玄铁安全系统安全工具用户手册

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修订历史

日期	版本	新增修改内容	作者
20230216	v1.2	• 新增boot.ext4签名功能	肖佳涛
20220420	v1.1	• 新增KDF工具	夏狼
20220328	v1.0	• 支持sectool工具说明	夏狼
20220311	v0.1	• 初版	夏狼

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1. 工具总览

工具名	说明	版本	仓库地址/附件

product	镜像签名工具	>= v1.0.23	随yoctool一起安装，参考yoctool用户手册： https://yuque.antfin-inc.com/occ/xyrz27/cywaud https://code.aone.alibaba-inc.com/thead/yoc_tools
efuse_utility	eFuse烧写工具	v1.2	仓库地址：git@gitlab.alibaba-inc.com:yocopen/efusehost.git 工具包：📎efuse_host_v1.2.tar.zip 工具包md5um: 5d8257ce606232f21a69110e1654f192
	efuse key加密工具	v1.0	📎efuse加解密脚本及使用方法说明 v1.0.7z
fastboot	镜像升级工具	v1.0	📎fastboot v1.0.zip
sectool	imagesign.sh	v1.0	git@gitlab.alibaba-inc.com:thead-os-platform/sectool.git
	bin2ext4.sh		
	kdf_gen.exe		

2. 工具介绍

2.1 product

product用于系统镜像的签名，支持指定的密钥证书等功能。

功能命令:

sigx

说明:

对已生成好的单个镜像(或者公钥PEM文件)进行签名。

输入product sigx可查看帮助信息。

示例:

2级公钥的签名

- 国际算法例子:

product sigx keystore/pubkeyB.pem -pvk keystore/privatekeyA.pem -pubk keystore/pubkeyA.pem -ss RSA2048 -ds SHA256 -npubk keystore/pubkeyB.pem -nss

RSA2048 –nds SHA256 –o sign_2nd_pubkey.bin

- 国密算法例子：

product sigx keystore_sm/pubkeyB.pem –pvk keystore_sm/privatekeyA.pem –pubk keystore_sm/pubkeyA.pem –ss SM2 –ds SM3 –npubk keystore_sm/pubkeyB.pem –nss SM2 –nds SM3 –o sign_2nd_pubkey.bin

镜像的签名(带有下级公钥)

- 国际算法例子：

product sigx iw.bin –pvk keystore/privatekeyB.pem –ss RSA2048 –ds SHA256 –npubk keystore/pubkeyC.pem –nss RSA2048 –nds SHA256 –iv 0 –ra 0xFFE0000000 –o sign_iw.bin

- 国密算法例子：

product sigx iw.bin –pvk keystore_sm/privatekeyB.pem –ss SM2 –ds SM3 –npubk keystore_sm/pubkeyC.pem –nss SM2 –nds SM3 –iv 0 –ra 0xFFE0000000 –o sign_iw.bin

镜像的加密签名(带有下级公钥)

- 国际算法例子：

product sigx iw.bin –pvk keystore/privatekeyB.pem –ss RSA2048 –ds SHA256 –npubk keystore/pubkeyC.pem –nss RSA2048 –nds SHA256 –ent AES_256_CBC –enk keystore/aes_256_cbc.key –iv 0 –ra 0xFFE0000000 –o sign_iw.bin

- 国密算法例子：

product sigx iw.bin –pvk keystore_sm/privatekeyB.pem –ss SM2 –ds SM3 –npubk keystore_sm/pubkeyC.pem –nss SM2 –nds SM3 –ent SM4_CBC –enk keystore_sm/sm4.key –iv 0 –ra 0xFFE0000000 –o sign_iw.bin

镜像的签名(不带有下级公钥)

- 国际算法例子：

product sigx iw.bin –pvk keystore/privatekeyB.pem –ss RSA2048 –ds SHA256 –iv 0 –ra 0xFFE0000000 –o sign_iw.bin

- 国密算法例子：

product sigx iw.bin –pvk keystore_sm/privatekeyB.pem –ss SM2 –ds SM3 –iv 0 –ra 0xFFE0000000 –o sign_iw.bin

镜像的加密签名(不带有下级公钥)

- 国际算法例子：

product sigx iw.bin –pvk keystore/privatekeyB.pem –ss RSA2048 –ds SHA256 –ent AES_256_CBC –enk keystore/aes_256_cbc.key –iv 0 –ra 0xFFE0000000 –o sign_iw.bin

- 国密算法例子：

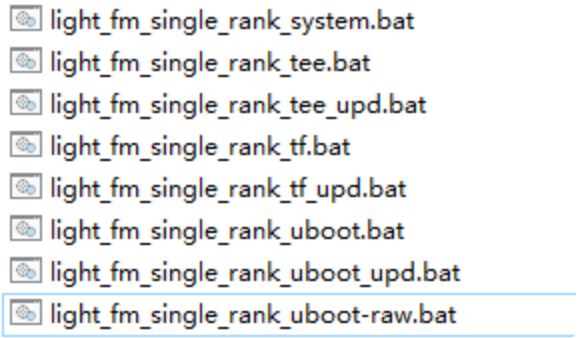
product sigx iw.bin –pvk keystore_sm/privatekeyB.pem –ss SM2 –ds SM3 –ent SM4_CBC –enk keystore_sm/sm4.key –iv 0 –ra 0xFFE0000000 –o sign_iw.bin

2.2 efuse utilty

efuse utility是用于芯片efuse初次烧写，利用SPI Blaster来进行烧写，运行在Windows下的一个工具。

2.3 fastboot

fastboot是一种比recovery更底层的刷机模式（俗称引导模式）。就是使用USB数据线连接终端的一种刷机模式。我们利用fastboot进行系统镜像的更新。



- light_fm_single_rank_system.bat – 用于直接烧写所有系统镜像
- light_fm_single_rank_uboot.bat – 用于直接烧写uboot，不进行升级流程
- light_fm_single_rank_uboot_upd.bat – 用于更新uboot镜像，进行升级路程
- light_fm_single_rank_uboot_raw.bat – 用于更新烧写uboot镜像(uboot损坏)，不进行升级流程
- light_fm_single_rank_tee.bat – 用于直接烧写tee，不进行升级流程
- light_fm_single_rank_tee_upd.bat – 用于直接更新tee镜像，进行升级流程
- light_fm_single_rank_tf.bat – 用于直接烧写tf，不进行升级流程
- light_fm_single_rank_tf_upd.bat – 用于直接更新tf镜像，进行升级流程

注意：

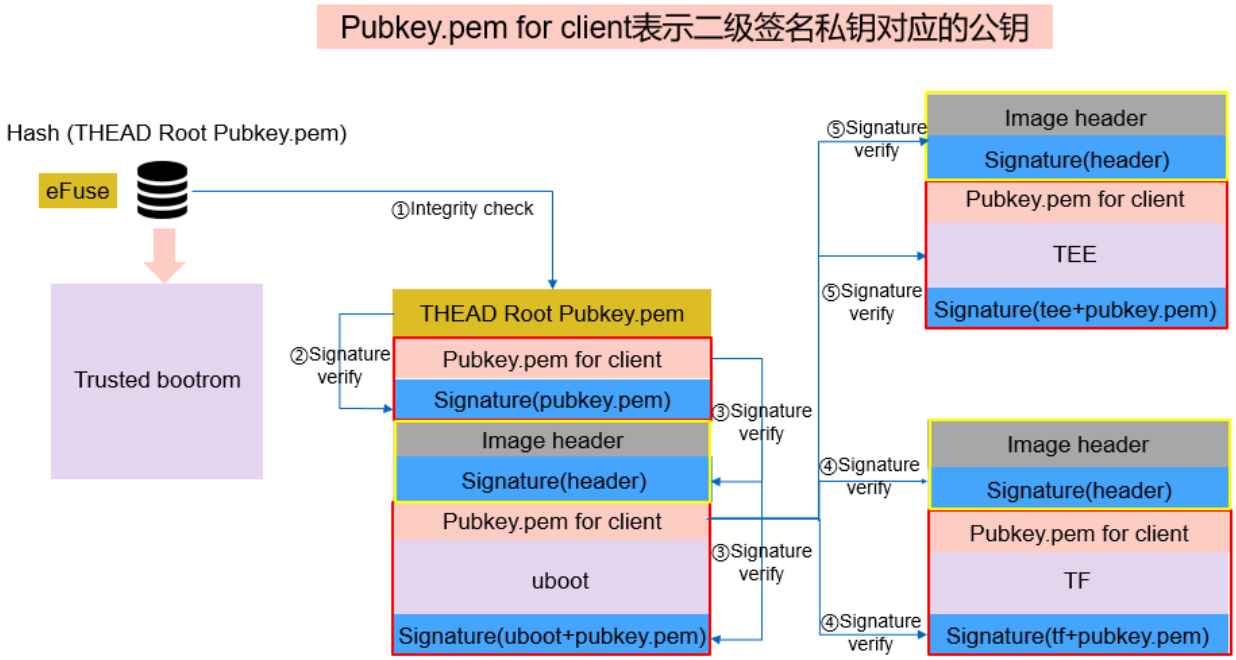
Fastboot工具使用前需要安装ADB驱动，请参考README指导安装。

2.4 sectool

sectool用于镜像签名打包的工具，包括支持二进制文件打包成EXT4文件。其主要包括imagesign.sh和bin2ext4.sh脚本。

```bash
cxx194832@docker-ubuntu18:~/sectool$ ls
bin2ext4  imagesign.sh  keystore  keystore_sm  README.md  tee  tf  tool  uboot
```

2.4.1 签名证书



在进行镜像签名前，可以在imagesign.sh脚本里通过修改以下两个变量来指定密钥证书。

- `client_public_cert`
- `client_private_cert`

注意：国际算法证书必须放在keystore文件夹下，国密算法证书必须放在keystore_sm文件夹下。以下证书用于uboot镜像签名，一般情况下由平头哥进行提供管理:

- `thead_root_public_cert`
- `thead_root_private_cert`
- `thead_b1_public_cert`
- `thead_b1_private_cert`

2.4.2 imagesign

imagesign工具是一个运行在shell下的一个脚本文件，其用于将一个二进制文件用指定的算法进行签名，同时还能指定镜像是否加密和版本号等信息，最后进行镜像内容和签名数据等信息打包，生成一个签名文件,注意最后一个参数image board type参数含义为镜像对应板子板子类型。

```bash
imagesign.sh utility version v1.0
The utility is designed for aim to help user generate new image file
with signature with desired sign scheme.

Usage:
imagesign.sh [chkuboot] [ia/sm] [enc/nor] [tf/tee/uboot] [ver] [image board type]
chkuboot: check uboot binary file is signed or not, if yes, it generates the original bboot binary file
signed algorithms
  ia - international algorithm
  sm - china algorithms
secure attribution
  enc - signed image with encryption
  nor - signed image without encryption
image file type
  tf   - trust_firmware binary image
  tee  - tee binary image
  uboot - uboot binary image
  ree - ree binary image
version
  ver - image version (x.y), eg 1.1, 2.1
image board type
  LA  - board light A
  LB  - board light B
  LP  - board lpi4a
  LG  - board beagle
  LD  - board ant_ref
```

2.4.2.1 生成SBMETA签名镜像

1. 需要签名的 `sbmeta.bin` 必须在 `./sbmeta` 文件夹下。 `sbmeta.bin` 可以由sectool默认生成，也可以由用户自定义生成。生成步骤为：
   a. 更改 `sbmeta.yaml` 文件，指定校验镜像

```bash
image_configs:
  #config of trust_firmware.bin
  -
    name: trust_firmware.bin
    device: 0
    partition: 3
    type: tf
    digest_scheme: sha256
    sign_scheme: rsa_2048
    is_image_encrypted: 0
    medium_type: emmc
    image_path: ./tf/trust_firmware.bin #recommend to this default path

  #config of tee.bin
  -
    name: tee.bin
    device: 0
    partition: 4
    type: tee
    digest_scheme: sha256
    sign_scheme: rsa_2048
    is_image_encrypted: 0
    medium_type: emmc
    image_path: ./tee/tee.bin #recommend to this default path

  #config of dtb
  -
    name: light-lpi4a-sec.dtb
    device: 0
    partition: 2
    type: dtb
    digest_scheme: sha256
    sign_scheme: rsa_2048
    is_image_encrypted: 0
    medium_type: emmc
    image_path: ./dtb/light-lpi4a-sec.dtb
```

b. 生成sbmeta.bin镜像

```bash
kjs@kjs-VirtualBox:~/sectool$ python sbmeta.py

# 查看生成的镜像
kjs@kjs-VirtualBox:~/sectool/sbmeta$ ls sbmeta
sbmeta.bin
```

注意：文件名必须是 `sbmeta.bin`， sbmeta文件夹名字不可以更改

2. 执行下面命令进行国际镜像算法签名

```bash
kjs@kjs-VirtualBox:~/sectool$ ./imagesign.sh ia nor sbmeta 1.0
Dump all parameters from user input.
-----------------------------------
Signed algorithem: ia
Secure attribution: nor
Image file: sbmeta
Image version: 1.0
-----------------------------------
Enter into image sign process ...
Start sbmeta Image (1.0) signed with international algorithms with secure attr (nor)
sign tool path: ./tool/product
Original file: sbmeta/sbmeta.bin
Signed file: sbmeta/signed_ia_nor_v1.0_sbmeta.bin
Image Version: 256
Relocate Addr: 0x100000
[2023-08-16 11:17:56] Sign a image file.
[2023-08-16 11:17:56] Sign ok.
Exit from image sign process ...
```

3. 查看生成的SBMETA签名镜像

```bash
kjs@kjs-VirtualBox:~/sectool$ ls sbmeta
sbmeta.bin  signed_ia_nor_v1.0_sbmeta.bin
```

生成的 `signed_ia_nor_v1.0_sbmeta.bin` 位于sbmeta文件夹下。

注意：

- **使用的时候必须将 `signed_ia_nor_v1.0_sbmeta.bin` 改名为 `sbmeta.bin`**

2.4.2.2 生成UBOOT签名镜像

1. 将需要签名的u-boot-with-spl.bin复制到uboot文件夹里

注意：文件名必须是 `u-boot-with-spl.bin`， uboot文件夹名字不可以更改

```bash
cxx194832@docker-ubuntu18:~/sectool$ ls uboot/
u-boot-with-spl.bin
```

2. 执行下面命令进行镜像签名

```bash
cxx194832@docker-ubuntu18:~/sectool$ ./imagesign.sh ia enc uboot 1.2
Dump all parameters from user input.
-----------------------------------
Signed algorithem: ia
Secure attribution: enc
Image file: uboot
Image version: 1.2
-----------------------------------
Enter into image sign process ...
Start uboot Image (1.2) signed with international algorithms with secure attr (enc)
sign tool path: ./tool/product
Original file: uboot/u-boot-with-spl.bin
Signed file: uboot/signed_ia_enc_u-boot-with-spl.bin
Image Version: 258
Relocate Addr: 0xFFE0000800
[2022-03-23 14:09:44] Sign a public key file.
[2022-03-23 14:09:44] rsa verify ok....
[2022-03-23 14:09:44] rsa verify ok....
[2022-03-23 14:09:44] Sign ok.
[2022-03-23 14:09:44] Sign a image file.
[2022-03-23 14:09:44] Sign ok.
Exit from image sign process ...

```

3. 查看生成的uboot签名镜像

```bash
cxx194832@docker-ubuntu18:~/sectool$ ls uboot/
signed_ia_enc_u-boot-with-spl.bin  signed_image_u-boot-with-spl.bin
signed_pubkey_u-boot-with-spl.bin  u-boot-with-spl.bin
```

生成的 `signed_ia_enc_u-boot-with-spl.bin` 位于uboot文件夹下。

注意：

- uboot签名镜像由 **`signed_pubkey_u-boot-with-spl.bin`** 和 **`signed_image_u-boot-with-spl.bin`** 两部分签名镜像组成。
- **`signed_pubkey_u-boot-with-spl.bin`** 由平头哥管理
- **`signed_image_u-boot-with-spl.bin`** 用于镜像升级，但签名镜像的私钥必须和 **`signed_pubkey_u-boot-with-spl.bin`** 了用的公钥配对。
- 使用的时候必须将 **`signed_ia_enc_u-boot-with-spl.bin`** 改名为 **`u-boot-with-spl.bin`**
- 当不确定当前的u-boot-with-spl.bin是否已经签名，可以通过 **`imagesign.sh chkuboot u-boot-with-spl.bin`** 命令进行检查，如果已经签名，则会生成原始未签名的u-boot-with-spl.bin文件(注:目前chkuboot不支持加密镜像的还原,即国密加密或者国际加密镜像无法使用chkuboot进行还原)，可以使用该文件进行其他算法的签名。
- 如果要支持镜像烧写防错措施，需要给签名命令里加上Board ID参数，该参数会作为板子的Identifier ID。

2.4.2.3 生成TF签名镜像

1. 将需要签名的trust_firmware.bin复制到tf文件夹里

注意：文件名必须是 `trust_firmware.bin`， tf文件夹名字不可以更改

```bash
cxx194832@docker-ubuntu18:~/sectool$ ls tf
trust_firmware.bin
```

2. 执行下面命令进行镜像签名

```bash
cxx194832@docker-ubuntu18:~/sectool$ ./imagesign.sh ia nor tf 1.2
Dump all parameters from user input.
-----------------------------------
Signed algorithem: ia
Secure attribution: nor
Image file: tf
Image version: 1.2
-----------------------------------
Enter into image sign process ...
Start tf Image (1.2) signed with international algorithms with secure att
r (nor)
sign tool path: ./tool/product
Original file: tf/trust_firmware.bin
Signed file: tf/signed_ia_nor_trust_firmware.bin
Image Version: 258
Relocate Addr: 0x0
[2022-03-23 14:12:36] Sign a image file.
[2022-03-23 14:12:36] Sign ok.
Exit from image sign process ...
```

3. 查看生成的TF签名镜像

```bash
cxx194832@docker-ubuntu18:~/sectool$ ls tf
signed_ia_nor_v1.2_trust_firmware.bin  trust_firmware.bin
```

生成的 `signed_ia_nor_trust_firmware.bin` 位于tf文件夹下。

注意：

- **使用的时候必须将 `signed_ia_nor_v1.2_trust_firmware.bin` 改名为 `trust_firmwar e.bin`**

2.4.2.4 生成TEE签名镜像

1. 将需要签名的tee.bin复制到tee文件夹里

注意：文件名必须是 `tee.bin` ， tee文件夹名字不可以更改

```bash
cxx194832@docker-ubuntu18:~/sectool$ ls tee
tee.bin
```

2. 执行下面命令进行镜像国密算法签名

```bash
cxx194832@docker-ubuntu18:~/sectool$ ./imagesign.sh ia nor tee 1.2
Dump all parameters from user input.
-----------------------------------
Signed algorithem: ia
Secure attribution: nor
Image file: tee
Image version: 1.2
-----------------------------------
Enter into image sign process ...
Start tee Image (1.2) signed with international algorithms with secure att
r (nor)
sign tool path: ./tool/product
Original file: tee/tee.bin
Signed file: tee/signed_ia_nor_tee.bin
Image Version: 258
Relocate Addr: 0xff000000
[2022-03-23 14:13:31] Sign a image file.
[2022-03-23 14:13:31] Sign ok.
Exit from image sign process ...

```

3. 查看生成的TEE签名镜像

```bash
cxx194832@docker-ubuntu18:~/sectool$ ls tee
signed_sm_nor_v1.2_tee.bin  tee.bin
```

生成的 `signed_sm_nor_v1.2_tee.bin` 位于tee文件夹下。

注意：

- **使用的时候必须将 `signed_sm_nor_v1.2_tee.bin` 改名为 `tee.bin`**

2.4.2.5 生成签名的boot.EXT4

步骤如下:

1. sectool根目录下新建ree文件夹
2. 将需要签名boot.ext4复制到ree文件夹

```bash
kjs@kjs-VirtualBox:~/sectool$ ls ./ree
boot.ext4
```

3. 将imagesign.sh文件中 `ree_sign_file_list` 改成需要签名的文件名，以对Kernel镜像 `Image` 和 `light-val-a-sec.dtb` 文件签名为例（多个文件用空格隔开）

```bash
#ree sign file list
ree_sign_file_list="Image light-a-val-sec.dtb"
```

4. 执行下面命令进行镜像国际算法签名

```bash
kjs@kjs-VirtualBox:~/sectools/sectool$ ./imagesign.sh ia nor ree 1.0
Dump all parameters from user input.
-----------------------------------
Signed algorithem: ia
Secure attribution: nor
Image file: ree
Image version: 1.0
Board id:
-----------------------------------
Enter into image sign process ...
Start ree Image (1.0) signed with international algorithms with secure attr (nor)
sign tool path: ./tool/product
Original file: bootimg/Image
Signed file: ree/signed_ia_nor_v1.0_Image
Image Version: 256
Relocate Addr: 0x200000
[2023-09-21 21:36:43] Sign a image file.

[2023-09-21 21:36:43] Sign ok.
Exit from image sign process ...
```

5. 查看生成的REE签名镜像

```bash
kjs@kjs-VirtualBox:~/sectools/sectool/ree$ ls

boot.ext4  signed_ia_nor_v1.0_Image
```

生成的签名的 `boot.ext4` 位于ree文件夹下。

注意：如果已经对 `./ree/boot.ext4` 的文件签过名，需要重新上传未签名过的 `boot.ext4` 文件

2.4.3 bin2ext4

bin2ext4工具用于将一个文件打包生成EXT4文件。

注意：在默认情况下，打包的EXT4文件大小是8M，如果文件真实大小大于8M，需要调整成合适的值。

```bash
dd if=/dev/zero of=$1 bs=1M count=8
```

2.4.3.1 生成uboot.EXT4

1. 将 `u-boot-with-spl.bin` 复制到bin2ext4文件下

```bash
cxx194832@docker-ubuntu18:~/sectool/bin2ext4$ ls
bin2ext4.sh Readme u-boot-with-spl.bin
```

2. 执行下面命令生成 `uboot.ext4`

```bash
cxx194832@docker-ubuntu18:~/sectool/bin2ext4$ ./bin2ext4.sh uboot.ext4 u-boot-with-spl.bin
bin2ext4 utility version v1.0

1+0 records in
1+0 records out
1048576 bytes (1.0 MB, 1.0 MiB) copied, 0.00185016 s, 567 MB/s
mke2fs 1.44.1 (24-Mar-2018)

Filesystem too small for a journal
Discarding device blocks: done
Creating filesystem with 1024 1k blocks and 128 inodes

Allocating group tables: done
Writing inode tables: done
Writing superblocks and filesystem accounting information: done
```

3. 查看生成的 `uboot.ext4` 文件

```bash
cxx194832@docker-ubuntu18:~/sectool/bin2ext4$ ls
bin2ext4.sh Readme u-boot-with-spl.bin  uboot.ext4
```

2.4.3.2 生成TF.EXT4

1. 将 `trust_firmware.bin` 复制到bin2ext4文件下

```bash
cxx194832@docker-ubuntu18:~/sectool/bin2ext4$ ls
bin2ext4.sh Readme trust_firmware.bin
```

2. 执行下面命令生成tf.ext4

```bash
cxx194832@docker-ubuntu18:~/sectool/bin2ext4$ ./bin2ext4.sh tf.ext4 trust_firmware.bin
bin2ext4 utility version v1.0

1+0 records in
1+0 records out
1048576 bytes (1.0 MB, 1.0 MiB) copied, 0.00112569 s, 931 MB/s
mke2fs 1.44.1 (24-Mar-2018)

Filesystem too small for a journal
Discarding device blocks: done
Creating filesystem with 1024 1k blocks and 128 inodes

Allocating group tables: done
Writing inode tables: done
Writing superblocks and filesystem accounting information: done
```

3. 查看生成的tf.ext4文件

```bash
cxx194832@docker-ubuntu18:~/sectool/bin2ext4$ ls
bin2ext4.sh Readme trust_firmware.bin  tf.ext4
```

2.4.3.3 生成TEE.EXT4

1. 将 `tee.bin` 复制到bin2ext4文件下

```bash
cxx194832@docker-ubuntu18:~/sectool/bin2ext4$ ls
bin2ext4.sh Readme tee.bin
```

2. 执行下面命令生成tee.ext4

```bash
cxx194832@docker-ubuntu18:~/sectool/bin2ext4$ ./bin2ext4.sh tee.ext4 tee.bin
bin2ext4 utility version v1.0

1+0 records in
1+0 records out
1048576 bytes (1.0 MB, 1.0 MiB) copied, 0.00112569 s, 931 MB/s
mke2fs 1.44.1 (24-Mar-2018)

Filesystem too small for a journal
Discarding device blocks: done
Creating filesystem with 1024 1k blocks and 128 inodes

Allocating group tables: done
Writing inode tables: done
Writing superblocks and filesystem accounting information: done
```

3. 查看生成的tee.ext4文件

```bash
cxx194832@docker-ubuntu18:~/sectool/bin2ext4$ ls
bin2ext4.sh Readme tee.bin  tee.ext4
```

2.4.3.4 生成TEE.<BOARD NAME>.EXT4

TEE.<BOARD NAME>.EXT4文件包括tee.bin和trust_firmware.bin文件，用于烧录至U-Boot tee分区。**LA开发板的文件名为tee.evb_light.ext4，LB为tee.light_b.ext4，SOM板为tee.lichee_pi_4a.ext4。**

操作如下：

1. 将 `tee.bin` 和 `trust_firmware.bin` 复制到bin2ext4文件下

```bash
cxx194832@docker-ubuntu18:~/sectool/bin2ext4$ ls
bin2ext4.sh Readme tee.bin trust_firmware.bin
```

2. 执行下面命令生成tee.ext4

```bash
cxx194832@docker-ubuntu18:~/sectool/bin2ext4$ ./bin2ext4.sh tee.evb_light.ext4 tee.bin
bin2ext4 utility version v1.0

8+0 records in
8+0 records out
8388608 bytes (8.4 MB, 8.0 MiB) copied, 0.00767809 s, 1.1 GB/s
mke2fs 1.44.1 (24-Mar-2018)
Discarding device blocks: done
Creating filesystem with 8192 1k blocks and 2048 inodes

Allocating group tables: done
Writing inode tables: done
Creating journal (1024 blocks): done
Writing superblocks and filesystem accounting information: done

```

3. 查看生成的tee.ext4文件

```bash
cxx194832@docker-ubuntu18:~/sectool/bin2ext4$ ls
bin2ext4.sh Readme tee.bin  tee.evb_light.ext4  trust_firmware.bin
```

2.4.3.5 生成SBMETA.EXT4

1. 将 `sbmeta.bin` 复制到bin2ext4文件下

```bash
cxx194832@docker-ubuntu18:~/sectool/bin2ext4$ ls
bin2ext4.sh Readme sbmeta.bin
```

2. 执行下面命令生成 `tee.ext4`

```bash
cxx194832@docker-ubuntu18:~/sectool/bin2ext4$ ./bin2ext4.sh sbnmeta.ext4 sbmeta.bin
bin2ext4 utility version v1.0

8+0 records in
8+0 records out
8388608 bytes (8.4 MB, 8.0 MiB) copied, 0.00836204 s, 1.0 GB/s
mke2fs 1.44.1 (24-Mar-2018)
Discarding device blocks: done
Creating filesystem with 8192 1k blocks and 2048 inodes

Allocating group tables: done
Writing inode tables: done
Creating journal (1024 blocks): done
Writing superblocks and filesystem accounting information: done

```

3. 查看生成的 `tee.ext4` 文件

```bash
cxx194832@docker-ubuntu18:~/sectool/bin2ext4$ ls
bin2ext4.sh Readme sbmeta.bin  sbmeta.ext4
```

2.4.4 KDF_GEN

KDF_GEN工具根据输入的CV_ROOTKEY和CV_COMMONKEY来派生KDF密钥，存在kdf_derived_key.dat，同时产生测试向量存在kdf_test_vector.dat里。

1. 将CV_ROOTKEY写入cv_rootkey.dat文件
2. 将CV_COMMONKEY写入cv_commonkey.dat文件
3. 执行key_gen.elf
4. 查看kdf_derived_key.dat和kdf_test_vector.dat

其中kdf_derived_key.dat包含所有预期生成的派生密钥， kdf_test_vector.dat包含生成派生密钥的测试向量。

2.4.5 KDF_GEN

3. 用户手册

文档名	文档链接
product用户手册	📎product用户手册_v1.2.pdf
fastboot用户手册	📎USB-Fastboot用户手册_v1.0.0.pdf
efuse上位机用户手册	📎eFuse上位机用户手册_v1.0.0.pdf