CYBERNETICA

SplitKey – A Threshold Cryptography Case Study

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Company introduction and background

- R&D intensive ICT company in Estonia
  - Research applied to practical security solutions since 1996
  - Researched time stamping, PKI, digital signatures, multi-party computation, ...
  - Developed and maintains Estonia's X-Road (UXP), i-voting, Sharemind, ...
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- Estonia/Latvia/Lithuania so far had three widely used methods of authentication
  - ID-cards (smart-cards), Mobile-ID (SIM based), and one-time code cards
  - 2014, EU PSD2 regulation came with **strong authentication** demand
  - There was a market need for new kind of approach

SplitKey digital signature scheme

- Software-based 2-out-of-2 threshold cryptosystem
- Based on:
  - Rivest, R., Shamir, A., Adleman, L.: A method for obtaining digital signatures and public-key cryptosystems. (1978)
  - Desmedt, Y., Fraenkel, Y.: Threshold cryptosystems. (1990)
  - Damgard, I., Mikkelsen, G. L., Skeltved, T.: On the security of distributed multiprime RSA. (2015)
  - Camenisch, J., Lehmann, A., Neven, G., Samelin, K.: Virtual Smart Cards: How to sign with a password and a server. (2016)

SplitKey key pair generation and signing operation

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- Composite signature: $s = CRT_{n_1,n_2}(s_1, s_2)$

Security reduction to the RSA

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Security strength (bits)	Symmetric key algorithms	RSA modulus n (bits)	SplitKey composite modulus $n_1 n_2$ (bits)
112	3TDEA	2048	6144
128	AES-128	3072	8192
192	AES-192	7680	16384

eIDAS QSCD/Common Criteria evaluation

- Based on the eIDAS regulation.
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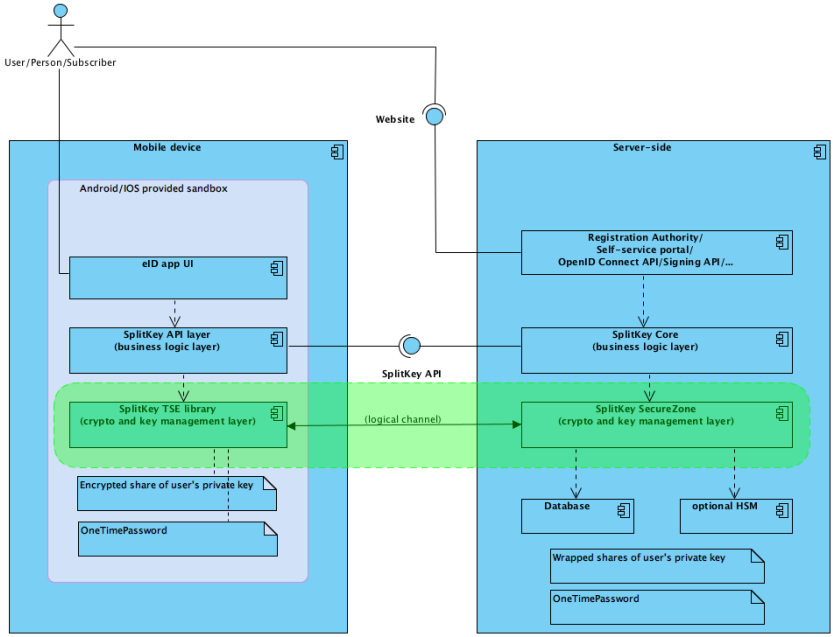
- Evaluation lab: TÜViT in Germany
- Consultant lab: CCLabs in Hungary
- Evaluation process started in the beginning of 2017 and finished in the end of 2018
- Evaluation assurance level for server-side component: EAL4 + AVA_VAN.5
- Evaluation assurance level for client-side component: EAL2


User/Person/Subscriber
Website
Mobile device
Android/IOS provided sandbox
eID app UI
SplitKey API layer
(business logic layer)
SplitKey TSE library
(crypto and key management layer)
Encrypted share of user's private key
OneTimePassword
Server-side
Registration Authority/
Self-service portal/
OpenID Connect API/Signing API/...
SplitKey Core
(business logic layer)
SplitKey API
(logical channel)
SplitKey SecureZone
(crypto and key management layer)
Database
optional HSM
Wrapped shares of user's private key
OneTimePassword

Covered threats in eIDAS QSCD

- Signer enrolment: Enrolment Forgery, Random Guessable, PubKey Forgery, MITM
- Signing process: PIN Guessing, Authentication Forgery, Access Control ByPass, Replay, MITM, Cloning, Tampering
- Cryptographic: Signature Forgery, Hash Forgery
- Other: Unauthorized System Access, Audit Log Forgery

Reduced threats, because of applied TC

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Policy security requirements for eIDAS QSCD

- Private key: Randomness, Confidentiality, Sole Control to Signer
- Signing process: Hash Integrity
- Cryptographic: Cryptographically Secure Signature Scheme
- Organisational: Qualified Trust Service Provider

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Smart-ID – A commercial service with SplitKey

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- Developed and operated by SK Identity Solutions AS, a private company in Estonia.
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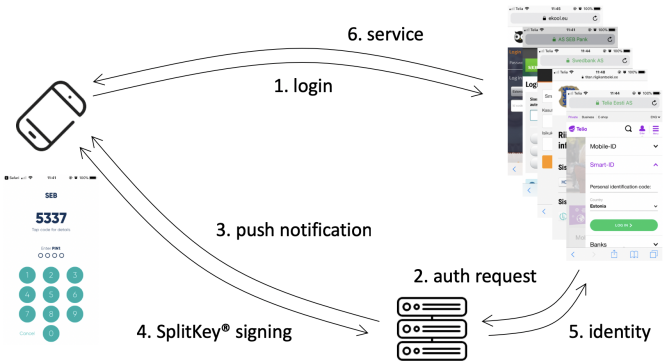
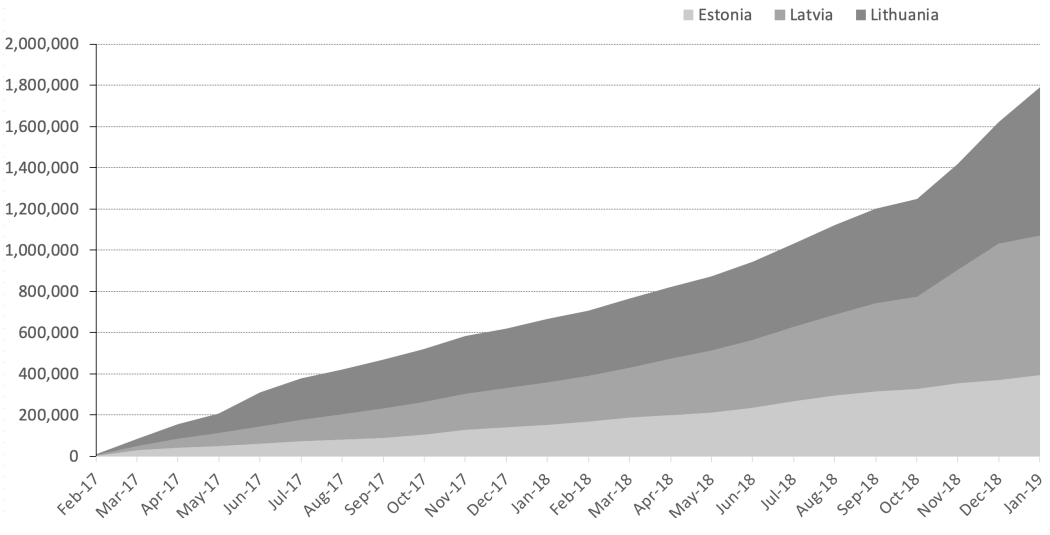
- SplitKey was originally developed for the Smart-ID service, now spun off to independent product line

Smart-ID authentication flow

- Authentication is started from the RP's webpage or RP's app, custom REST API.
- OpenID Connect API supported, but not widely used.



Smart-ID uptake since the launch



Smart-ID uptake and usage

- 1.88 M active users in total
- 35% of adult population in Estonia, Latvia, and Lithuania
- 43% - 49% of smartphone users
- 30 M transactions per month

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Questions?