Nand Flash Open Source Solution Develop Guide

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Preface

Overview

Rockchip SDKs use closed-source miniloader to load trust and u-boot by default. All memories (eMMC NAND or NOR Flash) are accessed through block interface. For developers who want to access NAND or NOR Flash through MTD interface, Rockchip provides open source SPL to load trust and u-boot, and access NAND or NOR Fash through MTD interface in u-boot.

Product Version

Chipset	Kernel version
RK3308	Linux 4.4, Linux4.19
RV1126 & RV1109	Linux 4.19

Intended Audience

This document (this guide) is mainly intended for:

Technical support engineers

Software development engineers

Revision History

Version	Author	Date	Change Description
V1.0.0	HKH	2019-06-20	Initial version
V1.0.1	HKH	2019-11-11	Add SD card upgrade introduction
V1.0.2	Ruby Zhang	2020-07-08	Update the format of the document
V1.1.0	Jair Wu	2020-07-10	Add u-boot compile introduction
V2.0.0	Jon Lin	2020-10-19	Improve the driver configuration and other details
V2.0.1	Jon Lin	2020-11-27	Add UBIFS multi volume support, increase or decrease ubiattach parameter description
V2.1.0	Jon Lin	2021-01-27	Add more UBIFS support
V2.1.1	CWW	2021-02-22	Update the format of the document

Contents

1. Notes on Open Source Solution

1.1 Feature

Confirm these following feature:

Note.	Support Device Type	Register Device Type	Filesystem	Download methods
SLC Nand open source solution (Parallel Nand)	SLC Nand	mtd、ubiblock	SquashFS、UBIFS	USB download、SD card download、Flash Programmer
SPI Nand open source solution	SPI Nand	mtd、ubiblock	SquashFS、UBIFS	USB download、SD card download、Flash Programmer

Main points：

- The device type to choose
- Does the filesystem meet the requirements

1.2 Nand Flash Infomation

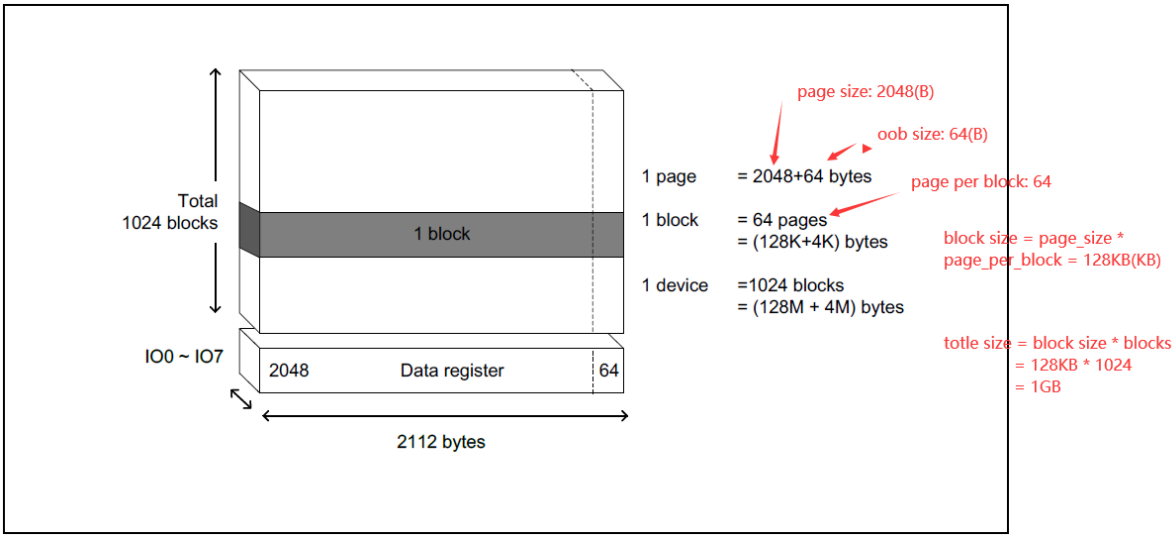
Making UBIFS images、IDB images(Pre loader) should depend on the concrete Nand flash infomation, including follow information:

- page size, SLC Nand is usually in 2KB or 4KB;
- page per block, SLC Nand is usually in 64 or 128;
- block size = page_size * page_per_block, SLC Nand is usually 128KB or 256KB;
- oob size, SLC Nand is usually in 64B, 128B or 256B.

The default configuration is mostly base on 2KB page size and 128 block size flash, change it if need when you perform the following process:

- Making Programmer images
- Making UBIFS filesystem images

The Nand flash information is mostly like this:



1.3 Other Notes

- UBFFS images is not compatible with two different Nand flash with different page size or block size, Therefore, the selection of flash devices should be careful.
- SLC NAND in the document refers to the parallel port NAND

2. Build Configuration Changes

2.1 SPL & U-Boot

Note.	Support Device Type	Driver Codes	Flash Framework	Device Register Type	Filesystem	Download methods
SLC Nand open source solution	SLC Nand	drivers/mtd/nand/raw	drivers/mtd/nand/raw	mtd	UBIFS	USB download、SD card download、Flash Programmer
SPI Nand open source solution	SPI Nand	drivers/spi	drivers/mtd/nand/spi	mtd	UBIFS	USB download、SD card download、Flash Programmer\

2.1.1 Configurations

The defconfig is configured as follows：

Add:

```
// MTD support
CONFIG_MTD=y
CONFIG_CMD_MTD_BLK=y
CONFIG_SPL_MTD_SUPPORT=y
CONFIG_MTD_BLK=y
CONFIG_MTD_DEVICE=y

// spi nand support
CONFIG_NAND=y
CONFIG_MTD_SPI_NAND=y
CONFIG_ROCKCHIP_SFC=y
CONFIG_SPL_SPI_FLASH_SUPPORT=y
CONFIG_SPL_SPI_SUPPORT=y

// nand support
CONFIG_NAND=y
CONFIG_CMD_NAND=y
CONFIG_NAND_ROCKCHIP=y
CONFIG_SPL_NAND_SUPPORT=y
CONFIG_SYS_NAND_U_BOOT_LOCATIONS=y
CONFIG_SYS_NAND_U_BOOT_OFFS=0x8000
CONFIG_SYS_NAND_U_BOOT_OFFS_REDUND=0x10000

// rkfw firmware uboot trust address (Needless in fit format)
CONFIG_RKFW_TRUST_SECTOR=0X3000     #The flashing address in memory is in
sectors, 1 sector=512 Bytes, which is the start address of the trust in
paramter.txt
CONFIG_RKFW_U_BOOT_SECTOR=0X2000    #The flashing address in memory is in
sectors, 1 sector=512 Bytes, which is the starting address of u-boot in
paramter.txt
```

Remove:

```
CONFIG_RKFLASH=y
CONFIG_RKNANDC_NAND=y
CONFIG_RKSFC_NAND=y
CONFIG_RKSFC_NOR=y
```

2.1.2 Compile Instrodution

64-bits:

Excute `./make.sh uboot` in root path of SDK or excute `./make.sh rk3308` in [ROOT PATH]/u-boot.

32-bits:

64-bits loader is needed in 32-bit u-boot compilation, so compile 64-bits u-boot firstly, backup spl/u-boot-spl.bin, replace spl/u-boot-spl.bin after compiling 32-bits u-boot, and then pack loader, commands are as follows:

```
cd u-boot
./make.sh rk3308
cp spl/u-boot-spl.bin ..
./make.sh rk3308-aarch32
cp ../u-boot-spl.bin spl/
./make.sh spl-s ../rkbin/RKBOOT/RK3308MINIALL_WO_FTL.ini
```

These commads will generate rk3308_loader_wo_ftl_v*.bin which you can flash into board as final loader.

2.2 Kernel

Note.	Support Device Type	Driver Codes	Flash Framework	Device Register Type	Filesystem	Download methods
SLC Nand open source solution	SLC Nand	drivers/mtd/nand/raw	drivers/mtd/nand/raw	mtd	UBIFS	USB download、SD card download、Flash Programmer
SPI Nand open source solution	SPI Nand	drivers/rkflash	drivers/rkflash	mtd	UBIFS	USB download、SD card download、Flash Programmer

2.2.1 SLC Nand Open Source Solution

Configuration：

```
CONFIG_RK_FLASH=n   /* It's not compatible */
CONFIG_MTD_NAND_ROCKCHIP_V6=y /* NandC v6 is depending on TRM NANDC-
>NANDC_NANDC_VER register, 0x00000801 */
# CONFIG_MTD_NAND_ROCKCHIP_V9=y /* NandC v9  is depending on TRM NANDC-
>NANDC_NANDC_VER register, 0x56393030, Currently only RK3326 is relevant */
CONFIG_MTD_CMDLINE_PARTS=y
```

Sources Codes：

```
./drivers/mtd/nand/raw/
```

Reserved 4 blocks for bad block table, so the firmware should not overlay the area and it's better to reserved 1MB, consult to "MTD Partition Table" chapter for detail.

2.2.2 SPI Nand Open Source Solution

Configuration：

```
CONFIG_RK_FLASH=y

CONFIG_RK_SFC_NAND=y     /* SPI Nand flash */
CONFIG_RK_SFC_NAND_MTD=y /* SPI Nand flash and partitions is register as mtd
device,  otherwise block devices(rkflash0pn)  */
CONFIG_MTD_CMDLINE_PARTS=y
```

Sources Codes：

```
./drivers/rkflash
```

SPI Nand Bad blocks Management Strategy：

The last 4 blocks are reserved for Nand bad block table, it's better to reserve 1MB.

Sources Codes：

```
./drivers/rkflash/sfc_nand_mtd_bbt.c
```

Reserved 4 blocks for bad block table, so the firmware should not overlay the area and it's better to reserved 1MB, consult to "MTD Partition Table" chapter for detail.

2.3 MTD Partition Table

2.3.1 Parse GPT And Generate MTD Partition In RK SDK

RK SDK support parsing GPT and generate mtdparts to kernel.

Notes：

- Each partition of SLC NAND and SPI NAND open source solution images should reserve 2 ~ 3 redundant flash block sizes, so that when bad blocks are encountered, there is redundant space to replace， especially for uboot partition。
- Partition should start from address which is flash block size aligned
- The last 4 blocks are reserved for Nand bad block table, so the firmware should not overlay the area, there are two specific situations:

  parameter.txt use the "grow" flag for the last partition in the code: the size of the last partition will be automatically adjusted in the code, and the SDK is the scheme by default;

  parameter.txt The last partition in does not use the "grow" flag or does not use the GPT scheme: the last user partition should not be defined to the 1MB space at the end of the flash.
- The partition table should be GPT table, that is, configure the following fields in parameter.txt file:

  ```
  TYPE: GPT
  ```

2.3.2 Dts Adds Rootfs Mount Information

Select and add the appropriate code in dts bootargs：

```
ubi.mtd=4 root=ubi0:rootfs rootfstype=ubifs
ubi.mtd=3 ubi.block=0,rootfs root=/dev/ubiblock0_0 rootfstype=squashfs    /*
Mount SquashFS on UBI block */
```

Note：

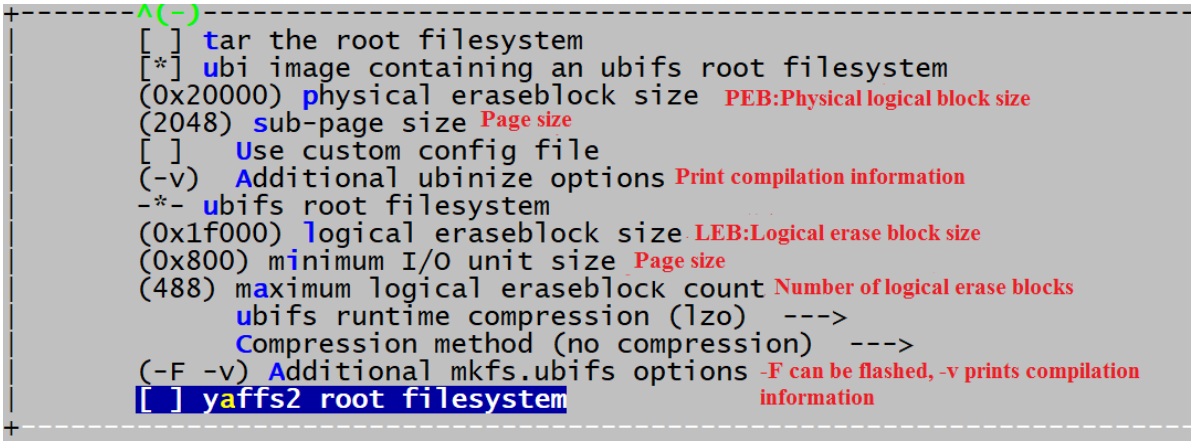
1. MTD partitions is correspond with partitions parameter.txt, counting from mtd0 or mtdblock0;
2. mtd is char device, mtdblock is block device

2.3.3 Vendor Storage

Add a partition "vnvm" in parameter.txt to enable vendor storage.
The size of the partition needs to be an integer multiple of the NAND flash block size, it is recommended to configure 1MB.

2.4 Buildroot

Takes ubifs as an rootfs example, refer to the configuration below, please refer to ubifs for detailed parameters configurations:



When finishing the configuration, use "make savedefconfig" to save Buildroot configuration.

2.5 Building Script Patch

Add spl building to build.sh. The generated spl file is located at "u-boot/spl/u-boot-spl.bin", but parts of SOC should patch following patches.

2.5.1 RK3308 Patches

Building Pre loader

The SDK generate Pre loader from the Miniloader project with FTL version which it not support this open source case, so you have to choose one of following patch:

Closed source without FTL support Miniloader.bin :

```
diff --git a/common/build.sh b/common/build.sh
index 671decd..c4fe085 100755
--- a/common/build.sh
+++ b/common/build.sh
@@ -46,7 +46,7 @@ function build_uboot(){
        if [ -f u-boot/*_loader_*.bin ]; then
                rm u-boot/*_loader_*.bin
        fi
-       cd u-boot && ./make.sh $RK_UBOOT_DEFCONFIG && cd -
+       cd u-boot && ./make.sh $RK_UBOOT_DEFCONFIG && ./make.sh spl-s
../rkbin/RKBOOT/RK3308MINIALL_WO_FTL.ini && cd -
        if [ $? -eq 0 ]; then
                echo "====Build uboot ok!===="
        else
```

Open source SPL:

consult to "Compile Instrodution" chapter.

Modify SDK Filesystem Configuration

Modify the following fields in BoardConfig.mk：

```
export RK_ROOTFS_TYPE=ubi
export RK_OEM_FS_TYPE=ubi
export RK_USERDATA_FS_TYPE=ubi
```

Package tools modification (tools directory), oem and userdata are not packaged as follows:

```
diff --git a/linux/Linux_Pack_Firmware/rockdev/rk3308-package-file
b/linux/Linux_Pack_Firmware/rockdev/rk3308-package-file
index 92c0259..260e2fe 100755
--- a/linux/Linux_Pack_Firmware/rockdev/rk3308-package-file
+++ b/linux/Linux_Pack_Firmware/rockdev/rk3308-package-file
@@ -9,8 +9,8 @@ uboot       Image/uboot.img
 boot        Image/boot.img
 rootfs      Image/rootfs.img
 recovery        Image/recovery.img
-oem                     Image/oem.img
-userdata:grow    Image/userdata.img
+#oem                    Image/oem.img
+#userdata:grow    Image/userdata.img
```

2.6 Partition Table

The partition table should be GPT table, that is, configure the following fields in parameter.txt file:

```
TYPE: GPT
```

2.7 SD Booting Upgrade

The SPL solution supports SD card upgrade solution. If you need this function, the following configuration should be turned on:

U-Boot directory：

```
diff --git a/arch/arm/dts/rk3308-evb.dts b/arch/arm/dts/rk3308-evb.dts
index 3178d45..68853d6 100644
--- a/arch/arm/dts/rk3308-evb.dts
+++ b/arch/arm/dts/rk3308-evb.dts
@@ -330,7 +330,7 @@
         sd-uhs-sdr25;
         sd-uhs-sdr50;
         sd-uhs-sdr104;
-        status = "disabled";
+        status = "okay";
 };

 &u2phy {
```

```
-CONFIG_OF_SPL_REMOVE_PROPS="pinctrl-0 pinctrl-names clock-names interrupt-parent
assigned-clocks assigned-clock-rates assigned-clock-parents"
+CONFIG_OF_SPL_REMOVE_PROPS=""
+CONFIG_SPL_PINCTRL_GENERIC=y
+CONFIG_SPL_PINCTRL=y
```

kernel directory:

```
diff --git a/arch/arm64/boot/dts/rockchip/rk3308.dtsi
b/arch/arm64/boot/dts/rockchip/rk3308.dtsi
index 8a98886..970fb69 100644
--- a/arch/arm64/boot/dts/rockchip/rk3308.dtsi
+++ b/arch/arm64/boot/dts/rockchip/rk3308.dtsi
@@ -1166,6 +1166,8 @@
                 nandc_id = <0>;
                 clocks = <&cru SCLK_NANDC>, <&cru HCLK_NANDC>;
                 clock-names = "clk_nandc", "hclk_nandc";
+                pinctrl-names = "default";
+                pinctrl-0 = <&flash_csn0 &flash_rdy &flash_ale &flash_cle
&flash_wrn &flash_rdn &flash_bus8>;
                 status = "disabled";
         };
```

```

```

```
diff --git a/drivers/mtd/nand/rockchip_nand_v6.c
b/drivers/mtd/nand/rockchip_nand_v6.c
index 5a74427..31208ba 100644
--- a/drivers/mtd/nand/rockchip_nand_v6.c
+++ b/drivers/mtd/nand/rockchip_nand_v6.c
@@ -20,6 +20,7 @@
 #include <linux/gpio.h>
 #include <linux/interrupt.h>
 #include <linux/iopoll.h>
+#include <asm/io.h>

 #define         NANDC_V6_NUM_BANKS      4
 #define         NANDC_V6_DEF_TIMEOUT    20000
@@ -689,6 +690,7 @@ static int rk_nandc_probe(struct platform_device *pdev)
         int irq;
         int ret;
         int clock_frequency;
+       void __iomem *base;

         nandc = devm_kzalloc(dev, sizeof(*nandc), GFP_KERNEL);
         if (!nandc)
@@ -697,6 +699,8 @@ static int rk_nandc_probe(struct platform_device *pdev)
         nandc->dev = dev;

         r = platform_get_resource(pdev, IORESOURCE_MEM, 0);
+       base = ioremap(0xff000000, 0x10000);
+       printk("%s %x %x\n", __func__, readl(base + 0x60), readl(base + 0x68));
         nandc->regs = devm_ioremap_resource(dev, r);
         if (IS_ERR(nandc->regs))
                 return PTR_ERR(nandc->regs);
```

Macros should be turned on in the defconfig of recovery

```
BR2_PACKAGE_MTD=y
```

When finishing building, use the tool SDDiskTool_v1.59 to make the card. First time to upgrade have to generate the firmware needed to upgrade Flash in the root directory of the SD card, so it will take longer time, but will be quicker later.

2.8 Enable Key Log

SPL Log:

```
U-Boot SPL board init
U-Boot SPL 2017.09-03071-g9cb6379-dirty (Jun 28 2019 - 10:29:22)
```

Then run `mount` command and it will mount as follows:

```
# mount
ubi0:rootfs on / type ubifs (rw,relatime)
/dev/ubi6_0 on /oem type ubifs (rw,relatime)
/dev/ubi7_0 on /userdata type ubifs (rw,relatime)
```

3. OTA

3.1 Upgrade MTD Partitions By Shell Command

First of all, if the image in the MTD partition uses the UBIFS file system, refer to the chapter "UBIFS OTA" chapter . Therefore, the MTD partition is mainly aimed at the firmware partitions that are read-only and have no file system, such as IDB, u-boot, kernel, etc.

u-boot SLC Nand

nand info：

```
nand info
```

nand erase：

```
nand erase off size
```

- off：block size aligned, unit byte, only hexadecimal is supported
- size：block size aligned, unit byte, only hexadecimal is supported

nand write：

```
nand write - addr off|partition size
```

- addr：memory address, only hexadecimal is supported
- off|partition：page size aligned, unit byte, only hexadecimal is supported
- size：page size aligned, unit byte, only hexadecimal is supported

nand read：

```
nand read - addr off|partition size
```

- addr：memory address, only hexadecimal is supported
- off|partition：page size aligned, unit byte, only hexadecimal is supported
- size：page size aligned, unit byte, only hexadecimal is supported

For instance:

```
tftp 0x4000000 rootfs.img
nand erase 0x600000 0x200000                        /* Erase the whole partion
before write */
nand write 0x4000000 0x600000 0x200000
```

u-boot SPI Nand

SPI Nand unable to support nand command, cmd/mtd.c is available.

mtd erase:

```
mtd erase <name> <off> <size>
```

- name：spi-nand0 for SPI Nand mtd devices
- off：page size aligned, unit byte, only hexadecimal is supported
- size aligned, unit byte, only hexadecimal is supported

mtd write:

```
mtd write <name> <addr> <off> <size>
```

- name：spi-nand0 for SPI Nand mtd devices
- addr：memory address, only hexadecimal is supported
- off：page size aligned, unit byte, only hexadecimal is supported
- size aligned, unit byte, only hexadecimal is supported

mtd read:

```
mtd read <name> <addr> <off> <size>
```

- name：spi-nand0 for SPI Nand mtd devices
- addr：memory address, only hexadecimal is supported
- off：page size aligned, unit byte, only hexadecimal is supported
- size aligned, unit byte, only hexadecimal is supported

For instance:

```
tftp 0x4000000 rootfs.img
mtd erase spi-nand0 0x600000 0x200000                        /* Erase the whole
partion before write */
mtd write spi-nand0 0x4000000 0x600000 0x200000
```

kernel

flash_eraseall：

```
flash_erase       /* for example: flash_erase /dev/mtd1 0 0 */
```

nanddump：

```
nanddump --bb=skipbad /dev/mtd3
```

1. --bb=METHOD, where METHOD can be 'padbad', 'dumpbad', or'skipbad':
2. padbad: dump flash data, substituting 0xFF for any bad blocks
3. dumpbad: dump flash data, including any bad blocks
4. skipbad: dump good data, completely skipping any bad blocks (default)

nandwrite：

```
nandwrite -p /dev/mtd3 /rockchip_test/rockchip_test.sh
```

Take /dev/mtd4 for instance:

```
flash_erase /dev/mtd4 0 0                                    /* Erase the whole
partion before write */
nandwrite -p /dev/mtd3 /userdata/boot.img
sync
nanddump --bb=skipbad /userdata/boot_read.img
md5sum /userdata/boot_read.img ...                            /* Add
verification */
```

3.2 Upgrade UBIFS Image By Shell Command

Consult to "UBIFS Instruction" -> "UBIFS OTA" chapter。

3.3 Upgrade MTD Partitions By APIs

First of all, if the image in the MTD partition uses the UBIFS file system, refer to the chapter "UBIFS OTA" chapter . Therefore, the MTD partition is mainly aimed at the firmware partitions that are read-only and have no file system, such as IDB, u-boot, kernel, etc.

u-boot

- Consult to drivers/mtd/nand/nand_util.c, Using those APIs with bad block management.
- For a complete write with less data (it is recommended to write less than 2KB data on each power on), you can consider using the corresponding interface of MTD to block device in RK SDK, source code drivers/mtd/mtd_blk.c, the block abstract interface has the following characteristics:

  Regardless of the amount of data in a single write request, the flash block corresponding to the data will be erased. Therefore, for fragmented and frequent write behavior, calling this interface will affect the life of flash.

kernel

Consult to ./miscutils/nandwrite.c ./miscutils/flash_eraseall.c, Using those APIs with bad block management.

user

Consult to ./miscutils/nandwrite.c ./miscutils/flash_eraseall.c and conbined with mtd ioctrl in include/uapi/mtd/mtd-abi.h.

4. UBIFS Filesystem

4.1 Instruction

UBIFS is the abbreviation of unsorted block image file system. UBIFS is often used in file system support on raw NAND as one of the successor file systems of JFFS2. UBIFS processes actions with MTD equipment through UBIFS subsystem.

4.2 Configuration

Kernel Configuration：

```
CONFIG_MTD_UBI=y
CONFIG_UBIFS_FS=y
CONFIG_UBIFS_FS_ADVANCED_COMPR=y
CONFIG_UBIFS_FS_LZO=y /* Using lzo */
```

4.3 Image Making And Mounting

4.3.1 Image Making

Introduction For Commands

```
Usage: mkfs.ubifs [OPTIONS] target
Make a UBIFS file system image from an existing directory tree
Examples:
Build file system from directory /opt/img, writting the result in the ubifs.img
file
        mkfs.ubifs -m 512 -e 128KiB -c 100 -r /opt/img ubifs.img
The same, but writting directly to an UBIFS volume
        mkfs.ubifs -r /opt/img/dev/ubi0_0
Creating an empty UBIFS filesystem on an UBIFS volume
        mkfs.ubifs/dev/ubi0_0
Options:
-r, -d, --root=DIR         build file system from directory DIR,
-m, --min-io-size=SIZE     minimum I/O unit size, NAND FLASH minimum write size,
page size,4096B or 2048B
-e, --leb-size=SIZE        logical erase block size, block size-2x (page size),
If block_size 256KB page_size 2KB then -e equals 258048, If block_size 128KB
page_size 2KB then -e equals 126976
-c, --max-leb-cnt=COUNT    maximum logical erase block count
-o, --output=FILE          output to FILE
-j, --jrn-size=SIZE        journal size
-R, --reserved=SIZE        how much space should be reserved for the super-user
-x, --compr=TYPE           compression type - "lzo", "favor_lzo", "zlib" or
"none" (default: "lzo")
-X, --favor-percent        may only be used with favor LZO compression and
defines how many percent better zlib should compress to make mkfs.ubifs use zlib
instead of LZO (default 20%)
-f, --fanout=NUM           fanout NUM (default: 8)
-F, --space-fixup          file-system free space has to be fixed up on first
mount(requires kernel version 3.0 or greater)
-k, --keyhash=TYPE         key hash type - "r5" or "test" (default: "r5")
-p, --orph-lebs=COUNT      count of erase blocks for orphans (default: 1)
-D, --devtable=FILE        use device table FILE
-U, --SquashFS-uids        SquashFS owners making all files owned by root
-l, --log-lebs=COUNT       count of erase blocks for the log (used only for
debugging)
-v, --verbose              verbose operation
-V, --version              display version information
```

```
-g, --debug=LEVEL          display debug information (0 - none, 1 - statistics, 2
- files, 3 - more details)
-h, --help                 display this help text
```

Process

1. Making UBIFS Images

```
mkfs.ubifs -F -d rootfs_dir -e real_value -c real_value -m real_value -v -o
rootfs.ubifs
```

2. Making UBI volume

```
ubinize -o ubi.img -m 2048 -p 128KiB ubinize.cfg
```

- -p：block size。
- -m：NAND FLASH minimum write size which usually equals page size
- -o：output file

ubinize.cfg content：

```
[ubifs-volumn]
mode=ubi
image=rootfs.ubifs
vol_id=0
vol_type=dynamic
vol_alignment=1
vol_name=ubifs
vol_flags=autoresize
```

- mode=ubi： default.
- image=out/rootfs.ubifs：input file
- vol_id=0：volume ID, different volume id for different volume.
- vol_type=dynamic： static for read-only
- vol_name=ubifs：volume name
- vol_flags=autosize.

For Instance:

page size 2KB, page per block 64, block size 128KB, partition size 64MB：

```
mkfs.ubifs -F -d /path-to-
it/buildroot/output/rockchip_rv1126_rv1109_spi_nand/target -e 0x1f000 -c 0x200 -m
0x800 -v -o rootfs.ubifs
ubinize -o ubi.img -m 2048 -p 128KiB ubinize.cfg
```

page size 2KB, page per block 128, block size 256KB, partition size 64MB：

```
mkfs.ubifs -F -d /path-to-
it/buildroot/output/rockchip_rv1126_rv1109_spi_nand/target -e 0x3f000 -c 0x100 -m
0x800 -v -o rootfs.ubifs
ubinize -o ubi.img -m 2048 -p 256KiB ubinize.cfg
```

page size 4KB, page per block 64, block size 256KB, partition size 64MB：

```
mkfs.ubifs -F -d /path-to-
it/buildroot/output/rockchip_rv1126_rv1109_spi_nand/target -e 0x3e000 -c 0x100 -m
0x1000 -v -o rootfs.ubifs
ubinize -o ubi.img -m 0x1000 -p 256KiB ubinize.cfg
```

Multi Volume Mirror Instance

Take a multi volume partition composed of page size 2KB, page per block 64, that is, block size 128KB, partition size 8MB, OEM and partition size 8MB UserData

```
mkfs.ubifs -F -d oem -e 0x1f000 -c 0x40 -m 0x800 -v -o oem.ubifs
mkfs.ubifs -F -d userdata -e 0x1f000 -c 0x40 -m 0x800 -v -o userdata.ubifs
ubinize -o oem_userdata.img -p 0x20000 -m 2048 -s 2048 -v
ubinize_oem_userdata.cfg
```

Set ubize_ oem_ userdata.cfg As follows:

```
[oem-volume]
mode=ubi
image=oem.ubifs
vol_id=0
vol_size=8MiB
vol_type=dynamic
vol_name=oem

[userdata-volume]
mode=ubi
image=userdata.ubifs
vol_id=1
vol_size=8MiB
vol_type=dynamic
vol_name=userdata
vol_flags=autoresize
```

mount：

```
ubiattach /dev/ubi_ctrl -m 4 -d 4 -b 5
mount -t ubifs /dev/ubi4_0 /oem
mount -t ubifs /dev/ubi4_1 /uesrdata
```

4.3.2 Image Making Of Empty Partition

```
ubiformat -y /dev/mtd4
ubimkvol /dev/mtd4 -N userdata -m /* -N specifies the volume name, - M
dynamically adjusts the partition device autorisize to the maximum */
```

4.3.3 UBIFS Partition Command Mount

```
ubiattach /dev/ubi_ctrl -m 4 -d 4
```

- -m：mtd num
- -d：ubi binding device
- -b, --max-beb-per1024：maximum expected bad block number per 1024 eraseblock, note that：
    1. 20 in default
    2. Partition image pre production: partition redundancy flash block < --max-beb-per1024 actual value < --max-beb-per1024 set value, that is, the actual value may be smaller than the set value
    3. Command to make empty partition as UBI image: - - max-beb-per1024, the actual value is equal to the set value
    4. The default value of SDK can be set to 10 (this value may not be set in the old version of SDK)
    5. If you need to optimize the space, please set the value flexibly: 4 + the number of blocks occupied by the partition * 1%, for example: flash block size 128KB, OEM space size 16MB, accounting for 128 flash blocks, you can consider filling in the value of 5;

```
mount -t ubifs /dev/ubi4_0 /oem
```

4.3.4 UBI Image Partition Overhead

After the UBI image is mounted on the file system, the effective space is less than the partition size. There are mainly UBIFS redundant information and the loss of reserved blocks for bad block replacement.

Accurate calculation

```
UBI overhead = (B + 4) * SP + 0 * (P - B - 4) /* the space cannot be obtained by
users */

P - The total number of physical blocks removed on the MTD device
SP - physical erase block size, typically 128KB or 256Kb
SL - logical erase block, i.e. mkfs - e parameter value, usually block_ size - 2
* page_ size
B - F1ash blocks reserved for bad block replacement, related to the ubiattach - b
parameter
O - overhead associated with storing EC and vid file headers in bytes, i.e. 0 =
SP - sl
```

General case 1

Flash block size 128KB, page size 2KB, 128 MB size, ubiattach - b is reserved by default of 20;

```
SP = block size = 128KB
SL = 128kb - 2 * 2KB = 124KB
B = --max-beb-per1024 * n_ 1024 = 20 * 1 = 20
O = 128KB -124KB = 4KB

UBI overhead = (20 + 4) * 128KB + 4KB * (P - 20 - 4) = 2976KB + 4KB * P
```

If the corresponding partition is 32MB, that is, P = 256, then the final UBI overhead = 2976kb + 4KB * 256 = 4000kb

General case 2

Flash block size 128KB, page size 2KB, 256 MB size, ubiattach - B reserved default 20;

```
SP = block size = 128KB
SL = 128kb - 2 * 2KB = 124KB
B = --max-beb-per1024 * n_ 1024 = 20 * 2 = 40
O = 128KB -124KB = 4KB

UBI overhead = (40 + 4) * 128KB + 4KB * (P - 40 - 4) = 5456KB + 4KB * P
```

If the corresponding partition is 32MB, that is, P = 256, then the final UBI overhead = 5456kb + 4KB * 256 = 6456kb

Detailed reference: flash space overhead chapter http://www.linux-mtd.infradead.org/doc/ubi.html#L_overhead

4.4 Support SquashFS In UBI Block

Kernel Configuration

```
+CONFIG_MTD_UBI_BLOCK=y
```

Define Rootfs In dts

```
dts: bootargs: cmdline:

- ubi.mtd=4              : Choose mtd(From 0)
- ubi.block=0,rootfs     : "rootfs" is vol_name(Consult to ubinize.cfg), block=0
is ubi block index
- root=/dev/ubiblock0_0  : rootfs block dev name, generate from UBI block device
drivers
- rootfstype=squashfs    : rootfs type
```

Making SquashFS UBI volume

Buildroot will automatically pack SquashFS image。If need, using mksquashfs command, for example：

```
sudo mksquashfs squashfs-root/ squashfs.img -noappend -always-use-fragments
```

Using ubinize to pack SquashFS image into UBI image:

Firstly generate ubinize.cfg：

```
cat > ubinize.cfg << EOF
[ubifs]
mode=ubi
vol_id=0
vol_type=static
vol_name=rootfs
vol_alignment=1
vol_flags=autoresize
image=/data/rk/projs/rv1126/sdk/buildroot/output/rockchip_rv1126_robot/images/roo
tfs.squashfs
EOF
```

Note:

- vol_type: should be static;
- image: input file, path to SquashFS image

then ubinize：

```
ubinize -o rootfs.ubi -p 0x20000 -m 2048 -s 2048 -v ubinize.cfg
```

-p, --peb-size: size of the physical eraseblock of the flash this UBI image is created for in bytes,kilobytes (KiB), or megabytes (MiB) (mandatory parameter)

-m, --min-io-size : minimum input/output unit size of the flash in bytes

-s, --sub-page-size: minimum input/output unit used for UBI headers, e.g. sub-page size in case of NAND flash (equivalent to the minimum input/output unit size by default)

rootfs.ubi is the output file.

Note：

- When using the open source solution in NAND products, Squashfs should not be directly mounted on the mtdblock, because mtdblock does not add bad block detection, so bad block cannot be skipped.

Manually mount UBI block reference

```
ubiattach /dev/ubi_ctrl -m 4 -d 4    /* mount the UBI device */
ubiblock -c /dev/ubi4_0              /* Extending UBI block support on UBI
devices */
mount -t squashfs /dev/ubiblock4_0 /oem
```

4.5 Optimization Of UBIFS Space Size

As can be seen from the above description, the mirror free space can be optimized through the following three points:

1. Select the appropriate -- max-beb-per1024 parameter, and refer to point 5 of the "- b parameter details" section of "Image making of empty partition"
2. Use UBI multi volume technology to share part of UBIFS redundant overhead. Refer to the description of multi volume production in "Image making"
3. Use the SquashFS supported by UBI block. Refer to the chapter "Support SquashFS In UBI Block"

UBIFS minimum partition:

```
Minimum block num = 4 (fixed reservation) + B + 17 / * B - F1ash blocks reserved
for bad block replacement, related to ubiattach - b parameter*/
```

It can be judged by printing log when ubiattach, for example:

```
ubi4: available PEBs: 7, total reserved PEBs: 24, PEBs reserved for bad PEB
handling: 20 /* B = 20 */
```

If the partition available PEBS + total reserved PEBS < minimum block num, an error will be reported when mounting:

```
mount: mounting /dev/ubi4_ 0 on userdata failed: Invalid argument
```

4.6 UBIFS OTA

To upgrade partitions using UBIFS, use the ubiupdatevol tool, the command is as follows:

```
ubiupdatevol /dev/ubi1_0 rootfs.ubifs
```

Note：

- rootfs.ubifs is made by mkfs.ubifs tool

5. PC Tools For Downloading

When download UBIFS images, the tools will automatically erase the whole partition, then download the images：

- AndroidTools tools version should equals V2.7.8 or above。
- upgrade_tools tools version should equals V1.5.6 or above。

Note:

- PC will download multyple

Note:

- PC tool burning will automatically copy multiple copies of IDB firmware from block 1 to block 7, that is:
  The first 1MB of page size 2KB flash is GPT partition and IDB space
  The first 2MB of page size 4KB flash is GPT partition and IDB space

6. Flash Programmer

6.1 SPI Nand Flash Programmer

6.1.1 Make SPI Nand Images

Input Files：SDK Output Files For PC Tools

```
[/IMAGES] tree
.
├── parameter.txt               // generate gpt.img
├── MiniLoaderAll.bin           // generate idblock.img
├── uboot.img
├── boot.img
├── rootfs.img
├── oem.img
└── update.img                  // not care
```

Make Images

tool burner_image_kits in SDK rkbin/ directory, command：

```
./rkbin/tools/burner_image_kits/make_spi_nand.sh <src_path> <dst_path>  <soc>
<block_size(KB)>
```

- src_path：SDK Output Files For PC Tools;
- dst_path：output directory；
- soc：chip(lowercase), e.g: rv1126
- block_size：flash block size；

e.g： rv1126 block size 128KB flash:

```
./rkbin/tools/burner_image_kits/make_spi_nand.sh ./IMAGES ./out rv1126 128
```

output files: Using For Flash Programmer

```
[/out] tree
.
└── 2048B_128KB
    ├── gpt.img
    ├── idblock.img.bak     // IDB image
    ├── idblocks.img        // idblock.img.bak multy copies in three
    ├── uboot.img
    ├── boot.img
    ├── rootfs.img
    └── oem.img
```

6.1.2 SPI Nand Flash Programmer Operation

Programmer Address

Assume that flash block size is 128KB, AndroidTools and it's corresponding flash programmer setting could be like this：

Input File: SDK output	AndroidTools Start(sector)	Flash Programmer Images	Programmer Start(block)	End(block)	Size(block)	Note
paramter.txt	0	gpt.img	0x0	0x1	0x1	Note 1
MiniLoaderAll.bin	0	idblocks.img	0x1	0x7	0x6	Note 2
uboot.img	0x2000	uboot.img	0x20	0x47	0x20	**Note 3**
boot.img	0x4800	boot.img	0x48	0xa0	0x50	
...	...	...	...			
xxx.img	0x3E000	xxx.img	0x3e0	0x3fb	0x18	Note 4

Table Note：

1. gpt.img should be placed in block 0；
2. idblocks.img should be placed from block 1 to block 7；
3. Except gpt.img and idblocks.img, other images should be place in the address based on parameter.txt address, 512B/sector, flash programmer Start block = sectors * 512B / block_size：

   128KB block size：sectors / 0x100
   256KB block size：sectors / 0x200
   Except gpt.img, other images size should less then partition size from 1 to 2 block size to make bad block replacement possible；
4. Resert the last 4 flash block size for bad block table, consider defining the reverted partition to avoid user use or future misuse.

Other Note

1. The image does not contain OOB data, fill it with "0xff" data by flash programmer ；
2. Erase all good blocks for none empty flash；
3. Enable verification

6.2 SLC Nand Flash Programmer

6.2.1 Make SLC Nand Images

Input Files：SDK Output Files For PC Tools

```
[/IMAGES] tree
.
├── parameter.txt               // generate gpt.img
├── MiniLoaderAll.bin           // generate idblock.img
├── uboot.img
├── boot.img
├── rootfs.img
├── oem.img
└── update.img                  // not care
```

Make Images

tool burner_image_kits in SDK rkbin/ directory, command：

```
./rkbin/tools/burner_image_kits/make_spi_nand.sh <src_path> <dst_path>  <soc>
<block_size(KB)> <page_size(B)> <oob_size(B)>
```

- src_path：SDK Output Files For PC Tools;
- dst_path：output directory；
- soc：chip(lowercase), e.g: rv1126
- block_size：flash block size；
- page_size：flash page size。
- oob_size：flash oob size per page

e.g： rv1126 block size 128KB flash page size 2KB oob size 64B flash:

```
./rkbin/tools/burner_image_kits/make_slc_nand.sh ./IMAGES ./out rv1126 128 2048
64
```

output files: Using For Flash Programmer

```
[/out] tree
.
└── 2048B_128KB
    ├── gpt.img
    ├── idblock.img.bak     // IDB image
    ├── idblocks.img        // idblock.img.bak multy copies in three
    ├── uboot.img
    ├── boot.img
    ├── rootfs.img
    └── oem.img
```

6.2.2 SLC Nand Flash Programmer Operation

Programmer Address

Assume that flash block size is 128KB, AndroidTools and it's corresponding flash programmer setting could be like this：

Input File: SDK output	AndroidTools Start(sector)	Flash Programmer Images	Programmer Start(block)	End(block)	Size(block)	Note
paramter.txt	0	gpt.img	0x0	0x1	0x1	Note 1
MiniLoaderAll.bin	0	idblocks.img	0x1	0x7	0x6	Note 2
uboot.img	0x2000	uboot.img	0x20	0x47	0x20	**Note 3**
boot.img	0x4800	boot.img	0x48	0xa0	0x50	
...	...	...	...			
xxx.img	0x3E000	xxx.img	0x3e0	0x3fb	0x18	Note 4

Table Note：

1. gpt.img should be placed in block 0；
2. idblocks.img should be placed from block 1 to block 7；
3. Except gpt.img and idblocks.img, other images should be place in the address based on parameter.txt address, 512B/sector, flash programmer Start block = sectors * 512B / block_size：

   128KB block size：sectors / 0x100
   256KB block size：sectors / 0x200
   Except gpt.img, other images size should less then partition size from 1 to 2 block size to make bad block replacement possible；
4. Resert the last 4 flash block size for bad block table, consider defining the reverted partition to avoid user use or future misuse.

Other Note

1. The image contain OOB data；
2. Erase all good blocks for none empty flash；
3. Enable verification

7. Reference documents

[1] UBI FAQ: http://www.linux-mtd.infradead.org/faq/ubi.html

[2] UBIFS FAQ: http://www.linux-mtd.infradead.org/faq/ubifs.html#L_lebsz_mismatch

[3] MTD FAQ: http://www.linux-mtd.infradead.org/faq/general.html