SmartCard-HSM

n-of-m Authentication Scheme

SmartCard-HSM is a light-weight, remote-manageable and user-centric hardware security module for secure key generation and storage

n-of-m authentication allows strict access control for sensitive keys

Motivation

- Certain cryptographic keys require very strict access control because a loss of control has a dramatic impact on security or data privacy
- Examples for such keys are
  - CA Root Keys
  - Escrow Keys
  - System Access Control Keys
  - Code Signing Keys
  - The Internet DNSSEC Root Keys (www.root-dnssec.org)

Dual Control / 4-Eye Principle

- A classical control measure is Dual-Control, also known as 4-Eye Principle
- Two persons (Key Custodians) need to collaborate in order to access the key
- A single person can not act without the other
- An attacker will need to compromise both persons
- Problem: If one person is not available, the scheme breaks

n-of-m Control

- n-of-m control requires n key custodians out of a group on m key custodians to collaborate in order to access a key
- Any combination of n key custodians collaborating allows access to the key
- If a single key custodian becomes unavailable, then the scheme still works until less than n key custodians are left
- m is defined initially and can not be changed at a later stage
- Classic algorithm: Shamir Shared Secret

n-of-m and the SmartCard-HSM

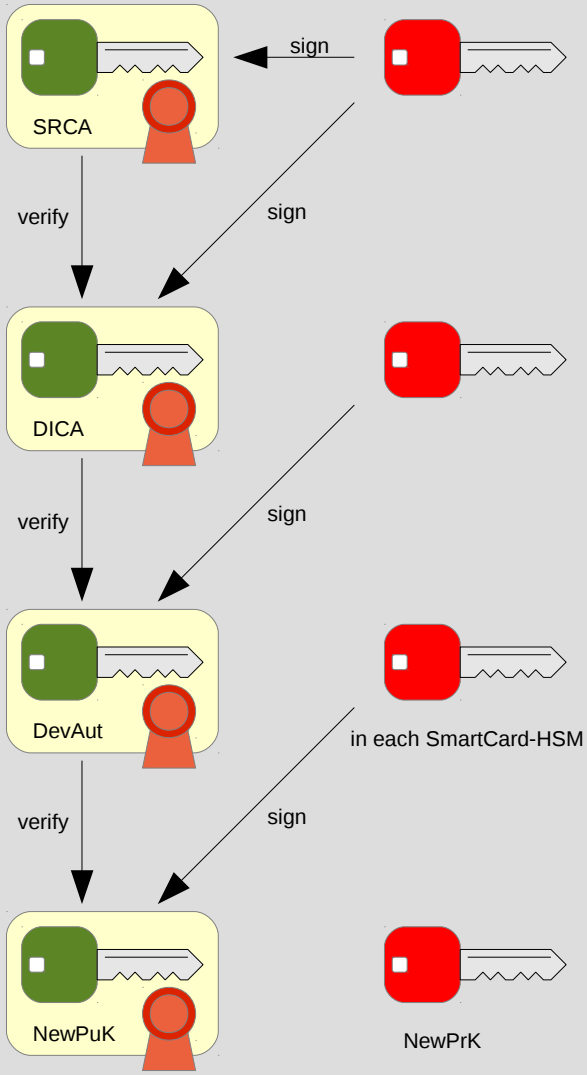
- The sc-hsm-tool implements n-of-m control for the Device Key Encryption Key (DKEK) using Shamir Shared Secret
- n-of-m for the DKEK is implemented outside the chip, as the current chip platform does not provide the required primitives to implement the algorithm
- n-of-m for authentication is implemented inside the chip and replaces the User-PIN authentication mechanism

Preconditions

- n-of-m for authentication requires
  - a set-up phase during which key custodians are enrolled
  - a use phase during which key custodians enable access to keys
- The SmartCard-HSM for the sensitive key is initialized during the set-up phase
- Each key custodian has it's own SmartCard-HSM that contains his personal authentication key
- Key custodians don't need to be physically present in any phase, as the protocol is designed to work remote

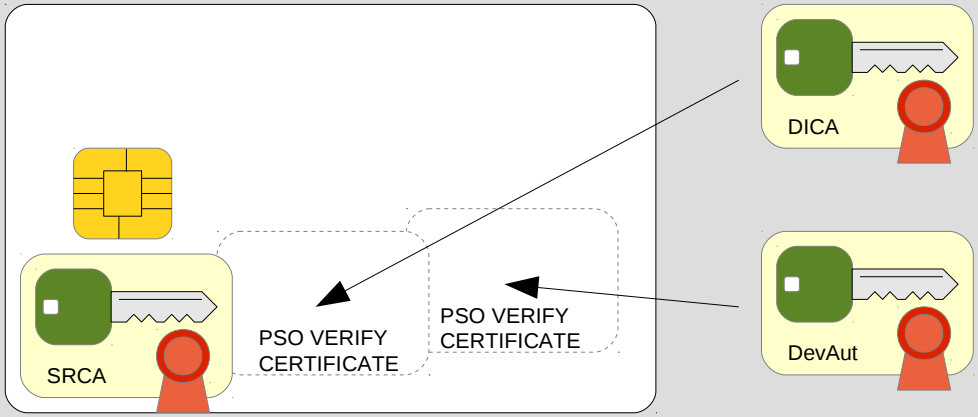
SmartCard-HSM PKI

- The build-in PKI issues a Card Verifiable Certificate (CVC) for each generated public key
- The authenticity of the public key can be validated using the chain from Scheme Root CA (SRCA), the Device Issuer CA (DICA) to the Device Authentication Certificate (DevAut)



CVC Validation

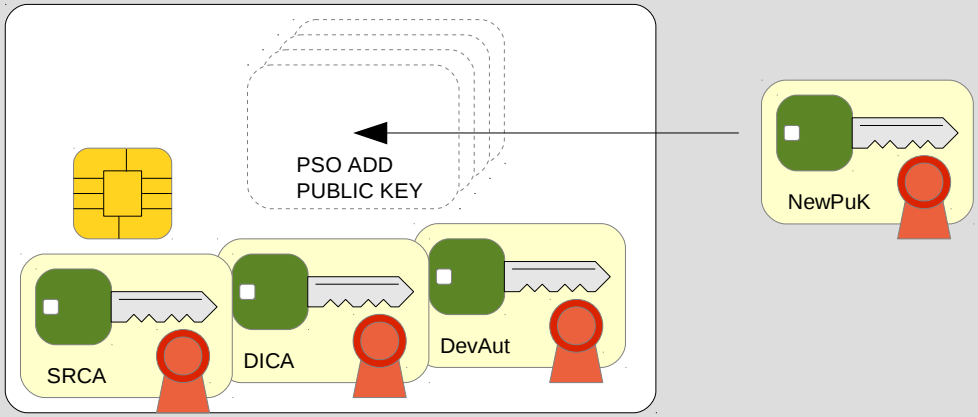
- The SmartCard-HSM can validate Device Issuer CA and Device Authentication Certificates using the PSO VERIFY CERTIFICATE command



- The Scheme Root CA certificate is embedded as trust-anchor in each SmartCard-HSM

Public Key Registration

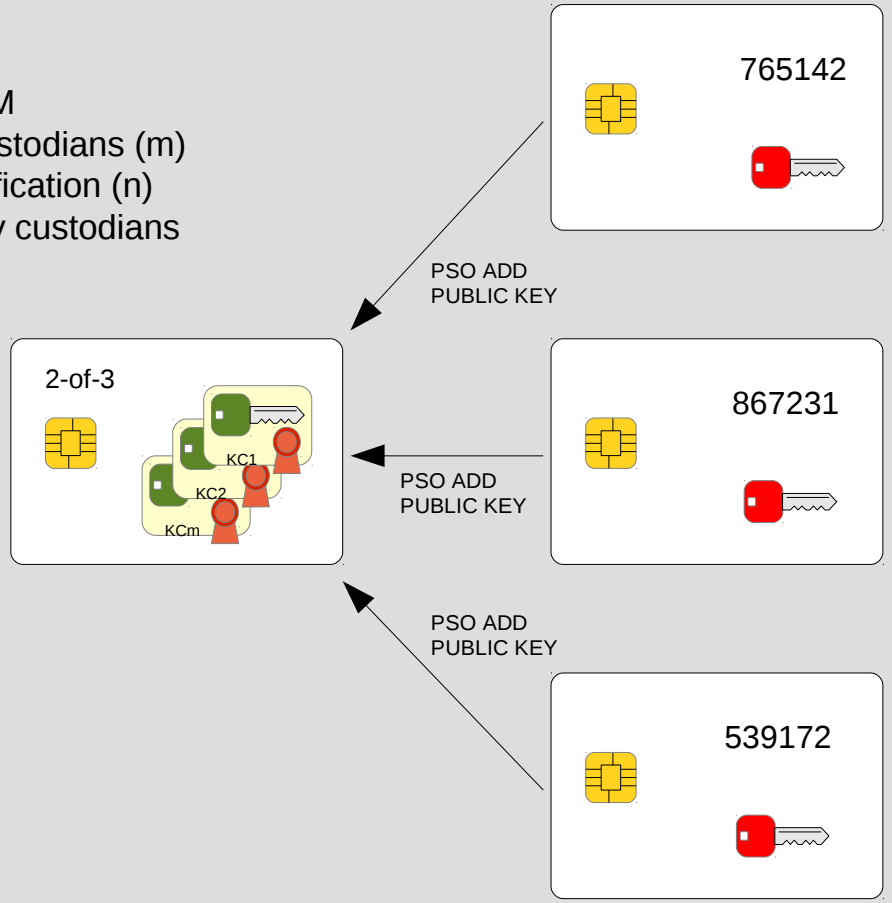
- Allows to register a public key for authentication during the set-up phase



- All m public keys of key custodians are registered
- After all keys are imported, the device is operational

Set-Up Phase

Administrator
1. Initialize SmartCard-HSM
2. Select number of key custodians (m)
3. Define threshold for verification (n)
4. Import public keys of key custodians



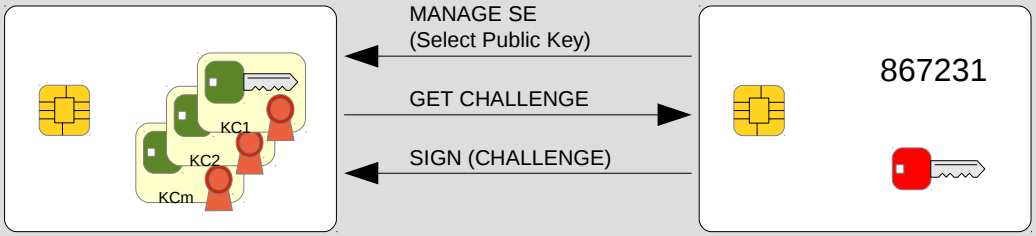
Key Custodian #1
1. Choose PIN
2. Generate Key

Key Custodian #2
1. Choose PIN
2. Generate Key

Key Custodian #3
1. Choose PIN
2. Generate Key

Public Key Authentication

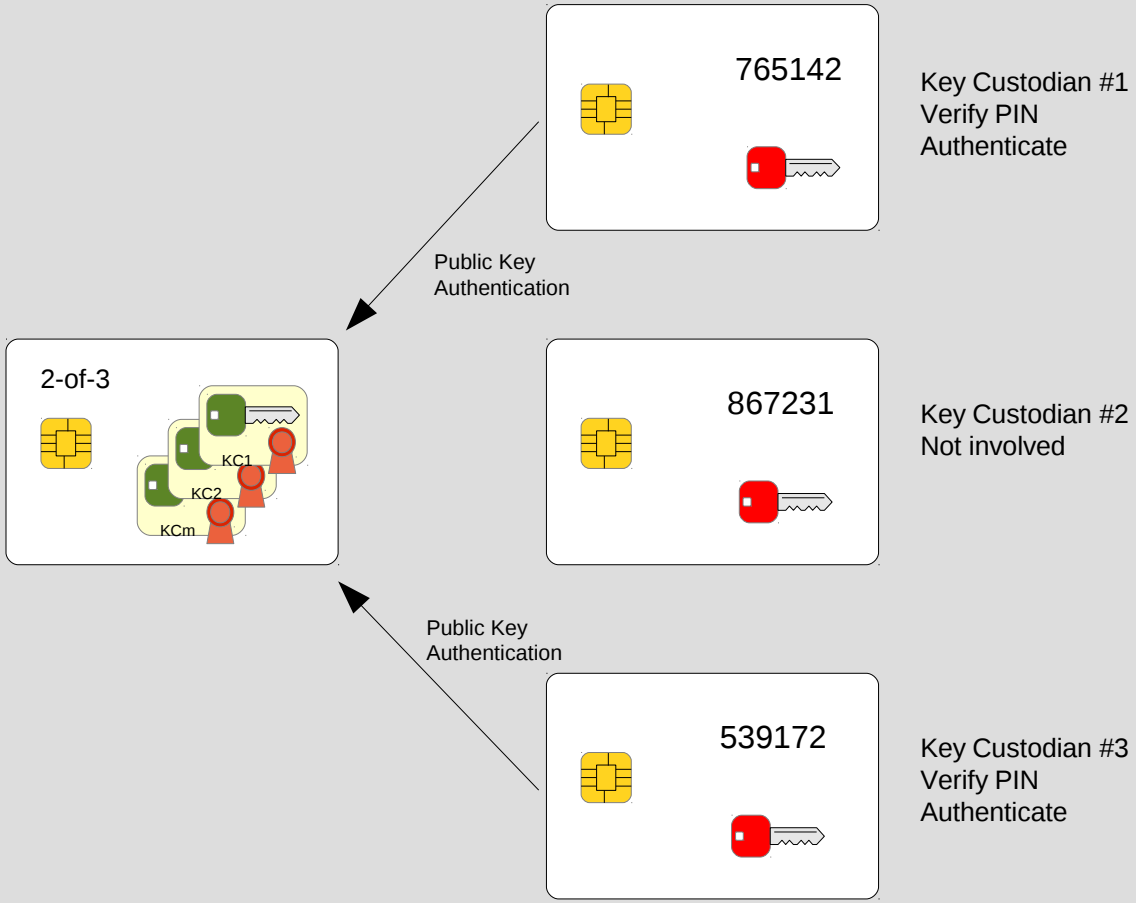
- Authenticate using the private key and a previously registered public key



- Within a session this can be repeated multiple time
- The authentication state is reset during logout or power-off
- Access is granted if n or more public keys are authenticated

Use Phase

n Key Custodians are required to authenticate towards the SmartCard-HSM in order to allow access to keys



Thank you for your attention

Please direct queries to

andreas.schwier@cardcontact.de

frank.thater@cardcontact.de