

UBIFS Support

UBIFS

UBIFS may be considered as the next generation of the JFFS2 file-system.

JFFS2 file system works on top of MTD devices, but UBIFS works on top of UBI volumes and cannot operate on top of MTD devices. In other words, there are 3 subsystems involved:

- MTD subsystem, which provides uniform interface to access flash chips. MTD provides an notion of MTD devices (e.g., /dev/mtd0) which basically represents raw flash;
- UBI subsystem, which is a wear-leveling and volume management system for flash devices; UBI works on top of MTD devices and provides a notion of UBI volumes; UBI volumes are higher level entities than MTD devices and they are devoid of many unpleasant issues MTD devices have (e.g., wearing and bad blocks); see here for more information;
- UBIFS file system, which works on top of UBI volumes.

For more information on MTD, refer <<http://www.linux-mtd.infradead.org/doc/general.html>^[1]>

For more information on UBI, refer <<http://www.linux-mtd.infradead.org/doc/ubi.html>^[2]>

For more information on UBIFS, refer <<http://www.linux-mtd.infradead.org/doc/ubifs.html>^[3]>

UBIFS User-space tools

UBI user-space tools, as well as other MTD user-space tools, are available from the the following git repository: [git://git.infradead.org/mtd-utils.git](http://git.infradead.org/mtd-utils.git)

The repository contains the following UBI tools:

```
ubininfo - provides information about UBI devices and volumes found in the system;

ubiattach - attaches MTD devices (which describe raw flash) to UBI and creates corresponding UBI devices;

ubidetach - detaches MTD devices from UBI devices (the opposite to what ubiattach does);

ubimkvol - creates UBI volumes on UBI devices;

ubirmvol - removes UBI volumes from UBI devices;

ubiupdatevol - updates UBI volumes; this tool uses the UBI volume update feature which leaves the volume in
               "corrupted" state if the update was interrupted; additionally, this tool may be used to wipe
               out UBI volumes;

ubircrc32 - calculates CRC-32 checksum of a file with the same initial seed as UBI would use;

ubinize - generates UBI images;

ubiformat - formats empty flash, erases flash and preserves erase counters, flashes UBI images to MTD devices;

mtdinfo - reports information about MTD devices found in the system.
```

All UBI tools support "-h" option and print sufficient usage information.

Roadmap

Note: Below Roadmap is for DM81xx platform only.

- Currently, 1-bit HW ECC scheme is used by default in u-boot as well as kernel. The same scheme is used to do read/write on NAND. So the UBIFS image is flashed (from kernel or u-boot) with 1-bit HW ECC scheme at present. The kernel supports 1-bit HW ECC by default and reads the UBIFS image that is flashed onto NAND while booting.
- We plan to support UBIFS implementation with BCH8 ECC scheme. Once this is implemented, the ECC scheme would need to be changed to BCH8 (in kernel or u-boot) and then the UBIFS image would have to be flashed. As the kernel would be reading the flashed UBIFS image while booting, it will have to use BCH8 ECC scheme to load the image.

Configuration

To enable UBIFS support, start the *Linux Kernel Configuration* tool:

```
$ make menuconfig
```

(1)

- Select *Device Drivers* from the main menu.

```
...
...
Power management options --->
[ ] Networking support --->
Device Drivers --->
...
```

Select *Memory Technology Device (MTD) Support* as shown here:

```
...
...
< > Connector - unified userspace <-> kernelspace linker --->
<*> Memory Technology Device (MTD) support --->
< > Parallel port support --->
...
```

Select *Enable UBI - Unsorted block images* as shown here:

```
...
<*> Enable UBI - Unsorted block images --->
```

(2)

- Select *Device Drivers* from the main menu.

```
...
...
Power management options --->
[ ] Networking support --->
Device Drivers --->
...
```

Select **Memory Technology Device (MTD) Support** as shown here:

```
...
...
< > Connector - unified userspace <-> kernelspace linker --->
<*> Memory Technology Device (MTD) support --->
< > Parallel port support --->
...
```

Select **NAND Device Support** as shown here:

```
...
...
[ ] NAND ECC Smart Media byte order
<*> NAND Device Support --->
...
```

Deselect Verify NAND page writes from the main menu.

```
[ ] Verify NAND page writes
...
...
```

(3)

- Select **File Systems** from the main menu.

```
...
...
Device Drivers --->
File systems --->
...
```

Select **Miscellaneous filesystems** as shown here:

```
...
...
Pseudo filesystems --->
[*] Miscellaneous filesystems --->
[*] Network File Systems --->
...
```

Select **UBIFS file system support** as shown here:

```
...
...
<*> UBIFS file system support
[ ] Extended attributes support
[ ] Advanced compression options
[ ] Enable debugging support
...
```

Compiling UBIFS Tools

The MTD and UBI user-space tools are available from the the following git repository:

```
git://git.infradead.org/mtd-utils.git
```

As of writing this wiki, the mtd-utils version is 1.4.8.

For instructions on compiling MTD-utils, refer MTD-Utills Compilation.

Creating UBIFS file system

From information on how to create a UBIFS image. refer create an UBIFS image ^[4]

- **mkfs.ubifs**

```
mtd-utils# mkfs.ubifs/mkfs.ubifs -r filesystem/ -F -o ubifs.img -m 2048 -e 126976 -c 1580
```

Where:

- **-m 2KiB (or 2048)**

The minimum I/O size of the underlying UBI and MTD devices. In our case, we are running the flash with no sub-page writes, so this is a 2KiB page.

- **-e 124KiB (or 126976)**

Erase Block Size: UBI requires 2 minimum I/O units out of each Physical Erase Block (PEB) for overhead: 1 for maintaining erase count information, and 1 for maintaining the Volume ID information. The PEB size for the XO flash is 128KiB, so this leads to each Logical Erase Block (LEB) having 124KiB available for data.

- **-c 1580**

The maximum size, in LEBs, of this file system. See calculation below for how this number is determined.

- **-r filesystem**

Use the contents of the 'filesystem/' directory to generate the initial file system image.

- **-F**

File-system free space has to be fixed up on first mount (http://www.linux-mtd.infradead.org/faq/ubifs.html#L_free_space_fixup ^[5])

- **-o ubifs.img**

Output file.

On AM335x, -F option is required when creating ubifs image. If this option is not used, Kernel may crash while loading the Filesystem from UBI partition.

The output of the above command, **ubifs.img** is fed into the 'ubinize' program to wrap it into a UBI image.

The images produced by *mkfs.ubifs* must be further fed to the ubinize tool to create a UBI image which must be put to the raw flash to be used a UBI partition.

- Create **ubinize.cfg** file and write the contents into it

```
mtd-utils# vi ubinize.cfg
[ubifs]                <== Section header
mode=ubi                <== Volume mode (other option is static)
image=ubifs.img         <== Source image
vol_id=0                <== Volume ID in UBI image
vol_size=192MiB         <== Volume size
vol_type=dynamic        <== Allow for dynamic resize
```

```
vol_name=rootfs      <== Volume name
vol_flags=autoresize <== Autoresize volume at first mount
```

[See calculations below to determine the value associated with 'vol_size']

- **ubinize**

```
mtd-utils# ubi-utils/ubinize -o ubi.img -m 2048 -p 128KiB -s 512 -O 2048 ubinize.cfg
```

Where:

-o ubi.img

Output file

-m 2KiB (or 2048)

Minimum flash I/O size of 2KiB page

-p 128KiB

Size of the physical eraseblock of the flash this UBI image is created for

-O 2048 offset if the VID header from start of the physical eraseblock

The output of the above command, '**ubi.img**' is the required image.

Calculations

Usable Size Calculation

As documented here ^[6], UBI reserves a certain amount of space for management and bad PEB handling operations. Specifically:

- 2 PEBs are used to store the UBI volume table
- 1 PEB is reserved for wear-leveling purposes;
- 1 PEB is reserved for the atomic LEB change operation;
- a % of PEBs is reserved for handling bad EBs. The default for NAND is 1%
- UBI stores the erase counter (EC) and volume ID (VID) headers at the beginning of each PEB. 1 min I/O unit is required for each of these.

To calculate the full overhead, we need the following values:

Symbol	Meaning	Value for XO test case
SP	PEB Size	128KiB
SL	LEB Size	128KiB - 2 * 2KiB = 124 KiB
P	Total number of PEBs on the MTD device	200MiB / 128KiB = 1600
B	Number of PEBs reserved for bad PEB handling	1% of P = 16
O	The overhead related to storing EC and VID headers in bytes, i.e. O = SP - SL	4KiB

```
UBI Overhead = (B + 4) * SP + O * (P - B - 4)
              = (16 + 4) * 128Kib + 4 KiB * (1600 - 16 - 4)
              = 8880 KiB
              = 69.375 PEBs (round to 69)
```

This leaves us with 1531 PEBs or 195968KiB available for user data.

Note that we used "-c 1580" in the above mkfs.ubifs command line to specify the maximum filesystem size, not "-c 1531". The reason for this is that mkfs.ubifs operates in terms of LEB size (124 KiB), not PEB size (128Kib). 195968KiB / 124 Kib = 1580.39 (round to 1580).

Volume size = 195968KiB (~192MiB)

Using UBIFS file system

Preparing NAND partition

Kindly erase the NAND partition before using it for UBI file system. The partition can be erased from either u-boot or from Linux.

Follow below steps to erase.

- From U-boot. Assuming NAND partition to be erased starts from "0x780000" and is of size "0xF880000".

```
u-boot# nand erase 0x00780000 0xF880000
```

- From Linux. Assuming MTD partition 7 needs to be erased and used for UBI file system.

```
root@arago-armv7:~# flash_eraseall /dev/mtd7
```

Flashing UBIFS image to a NAND partition

We can Flash UBIFS image from either Linux Kernel or U-Boot.

Follow steps mentioned here to create an UBIFS image.

From U-Boot,

Get the UBIFS image to U-Boot from tftp or MMC/SD or UART. Lets consider an example of MMC card.

Since we copy the data to NAND, Empty/Erase the required RAM. Then, get the UBIFS image to U-Boot

```
u-boot# mw.b 0x82000000 0xFF <filesystem_image_size> <=== filesystem image size is upward aligned to NAND block size,
                                     This is required to get rid of "Empty Flash" JFFS2 during kernel boot.

u-boot# mmc rescan

u-boot# fatload mmc 0 0x82000000 ubi.img
```

Next, erase the NAND. Switch to BCH8 ECC and the flash the image.

Example Assuming

1. NAND partition to be erased starts from "0x780000",
2. NAND partition of size "0xF880000" and
3. File system image size to be flashed is 0xFC0000 which is upward aligned to NAND block size

```
u-boot# nand erase 0x780000 0xF880000
u-boot# nandeccl hw 2
u-boot# nand write 0x82000000 0x780000 0xFC0000
```

From Linux,

- Flash the UBI file system image (ubi.img) to MTD partition "X"

```
ubiiformat /dev/mtd<X> -f ubi.img -s 512 -O 2048
```

Assuming 7th mtd partition, we can use the following command to flash the ubifs image to partition 7.

```
#ubiiformat /dev/mtd7 -f ubi.img -s 512 -O 2048
```

Using UBIFS image as root file system

- Set up the bootargs environment variable as below to use the UBIFS file system image present in a MTD partition:

```
setenv bootargs 'console=tty00,115200n8 noinitrd ip=off mem=256M rootwait=1 rw ubi.mtd=X,YYYY rootfstype=ubifs root=ubi0:rootfs init=/init'
```

Where X is the MTD partition number being used for file system and YYYY is the NAND page size. make sure that an UBI file system is flashed into this partition before passing it as a boot partition for Linux.

Assuming 7th mtd partition,

```
#setenv bootargs 'console=tty00,115200n8 noinitrd ip=off mem=256M rootwait=1 rw ubi.mtd=7,2048 rootfstype=ubifs root=ubi0:rootfs init=/init'
```

Mounting UBIFS image as a regular NAND partition

Assuming UBIFS image is already flashed to a NAND Partition, follow below steps to mount the same.

- Attach MTD device to UBI

```
ubiattach /dev/ubi_ctrl -m <X> -O 2048
```

Where "X" is the MTD partition number

Mtd device number 7 can be attached to ubi using

```
#ubiattach /dev/ubi_ctrl -m 7 -O 2048
```

- Mount the UBIFS image

```
mount -t ubifs ubiX:NAME /mount/point
```

Where "X" - UBI device number and "NAME" - UBI volume name from ubinize.cfg file.

Assuming ubi device 0 and rootfs is the volume name given in ubinize.cfg, ubifs image can be mounted to /media/card using

```
#mount -t ubifs ubi0:rootfs /media/card
```

Mounting a NAND partition using UBIFS

We can mount a particular NAND partition with UBIFS file system in the following way

- Format and attach the MTD partition

```
ubiformat /dev/mtd<X> -s 512 -O 2048
ubiattach /dev/ubi_ctrl -m <X> -O 2048
```

Where "X" is the MTD partition number

MTD partition number 7 can be formatted and attached using

```
ubiformat /dev/mtd7 -s 512 -O 2048
#ubiattach /dev/ubi_ctrl -m 7 -O 2048
```

- Create an UBI volume - the created volume will be empty

```
ubimkvol /dev/ubi0 -N <label> -s XXMiB
```

Where "XX" is the size of the partition to be mounted and "label" is the name for the volume.

10 MB ubi volume can be created with label **ubifs_volume** as

```
ubimkvol /dev/ubi0 -N ubifs_volume -s 10MiB
```

Also, user can create a UBI volume with volume size set to maximum available size

```
ubimkvol /dev/ubi0 -N <label> -m
```

where "label" is the name for the volume.

```
ubimkvol /dev/ubi0 -N ubifs_volume -m
```

- Mount the MTD partition

```
mount -t ubifs ubi0:<label> /mount/point
```

Make sure that the "label" used during ubimkvol is passed as an argument here.

Mounting of ubi volume can be achieved using

```
#mount -t ubifs ubi0:ubifs_volume /media/card
```

References

- [1] <http://www.linux-mtd.infradead.org/doc/general.html>
- [2] <http://www.linux-mtd.infradead.org/doc/ubi.html>
- [3] <http://www.linux-mtd.infradead.org/doc/ubifs.html>
- [4] http://www.linux-mtd.infradead.org/faq/ubifs.html#L_mkubifs
- [5] http://www.linux-mtd.infradead.org/faq/ubifs.html#L_free_space_fixup
- [6] http://www.linux-mtd.infradead.org/doc/ubi.html#L_overhead

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