MACRONIX

TF-M External Trusted Secure Storage Proposal

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Agenda

- PSA storage API spec review
- External trusted secure storage discussion
- Current external trusted secure storage implementation introduction

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- **PSA storage API spec review**
- External trusted secure storage discussion
- Current external trusted secure storage implementation introduction

PSA storage APIs spec review

- **Modern embedded platforms have multiple types of storage, each with different security properties .**
  - **on-chip flash storage**
  - **external storage that requires confidentiality, integrity, and replay protection from attackers with physical access to the device**
- **The PSA Storage APIs provide key/value storage interfaces for use with device-protected storage.**
  - **PSA Internal Trusted Storage API**
    - It is intended to be used for assets that must be placed inside internal flash. Some examples of assets that require this are replay protection values for external storage and keys for use by components of the PSA Root of Trust.
    - PSA ITS APIs:
      psa_its_set()
      psa_its_get()
      psa_its_get_info()
      psa_its_remove()

PSA storage APIs spec review

- **The PSA Storage APIs provide key/value storage interfaces for use with device-protected storage.**
  - **PSA Protected Storage API**
    - It is intended to be used to protect storage media that are external to the MCU package, with a promise of data-at-rest protection, including device-bound encryption, integrity, and replay protection.
    - PSA PS APIs:

      psa_ps_set()

      psa_ps_get()

      psa_ps_get_info()

      psa_ps_remove()

      psa_ps_create()

      psa_ps_set_extended()

      psa_ps_get_support()

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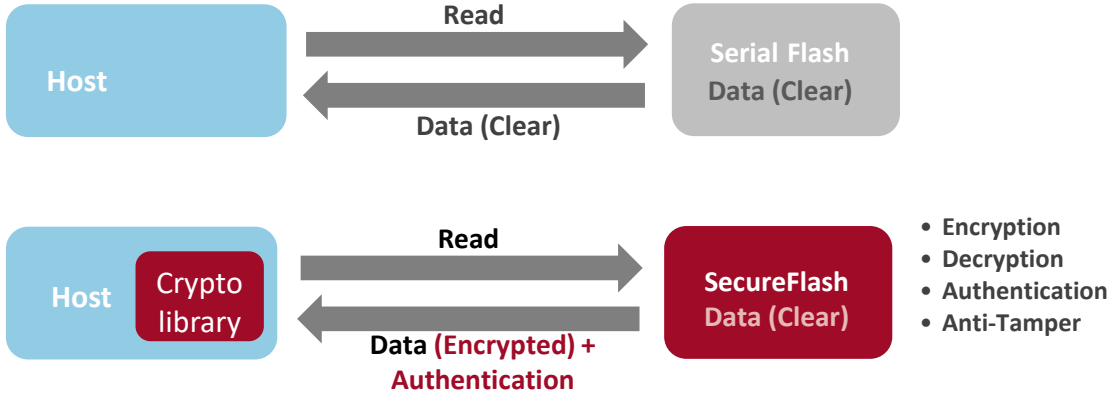
External trusted secure storage

- **The third storage - External trusted secure storage**
  - Unique identity
  - Mutual authenticated read/write between host and external trusted storage
  - Dynamic encrypted transaction on the interface bus against snooping
  - Hardware protection against tampering
  - Other security functions



- **PSA Storage APIs spec hasn't discussed this kind of storage yet.**

External trusted secure storage

- External trusted secure storage(ETSS) APIs

PSA ITS APIs	PSA PS APIs	ETSS APIs
psa_its_set()	psa_ps_set()	etss_set()
psa_its_get()	psa_ps_get()	etss_get()
psa_its_get_info()	psa_ps_get_info()	etss_get_info()
psa_its_remove()	psa_ps_remove()	etss_remove()
	psa_ps_create()	TBD
	psa_ps_set_extended()	TBD
	psa_ps_get_support()	TBD
		TBD

External trusted secure storage

- **External trusted secure storage(ETSS) requirements**
  1. **The technology and techniques used by the ETSS service MUST allow for frequent writes and data updates.**
  2. **The storage underlying the ETSS MUST support cryptographic functions to provide encryption, authentication, integrity or replay protection.**
  3. **The storage underlying the ETSS MUST keep cryptographic keys secure.**
  4. **The storage underlying the ETSS MAY support cryptographic keys secure update.**
  5. **The storage underlying the ETSS MAY have several isolated regions.**
  6. **The ETSS service MUST use the partition ID information associated with each request for its access control mechanism.**
  7. **The ETSS service MUST provide protection from one PSA partition accessing the storage assets of a different partition.**
  8. **The creation of a uid with value 0 (zero) must be treated as an error**
  9. **TBD**

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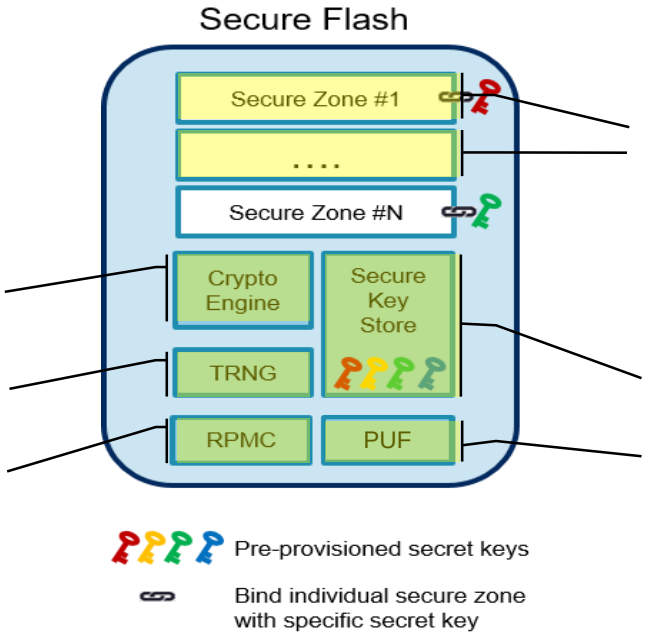
External trusted secure storage implementation

- **An example of external trusted secure storage medium**



Encryption/decryption/ authentication/integrity

High entropy random number

Replay protection

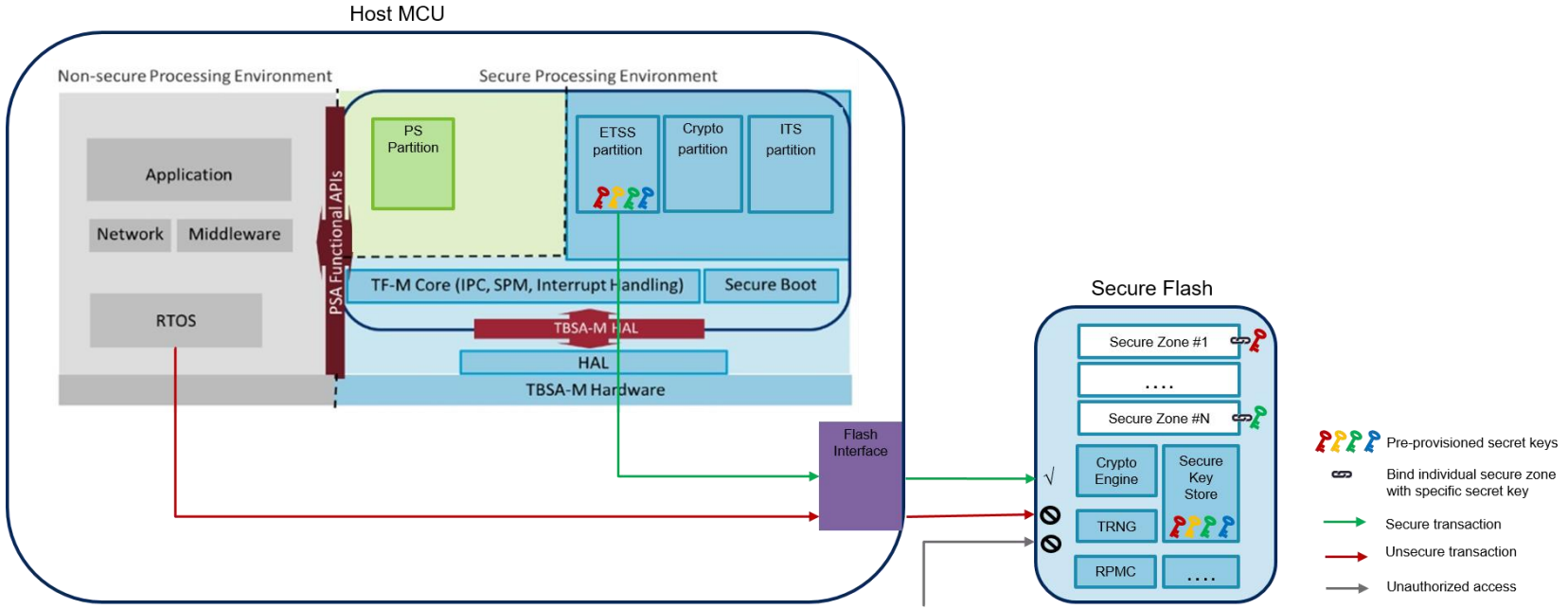
Secure storage area is partitioned into several isolated data zones configured with different access control, support multi-tenant isolation

Security keys never leave

Physical unique identity

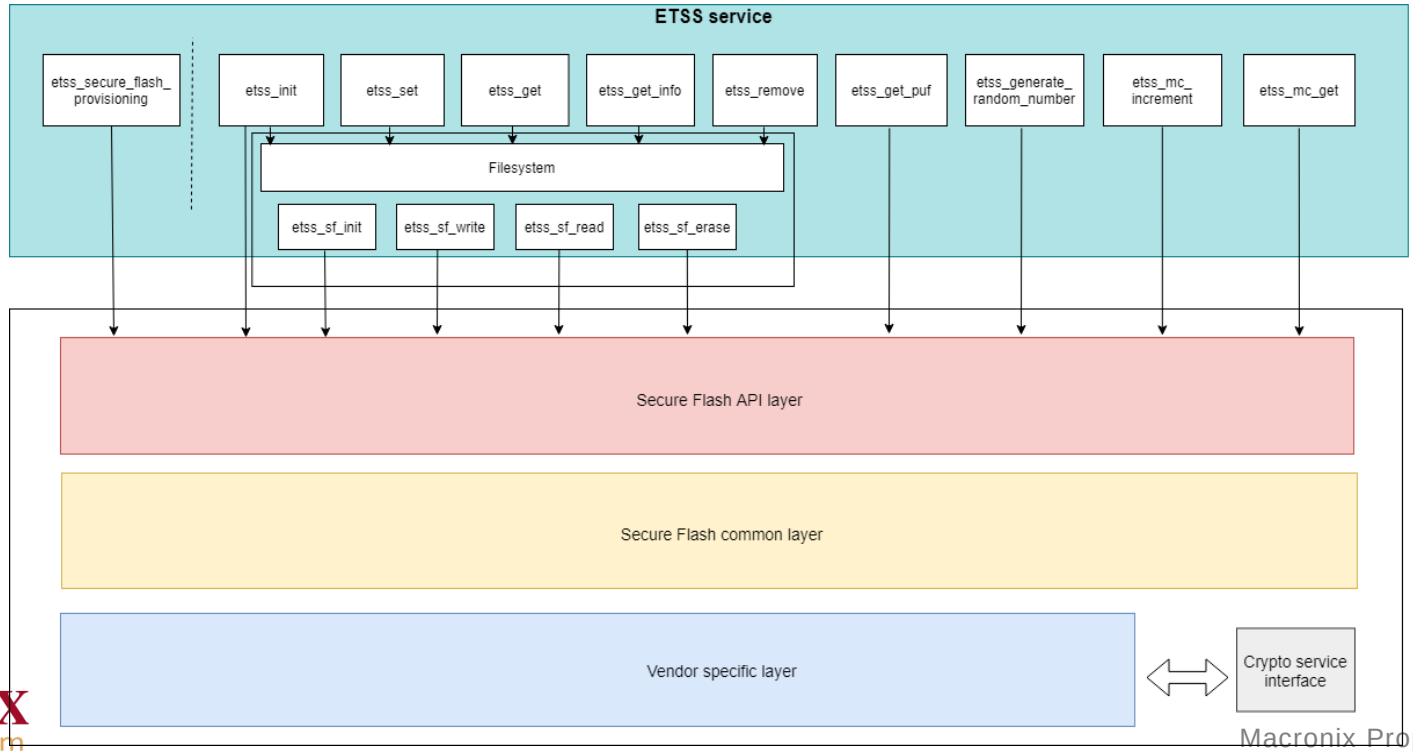
External trusted secure storage implementation

External Trusted Secure Storage(ETSS) partition



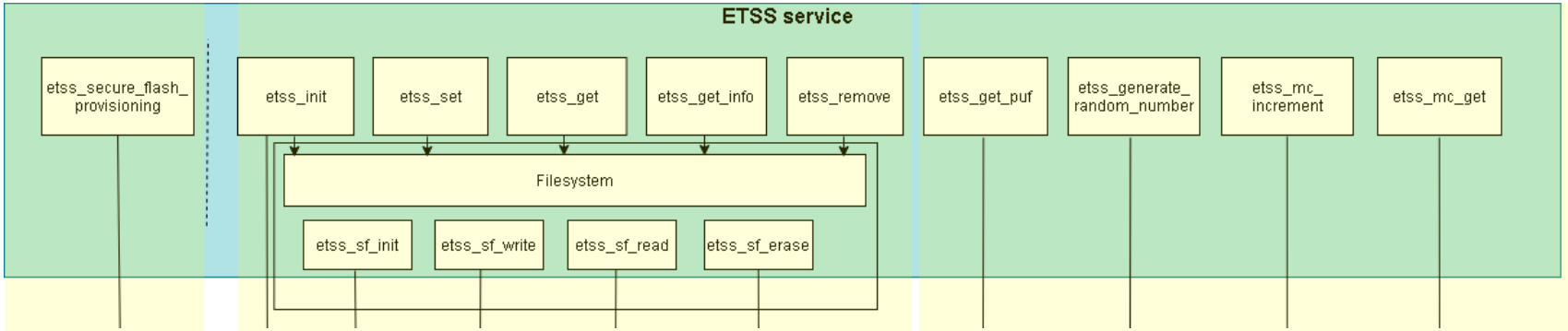
External trusted secure storage implementation

- ETSS partition framework



External trusted secure storage implementation

ETSS services



Factory provisioning
- Security keys
- Secure Flash configuration
- Application-zone binding
- …

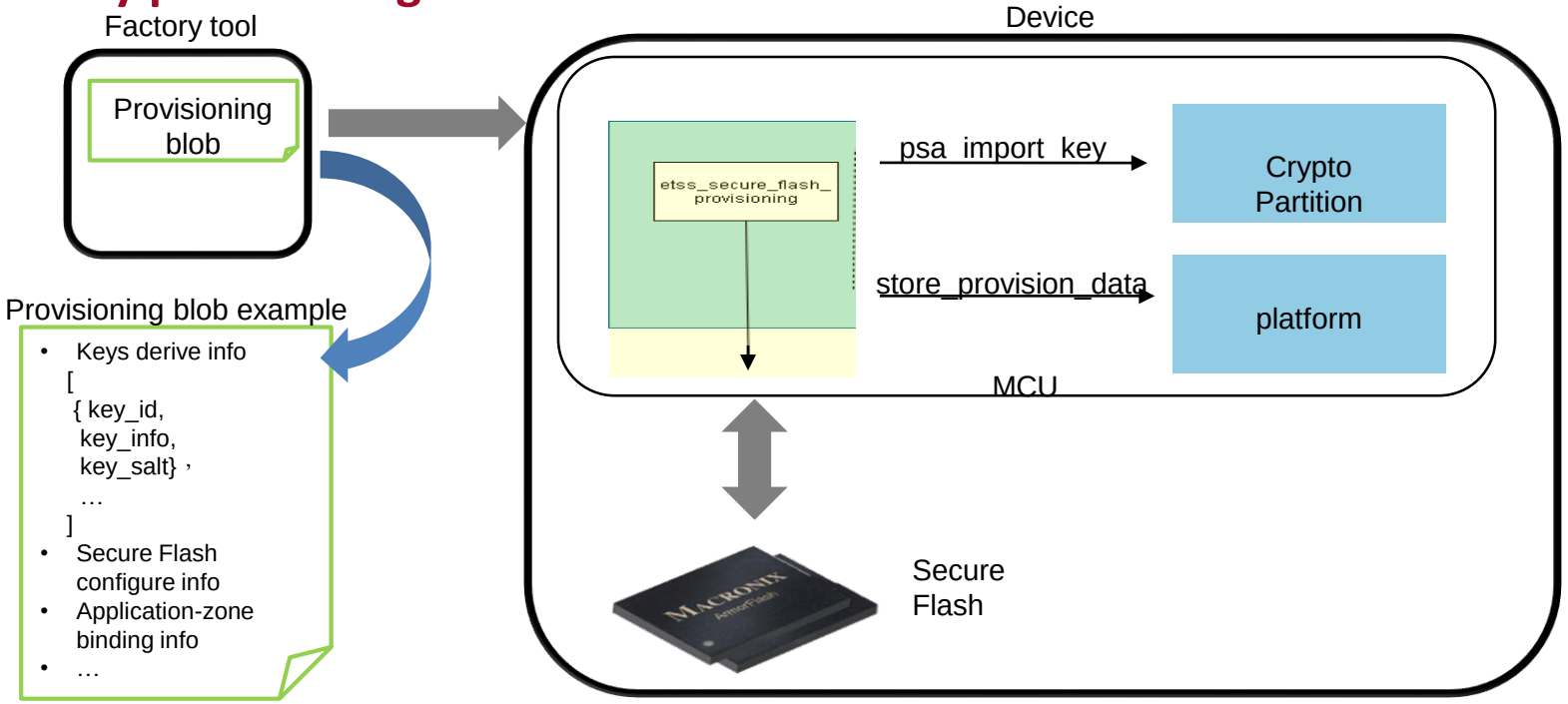
Secure storage services
- Reuse ITS filesystem based on secure Flash operations

Secure services
- Based on secure Flash security features
- Monotonic counter increase/get
- Generate random number
- Derive unique value from PUF

Factory provisioning → **Field deployment**

External trusted secure storage implementation

Factory provisioning

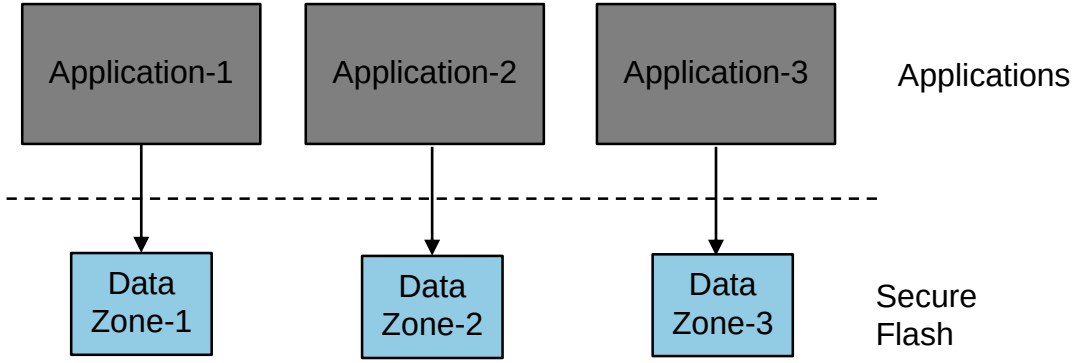


External trusted secure storage implementation

Factory provisioning

Provisioning blob example

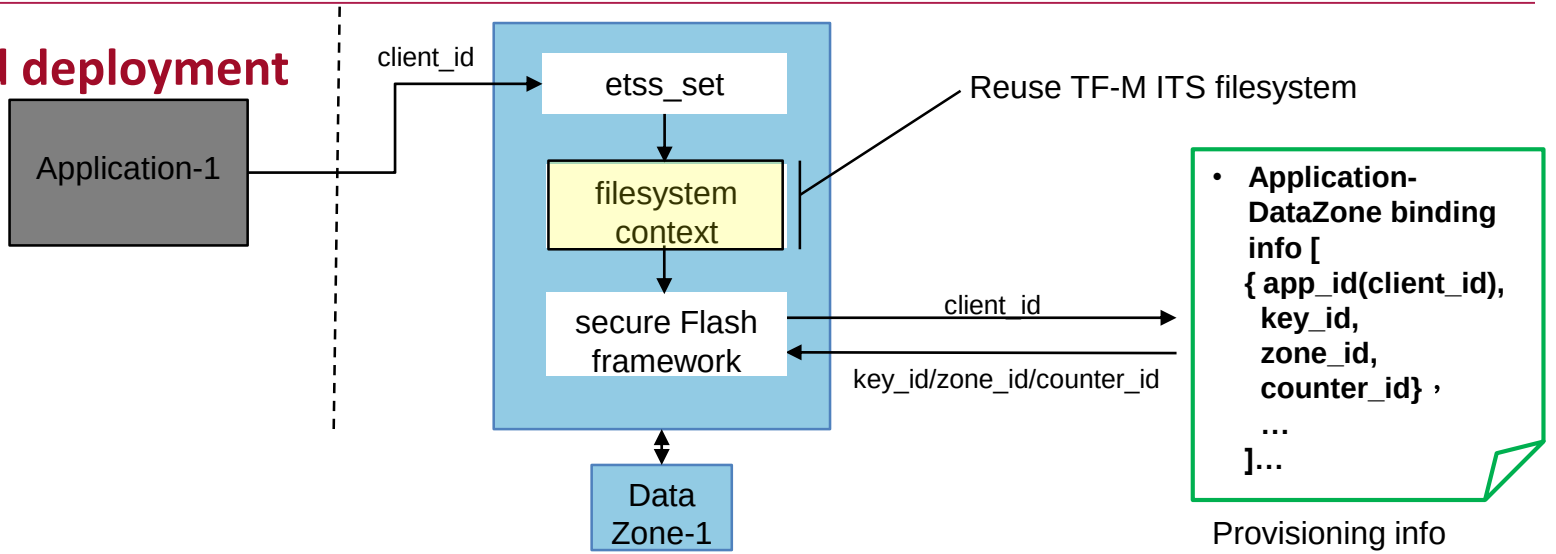
- Keys derive info
- Secure Flash configure info
- **Application-DataZone binding info [{ app_id, key_id, zone_id, counter_id} , …]…**



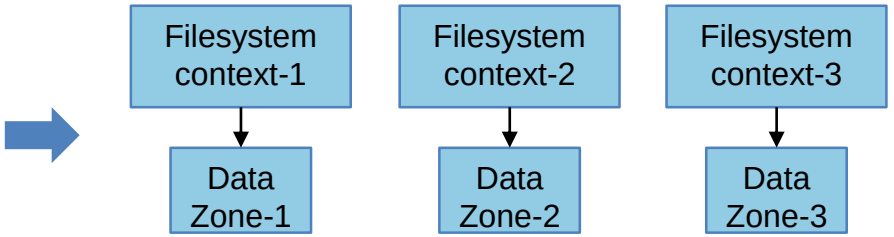
Application-DataZone binding example

External trusted secure storage implementation

Field deployment



As TF-M ITS filesystem is a concise filesystem, the size of its metadata region is small, it's acceptable to create a filesystem context upon each data zone.



External trusted secure storage implementation

- **ETSS partition APIs**

```
etss_err_t tfm_etss_secure_flash_provisioning(size_t data_length, const void *p_data);
etss_err_t tfm_etss_set(psa_storage_uid_t uid, size_t data_length, const void *p_data,
                        psa_storage_create_flags_t create_flags*);
etss_err_t tfm_etss_get(psa_storage_uid_t uid, size_t data_offset, size_t data_size,
                        void *p_data, size_t *p_data_length);
etss_err_t tfm_etss_get_info(psa_storage_uid_t uid, struct psa_storage_info_t *p_info);
etss_err_t tfm_etss_remove(psa_storage_uid_t uid);
etss_err_t tfm_etss_mc_increment(uint8_t mc_id);
etss_err_t tfm_etss_mc_get(uint8_t mc_id, uint8_t *buf, uint32_t buf_size);
etss_err_t tfm_etss_generate_random_number(uint8_t *buf, uint32_t buf_size);
etss_err_t tfm_etss_get_puf(uint8_t *buf, uint32_t buf_size, uint32_t *puf_len);
```

*: Currently etss_set() service always provides confidentiality and replay protection regardless of PSA_STORAGE_FLAG_CONFIDENTIALITY and PSA_STORAGE_FLAG_REPLAY_PROTECTION, so only PSA_STORAGE_FLAG_WRITE_ONCE has practical effect.

Thank you for your Attention

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