

# SKS – Secure Key Store

SEs (Security Elements), like Smart Cards, have since decades back been the preferred solution for storing cryptographic keys for authentication etc. This document outlines an enhanced SE-architecture which is *loosely* derived from TrustedComputingGroup's TPM (Trusted Platform Module) 1.2 specification. Due to the fact that SKS unlike TPMs does not imply securing the environment surrounding it, the SKS scheme is fully applicable to existing smart cards (after a firmware upgrade), which is a way reaching the critical mass for a secure key-provisioning facility that is lacking in for example current Internet browsers. A core characteristic of SKS is the ability "emulating" a set of independently issued and managed smart cards using on-line communication only. Although the preferred computing platform for housing an SKS is a mobile phone with NFC support, it should also be quite useful for enhanced USB memory sticks combining mass storage with secure key-containers. Rather than going into details, the following sections primarily cover the differences between traditional smart cards, TPM 1.2, and SKS.

## Key Execution

With key-execution this paper denotes signing, encrypting etc. In this respect SKS differs from TPMs and smart cards by offering a multi-issuer container where each issuer may deploy their own PUKs (Personal Unlock Keys), as an alternative to an SE device PUK that all issuers can use. Another distinguishing feature of SKS is that it supports a universal credential extension mechanism which for example can be used for Microsoft's Information Cards.

## Key Management

Key-management refers to deletion, renewal, and cloning of keys and certificates. In contrast to TPMs and smart cards, SKS utilizes PKI-based "proof-of-issuance" methods for isolating issuers from each other making remote updates in a shared container equally secure (but considerably more convenient), as using separate physical tokens, while still not requiring installation of additional trusted roots or similar. By using X.509 certificates as universal key-IDs, the SKS key-management operations can be applied to symmetric keys as well.

## Key Provisioning

Key-provisioning is an area where SKS markedly departs from smart cards because even if you buy a \$100 card; it still doesn't enable an *on-line issuer* to verify that keys were actually created in the card! The reason for this is fairly simple: smart card production and personalization is almost exclusively performed in-house by specific staff and software.

Because TPMs were designed to be bolted onto platforms, on-line provisioning became the only realistic method for distributing credentials. To also make on-line provisioning *trustworthy*, TPMs introduced embedded device keys and device attestations. SKS heavily builds on this concept but does not use the same methods due to its quite different heritage.

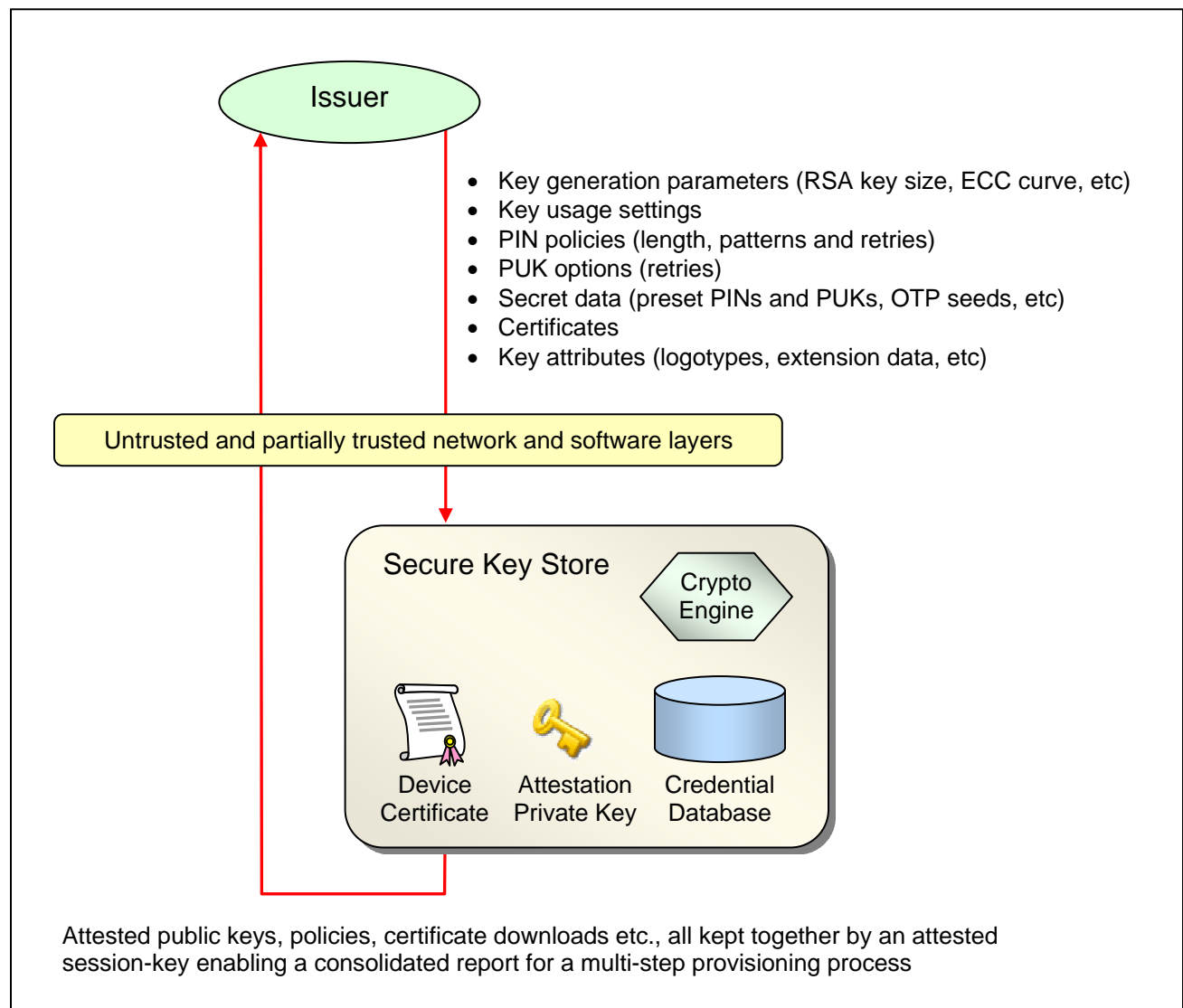
When TPMs were conceived the primary target was *more or less anonymous individuals doing business on the Internet while running on provably trusted platforms*. SKS is more like a branch on the European eID tree which means that hiding the device identity is not an option; device identity is probably rather a *prerequisite* (for the *issuer* only NB) since current eID card issuers know exactly which card they have issued to a certain individual including associated credentials.

It doesn't seem entirely unlikely that enterprises and on-line banks also would appreciate having an idea of in which devices they deploy their precious credentials.

## "Air-tight" Key Provisioning

As already mentioned SKS depends on the TPM device attestation concept. However, because SKS was explicitly designed to also be usable in a potentially untrusted computing environment ("unmeasured" using TPM terminology), SKS leverages device attestations for securing *all* aspects of a credential provisioning process ranging from key generation, key usage settings, PIN policy definitions, downloading secret data like PUKs and OTP (One Time Password) seeds, to the final step where certificates are fitted to their respective private keys.

On the next page there is a picture showing the architectural components and a simplified information flow of the air-tight provisioning system supported by SKS.



## Dual-use Device IDs

The Device Certificate is used as a trusted device ID in a provisioning process. That is, an issuer may reject requests attested by SKSes manufactured by (for the issuer) unknown vendors.

A side-effect of using certificate-based device IDs is that you can create efficient and still quite secure *on-line* enrollment processes where a non-authenticated user signs-up for credentials by sending an SKS-attested request to an issuer. The issuer can then verify the user's identity with an OOB (Out Of Band) method meeting the issuer's policy. The final part is asking the user for something like the first 8 characters of the 40 hexadecimal-digit SHA1 certificate hash which is the short-form of the device ID. If the answer is matching the device ID of the request, the issuer returns the completed credential package to the user's SKS. Note that this scheme can completely eliminate enrollment passwords!

Improved methods for remote provisioning are primarily needed for consumers, mobile phones, employees in virtual organizations, as well as for replacement credentials for people who have lost their card far away from the main office.

## Additional Information

For those who are interested in details regarding air-tight provisioning, it is recommended taking a peek at <http://keycenter.webpki.org>

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