

Rockchip Linux Upgrade Solution

Introduction

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Preface

Overview

This document is intended to help engineers quickly familiar with Rockchip Linux platform upgrade solution and do secondary development.

Intended Audience

This document is mainly suitable for below engineers:

Field Application Engineer

Software Development Engineer

Product Version

Chipset	Kernel version
RK3308	4.4

Revision History

Date	Version	Author	Revision Description
2019-06-05	V1.0	HKH/MLC	Initial version

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1. Overview

Rockchip Linux platform supports two upgrade modes: Recovery mode and Linux A/B mode:

1. Recovery mode: there is a separate partition (recovery.img) on the machine for upgrade.
2. Linux A/B mode: there are two sets of firmware on the machine that can be switched

Users can choose one according to their requirements for both the modes with their advantages and disadvantages.

2. Recovery Mode

2.1. Overview

There are one more partition which is consists of kernel+resource+ramdisk and mainly used for upgrade operations on the machine in recovery mode. U-boot will determine whether the system to be booted is a normal system or a recovery system based on the fields stored in the misc partition (see the misc partition section for details). Due to system independence, the recovery mode can guarantee the integrity of upgrade even when upgrade process is interrupted. If the power is abnormally powered down, the upgrade can still continue.

Advantages:

1. It can guarantee the integrity of upgrade.

Disadvantages:

1. There is one more partition which is only used for upgrade in the system.
2. Reboot the system into recovery mode during upgrade process and should not upgrade directly in the current system.

Partition Instruction:

Partition name	Image name	Description
loader	MiniLoaderAll.bin	First level loader
u-boot	uboot.img	Second level loader
trust	trust.img	Secure environment, like OP-TEE, ATF
misc	misc.img	Boot parameter partition
recovery	recovery.img	Root file system consisting of kernel+dtb+ramdisk
boot	boot.img	kernel+dtb
rootfs	rootfs.img	Root file system, read only
oem	oem.img	used for manufacturer, read and write
userdata	userdata.img	used for users, read and write

2.2. Configure and Compile

Buildroot: the recovery configuration files are selected as follows: (make menuconfig):

```
1 BR2_PACKAGE_RECOVERY=y #turn on upgrade related functions
2 BR2_PACKAGE_RECOVERY_USE_UPDATEENGINE=y #use the new upgrade program, if not
  configured, the original upgrade process will be used by default.
3 BR2_PACKAGE_RECOVERY_RECOVERYBIN=y #turn on recovery bin file
4 BR2_PACKAGE_RECOVERY_UPDATEENGINEBIN=y #compile the new upgrade program
```

Buildroot: the rootfs configuration files are selected as follows (make menuconfig):

```
1 BR2_PACKAGE_RECOVERY=y #turn on upgrade related functions
2 BR2_PACKAGE_RECOVERY_USE_UPDATEENGINE=y #use the new upgrade program
3 BR2_PACKAGE_RECOVERY_UPDATEENGINEBIN=y #compile the new upgrade program
```

With and Without Display

Currently only RK3308 uses the recovery without display, if the recovery of other chipset do not need display, just configure the following item in the file "buildroot/package/rockchip/recovery/recovery":

```
1 TARGET_MAKE_ENV += RecoveryNoUi=true
```

The SDK will enable the above configuration by default, so users do not need to configure it again. The source code is in "external/recovery/" directory, if you need to do some modifications, compile as follows:

Step1: run the following command:

```
1 Source envsetup.sh
```

Step2: choose the rootfs configuration of a platform, and then run the following command:

```
1 make recovery-dirclean
2 Source envsetup.sh
```

Step3: choose the recovery configuration of a platform, and then run the following command:

```
1 make recovery-dirclean
2 ./build.sh
```

Step4: flashing the firmware again.

2.3. OTA Upgrade

The upgrade supports network upgrade and local upgrade, and you can specify the partition to be upgraded. Run the following command on the normal system.

Network upgrade:

```
1 # updateEngine --misc=update --image_url=firmware address --partition=0x3F00
  --version_url=version file address --savepath=/userdata/update.img --reboot
2 updateEngine --image_url=http://172.16.21.110:8080/recovery/update.img --
  misc=update --savepath=/userdata/update.img --reboot &
```

Local upgrade:

```
1 updateEngine --image_url=/userdata/update.img --misc=update --
  savepath=/userdata/update.img --reboot &
```

Process introduction:

1. Firmware versions comparison(--version_url)
2. Download the firmware(--image_url) and save it locally(--savepath)
3. Upgrade recovery partition
4. Reboot(--reboot)
5. Enter the recovery mode, upgrade the partition(--partition)
6. Successfully upgrade and reboot into the normal system.

Optional parameters:

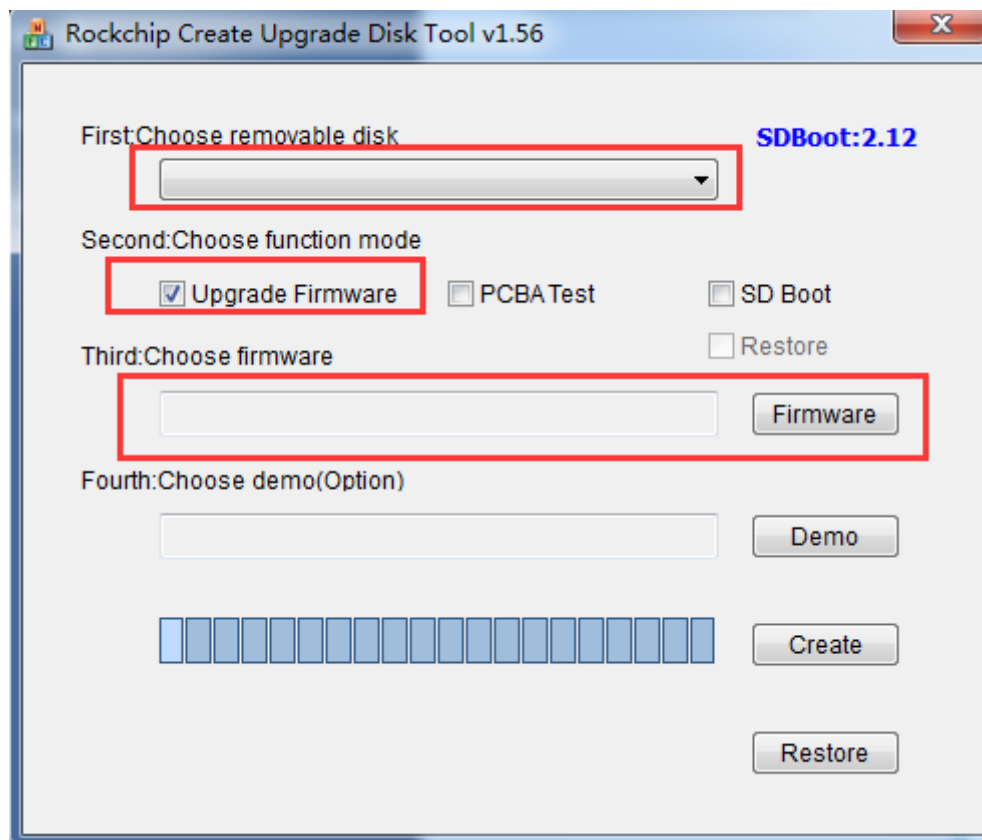
1. --version_url: remote address or local address. If this parameter is not set, versions comparison will not do.
2. --savepath: firmware saves path, it is "/tmp/update.img" by default. It is recommended to set to "/userdata/update.img".
3. --partition: set the partition to be upgraded. It is recommended to set it to 0x3F00. **It is not supported to upgrade the parameter and loader partitions.** See the upgrade program introduction for details.
4. --reboot: after upgrading the recovery partition, reboot into the recovery mode.

2.4. Create an Upgrade Disk

Creating an upgrade disk refers to inserting the SD card created by the SDDiskTool card-making tool to the machine to upgrade, this section will introduce how to create a upgrade disk and some upgrade issues in details.

Create an Upgrade Disk

As shown in the figure below, use the tool in the project directory "tools\windows\SDDiskTool" to create a upgrade disk.



Choose the packaged update.img file by the "Firmware" button.

After that, click the "Create" button. If the creation is successful, a prompt will appear.

At this point, there will be two files in the root directory of the SD card, and the upgraded firmware update.img will be named sdupdate.img.

After all the preparations are completed, insert the SD card into the device and power on.

2.5. Log Checking

1. Check log by serial port

In the "buildroot/output/rockchip_rk3308_recovery/target" directory:

```
1 | $ touch .rkdebug
```

Create this hidden file to print the upgraded log in recovery mode by serial port.

2. Checking through the "userdata/recovery/Log" file:

After upgrading, check the log file under "userdata/recovery" directory in the device.

```
1 | $ cat userdata/recovery/Log
```

3. Linux A/B Mode

3.1. Overview

You have to prepare two separate system firmwares which are respectively stored in the flash in Linux A/B mode . The system can be booted from one of the slots. If the current slot fails to boot, it can be started from another slot, and the system can be directly upgraded in the boot state, without entering the system upgrade mode, and just restart the system to enter the upgraded system.

The following **advantages** are included in Linux A/B mode due to its two boot slots:

1. The machine can be upgraded directly on the current system without rebooting into upgrade mode.
2. Prevent the machine from crashing for failure upgrade. If the upgrade fails, the machine can return to the current version.
3. If the current system is destroyed due to misoperation, the system will automatically switch to another slot.

Disadvantages:

1. There are two slots in Linux A/B mode, so it will increase the system firmware usage on the flash.

Partition:

Since there are already multiple backups of miniloader, trust, and uboot on the device, these partitions do not support the dual partitions at present, only the boot and system are dual-partitioned. The partition table is as follows:

Partition	Image	Description
loader	Miniloader.bin	First level loader, there are 4 backups in the device
uboot	uboot.img	Second level loader, there are 2 backups in the device, the backups number can be changed by modifying the "u-boot/make.sh"
trust	trust.img	Related to secure, there are 2 backups in the device, the backups number can be changed by modifying the "u-boot/ make.sh"
misc	misc.img	Boot parameter partition
boot_a	boot.img	kernel+dtb, boot system_a
boot_b	boot.img	kernel+dtb, boot system_b
system_a	rootfs.img	Root file system
system_b	rootfs.img	Root file system
userdata	userdata.img	No backup

3.2. Boot Process

3.2.1. Data Format and Storage

The storage position is 2K offset from the misc partition, and AvbABSlotData and AvbABData data structures are as follows

AvbABSlotData: store slot_a and slot_b

Date name	Usage
unsigned char priority	Partition priority, 0~15, 0 is not automatic, 15 is the highest priority
unsigned char tries_remaining	The number of attempts to start, the highest is 7, can be modified
unsigned char successful_boot	0: unbootable, 1: bootable
unsigned char is_update:1	0: upgrade failed, 1: upgrade successfully , and the last 7 bits are reserved data.

AvbABData: slot_a and slot_b boot information

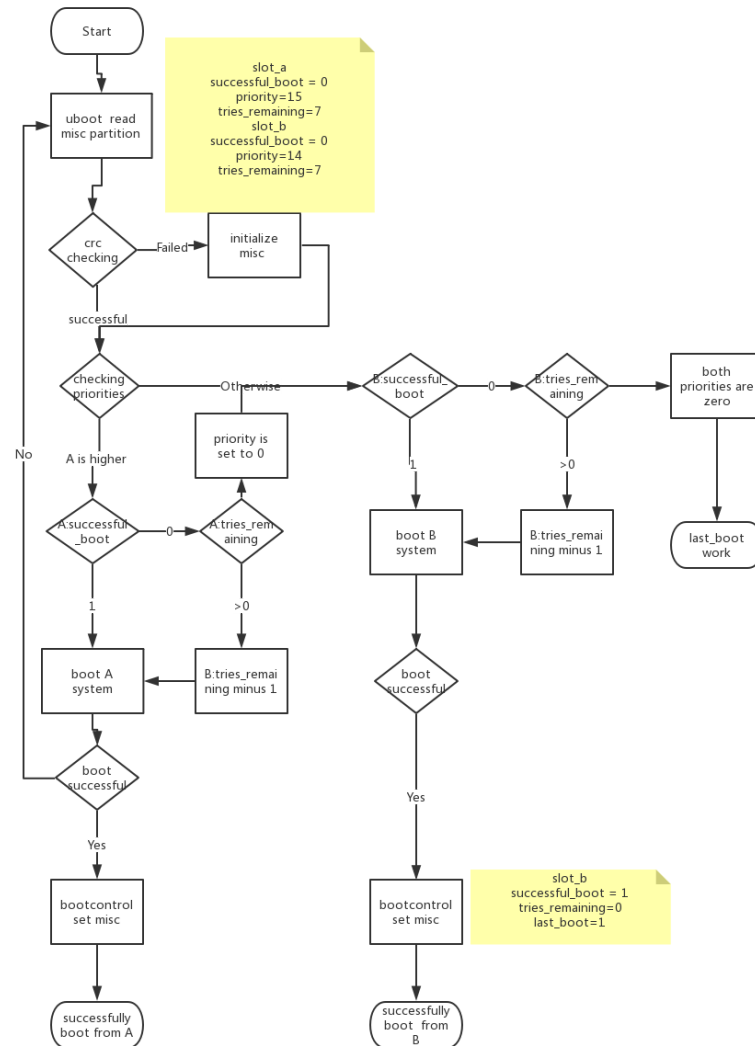
Date name	Usage
unsigned char magic[AVB_AB_MAGIC_LEN]	structure header information: \0AB0
unsigned char version_major	version information
unsigned char version_minor	version information
unsigned char reserved1[2]	reserved data
AvbABSlotData slots[2]	Partition boot information
unsigned char last_boot	The partition that was successfully boot last time: 0->slot_a, 1->slot_b
unsigned char reserved2[11]	reserved data
unsigned char crc32	Crc data verification

3.2.2. Boot Process

According to the configuration method of the upper bootcontrol program, there are two boot modes: successful_boot and reset retry. The difference of the two modes is as follows:

Mode	Advantage	Disadvantage	parameters need to set when successfully boot(A boot)	parameters need to set when upgrade(A boot, B upgrade)
Successful_boot	As long as the system is booted normally, it will not go back to the old version of firmware.	After the device is working for a long time, if some memory are stored abnormally, the system will always restart.	tries_remaining=0 successful_boot=1 last_boot=0	A:priority=14 B:priority=15
Reset retry	Always maintain the retry mechanism can fix storage issues	1. The machine will go back to the old version which may not be controlled. 2.If the retry try many times for users misoperation, it will be misidentified that the current partition is bootable.	tries_remaining=7 last_boot=0	A:priority=14 B:priority=15

3.2.3. Boot Process



3.3. Compilation Configuration

3.3.1. uboot

Add the following configurations to defconfig, take rk3308 64bit for example: "u-boot/configs/rk3308_defconfig":

```
1 CONFIG_AVB_LIBAVB=y
2 CONFIG_AVB_LIBAVB_AB=y
3 CONFIG_AVB_LIBAVB_ATX=y
4 CONFIG_AVB_LIBAVB_USER=y
5 CONFIG_RK_AVB_LIBAVB_USER=y
6 CONFIG_ANDROID_AB=y
```

3.3.2. Buildroot

```
1 BR2_PACKAGE_RECOVERY=y #enable recovery function
2 BR2_PACKAGE_RECOVERY_BOOTCONTROL=y #enable the boot control script
3 BR2_PACKAGE_RECOVERY_RETRY=y #The boot mode is retry mode. it is
  successful_boot mode by default when not configured.
4 BR2_PACKAGE_RECOVERY_USE_UPDATEENGINE=y #Use the new upgrade program
5 BR2_PACKAGE_RECOVERY_UPDATEENGINEBIN=y #compile the new upgrade program
```

Note: after finishing the configuration, you must recompile as follows:

```
1 make recovery-dirclean
2 make recovery
3 ./build.sh
```

3.3.3. Partition Table

Set parameter partition table of corresponding BoardConfig.mk as follows:

```
1 #choose device/rockchip/rk3308/parameter-ab-64bit.txt file
2 # parameter for GPT table
3 export RK_PARAMETER=parameter-ab-64bit.txt
```

64bit: please refer to /device/rockchip/rk3308/parameter-ab-64bit.txt

32bit: please refer to /device/rockchip/rk3308/parameter-ab-32bit.txt

3.3.4. Firmware output

Enable Linux A / B automatic compilation system of corresponding BoardConfig.mk as follows:

```
1 #choose enable Linux A/B
2 export RK_LINUX_AB_ENABLE=true
```

Run the following command after finishing the above setting :

```
1 source envsetup.sh
2 ./build.sh
```

The following firmwares will be generated:

```

1  tree rockdev/
2  rockdev/
3  |  — boot.img
4  |  — MiniLoaderAll.bin
5  |  — misc.img
6  |  — oem.img
7  |  — parameter.txt
8  |  — recovery.img
9  |  — rootfs.img
10 |  — trust.img
11 |  — uboot.img
12 |  — update_ab.img
13 |  — update.img
14 |  — update_ota.img
15 |  — userdata.img
16
17 0 directories, 13 files

```

Firmware Upgrade

In the rockdev and IMAGE directories, there will be update_ota.img for OTA upgrades. The IMAGE package includes boot.img and rootfs.img. The "tools/linux/Linux_Pack_Firmware/rockdev/rk3308-package-file-ota" file can be modified according to actual cause. As shown below:

#	NAME	Relative path
1	#	
2	#	
3	#HWDEF	HWDEF
4	package-file	package-file
5	bootloader	Image/MiniLoaderAll.bin
6	parameter	Image/parameter.txt
7	#trust	Image/trust.img
8	#uboot	Image/uboot.img
9	boot	Image/boot.img
10	rootfs	Image/rootfs.img
11	#recovery	Image/recovery.img
12	#oem	Image/oem.img
13	#userdata:grow	Image/userdata.img
14	#misc	Image/misc.img
15	#	要写入backup分区的文件就是自身 (update.img)
16	#	SELF 是关键字, 表示升级文件 (update.img) 自身
17	#	在生成升级文件时, 不加入SELF文件的内容, 但在头部信息中有记录
18	#	在解包升级文件时, 不解包SELF文件的内容。
19	#backup	RESERVED
20	#update-script	update-script
21	#recover-script	recover-script

****Firmware flashing**

The update_ab.img is generated in both rockdev and IMAGE directories, which is used for flashing. Modify the file "tools/linux/Linux_Pack_Firmware/rockdev/rk3308-package-file-ab" file as needed. As shown below:

```

1 # NAME      Relative path
2 #
3 #HWDEF      HWDEF
4 package-file package-file
5 bootloader  Image/MiniLoaderAll.bin
6 parameter   Image/parameter.txt
7 trust       Image/trust.img
8 uboot       Image/uboot.img
9 boot_a      Image/boot.img
10 boot_b     Image/boot.img
11 system_a   Image/rootfs.img
12 system_b   Image/rootfs.img
13 oem        Image/oem.img
14 userdata:grow Image/userdata.img
15 # 要写入backup分区的文件就是自身 (update.img)
16 # SELF 是关键字，表示升级文件 (update.img) 自身
17 # 在生成升级文件时，不加入SELF文件的内容，但在头部信息中有记录
18 # 在解包升级文件时，不解包SELF文件的内容。
19 backup     RESERVED
20 #update-script update-script
21 #recover-script recover-script

```

3.4. OTA Upgrade

Upgrade online:

```

1 # updateEngine --update --image_url=firmware address --partition=0x3F00 --
  version_url=version file address --savepath=save the firmware address --
  reboot
2 updateEngine --image_url=http://172.16.21.110:8080/linuxab/update.img --
  update --reboot

```

Upgrade locally:

```

1 # updateEngine --update --image_url=firmware address --partition=0x3F00 --
  version_url=version file address --savepath=save the firmware address --
  reboot
2 updateEngine --image_url=/userdata/update.img --update --reboot

```

Process introduction:

1. Firmware versions comparison
2. Download the firmware (--image_url) and save it locally (--savepath)
3. Upgrade the specified partition(--partition)
4. Set the upgrade partition to the partition to be upgraded
5. Restart
6. Try to boot the upgraded partition

Optional parameters:

1. --partition: set the partition to be upgraded. In Linux A/B mode, it is recommended to upgrade only boot and system, that is setting it to 0x0A00. **It is not supported to upgrade the parameter and loader partitions.** See parameter instruction for details.
2. --version: if this parameter is not set, there will be no versions comparison.
3. --savepath: firmware save path. It is "/tmp/update.img" by default. and it is recommended to use the default value.
4. --reboot: reboot after upgrade

3.5. Partition Boot Settings

3.5.1. Bootable Settings

Set the current partition to be bootable by the misc and then execute after the system successfully boots, mark the system to start successfully. Please refer to the following script.

```
1 | $external/recovery/update_engine$ cat S99_bootcontrol
2 | case "$1" in
3 |     start)
4 |         /usr/bin/updateEngine --misc=now
5 |         ;;
6 |     stop)
7 |         printf "stop finished\n"
8 |         ;;
9 |     *)
10 |         echo "Usage: $0 {start|stop}"
11 |         exit 1
12 |         ;;
13 | esac
14 | exit 0
```

3.5.2. Upgrade Partition Settings

```
1 | updateEngine --misc=other --reboot
```

Process introduction:

1. Write a command to the position 4K offset from the misc in order to boot another partition
2. Restart

Optional parameter:

1. --reboot, the machine will not restart immediately and will not take effect until the next reboot by default.

Note: the updateEngine program is automatically set after OTA upgrade is completed, no need to repeat the settings.

4. Restore the Factory Settings

The configuration files that can be read and written were stored in the userdata partition. The factory firmware will set some configuration parameters by default. After using a period of time, the configuration file will be generated or modified. Sometimes users need to clear the data, at this time, they need to restore the factory configuration.

SDK implementation:

Function keys "RECOVERY + VOLUMEUP" are used to trigger to restore the factory configuration, please refer to the code in these directory:

buildroot/board/rockchip/rk3308/fs-overlay/etc/input-event-daemon.conf

board/rockchip/rk3308/fs-overlay/usr/sbin/factory_reset_cfg

```
1 | updateEngine --misc=wipe_userdata --reboot
```

Process introduction:

1. Write format command to the position that 4k offset from the misc partition
2. Reboot(--reboot)
3. The S21mountall.sh is used to identify formatting commands in the misc
4. format the userdata

Optional parameter:

1. --reboot: if this parameter was not set, the factory settings will be restored after the next reboot of the machine.

5. Details of the Upgrade Program

5.1. Parameters

The updateEngine mainly includes upgrading partition and writing the Misc configuration function, command parameters are as follows:

```
1  updateEngine --help
2  *** update_engine: Version V1.0.1 ***.
3  --misc=now          Linux A/B mode: Setting the current partition to
bootable.
4  --misc=other        Linux A/B mode: Setting another partition to bootable.
5  --misc=update       Recovery mode: Setting the partition to be upgraded.
6  --misc=wipe_userdata Format data partition.
7  --update            Upgrade mode.
8  --partition=0xFF00  Set the partition to be upgraded.
9                      0xFF00: 1111 1111 1000 0000.
10                     111111111: loader parameter uboot trust boot recovery
rootfs oem misc.
11 --reboot            Restart the machine at the end of the program.
12 --version_url=url   The path to the file of version.
13 --image_url=url     Path to upgrade firmware.
14 --savepath=url      save the update.img to url.
```

--misc

now: used to set the current partition as a bootable partition in Linux A/B mode

Note: The "external/recovery/update_engine/S99bootcontrol" script will run this command in the end of booting, setting the current partition as a bootable partition, which needs to be enabled.

```
1  BR2_PACKAGE_RECOVERY_BOOTCONTROL=y
```

other: used to set another partition as the upgraded partition, and try to boot from another partition after reboot in Linux A/B mode.

Note: if the updateEngine is used to upgrade, it will be set automatically after the upgrade is completed, no need to repeat the settings.

update: used to upgrade the recovery partition in the normal system, and upgrade the remaining partitions in the recovery system in Recovery mode.

display: used to debug, display the data structure of the misc partition.

--update

sdboot: do the sdboot upgrade process, that is, operate flash directly without partition concept.

Without parameters: mainly used in Linux A/B mode, directly upgrade in the current mode.

--partition=0x0000

Set the partition to be upgraded, the default value is 0x3F00, upgrade uboot, trust, boot, recovery, rootfs, oem partitions. The higher 9 bits are already used, and the lower 7 bits are reserved bits which can be extended.

1: upgrade, 0: not upgraded

bits	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
partition	loader	parameter	uboot	trust	boot	recovery	rootfs	oem	misc	reserved	reserved	reserved	reserved	reserved	reserved	reserved

--reboot

After the updateEngine runs successfully, the machine restarts.

--vversion_url

If it was set, it will be compared to the RK_VERSION= version value in the "/etc/version" file before upgrade.

Local path: read the version number from the firmware.

Remote path: download the version file from the remote, and the remote version file format must be consistent with the "/etc/version".

--image_url

Set the path of the upgrade firmware, which can be remote or local path.

--savepath

Set the path where the firmware is saved. If it is not set and the upgraded firmware path is a remote address, the default value is /tmp/update.img.

5.2. Upgrade Customize Partition

```

1  typedef struct {
2      char name[32];          //firmware name
3      bool need_update;      //need to upgrade
4      bool is_ab;            //whether it is A/B dual partition
5      long long size;        //firmware size
6      long long offset;      //Offset position in update.img
7      long long flash_offset; //Offset position in flash
8      char dest_path[100];    //Target path
9      update_func cmd;        //Upgrade function
10 } UPDATE_CMD, *PUPDATE_CMD;

```

To upgrade the customize partition "factory", add the following line below, and --partition needs to set the corresponding bit value to 1:

```

1  {"factory", false, false, 0, 0, 0, "", flash_normal},

```

external/recovery/update_engine/update.cpp

```

1  UPDATE_CMD update_cmd[] = {
2      {"bootloader", false, false, 0, 0, 0, "", flash_bootloader},
3      {"parameter", false, false, 0, 0, 0, "", flash_parameter},
4      {"uboot", false, false, 0, 0, 0, "", flash_normal},
5      {"trust", false, false, 0, 0, 0, "", flash_normal},
6      {"boot", false, true, 0, 0, 0, "", flash_normal},
7      {"recovery", false, false, 0, 0, 0, "", flash_normal},
8      {"rootfs", false, true, 0, 0, 0, "", flash_normal},
9      {"oem", false, false, 0, 0, 0, "", flash_normal},
10     {"misc", false, false, 0, 0, 0, "", flash_normal},
11 };

```

6. Appendix

6.1. Firmware Package Tools

6.1.1. Windows Package Tool

The Windows package tool is located in the tools\windows\AndroidTool\rockdev directory. Modify the package-file first to add the image to be upgraded into package. Note that the path here is relative path.

The mkupdate.bat batch program will link the "tools\windows\AndroidTool\rockdev\Image" to the rockdev directory under root directory. So please make sure the corresponding image exists under rockdev. Then execute the mkupdate.bat which will package corresponding image in rockdev under root directory into update.img and stored in rockdev under root directory.

6.1.2. Linux Package Tool

The Linux package tool is available in the "tools/linux/Linux_Pack_Firmware/rockdev" directory. Modify the package-file first to add the image to be upgraded into package. Note that the path here is relative path.

The "tools/linux/Linux_Pack_Firmware/rockdev/Image" will link to the rockdev under root directory. So please make sure the corresponding image under rockdev exists. Then execute the mkupdate.sh which will package the corresponding image in rockdev under root directory into update.img and stored in rockdev under root directory.

6.2. Misc Partition

The Misc partition is a partition without a file system. It is used to store some boot configuration parameters. The current structure is as follows. Please see the "external/recovery/bootloader.h" and "external/recovery/update_engine/rkbootloader.cpp" for details.

Offset address	Usage
2k	Linux A/B partition boot information
4k	Format command
16k	Communication between Recovery system and Normal system