Android tamper-resistant anti-replay secure storage solution and virtualization

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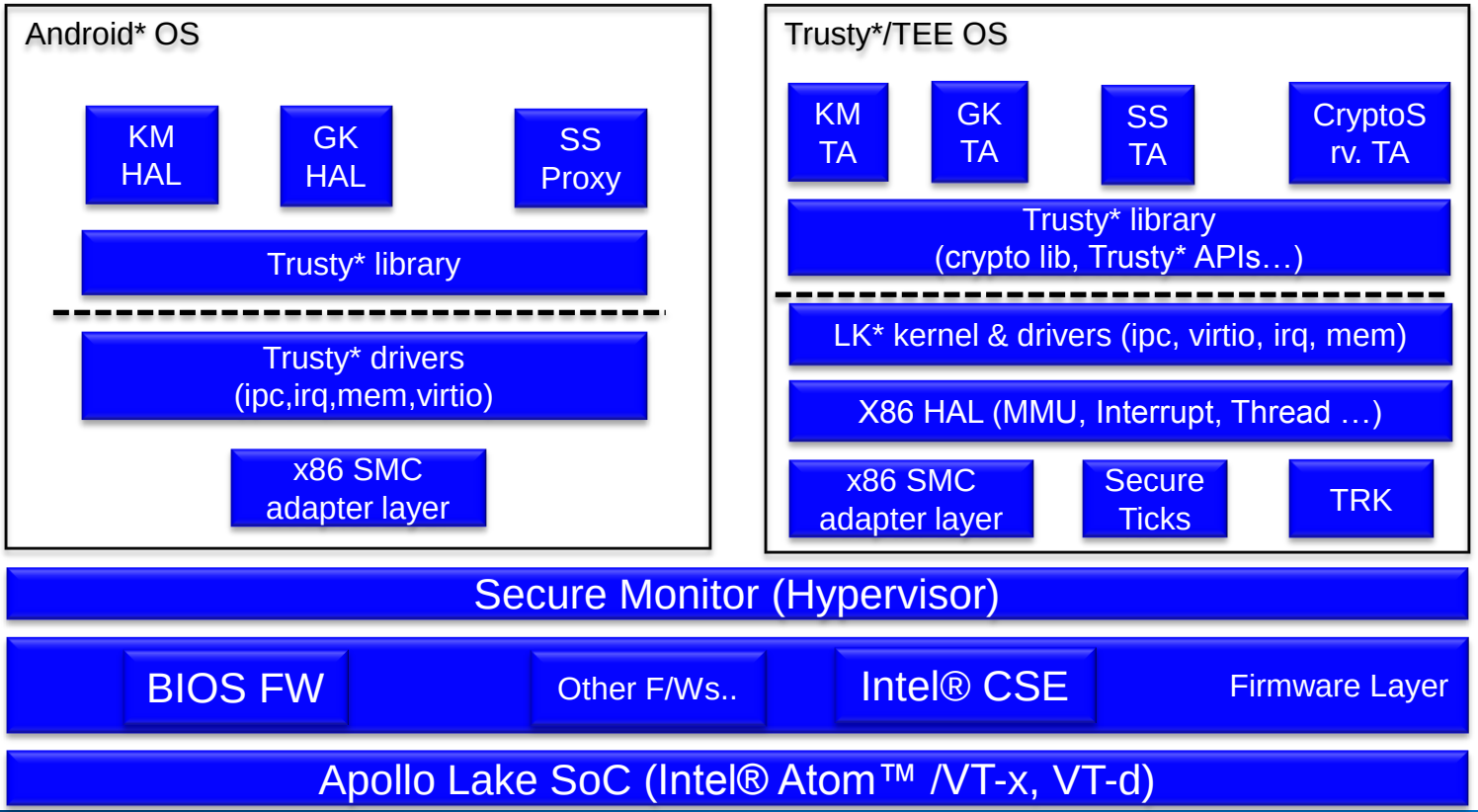
Intel Android Automotive IVI Plati



Agenda

- Problem Statement
- Replay Protected Memory Block (RPMB)
- TEE/Trusty Secure Storage (SS)
- Secure Storage Virtualization on Hypervisor
- Future Directions

Problem Statement

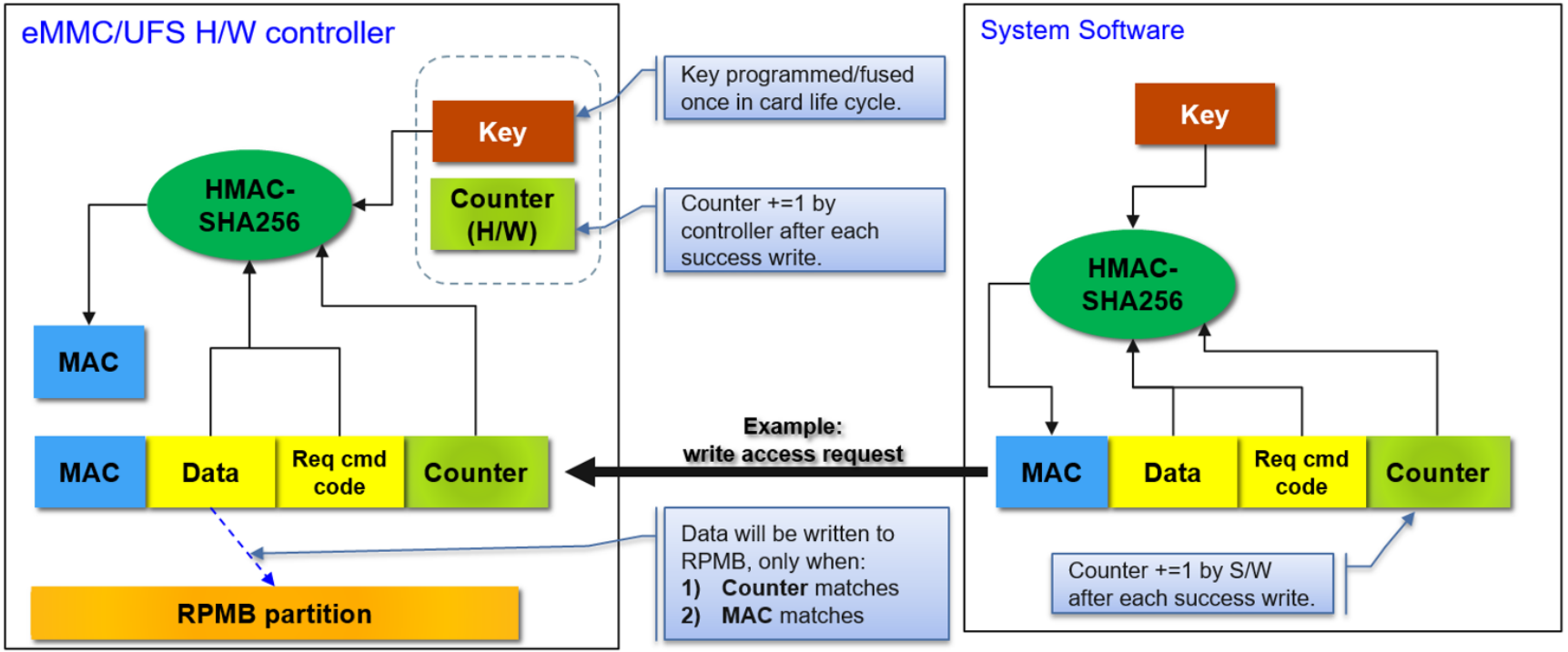
- Data security and privacy:
  - Screen-unlock (password/pin/pattern) attempt failure record for defending against brute force attack: https://source.android.com/security/authentication/gatekeeper
  - The version of system image for preventing roll-back attack
  - Keybox (keypairs), e.g. for content protection and attestation
  - The templates of fingerprint or iris sensor images for authentication
- Google CDD requirements since Marshmallow :
  - [SR] STRONGLY RECOMMENDED/ SHOULD to use tamper-evident storage

Replay Protected Memory Block

Technical Details

- eMMC/UFS/NVMe have fixed physical RPMB partition(s) in device
  - pre-allocated during flash device manufacture.
- RPMB key can only be programmed once in its life time, and is invisible to any software as long as it is programed into h/w device.
- All data read/write request of access to RPMB will be authenticated by H/W RPMB controller with RPMB Authkey (Authentication Key):
  - Authenticate algorithm is HMAC-SHA256 (or 512)
  - H/W built-in monotonic Write Counter is used for replay-protection on WRITE access;
  - Software generated Random Number is used for replay-protection on READ access.
- Without RPMB Authkey, read access is still possible, but the data being read may not be authentic.

How it works (e.g. authenticated w

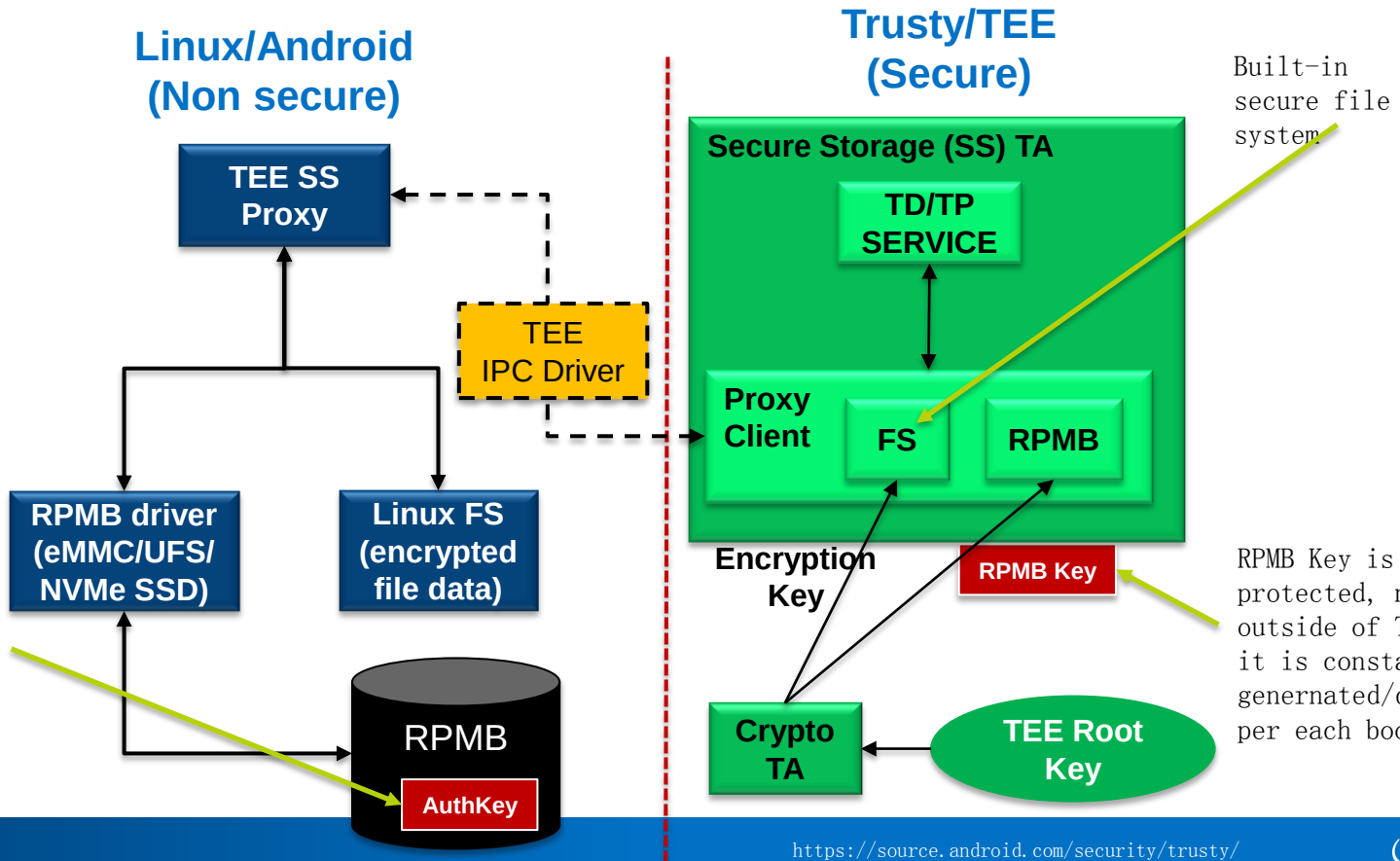


RPMB Key Generation and Programmi

- RPMB Key generation requirements:
  - Key is tied to hardware unique key (HUK).
  - Key is also bound to eMMC/UFS/NVMe flash storage serial #.
- RPMB key programming:
  - Typically firmware is responsible for programing the RPMB Key (in cleartext) into RPMB controller through RPMB key programming interface.
  - Do it once in factory, or just right after eMMC/UFS replacement if applicable.
  - Key cannot be changed once it’s programmed successfully (FUSED)

TEE/Trusty Secure Storage (SS) Architecture

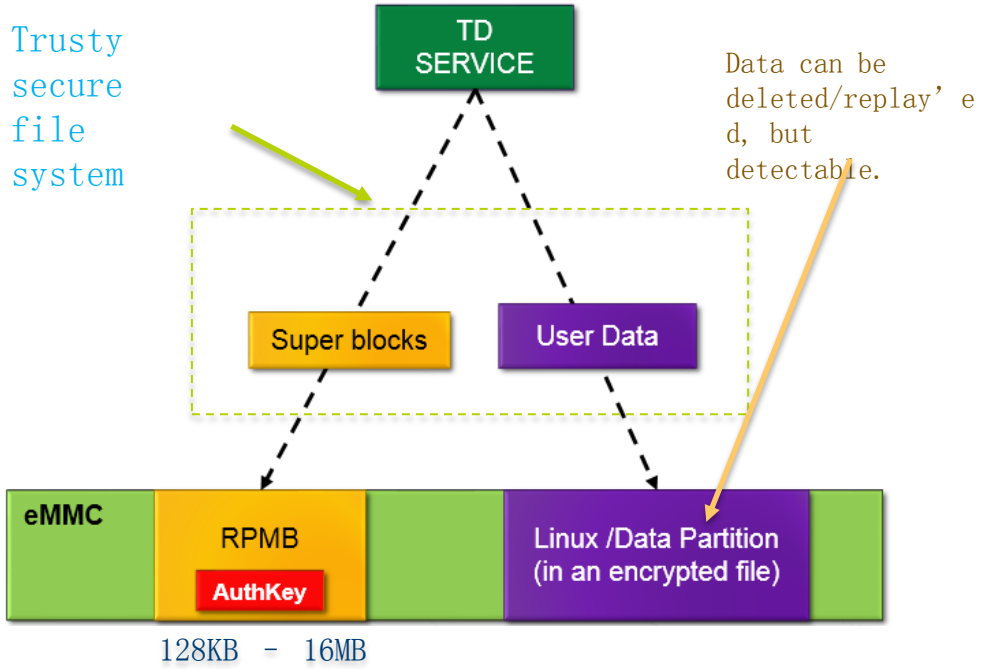
Trusty*(TEE) Secure Storage



https://source.android.com/security/trusty/
https://android.googlesource.com/trusty/app/storag

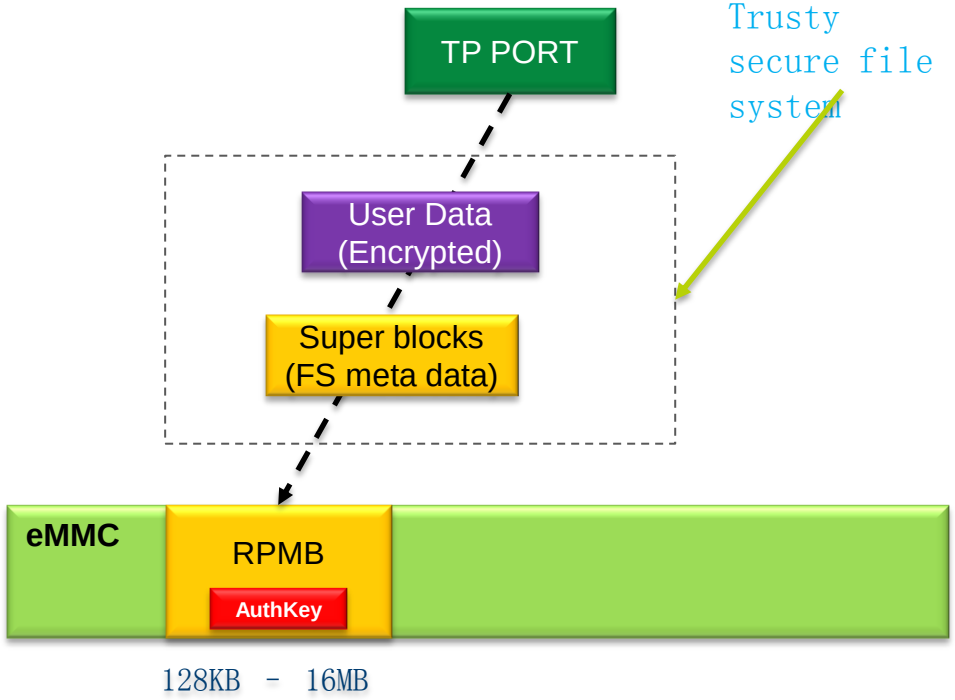
SS – Trusty TD Service: Tamper-De

1. File system meta-data is stored in RPMB
2. The user data encrypted with hardware-backed encryption key, is stored in Android/Linux-backed file system.
3. Support large amount of data.

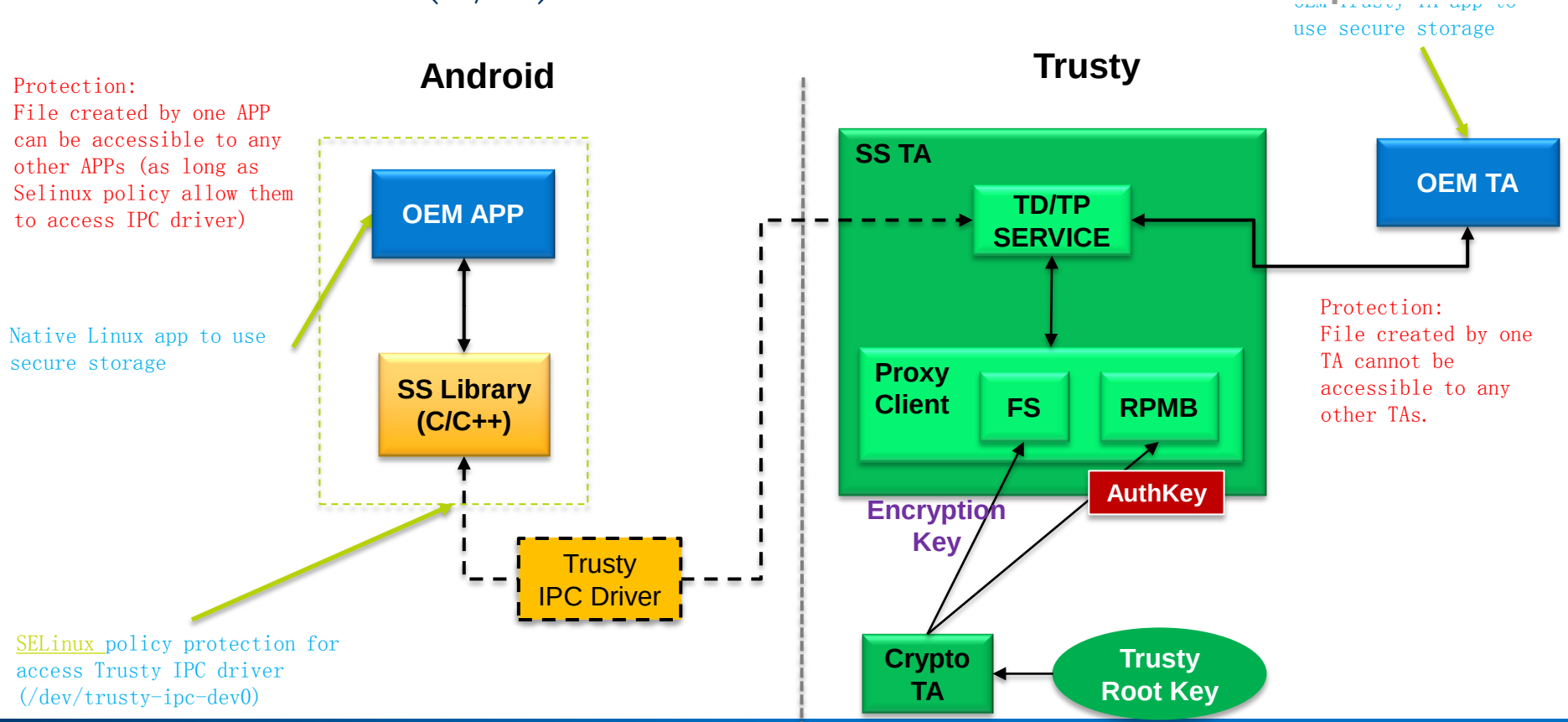


SS - Trusty TP Service: Tamper-Pr

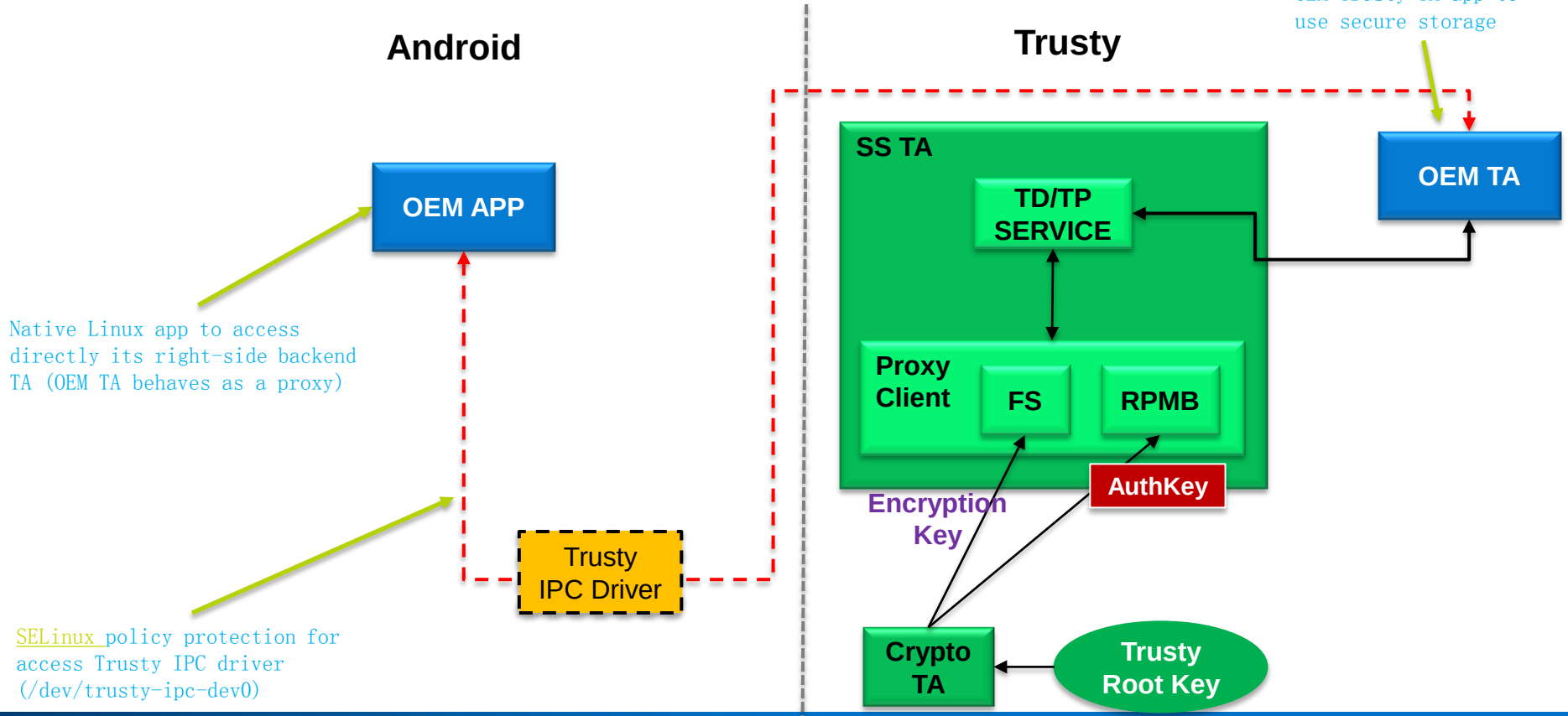
1. File system meta-data is stored in RPMB as well, and user Data also stored in RPMB
2. Size constrained; Typically 4MB, depending on eMMC/UFS/NVMe RPMB size.
3. Higher level of protection - Tamper Resistant!
4. Data survives in factory reset.



How to use (1/2)

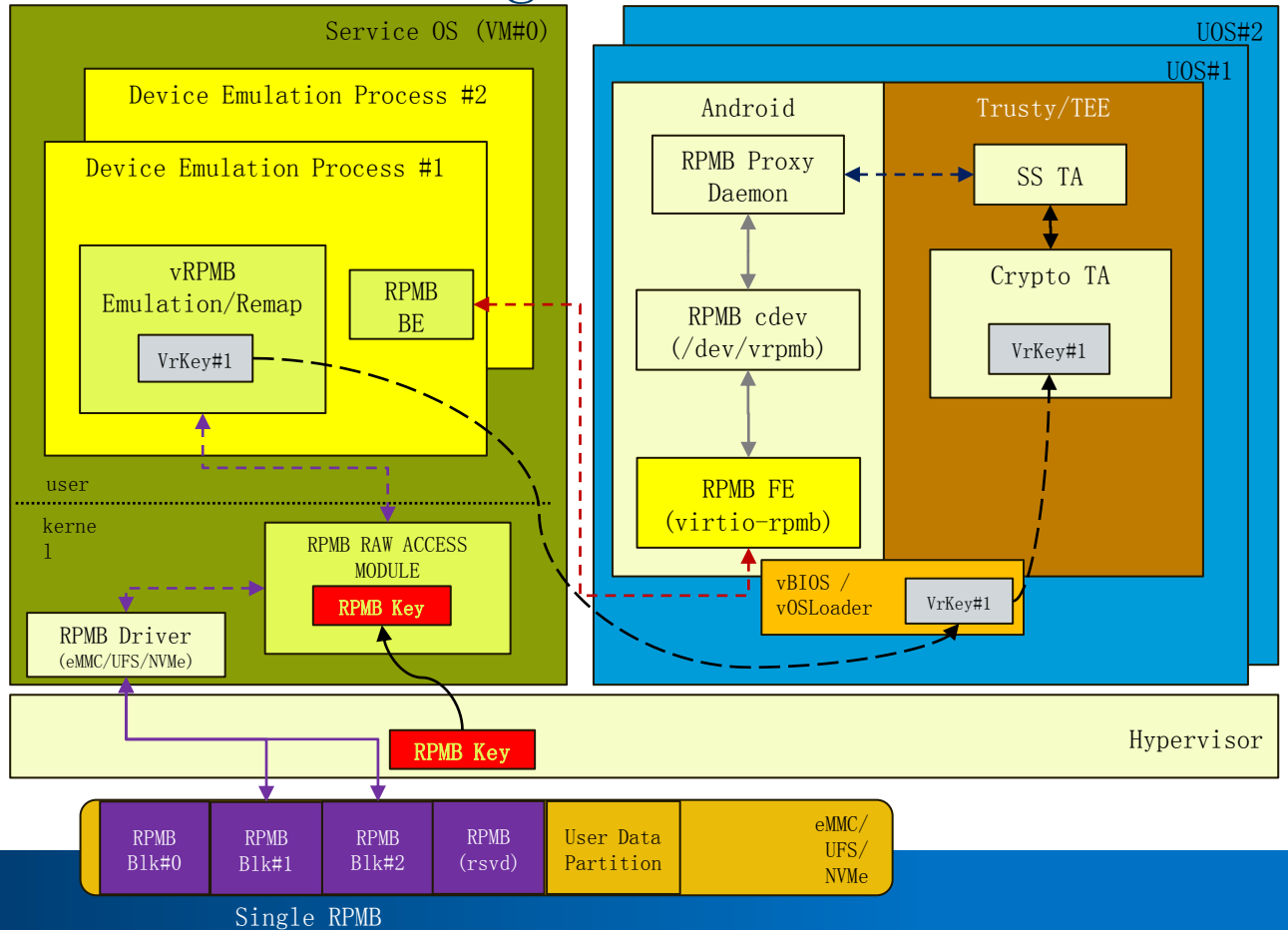

Android
Trusty
Protection:
File created by one APP can be accessible to any other APPs (as long as Selinux policy allow them to access IPC driver)
Native Linux app to use secure storage
OEM APP
SS Library (C/C++)
Trusty IPC Driver
SELinux policy protection for access Trusty IPC driver (/dev/trusty-ipc-dev0)
SS TA
TD/TP SERVICE
Proxy Client
FS
RPMB
AuthKey
Encryption Key
Crypto TA
Trusty Root Key
OEM TA
use secure storage
Protection:
File created by one TA cannot be accessible to any other TAs.

How to use (2/2)


Android
Trusty
OEM APP
Native Linux app to access directly its right-side backend TA (OEM TA behaves as a proxy)
Trusty IPC Driver
SELinux policy protection for access Trusty IPC driver (/dev/trusty-ipc-dev0)
use secure storage
SS TA
TD/TP SERVICE
OEM TA
Proxy Client
FS
RPMB
AuthKey
Encryption Key
Crypto TA
Trusty Root Key

Secure Storage Virtualization on Hypervisor

Secure Storage Virtualization



1. SOS (Service OS) is a closed system and privileged VM
2. The VrKey (virtual RPMB key) is generated randomly per UOS reboot, and securely distributed it to vSBL/vOSLoader/TEE.
3. Forward/remap vRPMB data/frame to physical RPMB partition.

Future Directions

Future Plan

- Multiple RPMB Targets / Partitions with H/W support
  - UFS3.0 supports 4 RPMB Partitions
  - NVMe storage supports MULTIPLE RPMB partitions

Q & A