition is an organization-wide transformation
The topic gained traction worldwide but still a lot to do

Raise awareness in your organization regarding upcoming post-quantum standards and requirements

Perform an inventory to understand how cryptography is used in your products/solutions

Perform a threat-and-risk analysis to define a migration strategy of your products/solutions

Engage with customers and suppliers to align roadmaps and requirements

Evaluate the impact of post-quantum cryptography on the requirements of your products/solutions

Prepare devices and infrastructure for a in-field migration to post-quantum cryptography

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