Keymaster and Gatekeeper

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Agenda

1. **Introduction to Keymaster and Gatekeeper**
2. OP-TEE enablement
   a. Current status
   b. How to try it out
   c. What is next?

Keymaster

- Access control on keys - Who, when?
- Version binding - Rollback prevention using key + OS patch level
- Client binding - Associate a key with a certain application
- Expiration - How long is a key valid?
- Root of Trust Binding - All keys must be bound to the ROTK/HUK
- Velocity - Prevents brute force attacks
- Attestation - Ensure that keys are stored in hardware backed environment
- Authorization Tags - Set of properties and types
- Android O: Mandatory!

Gatekeeper

- Password and pattern authentication
- Enrolls and verifies passwords
- Leverages hardware-backed secret key
- Responsible for throttling brute force attacks
- Sign authentication attestations and sends them to Keymaster

Architecture Overview

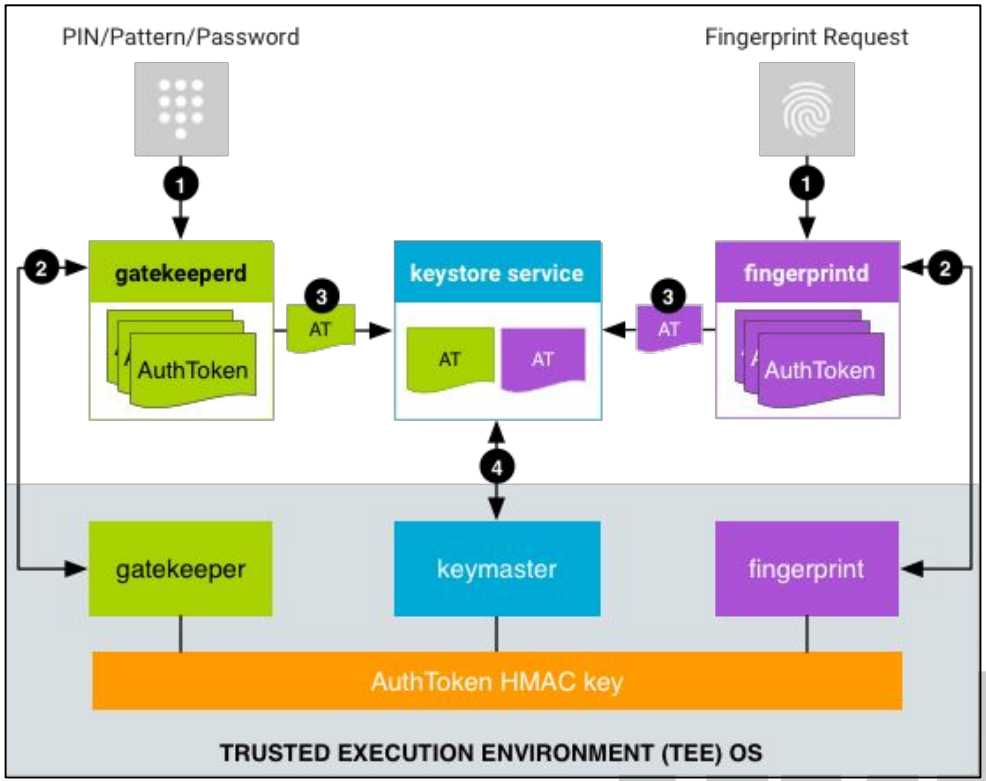
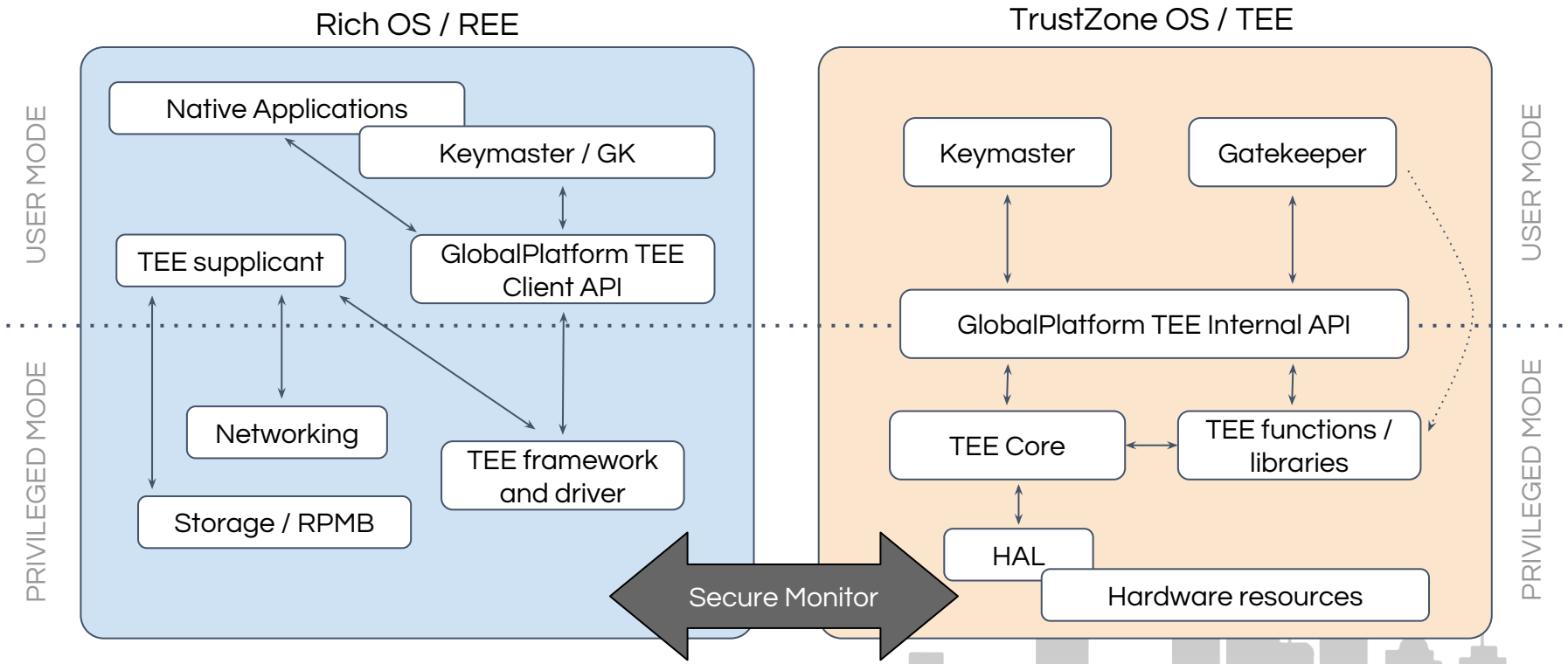
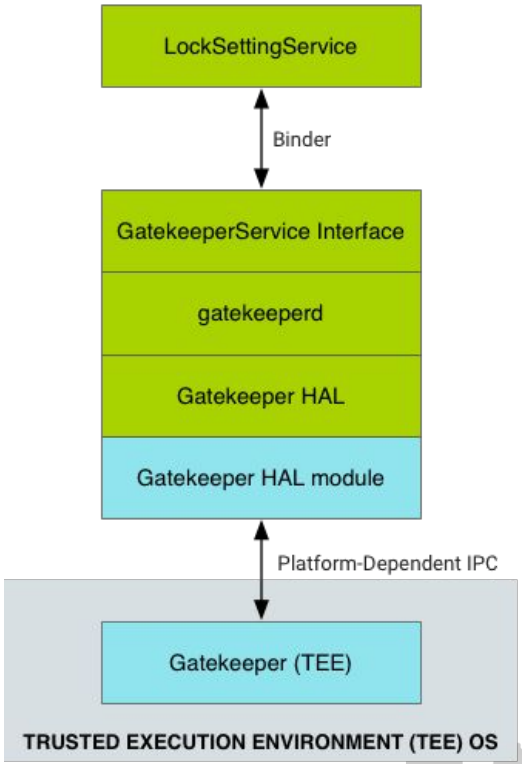


Image source: https://source.android.com/security/

OP-TEE: KM/GK


Rich OS / REE
TrustZone OS / TEE
USER MODE
PRIVILEGED MODE
Native Applications
Keymaster / GK
TEE supplicant
GlobalPlatform TEE Client API
Networking
TEE framework and driver
Storage / RPMB
Keymaster
Gatekeeper
GlobalPlatform TEE Internal API
TEE Core
TEE functions / libraries
HAL
Hardware resources
Secure Monitor
USER MODE
PRIVILEGED MODE

AOSP components



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Where to start?

- Starting from scratch (more or less)
  - Sept ‘17- an ‘18: On the roadmap (related PKCS#11 work took precedence)
  - Feb-April ‘18: Running with modest pace
  - May-June ‘18: Full speed, several engineers involved

- Third party company donated a KM2/GK implementation for OP-TEE
  - Sanity check, test, review == good! →
    Throw away what we had been doing prior to this
  - July ‘18 - until now: Integrate new KM2/GK solution
    - Integration into HiKey 6220 build system
    - Fixes/changes for Treble enablement
    - Solving VTS test regressions
    - Refactor code and cleanup for upstreaming

Current status

- All(*) KM/GK VTS test cases are passing
- Creating a stable manifest based where changes are on forks
- Refactor code
  - Remove pseudo-TA supporting KM
  - Move pseudo-TA functionality into the KM TA

(*) After upgrading to a new AOSP version we have two regressions

How to try it?

- Build

```
$ git clone https://github.com/linaro-swg/optee_android_manifest -b yvr18
$ cd optee_android_manifest
$ ./sync.sh -v p -bm pinned-manifest-stable_yvr18.xml
$ ./build-p.sh
```

How to try it?

- Flash (HiKey 6220)
  - Put board in recovery mode by connecting jumpers 1-2 and 3-4
  - Run command

    $ cp -a out/target/product/hikey/*.img device/linaro/hikey/installer/hikey/

    $ sudo ./device/linaro/hikey/installer/hikey/flash-all.sh /dev/ttyUSB<x>

    x = device number that appears after rebooting with the 3-4 jumper connected

    e.g.

    $ sudo ./device/linaro/hikey/installer/hikey/flash-all.sh /dev/ttyUSB0
  - Power off board
  - Remove jumper 3-4
  - Power on board

How to try it?

- Test

```
$ adb root
$ adb shell /data/nativetest64/VtsHalKeymasterV3_0TargetTest/VtsHalKeymasterV3_0TargetTest

# help
$ adb shell /data/nativetest64/VtsHalKeymasterV3_0TargetTest/VtsHalKeymasterV3_0TargetTest --help
```

NOTE

- Run above commands from a terminal that is NOT the board console
- This is test build so there will be lots of debug prints!
- Test can take up to an hour to complete

How to try it?

NOTE (cont.)

- The `vendor.hwcomposer-2-1` service repeatedly fails to start and continuously clutters the console with error messages.
  - This is **NOT** an OP-TEE related issue
  - Linaro AOSP engineers currently working on fix
  - Temporary workaround - delete `/vendor/etc/init/android.hardware.graphics.composer@2.1-service.rc` and reboot

How to try it?

- Pre-built binaries
  http://people.linaro.org/~victor.chong/prebuilt/pie/kmgk/yvr18/

Name	Last modified	Size	Description
Parent Directory		-	
boot.img.xz	2018-09-07 07:50	7.1M	
cache.img.xz	2018-09-07 07:50	732	
fip.bin	2018-09-07 07:53	1.6M	
flash-all.sh	2018-09-07 07:54	2.1K	
hisi-idt.py	2018-09-07 07:53	8.4K	
l-loader.bin	2018-09-07 07:53	133K	
nvme.img	2018-09-07 07:53	128K	
ptable-aosp-4g.img	2018-09-07 07:53	17K	
ptable-aosp-8g.img	2018-09-07 07:53	17K	
ramdisk.img.xz	2018-09-07 07:50	1.5M	
system.img.xz	2018-09-07 07:52	338M	
userdata.img.xz	2018-09-07 07:52	3.9M	
vendor.img.xz	2018-09-07 07:52	4.9M	

Sample test output

```
[==========] Running 106 tests from 12 test cases.
[----------] Global test environment set-up.

[----------] 1 test from KeymasterVersionTest
[ RUN      ] KeymasterVersionTest.SensibleFeatures
[     OK   ] KeymasterVersionTest.SensibleFeatures (1 ms)
[ RUN      ] NewKeyGenerationTest.Rsa
[     OK   ] NewKeyGenerationTest.Rsa (520247 ms)
<snip>
[ RUN      ] KeyDeletionTest.DeleteAllKeys
[     OK   ] KeyDeletionTest.DeleteAllKeys (0 ms)
[----------] 3 tests from KeyDeletionTest (11384 ms total)

[----------] Global test environment tear-down
[==========] 106 tests from 12 test cases ran. (1295946 ms total)
[  PASSED  ] 106 tests.
```

What is next?

- Refactor the pseudo and dynamic Trusted Application
- Improve SE policies → allow running as non-root user
- Upstream Keymaster + Gatekeeper (and OP-TEE?) to the AOSP project
- Keymaster v4
- Fingerprintd?

Backup

Keymaster Functions

getHardwareFeatures()
addRngEntropy()
generateKey()
getKeyCharacteristics()
importKey()
exportKey()
deleteKey()
deleteAllKeys()
destroyAttestationIds()

begin()
update()
finish()
abort()

Gatekeeper Functions

enroll()

verify()