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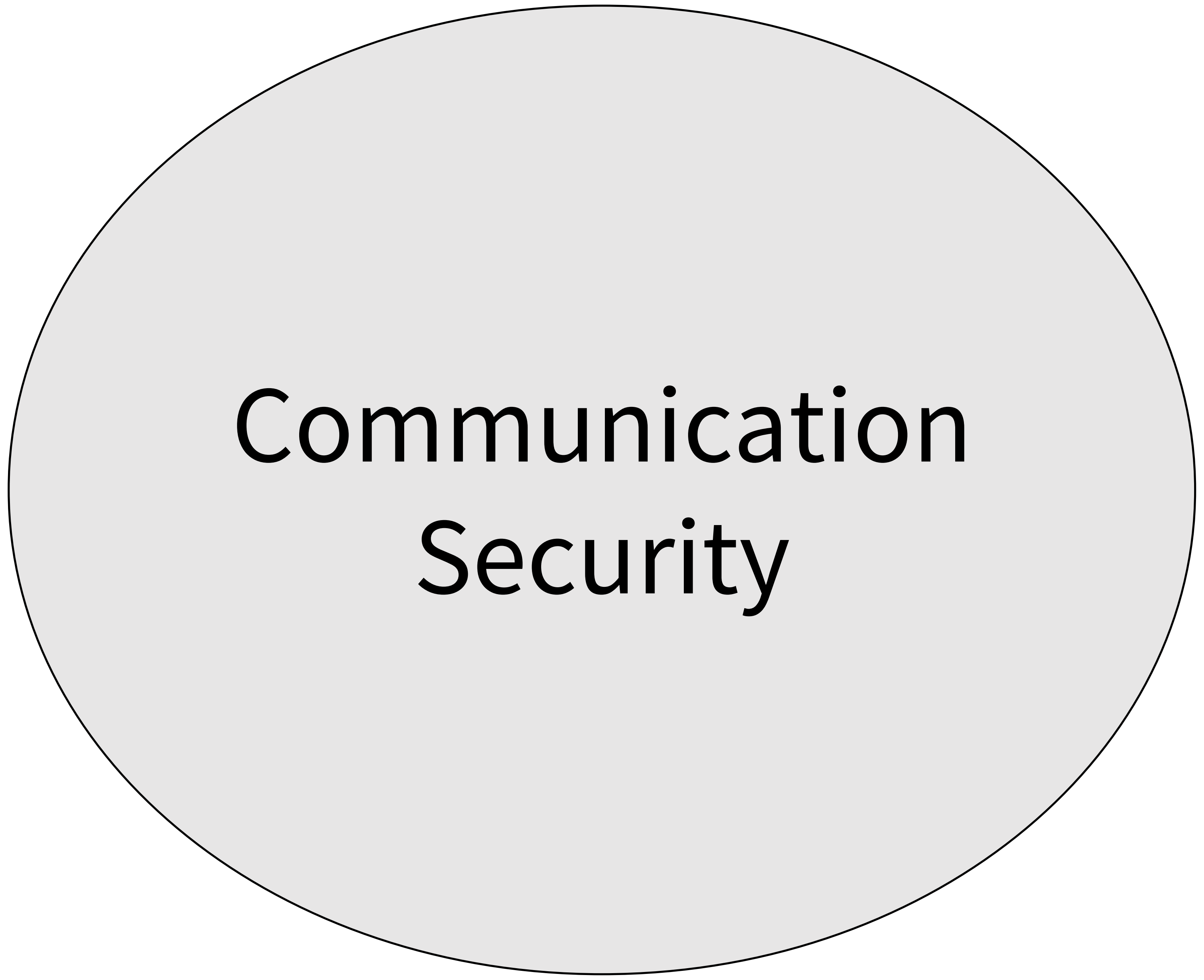
Is Remote Attestation Relevant for Embedded Devices?"

Hannes Tschofenig

RIOT Summit: A Long Journey

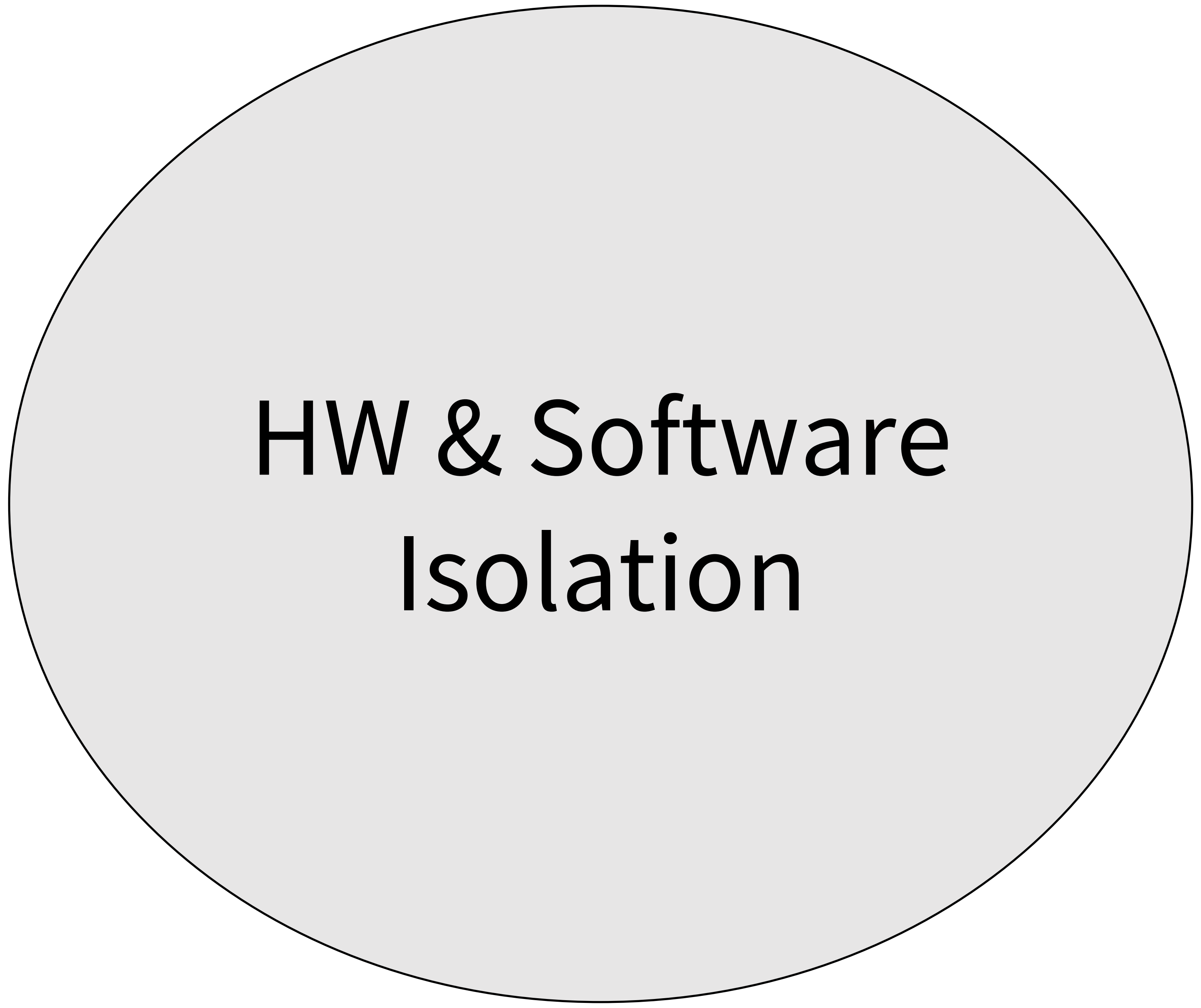


Communication Security

In any distributed systems there is (naturally) interest in securing the communication between endpoints.

RIOT Summit: A Long Journey

With the increase of vulnerabilities on the endpoints many isolation technologies were developed.



HW & Software Isolation

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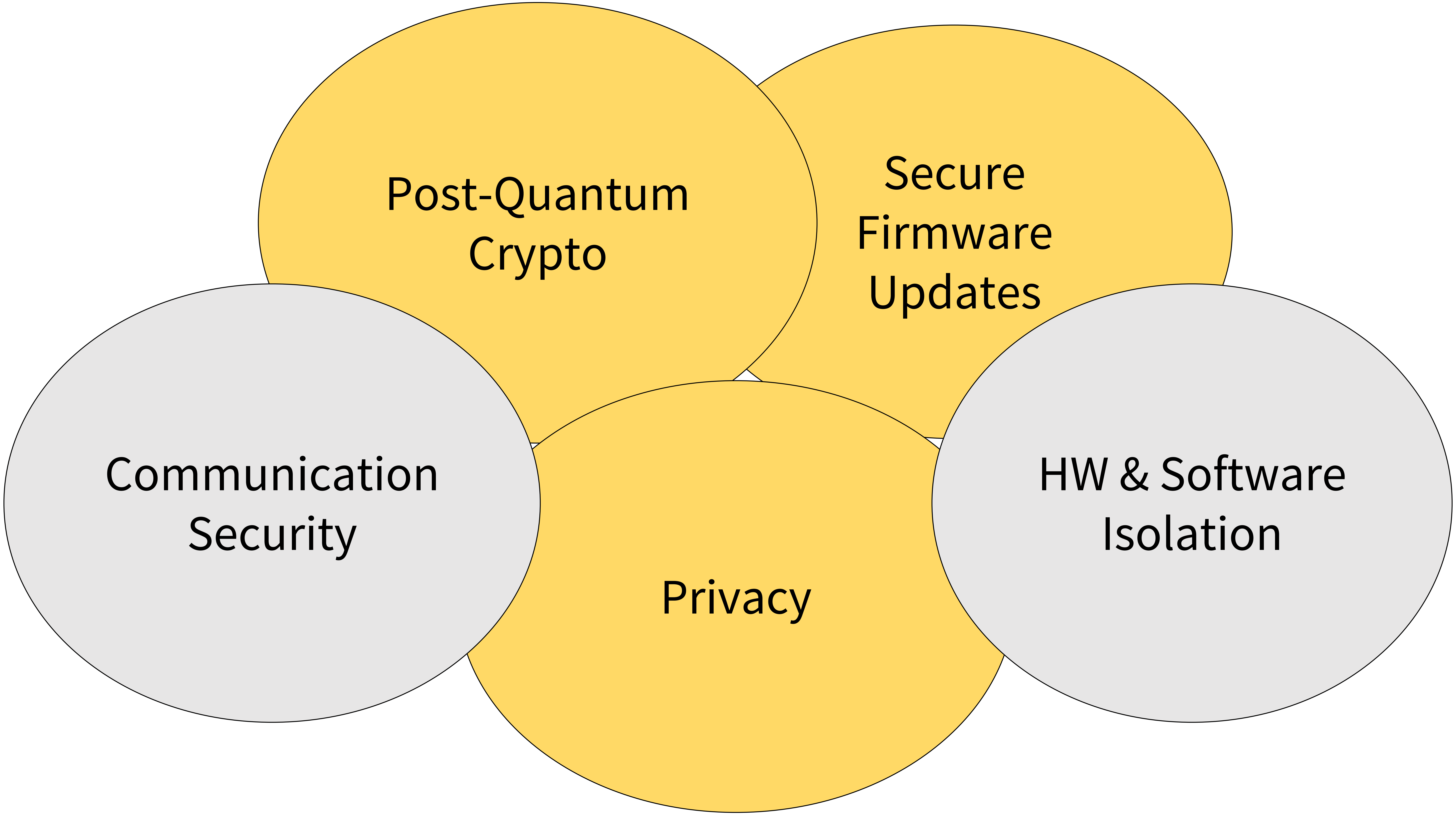

How to communicate that the device …

- is running the expected bootloader, firmware, application software?
- has specific security-settings?
- has been manufactured by company Y?
- uses certified hardware?
- stores keys in a secure element?
- …

Use Cases

- Network Endpoint Assessment
- Confidential Computing
- Protection of confidential ML models
- Critical Infrastructure Control
- Trusted Execution Environment Provisioning
- FIDO Authenticators
- CA/Browser Forum - Code Signing
- Digital Identity Wallet
- DRM
- CAPTCHA replacement
- Device Onboarding

Use Cases

Provision confidential workload (code, and data) only to trusted environment.

- Network Endpoint Assessment
- **Confidential Computing**
- Protection of confidential ML models
- Critical Infrastructure Control
- Trusted Execution Environment Provisioning

- FIDO Authenticators
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Store digital credential only on device that offers certain security protection

- Network Endpoint Assessment
- Confidential Computing
- Protection of confidential ML models
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- DRM
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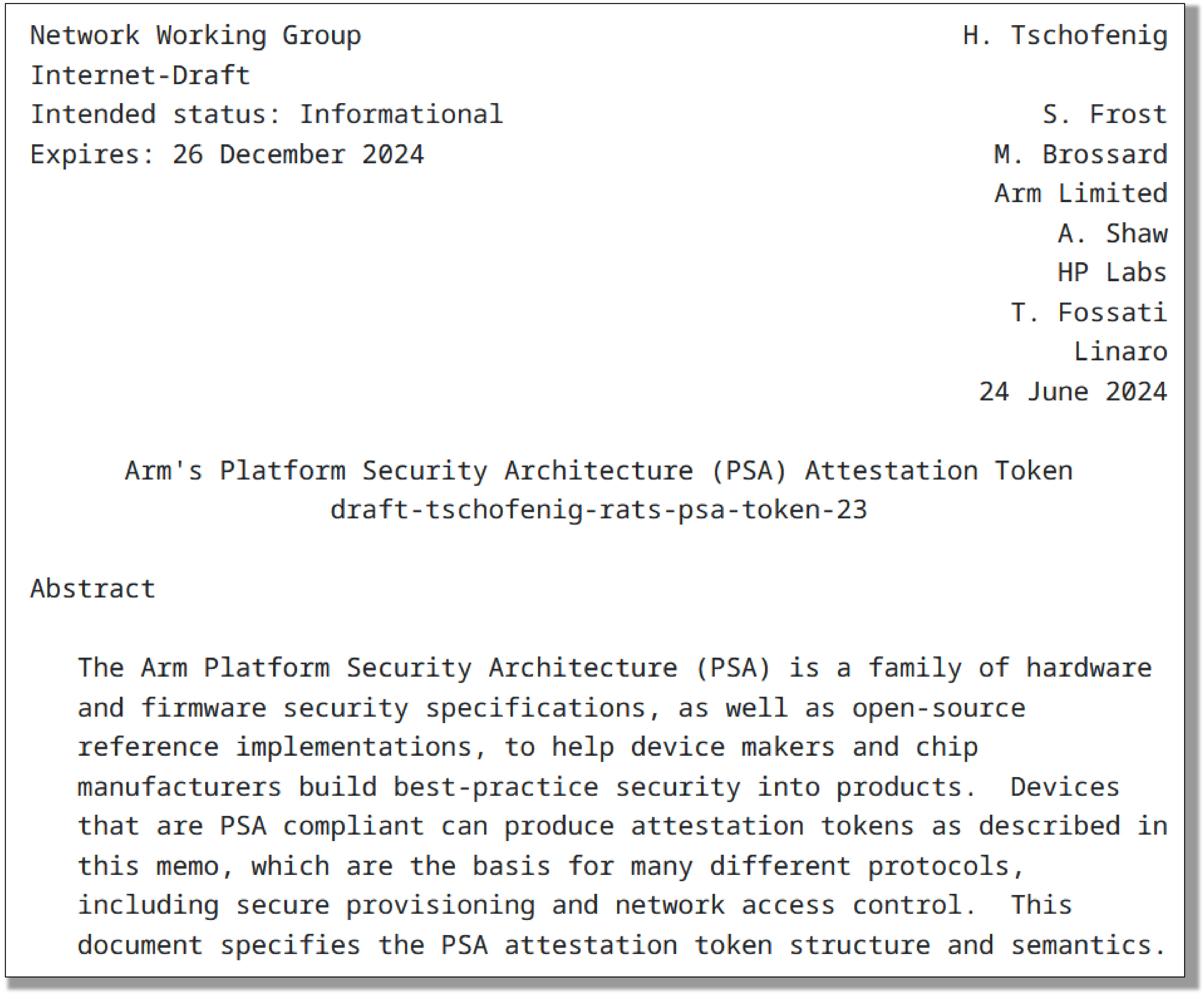
Attestation for Microcontrollers

- PSA Attestation Token represents early work.
- Offers *initial* attestation, i.e. limited set of Target Environments, namely those representing the first, foundational stages of the boot process.
- Reference implementation for devices available with Trusted Firmware M (→ attestation service) and the verification service Veraison.



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Network Working Group                                      H. Tschofenig
Internet-Draft
Intended status: Informational                                  S. Frost
Expires: 26 December 2024                                    M. Brossard
                                                             Arm Limited
                                                                 A. Shaw
                                                                 HP Labs
                                                              T. Fossati
                                                                  Linaro
                                                            24 June 2024


        Arm's Platform Security Architecture (PSA) Attestation Token
                    draft-tschofenig-rats-psa-token-23

Abstract

   The Arm Platform Security Architecture (PSA) is a family of hardware
   and firmware security specifications, as well as open-source
   reference implementations, to help device makers and chip
   manufacturers build best-practice security into products.  Devices
   that are PSA compliant can produce attestation tokens as described in
   this memo, which are the basis for many different protocols,
   including secure provisioning and network access control.  This
   document specifies the PSA attestation token structure and semantics.
```

Attester

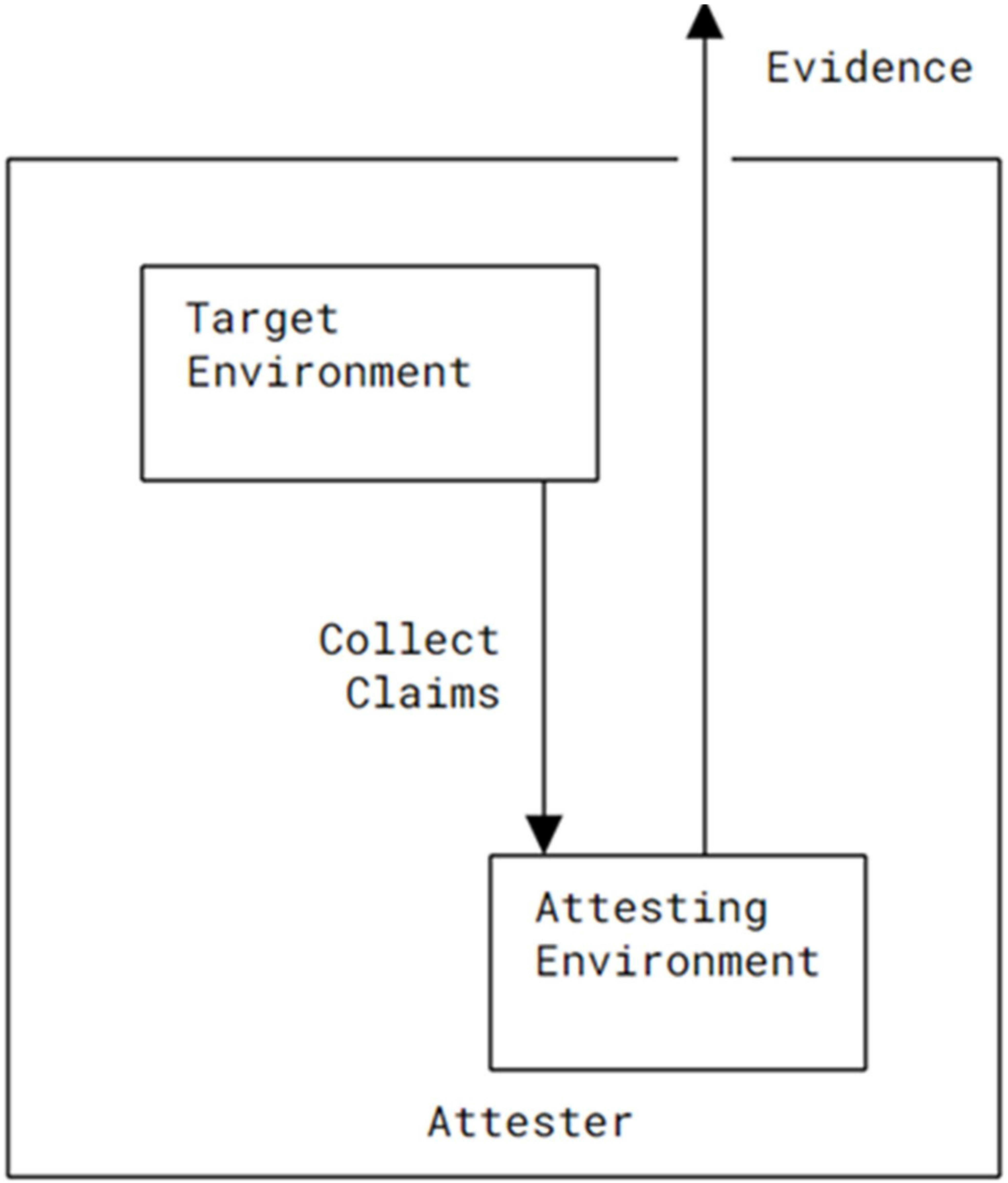
Collects information about Target Environments in form of claims.

Examples for collected information:

- Software measurements (version number, hash value)
- Device configuration (lifecycle state)

Cryptographically protects collected information (with digital signature or MAC) and releases it as Evidence.

Entities and communication patterns described in RFC 9334.



Variants of Attestation

Platform Attestation

- Foundational software (e.g., firmware & bootloader),
- Configuration (e.g., lifecycle state)
- Hardware properties

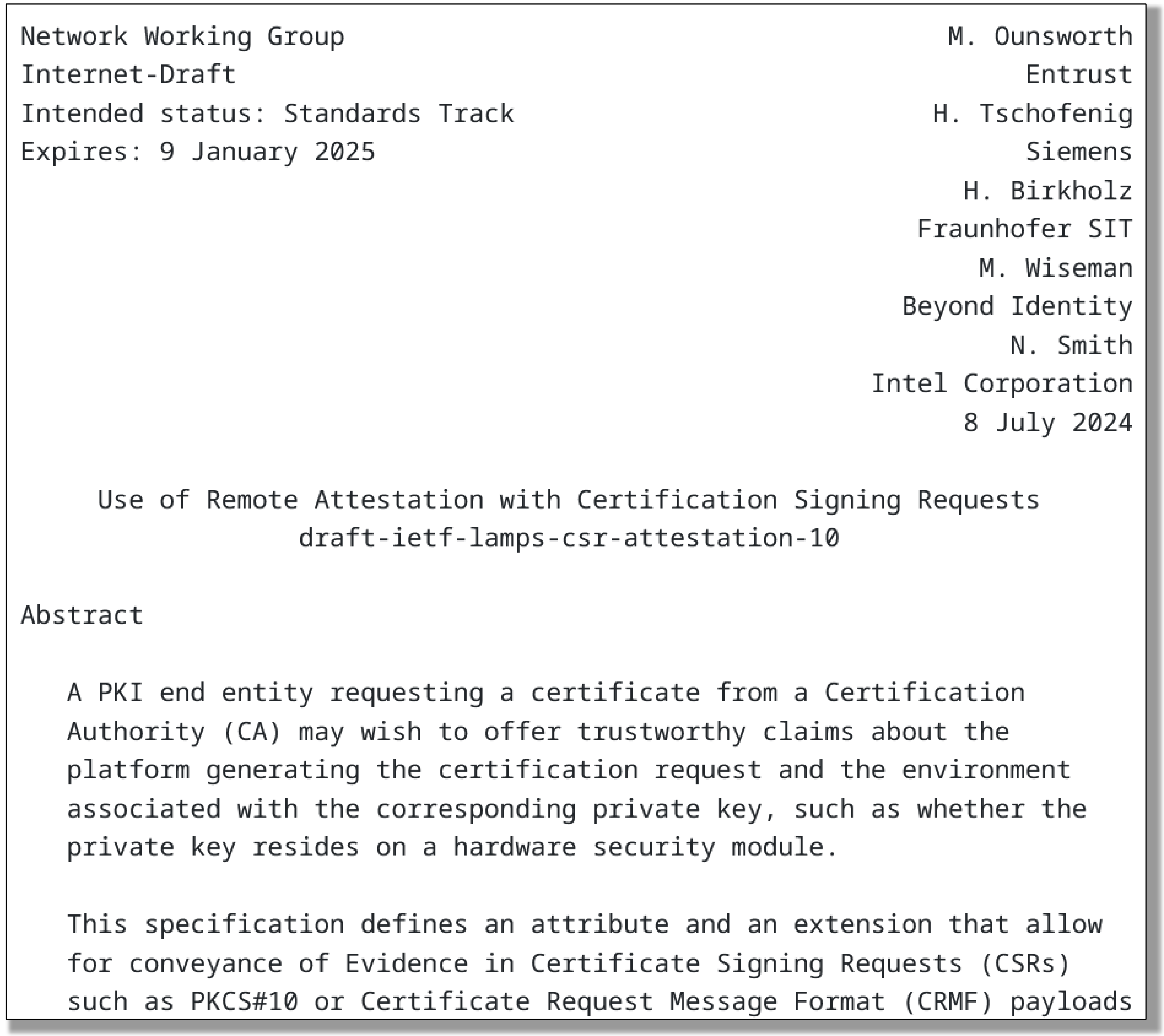
Key Attestation

- Key generation and storage attributes, i.e., how a key is stored (e.g., “secure element protected”)
- Which operations can be performed using the key(s) (e.g., signing)

Additional dimension: How often can information change?

Key Attestation: New Work on Attested CSR

- CSR = Certificate Signing Request
  - PKCS#10 – RFC 2986
  - Certificate Request Message Format (CRMF) – RFC 4211
- Developed in a design team of ~30 persons comprised of
  - HSMs: Entrust, Thales, Utimaco, I4P, Crypto4A, Fortanix, Intel (TPM)
  - CAs (and CA software vendors): Entrust, Digicert, KeyFactor, Smallstep
  - Users of the technology: Siemens, Bloomberg, Nokia, Ericsson
  - Various IETF, NIST and TCG veterans



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Network Working Group                                      M. Ounsworth
Internet-Draft                                                  Entrust
Intended status: Standards Track                           H. Tschofenig
Expires: 9 January 2025                                         Siemens
                                                             H. Birkholz
                                                          Fraunhofer SIT
                                                              M. Wiseman
                                                         Beyond Identity
                                                                N. Smith
                                                       Intel Corporation
                                                             8 July 2024


     Use of Remote Attestation with Certification Signing Requests
                  draft-ietf-lamps-csr-attestation-10

Abstract

   A PKI end entity requesting a certificate from a Certification
   Authority (CA) may wish to offer trustworthy claims about the
   platform generating the certification request and the environment
   associated with the corresponding private key, such as whether the
   private key resides on a hardware security module.

   This specification defines an attribute and an extension that allow
   for conveyance of Evidence in Certificate Signing Requests (CSRs)
   such as PKCS#10 or Certificate Request Message Format (CRMF) payloads
```
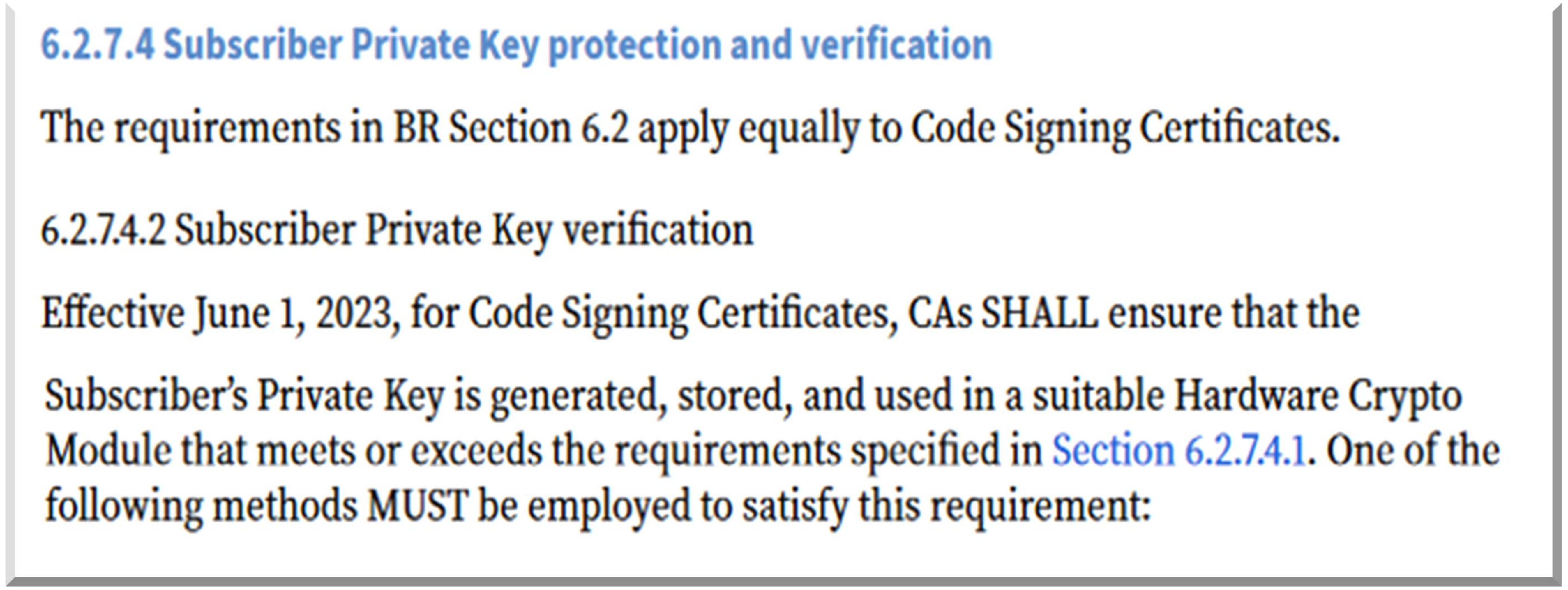

Motivation CSR Attestation

To help prevent code signing keys from “walking away”, the CA/Browser Forum instituted a requirement, effective June 1, 2023 that all publicly-trusted code signing keys must be in >= FIPS 140-2 level 2 or CC EAL 4+ hardware.



6.2.7.4 Subscriber Private Key protection and verification

The requirements in BR Section 6.2 apply equally to Code Signing Certificates.

6.2.7.4.2 Subscriber Private Key verification

Effective June 1, 2023, for Code Signing Certificates, CAs SHALL ensure that the

Subscriber’s Private Key is generated, stored, and used in a suitable Hardware Crypto Module that meets or exceeds the requirements specified in Section 6.2.7.4.1. One of the following methods MUST be employed to satisfy this requirement:

Reference: https://cabforum.org/wp-content/uploads/Baseline-Requirements-for-the-Issuance-and-Management-of-Code-Signing.v3.3.pdf

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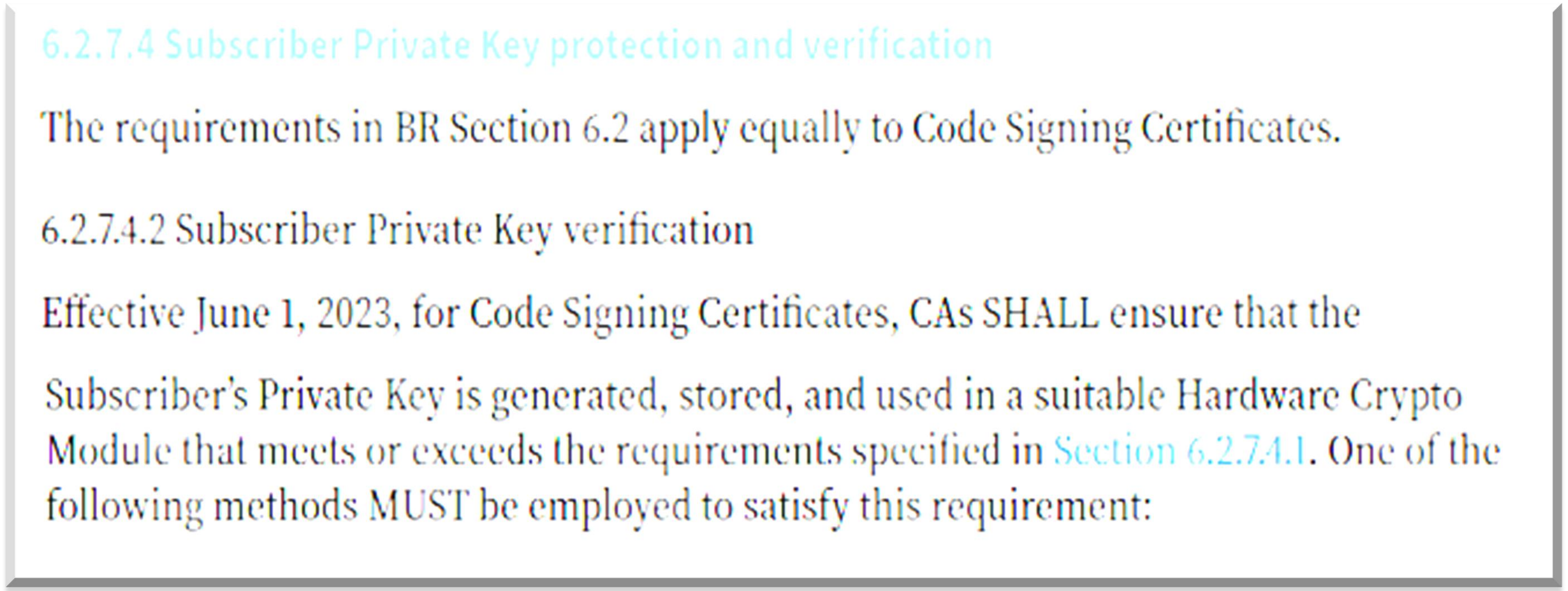

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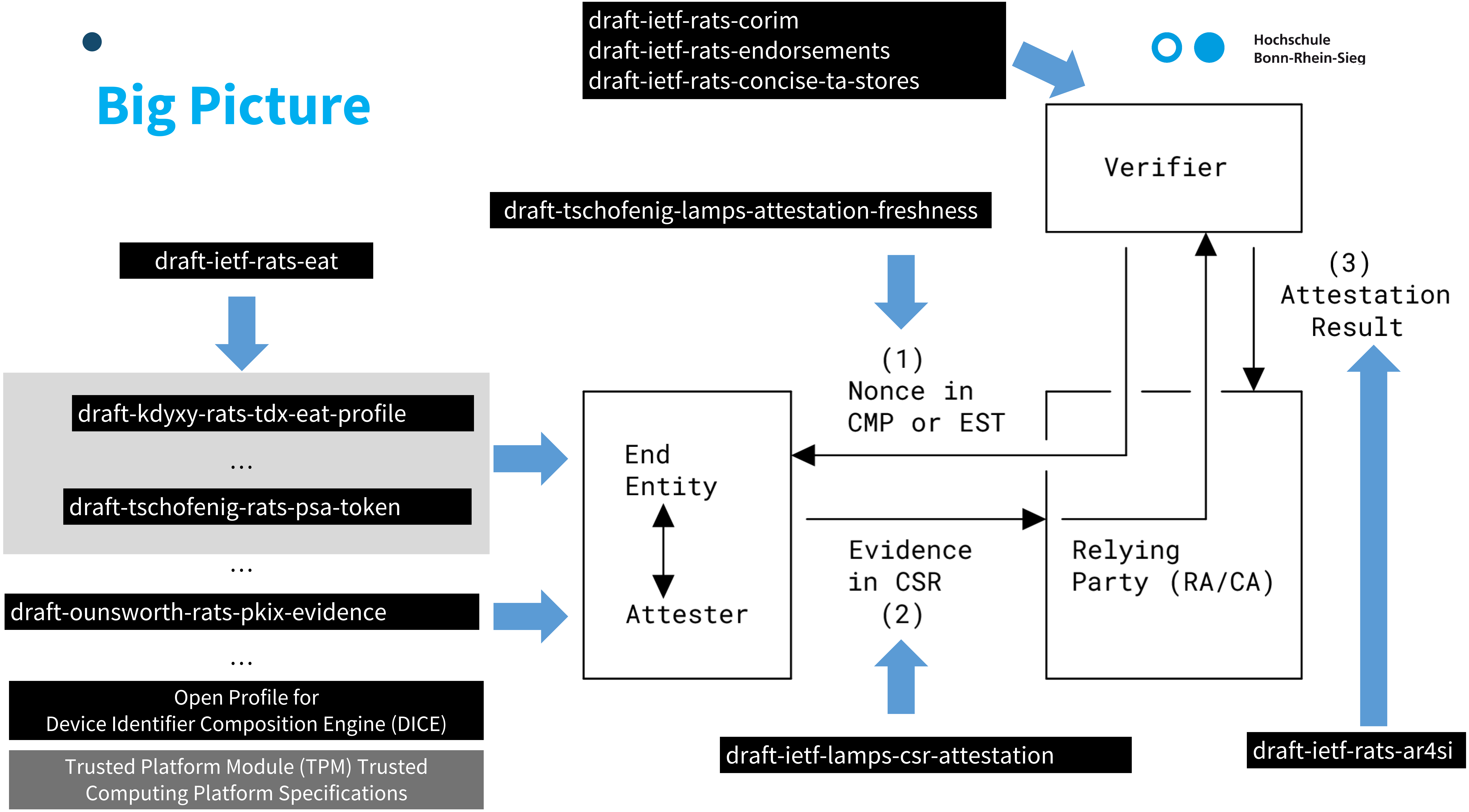
Problem #1: How is an HSM operator supposed to prove this to a CA?

Remote Attestation

Problem #2: How is a CA supposed to decide what evidence counts and what doesn’t?

Verifier Configuration

Big Picture



draft-ietf-rats-corim
draft-ietf-rats-endorsements
draft-ietf-rats-concise-ta-stores

draft-tschofenig-lamps-attestation-freshness

draft-ietf-rats-eat

draft-kdyxy-rats-tdx-eat-profile

...

draft-tschofenig-rats-psa-token

...

draft-ounsworth-rats-pkix-evidence

...

Open Profile for
Device Identifier Composition Engine (DICE)

Trusted Platform Module (TPM) Trusted
Computing Platform Specifications

draft-ietf-lamps-csr-attestation

draft-ietf-rats-ar4si

Attestation for Embedded Devices

Where is it useful?

Device-to-Device Communication Pattern

Device Onboarding Use Cases

Dynamic Attestation Information

Confidential AI

Microcontroller is part of an SoC design

Device uses Measured Boot

Next Steps

Call for Support: Your Input is needed

CSR Attestation

- Draft in last call for comments: https://datatracker.ietf.org/doc/draft-ietf-lamps-csr-attestation/
- For TPM-based key attestation, scripts for use with CSRs are available at: https://github.com/mwiseman-byid/csr-attestation-tpm-example

PKI-based Evidence

- Evidence format that is tailored to PKI deployments: https://datatracker.ietf.org/doc/draft-ounsworth-rats-pkix-evidence/

Use of attestation in TLS

- Draft: https://datatracker.ietf.org/doc/draft-fossati-tls-attestation/
- Reference implementation (part of the attested TLS implementation):
  https://github.com/veraison/services/tree/demo-attested-tls
  https://github.com/CCC-Attestation/attested-tls-poc