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Keep your fingers off my keys

today & tomorrow

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Keys?

- **Encryption keys**
  - asymmetric e.g. RSA, ECC public/private **key** pairs for wrapping
  - symmetric e.g. AES, RC4, 3DES **keys**
- **Signature keys**
  - asymmetric e.g. DSA, ECDSA public/private **key** pairs for signing (of object hashes)
  - hash algorithms e.g. SHA-2, SHA-3
- **Certificates**
  - digitally signed **public keys**

The digital “certificate”

Public

Subject identifier: securosys.ch Issuer identifier: swisssign.com
Subject public key, e.g. RSA 4096
validity period
“checksum” = hash of above
Issuer signature, e.g. RSA 4096

Secured

Issuer signature validation key, e.g. RSA 4096
Subject private key
Issuer signature key

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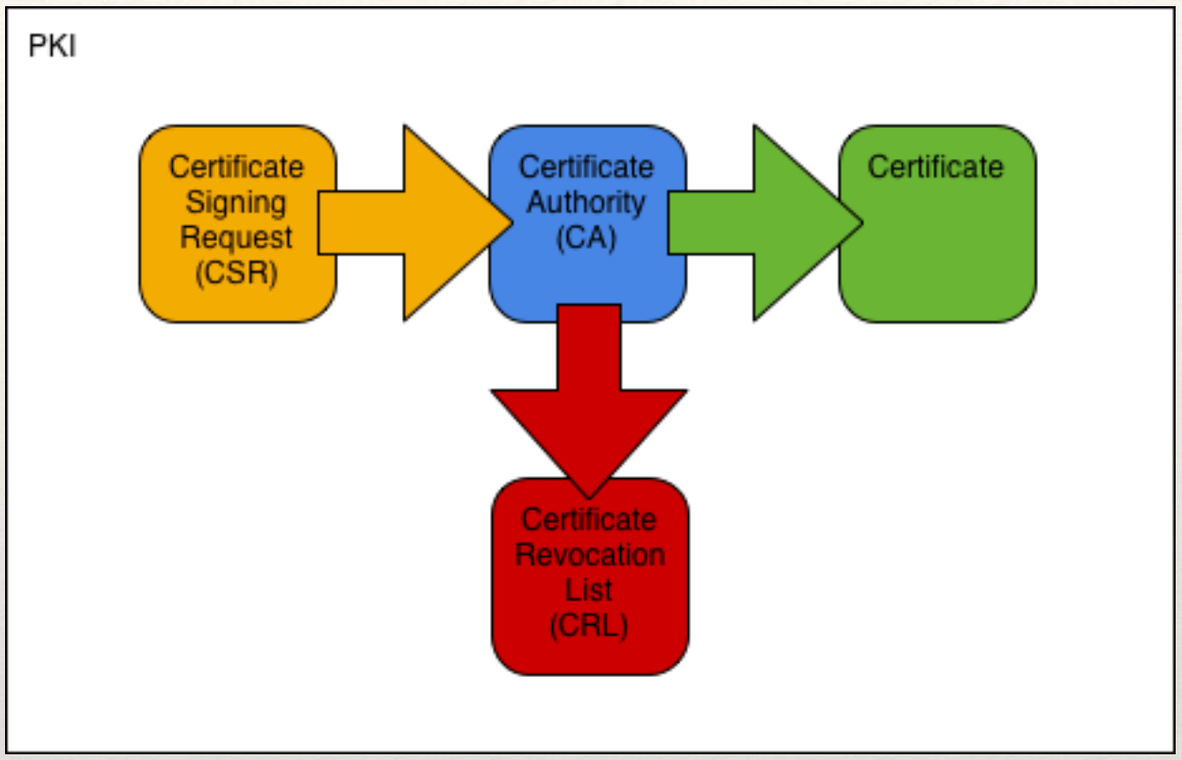
Key and Certificate Generation

- A CSR requires to
  - generate a key pair
  - safely store the private key for later usage
- CA requires to (after RA assures validity of CSR)
  - sign CSR with the secret key
  - safely store the secret key
- CA issues the Certificate
- Keys can be “revoked” thus revocation list CRL are required



Keys have to be managed!

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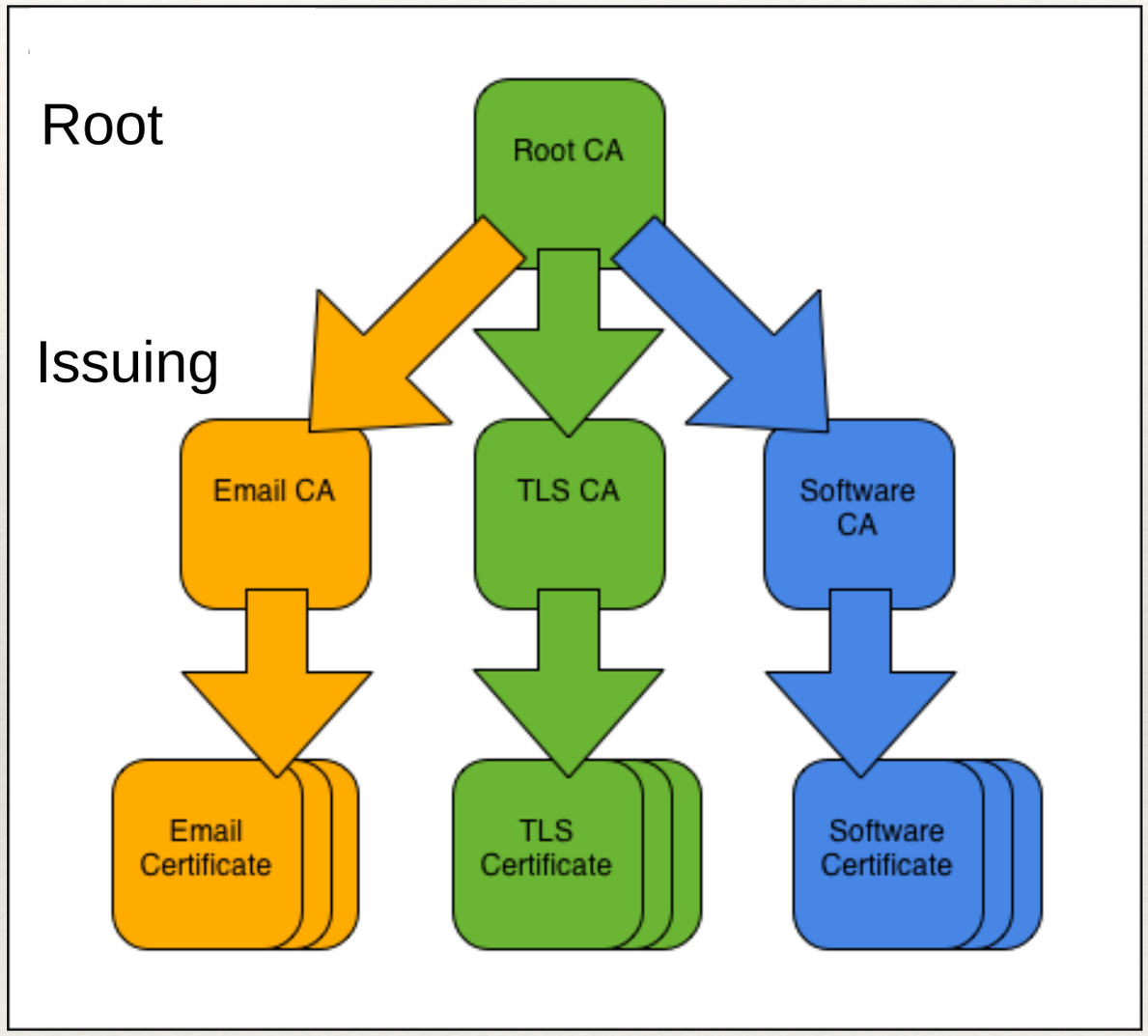
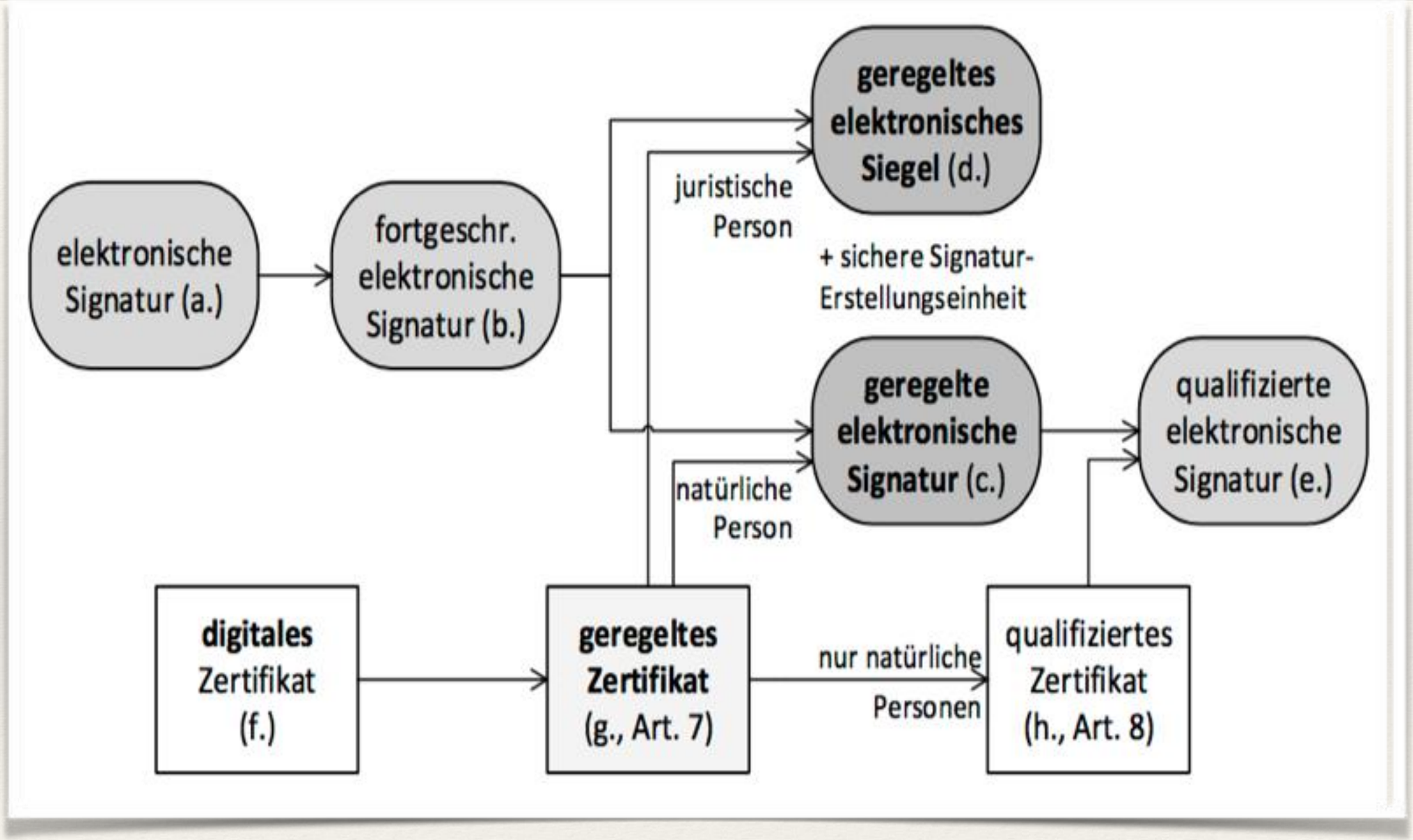
Key Management

- Typically trust is organized hierarchically
- Even in simple PKI case multiple key pairs are involved
- Different applications have different policies. This is best organized using multiple issuing certificates
- Keys can be “revoked” thus each CA needs to generate (and sign) revocation lists



“qualifizierte” elektronische Signatur



- Codified in ZertES (SR 943.02), equivalent codifications in all EU countries [3]
- issuing device (CC EAL4+, FIPS140-2 L3, or equivalent) and audited procedures (CP/CPS)

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Where are cryptographic keys used?

- Payment infrastructure
  - payment card
  - Clearing, Settlement (e.g. SIC)
- “geregelte” digital signature
  - MWST
  - e-GOV/HEALTH/PASS,…
- Web server authentication
  - (e.g. https), “SSL” certificates
  - EV-certificates
- Infrastructure Services
  - IPSEC/SSL VPN
  - DNSSEC
  - SMTP(mail)
- Personal digital signatures
  - S/MIME (email)
  - ssh, login
- Data Storage
  - TDE (Oracle, SQL Server)
  - drive encryption
  - Cloud storage and service (CASB)

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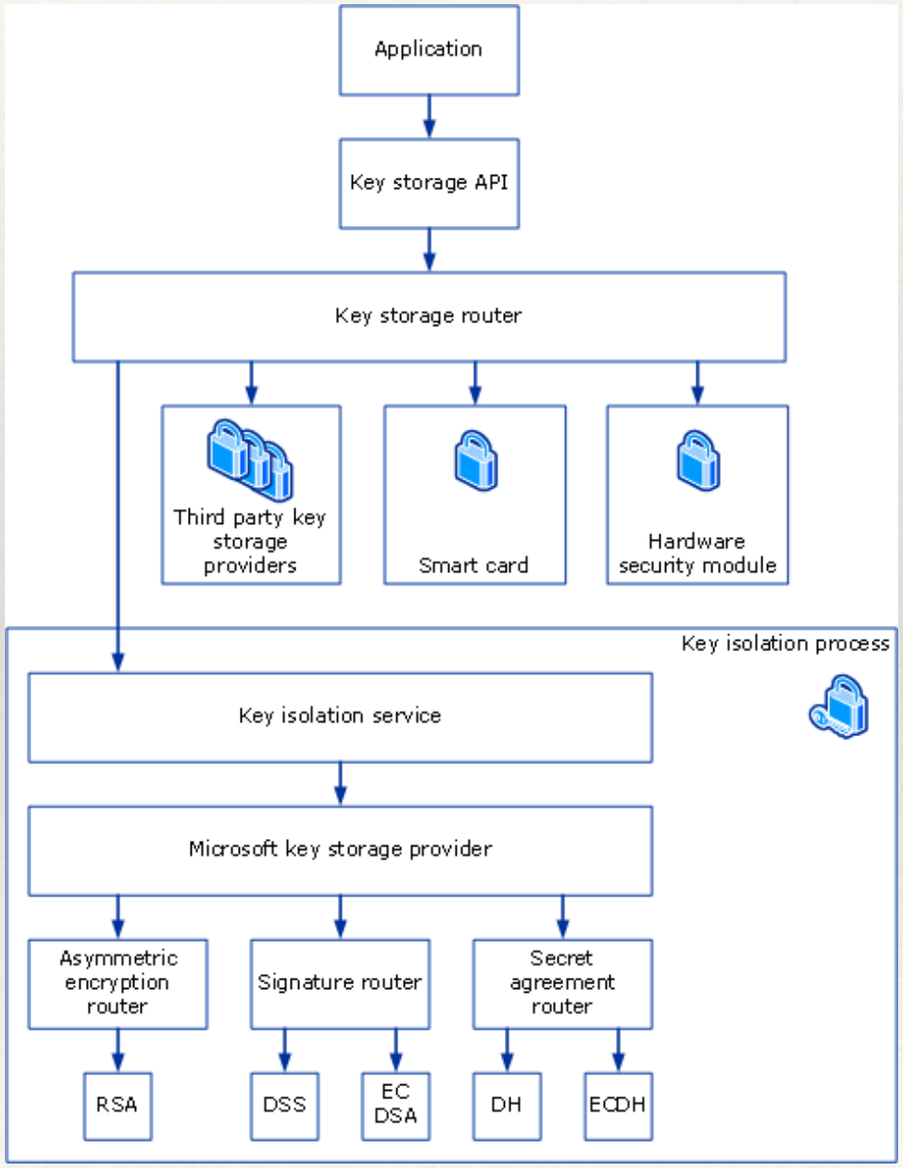
Private & Secret Key Storage

Unix (& Linux)

- Keys are typically stored in files, e.g. in users home directory
- Keys are protected by user / group file permissions
- privileged users (e.g. “root”) can access everything

```
dasen$ ls -al .ssh
drwx------  1 dasen  staff   264 Jan 27  2015 .
drwxr-xr-x+ 1 dasen  staff  1792 May 12 16:21 ..
-rw-------  1 dasen  staff  1766 Jan 27  2015 id_rsa
-rw-r--r--  1 dasen  staff   400 Jan 27  2015 id_rsa.pub
```

Microsoft Windows



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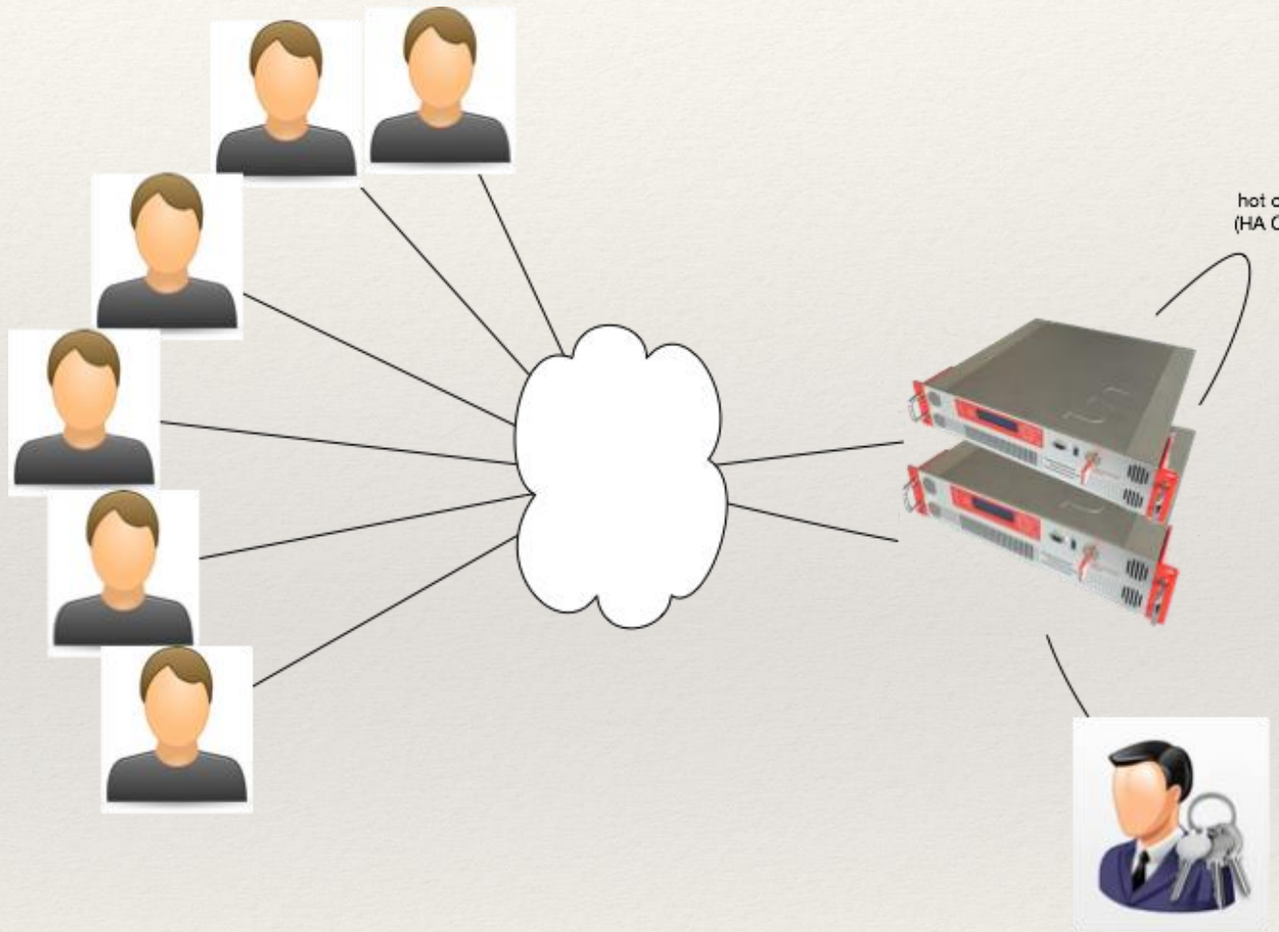
The managed Key Store

- Dedicated Module storing encryption keys
- Device protects keys against loss and thus serves as the **Trust Anchor** for the infrastructure.
- One central place to store private and secret keys



Private and secret keys never leave the Security Module

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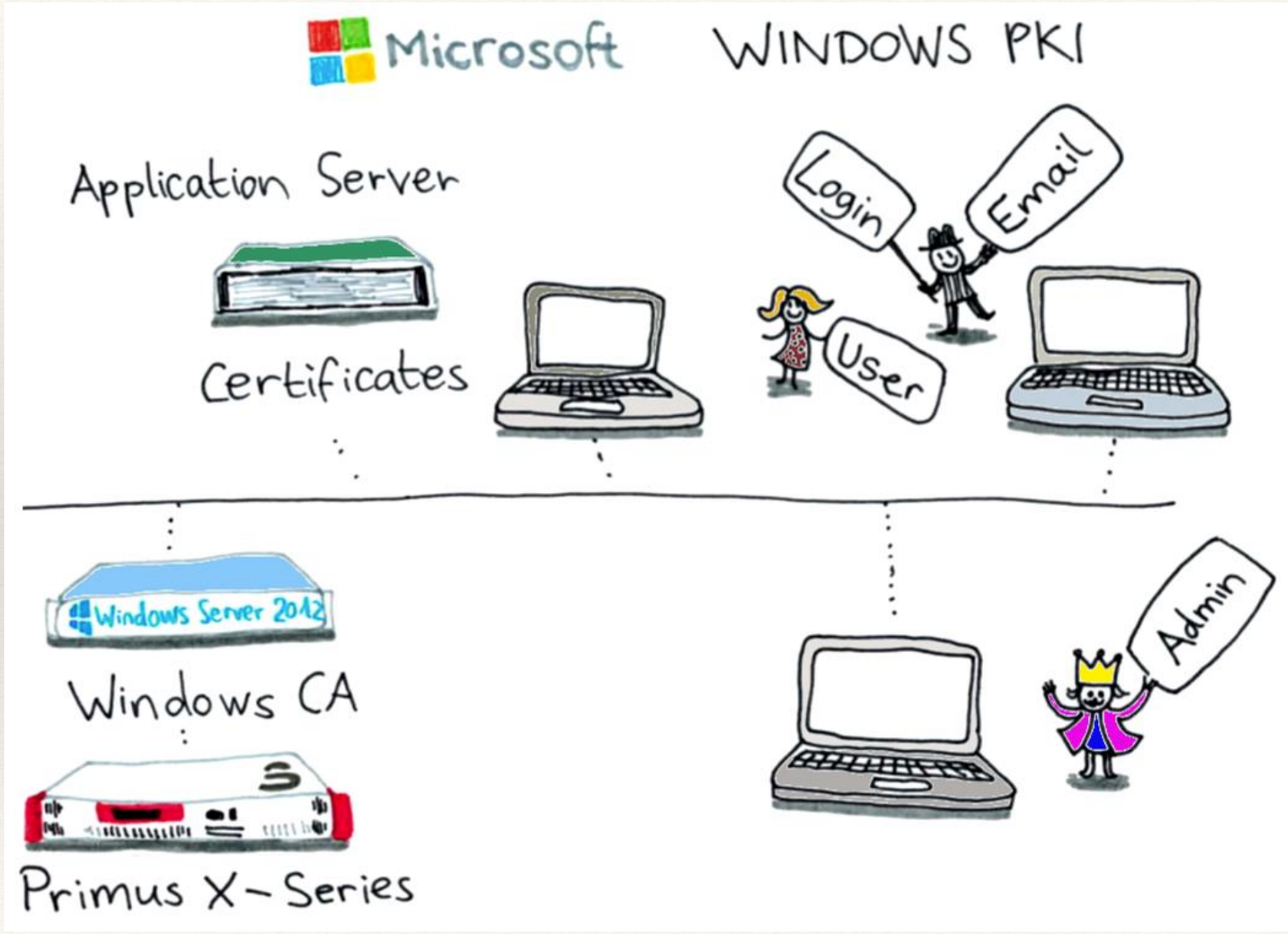
On premise IT with PKI



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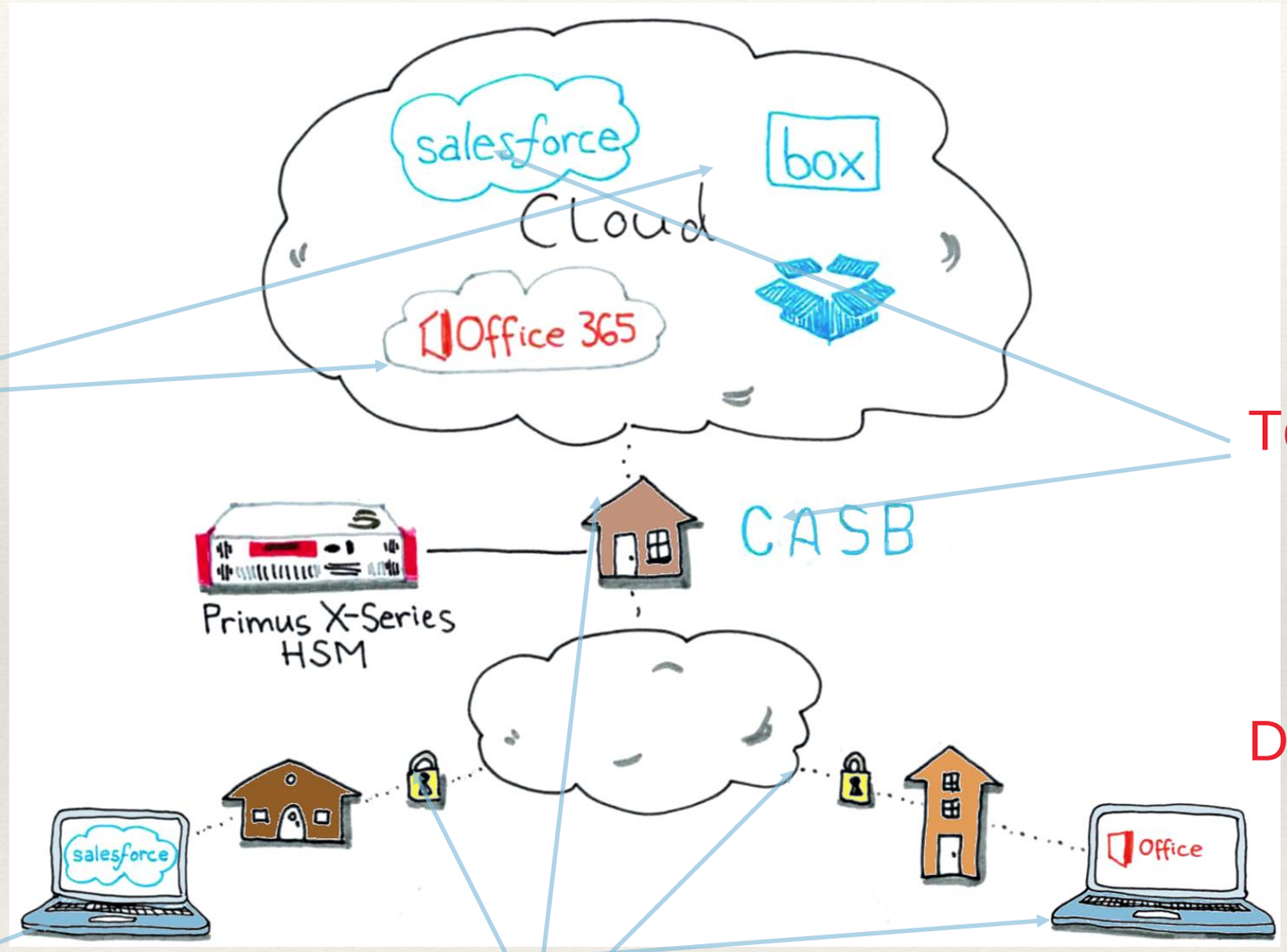
Cloud Security



Storage Encryption

BYOK

Tokenisation

DB Encryption

User authentication

VPN link encryption

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The Post Quantum World

- Asymmetric public key algorithms
  - **RSA** (integer factorization) broken by Shor's algorithm
  - **DSA, DH, ECDSA, ECDH** (discrete logarithm) broken by derived Shor algorithm
- Symmetric key algorithms
  - **AES, 3DES, …**
  - strength reduced from n-bits to n/2-bits by Grovers algorithm
  - **SHA(-256)** strength reduced n-bits to n/2-bits

… but…

Algo	qubits	runtime	expected # qubits to break
RSA	2n	c * n^3	~6000qb @ RSA3072
ECC	f’(n)(f(n)	c * n^3	~3000qb @ ECC512
AES	c * n	O(2^(n/2))	~6500qb @ AES 256

State of the Art: Today O(10) qubits

Proos and Zalka, 2008
Grasses et. al, 2015

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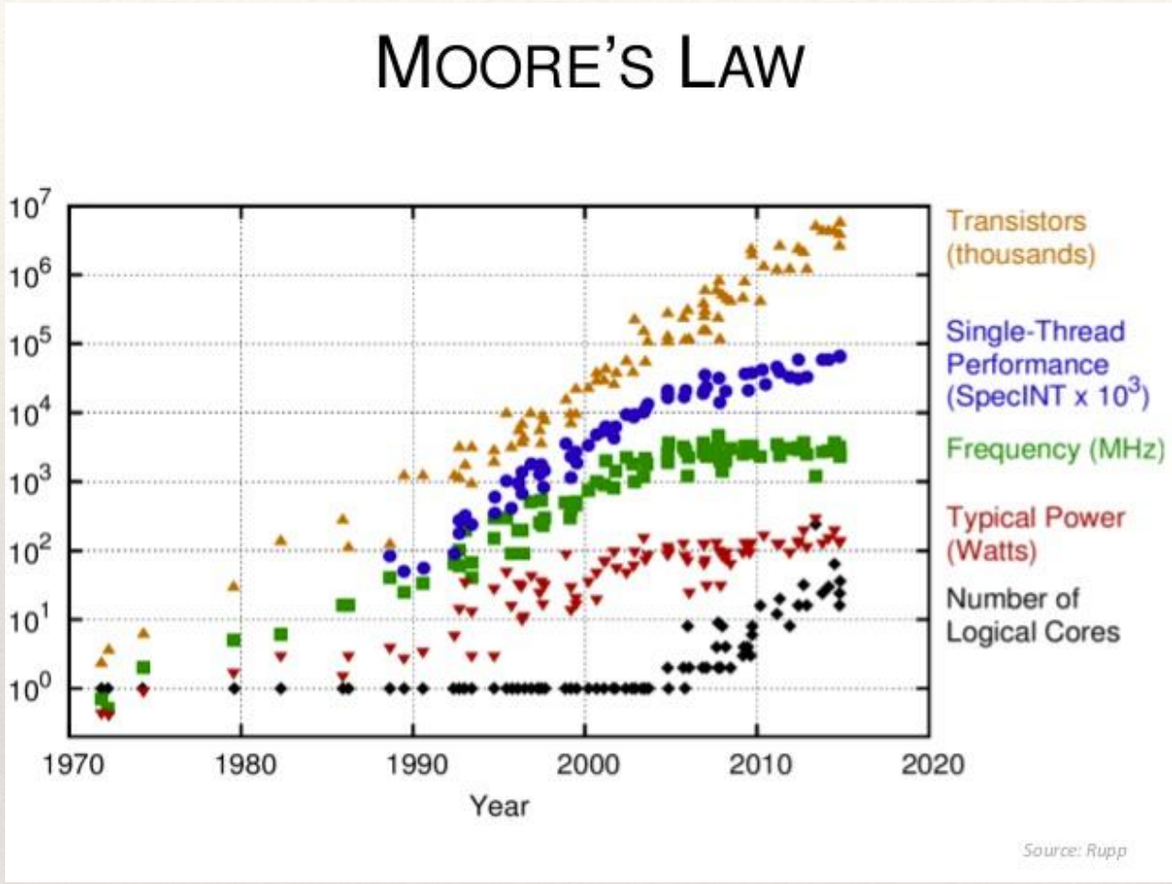
…when should we worry?

- Assuming MOORE's "law", we will have to worry in 20-50y from now.
- But does it apply at all?



Quantum Computers are NOT on a predictable technological scaling path, but assume new DISRUPTIVE technologies.

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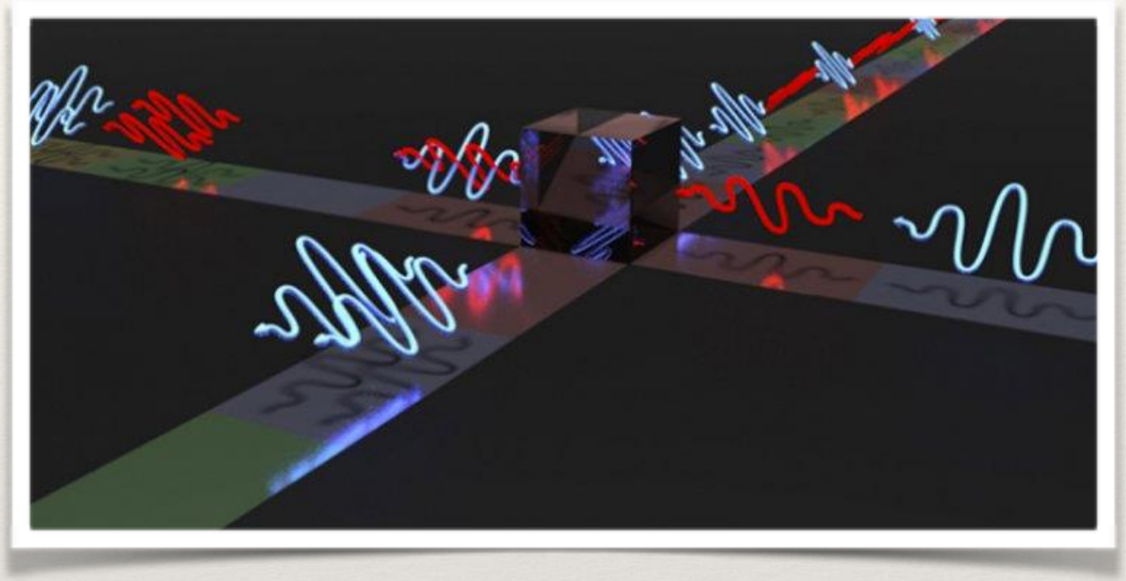
If I worry anyhow ?

- Use Protocols mostly based symmetric (AES) cryptography
  - AES
  - Kerberos
    - Safely lock away the key (e.g. HSM)
- Use long key sizes for asymmetric algorithms
  - gives you more time to transition to new algorithms
- Be prepared for post quantum algorithms
  - Future signatures and keys may consist of much longer bit strings,
- Use upgradable crypto hardware and software

Should I wait for PQC ?

- Various Research efforts on going
  - EU SAFEcrypto
    - http://www.safecrypto.eu
  - NIST PQCrypto
    - http://csrc.nist.gov/groups/ST/post-quantum-crypto
- Candidates for PQC
  - Lattice-based (NTRU, BLISS, LWE)
  - Code-based (McEliece)
  - …



These crypto systems are years away from adoption

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Address Current Threats!

- Harden your infrastructure
- Use PKI with strong cryptography
- Manage your keys
- Work with trusted suppliers

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Summary

- Digital keys are a crucial part of the digital world.
- Keys must be safeguarded. You want to know where and when they are accessed
- Keys must be managed
- PKI is the state of the art
- Keys are trusted if generated with a trustworthy key generator.
- PQC is not ready for adoption

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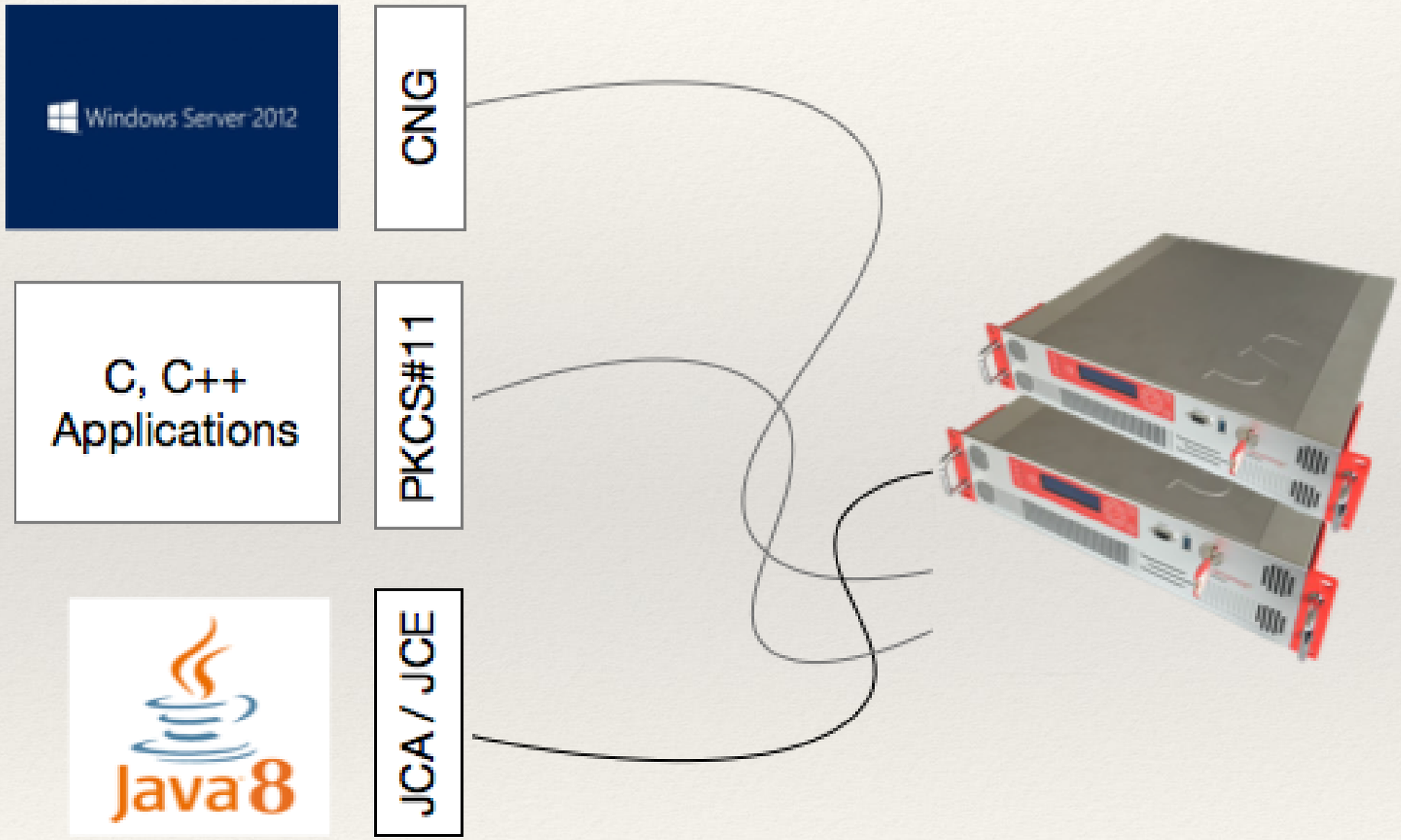
SWISS SECURITY TECHNOLOGIES
FOR COMMUNICATIONS SYSTEMS

Do I care? What are the risks?

- **Loss of** “qualifiziertes Zertifikat”, “geregeltes Zertifikat” **signature certificate private key**
  - Legally binding signatures can be issued
- **Loss of communication certificate private keys**
  - interception possibility (eaves dropping, man in the middle)
  - potentially conflict with data protection laws
- **Loss of storage keys**
  - loss of intellectual property,
  - business continuity cost (e.g. after loss of credit card holder data)
  - potentially conflict with data protection laws
- **Loss of “SSL” certificate private key** (e.g. EV certificate)
  - Web site, email impersonation => attack vector
  - Risk for reputation with customers / partners

Integration of a trust anchor



Generating and managing keys

- Use a secure key generation device (HSM)
  - Hardware random number generator
    - Validated encryption algorithms
- Keep private keys in protected storage
  - Hardware security module
- Use a Software CA or Windows built-in CA