U-Boot: Verified RSA *Boot on ARM target*

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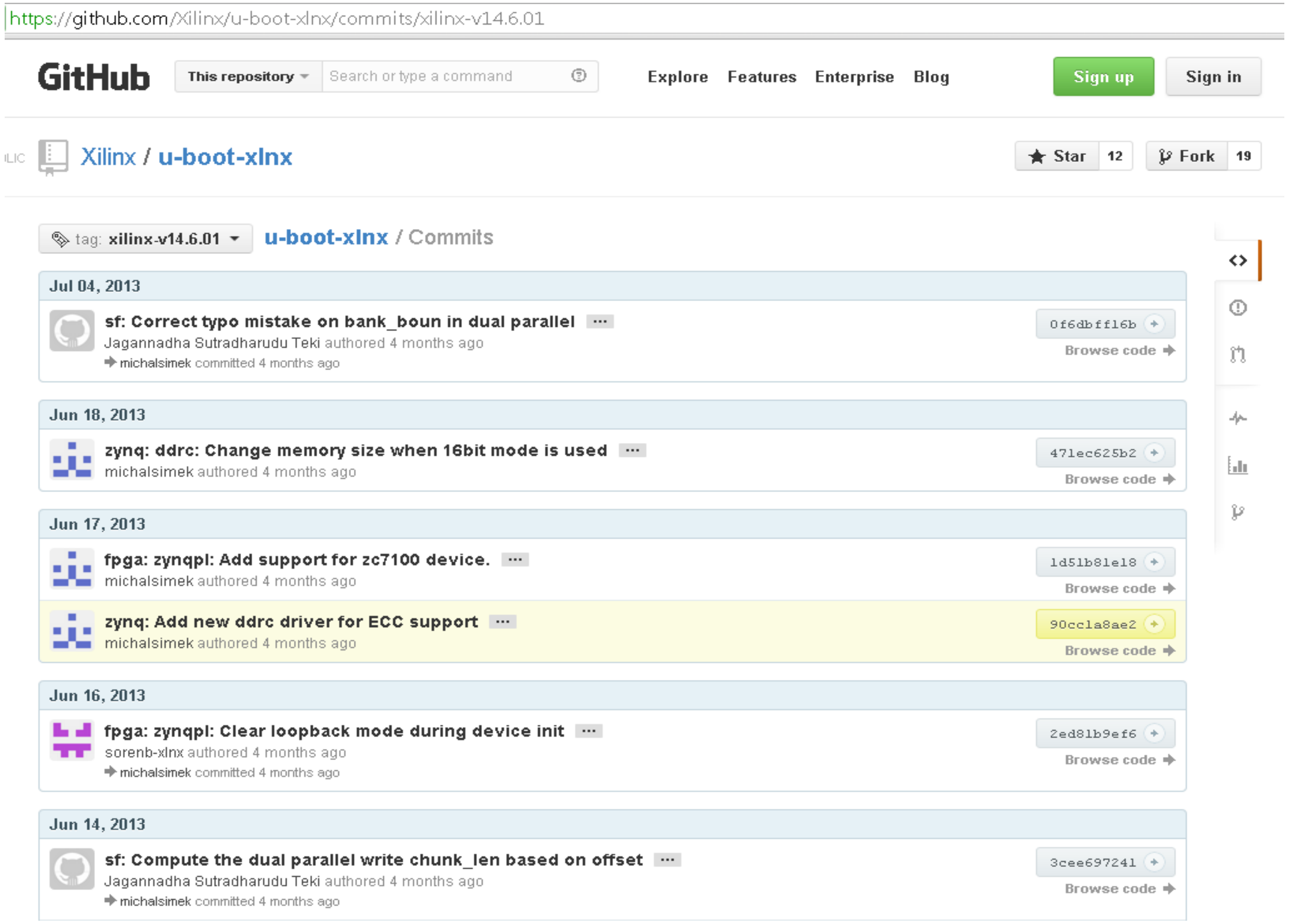
U-Boot Mini Summit- Edinburgh, 2013 Oct

Agenda

- Zynq U-Boot
- SPI Custodianship
- Verified Boot
- RSA Concept
- U-boot Verified RSA Boot
- Current u-boot state(Simon’s support)
- U-boot needs
- Demo run
- TODO
- References

Zynq U-Boot



https://github.com/Xilinx/u-boot-xlnx/commits/xilinx-v14.6.01

Xilinx / u-boot-xlnx

tag: xilinx-v14.6.01 u-boot-xlnx / Commits

Jul 04, 2013

sf: Correct typo mistake on bank_boun in dual parallel ...
Jagannadha Sutradharudu Teki authored 4 months ago
michalsimek committed 4 months ago
0f6dbff16b Browse code

Jun 18, 2013

zynq: ddrc: Change memory size when 16bit mode is used ...
michalsimek authored 4 months ago
471ec625b2 Browse code

Jun 17, 2013

fpga: zynqpl: Add support for zc7100 device. ...
michalsimek authored 4 months ago
1d51b81e18 Browse code

zynq: Add new ddrc driver for ECC support ...
michalsimek authored 4 months ago
90cc1a8ae2 Browse code

Jun 16, 2013

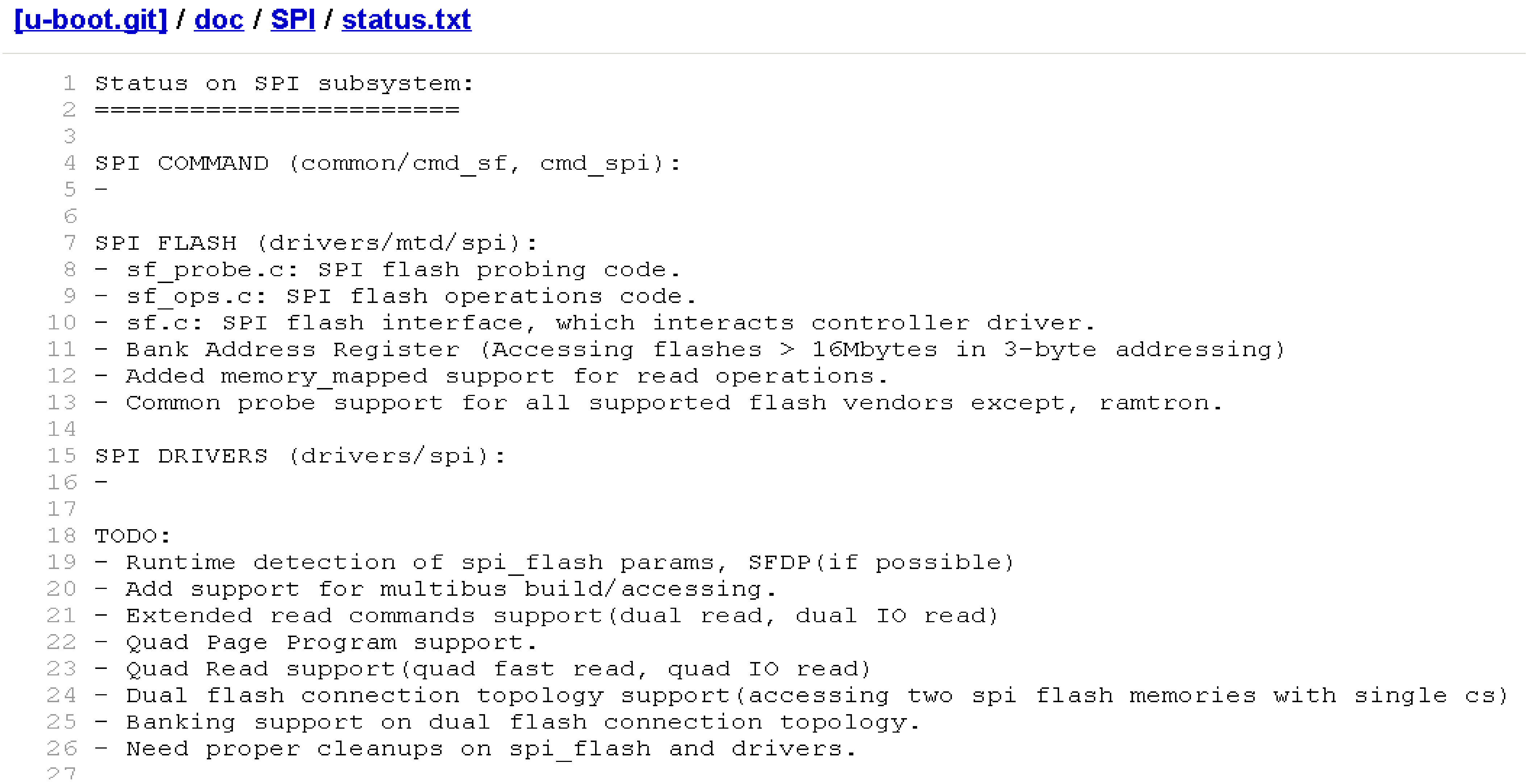
fpga: zynqpl: Clear loopback mode during device init ...
sorenb-xlnx authored 4 months ago
michalsimek committed 4 months ago
2ed81b9ef6 Browse code

Jun 14, 2013

sf: Compute the dual parallel write chunk_len based on offset ...
Jagannadha Sutradharudu Teki authored 4 months ago
michalsimek committed 4 months ago
3cee697241 Browse code

- Good customer support till now – feature additions SPI/QSPI, support new boards, d-caches and bug fixes
- **~75%** of u-boot-xlnx code is in ML, rest will push soon.

SPI Custodianship



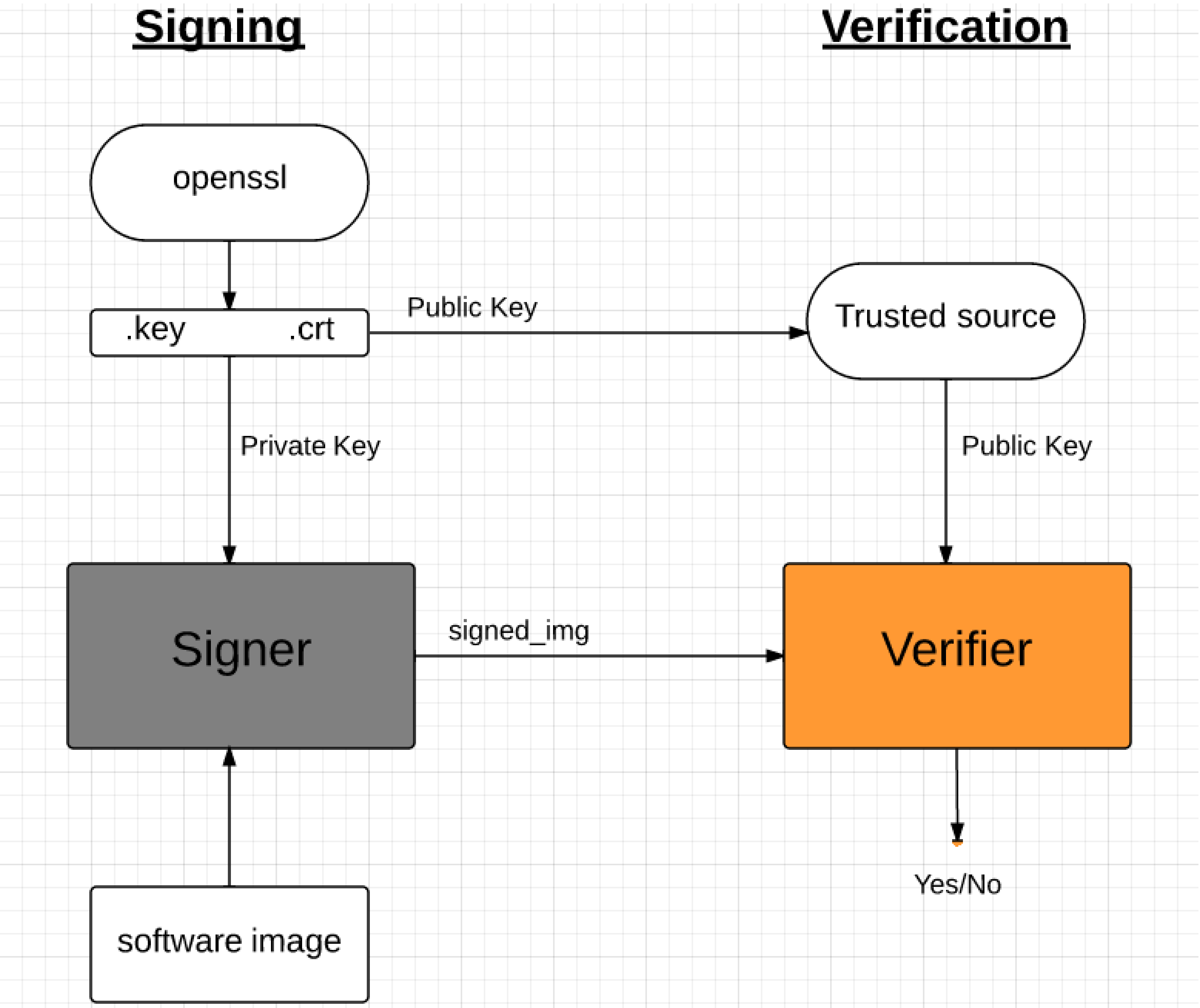
[u-boot.git] / doc / SPI / status.txt

```
Status on SPI subsystem:
=======================

SPI COMMAND (common/cmd_sf, cmd_spi):
-

SPI FLASH (drivers/mtd/spi):
- sf_probe.c: SPI flash probing code.
- sf_ops.c: SPI flash operations code.
- sf.c: SPI flash interface, which interacts controller driver.
- Bank Address Register (Accessing flashes > 16Mbytes in 3-byte addressing)
- Added memory_mapped support for read operations.
- Common probe support for all supported flash vendors except, ramtron.

SPI DRIVERS (drivers/spi):
-

TODO:
- Runtime detection of spi_flash params, SFDP(if possible)
- Add support for multibus build/accessing.
- Extended read commands support(dual read, dual IO read)
- Quad Page Program support.
- Quad Read support(quad fast read, quad IO read)
- Dual flash connection topology support(accessing two spi flash memories with single cs)
- Banking support on dual flash connection topology.
- Need proper cleanups on spi_flash and drivers.
```

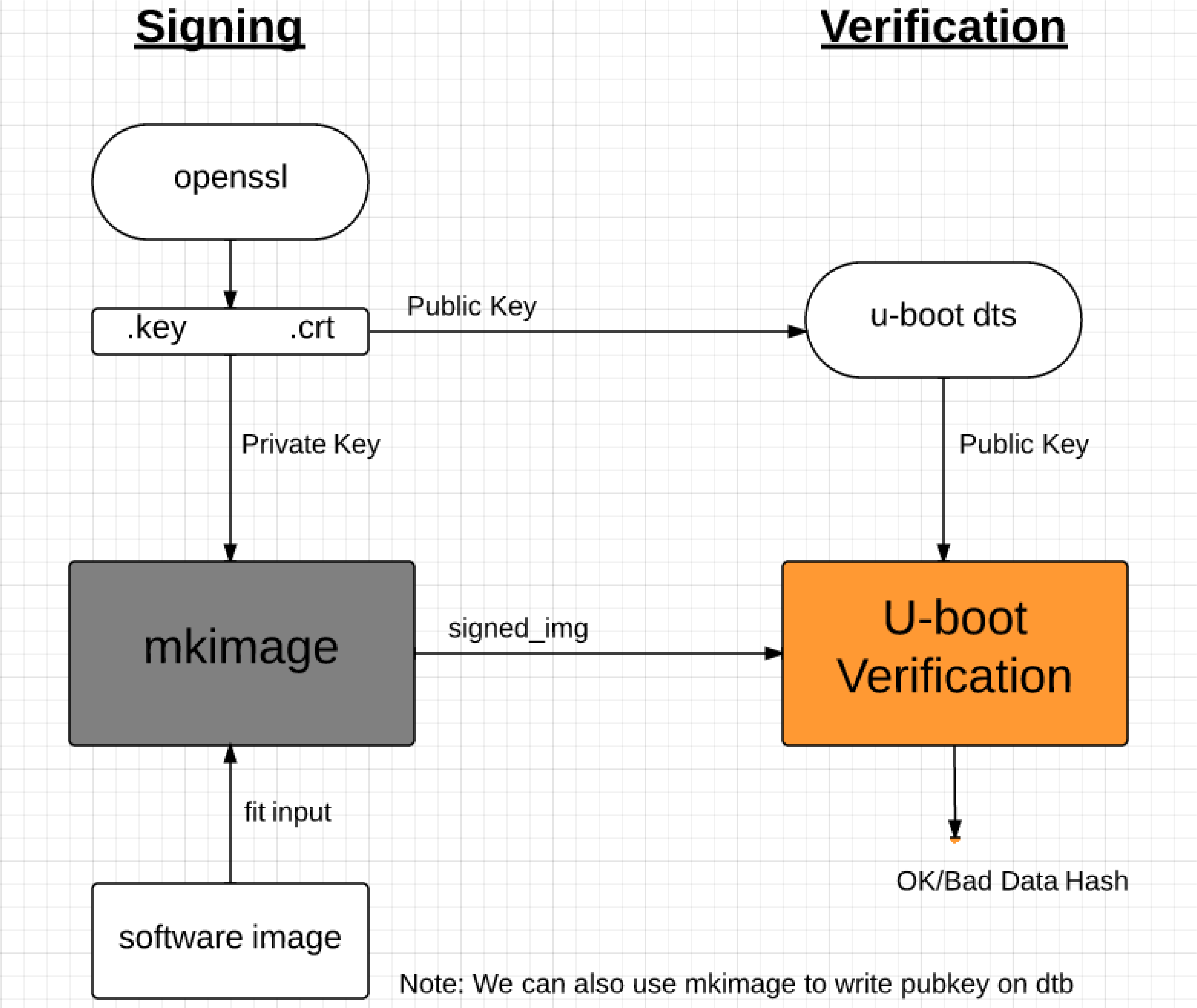
Verified Boot

- Verified – Secure – Trusted boot
- Verify the loaded software to ensure that it is authorized during boot.
- Benefits:
  - Prevent from malware
  - Provide authorized read access
  - Machine safe – runs only signed software
  - Possible to filed-upgrade the software

RSA Concept

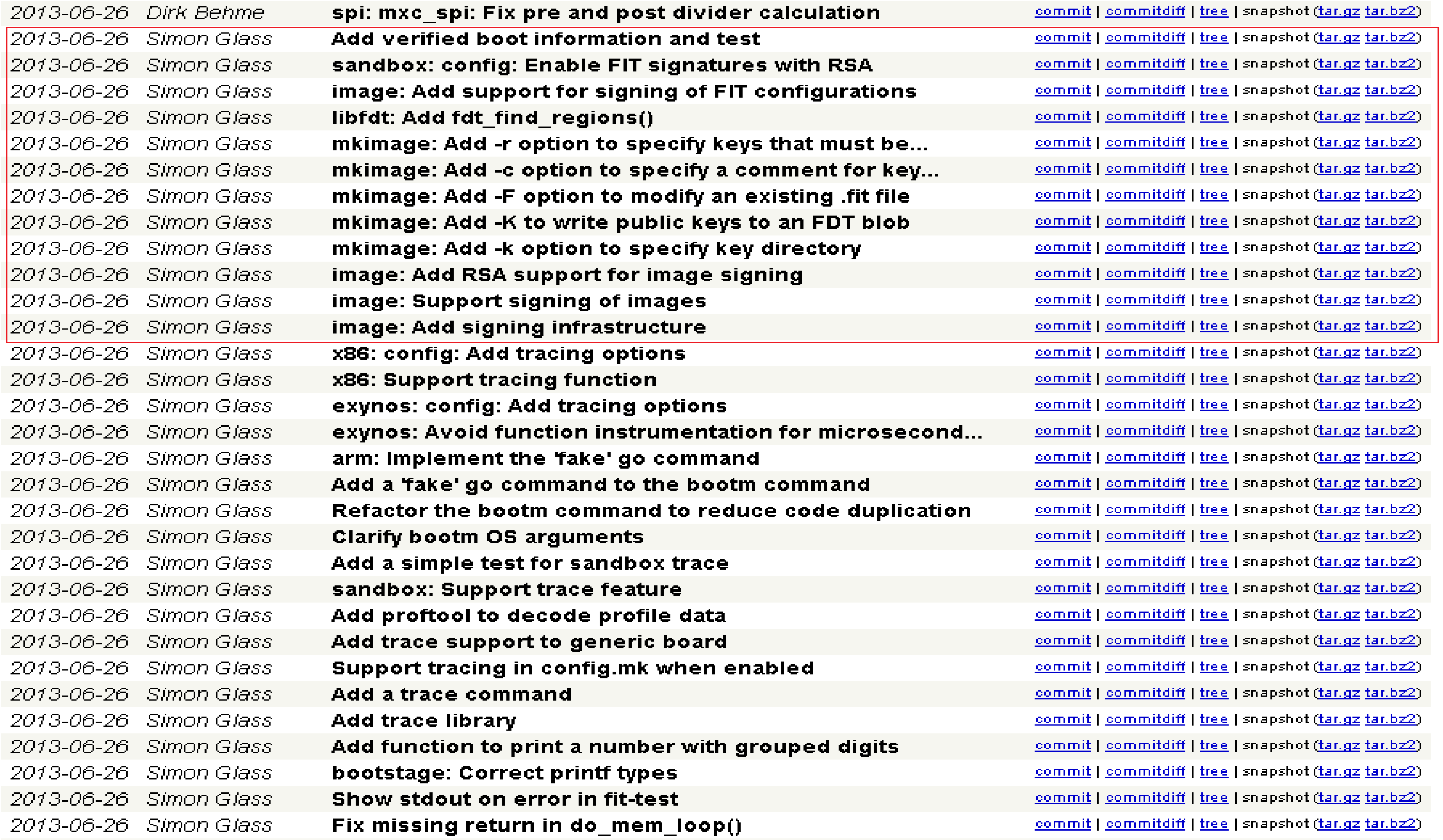

Signing
Verification
openssl
.key
.crt
Public Key
Trusted source
Private Key
Public Key
Signer
signed_img
Verifier
Yes/No
software image

U-boot Verified RSA Boot



Note: We can also use mkimage to write pubkey on dtb

Current u-boot state (Simon's support)



2013-06-26	Dirk Behme	spi: mxc_spi: Fix pre and post divider calculation	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	Add verified boot information and test	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	sandbox: config: Enable FIT signatures with RSA	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	image: Add support for signing of FIT configurations	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	libfdt: Add fdt_find_regions()	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	mkimage: Add -r option to specify keys that must be...	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	mkimage: Add -c option to specify a comment for key...	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	mkimage: Add -F option to modify an existing .fit file	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	mkimage: Add -K to write public keys to an FDT blob	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	mkimage: Add -k option to specify key directory	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	image: Add RSA support for image signing	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	image: Support signing of images	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	image: Add signing infrastructure	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	x86: config: Add tracing options	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	x86: Support tracing function	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	exynos: config: Add tracing options	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	exynos: Avoid function instrumentation for microsecond...	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	arm: Implement the 'fake' go command	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	Add a 'fake' go command to the bootm command	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	Refactor the bootm command to reduce code duplication	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	Clarify bootm OS arguments	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	Add a simple test for sandbox trace	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	sandbox: Support trace feature	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	Add proftool to decode profile data	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	Add trace support to generic board	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	Support tracing in config.mk when enabled	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	Add a trace command	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	Add trace library	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	Add function to print a number with grouped digits	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	bootstage: Correct printf types	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	Show stdout on error in fit-test	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)
2013-06-26	Simon Glass	Fix missing return in do_mem_loop()	commit | commitdiff | tree | snapshot (tar.gz tar.bz2)

U-boot needs

- Enable FIT
  - CONFIG_FIT - enable support for the FIT uImage format
- Enable FDT
  - CONFIG_OF_CONTROL
  - CONFIG_OF_SEPARATE
- ***Enable verified boot***
  - ***CONFIG_FIT_SIGNATURE - enables signature verification of FIT images***
  - ***CONFIG_RSA - enables the RSA algorithm used for FIT image verification***

Demo run…

- Build FDT u-boot
- Build rsa_signed image
- Build FDT u-boot with public key
- Run rsa_signed image

Build FDT u-boot

- Setup the toolchain:

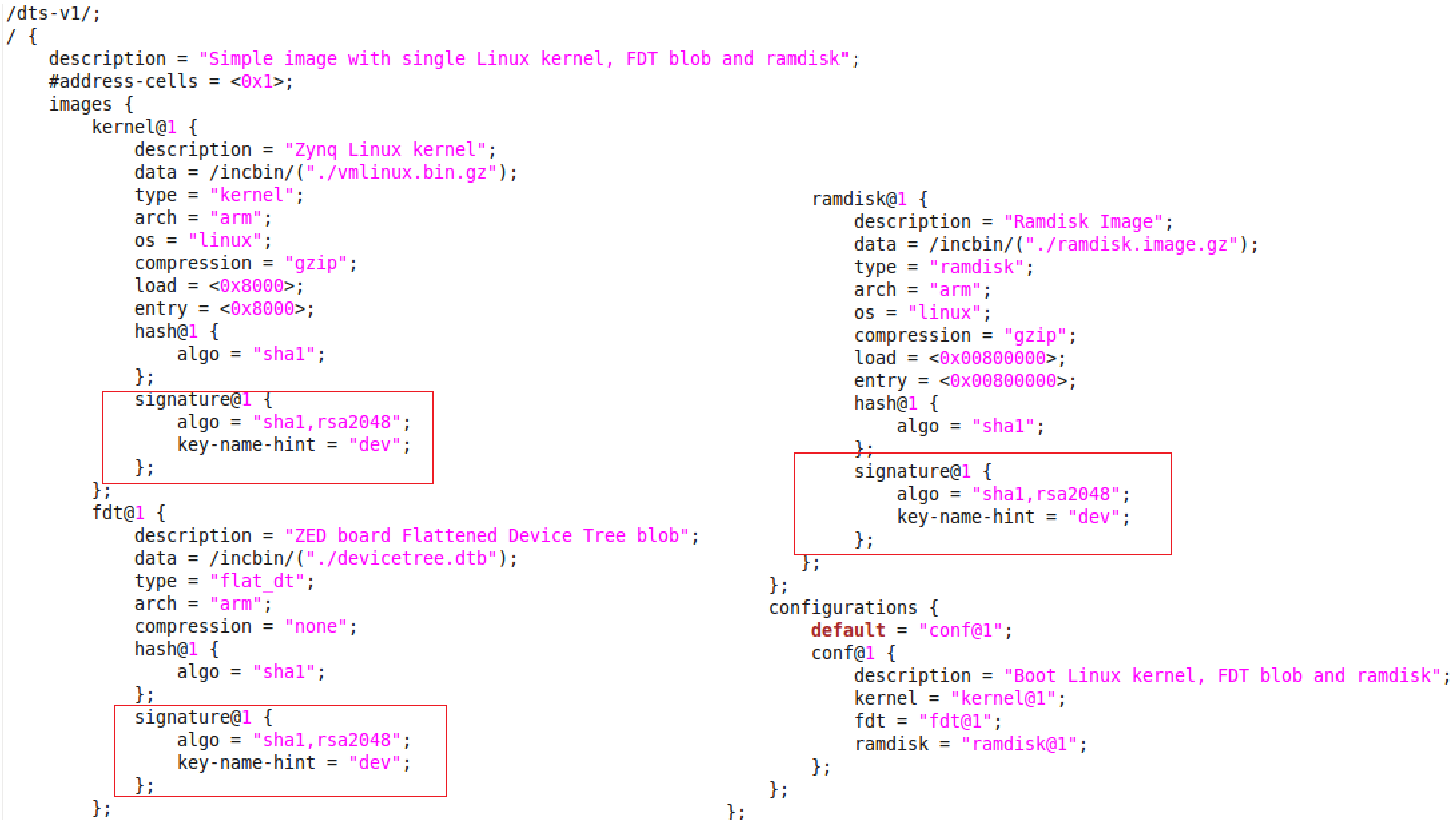
  http://www.wiki.xilinx.com/Zynq+Base+TRD+14.5#x-5 Building the U-boot Boot Loader

- Clone u-boot-spi.git

```
$ git clone git://git.denx.de/u-boot-spi.git
$ cd u-boot-spi
$ git checkout –b master-xlnx origin/master-xlnx
```

- U-boot build

```
$ make zynq_zed_config
$ make DEVICE_TREE=zynq-zed -j4
```



```
/dts-v1/;
/ {
    description = "Simple image with single Linux kernel, FDT blob and ramdisk";
    #address-cells = <0x1>;
    images {
        kernel@1 {
            description = "Zynq Linux kernel";
            data = /incbin/("./vmlinux.bin.gz");
            type = "kernel";
            arch = "arm";
            os = "linux";
            compression = "gzip";
            load = <0x8000>;
            entry = <0x8000>;
            hash@1 {
                algo = "sha1";
            };
            signature@1 {
                algo = "sha1,rsa2048";
                key-name-hint = "dev";
            };
        };
        fdt@1 {
            description = "ZED board Flattened Device Tree blob";
            data = /incbin/("./devicetree.dtb");
            type = "flat_dt";
            arch = "arm";
            compression = "none";
            hash@1 {
                algo = "sha1";
            };
            signature@1 {
                algo = "sha1,rsa2048";
                key-name-hint = "dev";
            };
        };
        ramdisk@1 {
            description = "Ramdisk Image";
            data = /incbin/("./ramdisk.image.gz");
            type = "ramdisk";
            arch = "arm";
            os = "linux";
            compression = "gzip";
            load = <0x00800000>;
            entry = <0x00800000>;
            hash@1 {
                algo = "sha1";
            };
            signature@1 {
                algo = "sha1,rsa2048";
                key-name-hint = "dev";
            };
        };
    };
    configurations {
        default = "conf@1";
        conf@1 {
            description = "Boot Linux kernel, FDT blob and ramdisk";
            kernel = "kernel@1";
            fdt = "fdt@1";
            ramdisk = "ramdisk@1";
        };
    };
};
```

Build rsa_signed

- RSA key generation:

```
- Create RSA key pair
$ openssl genrsa -F4 -out mykeys/dev.key 2048
- Create a certificate contains public key
$ openssl req -batch -new -x509 -key mykeys/dev.key -out mykeys/dev.crt
```

- Create dtb for existing u-boot dts

```
$ dtc -p 0x1000 board/xilinx/dts/zynq-zed.dts -O dtb -o zynq-zed.dtb
$ cp zynq-zed.dtb zynq-zed-pubkey.dtb
```

- Sign the images with mykeys

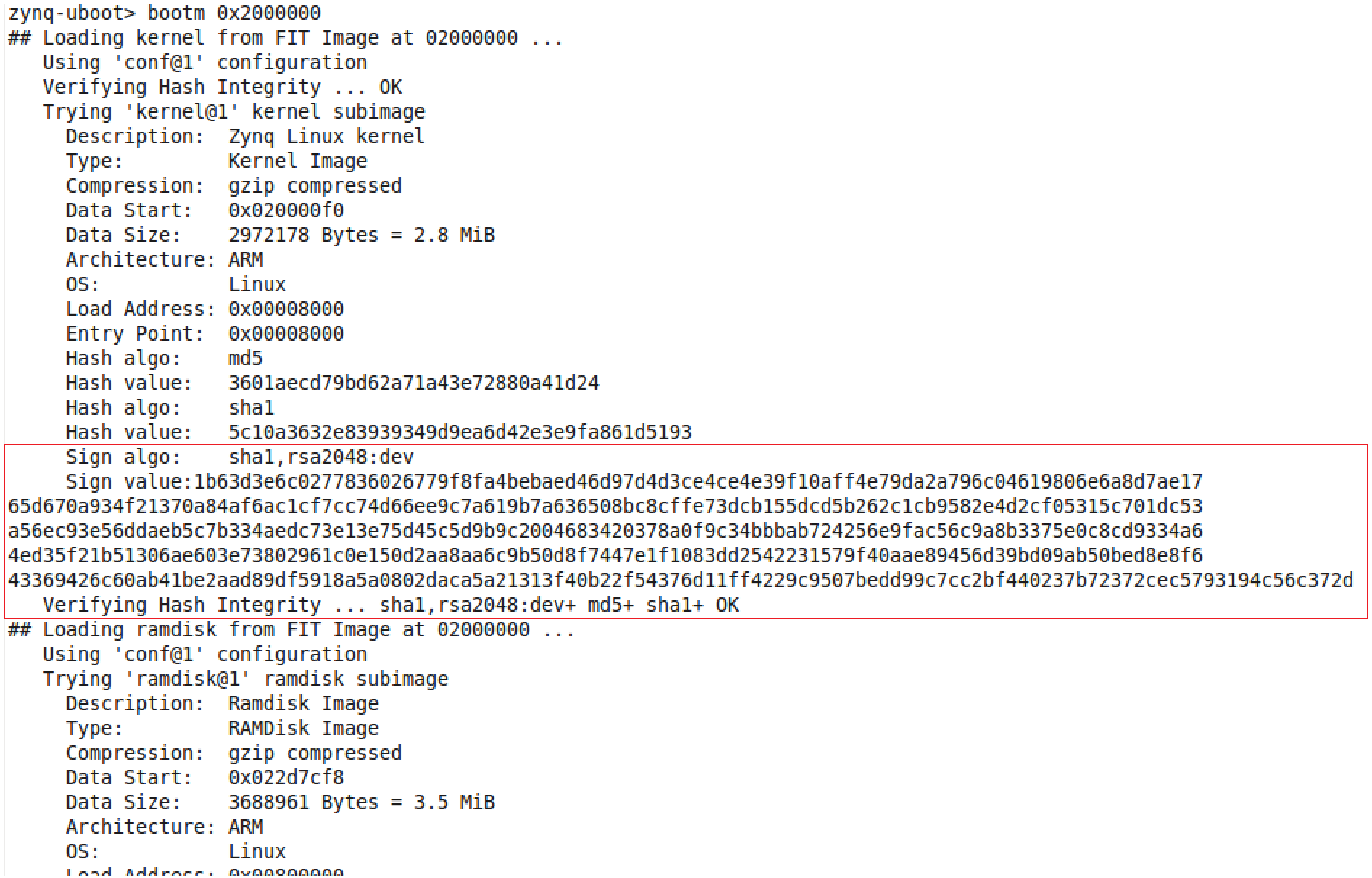
```
$ DTC_OPS="-I dts -O dtb -p 2000"
$ mkimage –D “${DTC_OPS}” –f rsa.its –K zynq-zed-pubkey.dtb –k mykeys –r rsa_signed.img
```

Build FDT u-boot with public key

- For building FDT u-boot with public key- externally

```
$ make DEV_TREE_BIN=./zynq-zed-pubkey.dtb
```

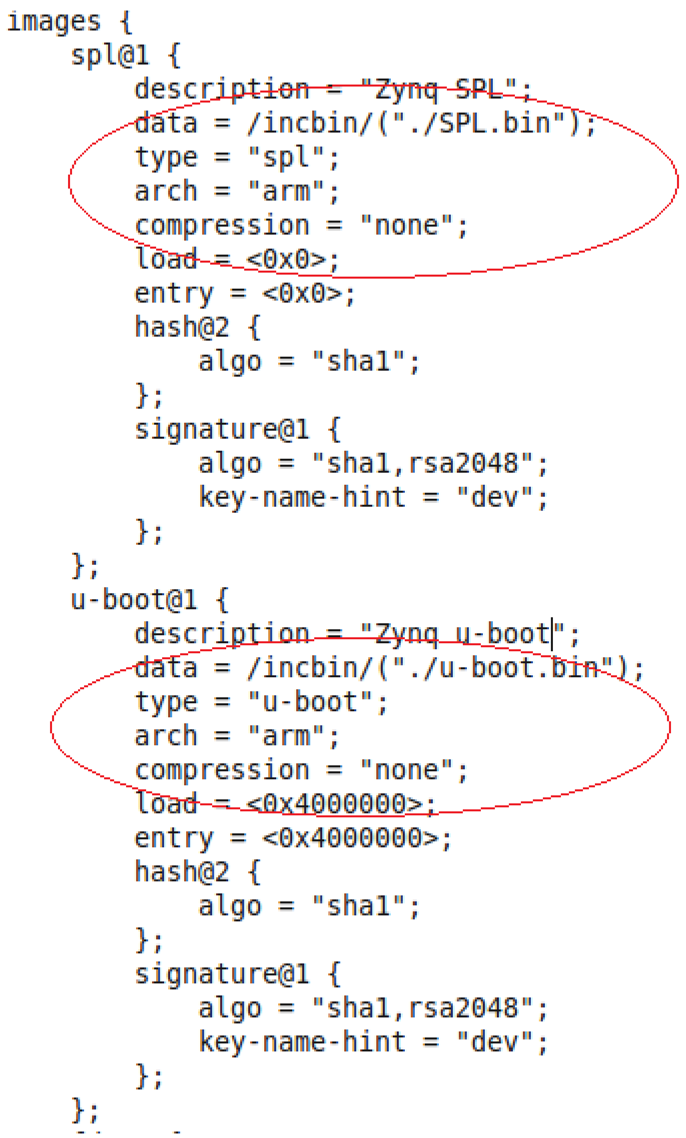
u-boot-dtb.bin -> Is final FDT u-boot image with public key on it, hence the pubkey will used in verification process.



```
zynq-uboot> bootm 0x2000000
## Loading kernel from FIT Image at 02000000 ...
   Using 'conf@1' configuration
   Verifying Hash Integrity ... OK
   Trying 'kernel@1' kernel subimage
     Description:  Zynq Linux kernel
     Type:         Kernel Image
     Compression:  gzip compressed
     Data Start:   0x020000f0
     Data Size:    2972178 Bytes = 2.8 MiB
     Architecture: ARM
     OS:           Linux
     Load Address: 0x00008000
     Entry Point:  0x00008000
     Hash algo:    md5
     Hash value:   3601aecd79bd62a71a43e72880a41d24
     Hash algo:    sha1
     Hash value:   5c10a3632e83939349d9ea6d42e3e9fa861d5193
     Sign algo:    sha1,rsa2048:dev
     Sign value:1b63d3e6c0277836026779f8fa4bebaed46d97d4d3ce4ce4e39f10aff4e79da2a796c04619806e6a8d7ae17
65d670a934f21370a84af6ac1cf7cc74d66ee9c7a619b7a636508bc8cffe73dcb155dcd5b262c1cb9582e4d2cf05315c701dc53
a56ec93e56ddaeb5c7b334aedc73e13e75d45c5d9b9c2004683420378a0f9c34bbbab724256e9fac56c9a8b3375e0c8cd9334a6
4ed35f21b51306ae603e73802961c0e150d2aa8aa6c9b50d8f7447e1f1083dd2542231579f40aae89456d39bd09ab50bed8e8f6
43369426c60ab41be2aad89df5918a5a0802daca5a21313f40b22f54376d11ff4229c9507bedd99c7cc2bf440237b72372cec5793194c56c372d
   Verifying Hash Integrity ... sha1,rsa2048:dev+ md5+ sha1+ OK
## Loading ramdisk from FIT Image at 02000000 ...
   Using 'conf@1' configuration
   Trying 'ramdisk@1' ramdisk subimage
     Description:  Ramdisk Image
     Type:         RAMDisk Image
     Compression:  gzip compressed
     Data Start:   0x022d7cf8
     Data Size:    3688961 Bytes = 3.5 MiB
     Architecture: ARM
     OS:           Linux
     Load Address: 0x00800000
```

TODO

- Possible TODO’s @ doc/uImage.FIT/signature.txt
- ***Signed_image creations support for bootable images (SPL) or FIT support in SPL ???***



```
images {
    spl@1 {
        description = "Zynq SPL";
        data = /incbin/("./SPL.bin");
        type = "spl";
        arch = "arm";
        compression = "none";
        load = <0x0>;
        entry = <0x0>;
        hash@2 {
            algo = "sha1";
        };
        signature@1 {
            algo = "sha1,rsa2048";
            key-name-hint = "dev";
        };
    };
    u-boot@1 {
        description = "Zynq u-boot";
        data = /incbin/("./u-boot.bin");
        type = "u-boot";
        arch = "arm";
        compression = "none";
        load = <0x4000000>;
        entry = <0x4000000>;
        hash@2 {
            algo = "sha1";
        };
        signature@1 {
            algo = "sha1,rsa2048";
            key-name-hint = "dev";
        };
    };
```

References

- Zynq u-boot-xlnx.git repo

https://github.com/Xilinx/u-boot-xlnx

- For verified boot: doc/uImage.FIT/verified-boot.txt
- For signature: doc/uImage.FIT/signature.txt
- Sample sign its: doc/uImage.FIT/sign-configs.its
- Code for this demo run

http://git.denx.de/?p=u-boot/u-boot-spi.git;a=shortlog;h=refs/heads/master-xlnx

- Possible TODO’s on doc/uImage.FIT/signature.txt
- Any questions - mail to sjg@chromium.org CC u-boot@lists.denx.de, jagannadh.teki@gmail.com