

**MTK OpenWrt SDK User Manual**

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# About MTK OpenWrt SDK

## What is OpenWrt

Openwrt Logo.svg

Figure ‑. OpenWrt Logo

* From <https://openwrt.org/> :

OpenWrt is described as a Linux distribution for embedded devices.

Instead of trying to create a single, static firmware, OpenWrt provides a fully writable filesystem with package management. This frees you from the application selection and configuration provided by the vendor and allows you to customize the device through the use of packages to suit any application. For developer, OpenWrt is the framework to build an application without having to build a complete firmware around it; for users this means the ability for full customization, to use the device in ways never envisioned.

* From <https://en.wikipedia.org/wiki/OpenWrt> :

OpenWrt is a linux distribution primarily used on embedded devices to route network traffic. The main components are the Linux kernel, uClibc, busybox, and OpenWrt framework utilities. All components have been optimized for size, to be small enough for fitting into the limited storage and memory available in the routers.

### What is lede?

On 4 May, 2016, some of the OpenWrt developers announced that they are going to start a new project named “lede”, which stands for “*Linux Embedded Development Environment”*. Actually lede is a fork of OpenWrt, that’s why they call that announcement as “reborn of OpenWrt”.

* Description from <https://lede-project.org/>

The LEDE Project (“Linux Embedded Development Environment”) is a Linux operating system based on OpenWrt. It is a complete replacement for the vendor-supplied firmware of a wide range of wireless routers and non-network devices.

**About 1 year later, OpenWrt and Lede finally merged together. They both refer to the same thing now.**

## MediaTeK’s OpenWrt SDK

MediaTek starts to support OpenWrt project since 2013. We provide customized SDK based on stable releases of OpenWrt or LEDE.

To provide better performance and better stability, some of OpenWrt’s components are replaced by MTK ‘s proprietary implementations, including some applications, kernel and drivers (ethernet, USB, WiFi, SD Card, etc.).

## SDK Revision History

### V4.x

SDK V4.x series are independently developed from previous SDK.

SDK V4.0 is the latest MTK OpenWrt SDK. It is developed based on **LEDE 17.01**. It uses customized kernel linux-4.9.92.

**Supported SoC Chips**: MT7622, MT7623

**Supported WiFi Chips**: MT7622, MT7615e

Older chips such as MT7620/MT7628/MT7621, you should turn to v3.x series, which is still under maintaining.

# Using MTK OpenWrt SDK

## Unzip the code

Unzip the SDK, you will get the following folders and files:

drwxr-xr-x. 7 user user 4096 Dec 21 14:26 autobuild

-rw-r--r--. 1 user user 179 Dec 21 14:22 BSDmakefile

drwxr-xr-x. 2 user user 96 Dec 21 14:22 config

-rw-r--r--. 1 user user 573 Dec 21 14:22 Config.in

drwxr-xr-x. 2 user user 4096 Dec 21 14:26 dl

-rw-r--r--. 1 user user 244 Dec 21 14:22 do.not.release

-rw-r--r--. 1 user user 295 Dec 21 14:22 feeds.conf.default

drwxr-xr-x. 3 user user 4096 Dec 21 14:22 include

-rw-r--r--. 1 user user 17992 Dec 21 14:22 LICENSE

-rw-r--r--. 1 user user 3026 Dec 21 14:22 Makefile

drwxr-xr-x. 14 user user 4096 Dec 21 14:22 package

-rw-r--r--. 1 user user 1014 Dec 21 14:22 README

-rwxr-xr-x. 1 user user 4381 Dec 21 14:22 release\_sdk.sh

-rw-r--r--. 1 user user 12767 Dec 21 14:22 rules.mk

drwxr-xr-x. 4 user user 4096 Dec 21 14:22 scripts

drwxr-xr-x. 6 user user 94 Dec 21 14:22 target

drwxr-xr-x. 13 user user 4096 Dec 21 14:22 toolchain

drwxr-xr-x. 58 user user 4096 Dec 21 14:22 tools

* **autbuild**: some configuration files which may help you to build a default firmware.
* **BSDmakefile**: makefile for BSD system.
* **config**: a collection of global configrations for menuconfig.
* **Config.in:** main entrance of all configuration menu. It refers to a lot of other “config.in” from under **config** folder.
* **dl:** This folder is where openwrt puts its downloaded components. We aready put some components here, including customized kernel, some MediaTek’s proprietary applications.
* **docs**: some help manual in TeX/LaTeX format.
* **feeds.conf.default**: OpenWrt have thousands of 3rd party components (plugins) you can install with “scripts/feeds” command, they are hosted in serval repositories, and this file records url of those repositories.
* **include**: a bunch of “\*.mk” files. It consists OpenWrt’s powful (also complicated) build system. They will be included into almost every Makefile in OpenWrt.
* **LICENCE**: GPLv2 licence.
* **Makefile**: Core makefile, it defines entrance to the giant make system.
* **package**: A package is a configurable comipling unit of OpenWrt. OpenWrt’s consists of a lot of packages, such as busybox, dnsmasq, procd, ubus, uci…They are all defined under this folder.
* **README**: Read it.
* **rules.mk**: a general makefile that defines some global variables and routines, it is included in every Makefile, directly or indirectly.
* **scripts**: many helper scripts that is going to be used during configuration and compiling.
* **target**: It includes platform specific stuff. Every platform that is supported by OpenWrt has a folder which includes its source code, patches, scripts, configurations, dts, etc.
* **toolchain**: Defines cross compiler’s configuration, compiling and installation.
* **tools**: source code of some tools, which will be used during compiling.

## Setup precondition

OpenWrt requires some tools from your host, if one of them is missing, you will get errors at the beginning of configuring or compiling.

Normally you can skip this step and jump to configuration or compilation directly. Once you get errors, you can go back here to install tools that was missing.

Note that these commands requires root previlidge.

* **If you are working on a RedHat or CentOS server:**

yum install binutils

yum install bzip2

yum install gawk

yum install gcc

yum install gcc-c++

yum install gettext

yum install make

yum install ncurses-devel

yum install patch

yum install unzip

yum install wget

yum install zlib-devel

yum install subversion

* **If you are working on a Ubuntu server:**

apt-get install g++

apt-get install libncurses5-dev

apt-get install zlib1g-dev

apt-get install bison

apt-get install flex

apt-get install unzip

apt-get install autoconf

apt-get install gawk

apt-get install make

apt-get install gettext

apt-get install gcc

apt-get install binutils

apt-get install patch

apt-get install bzip2

apt-get install libz-dev

apt-get install asciidoc

apt-get install subversion

## Configure the SDK

OpenWrt is highly configurable.

OpenWrt supports a lot of target boards, a lot of applications, and every component of OpenWrt may have a lot of configurable features.

Before you start to build it, you must configure it.

### Configure OpenWrt

Under SDK root folder, execute:

**make menuconfig**

You will get a menu that lists out all configurable features of the SDK.

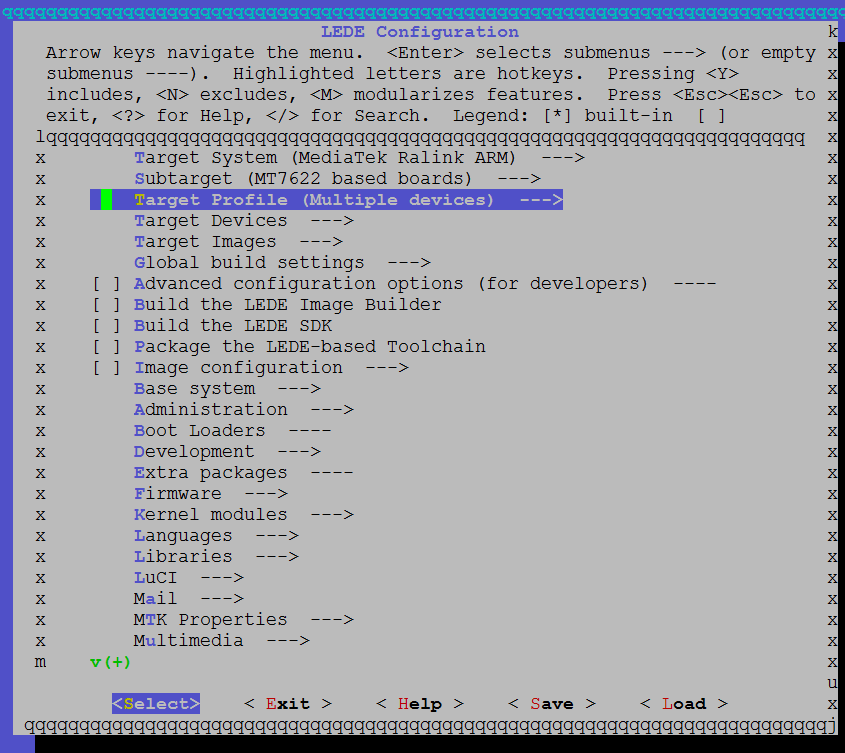


Figure ‑ SDK menuconfig

For the simplest start, you need to configure at least 3 items:

Target System (MediaTek Ralink ARM) ---> # platform

Subtarget (MT7622 based boards) ---> # chipset

Target Profile (MTK7622 ac2600 rfb1 AP ) ---> # product model

If you select “Multiple devices” as target profile, a new “Target Devices” will turn up. You should select the devices your need.

Target System (MediaTek Ralink ARM) ---> # platform

Subtarget (MT7622 based boards) ---> # chipset

Target Profile (Multiple devices) ---> # product model

Target Devices ---> # target devices

After menuconfig done, you configuration will be saved into “**.config**”.

Note that OpenWrt uses a different configuration syntax from kernel for ***tristage*** ***features***.

* (\*) means this feature will be built and installed into the firmware directly.
* (M) means this feature will be built as a stand alone package (or plugin), that can be installed into the target system at runtime.

### Configure Linux Kernel

OpenWrt provides default kernel configuration, you can find it at target/linux/<target>/<subtarget>/config-<kernel-version>. If the default configuration does not meet your needs, you can configure the kernel by yourself.

Under SDK root folder, execute:

**make kernel\_menuconfig**

Then you will see the classic kernel configuration menu. It uses the same syntax as linux kernel configuration.

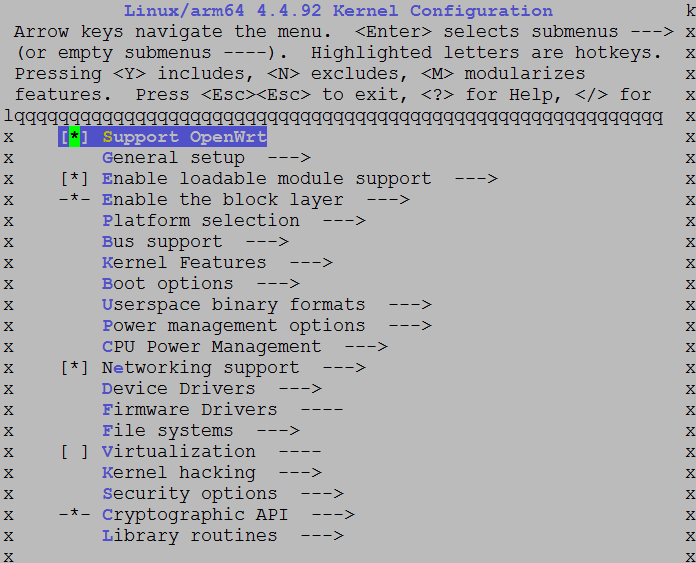


Figure ‑ OpenWrt Kernel\_menuconfig

After configuration done, you configuration will be saved into target/linux/<target>/<subtarget>/config-<kernel-version>.

### Install and configure wireless drivers

Since SDK V4.x, MediaTek’s Wireless drivers are not released along with OpenWrt SDK. They are taken as a normal package of OpenWrt, and are built outside the kernel source tree.

Check the “WiFi Drivers” section for more information.

### Using pre-defined configurations

Under “autobuild” folder, there are some pre-defined configurations, which can be a good start for you.

You can copy one of them to the root folder and rename it to “.config”.

**cp autobuild/xxxx.config .config**

**make defconfig**

## Build

Under SDK root folder, call:

**make**

or

**make V=s** # this will produce verbose log

or

**make V=s -j4** # this makes 4 parallel build threads, can be faster in multi-core environment.

OpenWrt’s Compilation happens in “build\_dir”, normally it includes 4 stages:

1. Prepare
   1. locate the source code. Typically it resides under “dl” folder as a tarball.
   2. Install the source code under “build\_dir”
   3. Apply patches to the source code if necessary.
2. Compile
3. Install
   1. Install the component into rootfs.
   2. Install the IPK under “bin” folder.
   3. Install headers, libraries into “staging\_dir” if necessary.
4. Clean
   1. Clean up the code under “build\_dir”

Some other info you may want to know:

* If you have selected a feature that is not in the default configurations, the SDK may needs to download corresponding source code from Internet. In that case, you need to make sure your build host can access the open Internet.
* The first compilation will take a long time because it needs to build the toolchain and host tools first. After the first build, normally your build will be ready in minutes.
* If anything goes wrong during building, use “make V=s” (strip the “-j” parameter) to see what happened.

If everything is OK, you will get a “bin” folder, with both firmwares and packages(\*.ipk) inside.

### Partial build

Other than the full firmware, OpenWrt supports to build a component individually. This is useful when you want to develop or debug a component.

To build the kernel:

**make target/linux/compile**

To build a package:

**make package/<package path>/compile**

Some times you need to clean the component first, you can combine several stages together:

**make target/linux/{clean,prepare,compile}**

**make package/<package path>/{clean,prepare,compile}**

Note that a partial build will not update the final firmware, it just updates the component.

### Firmwares and packages

After a successful build, you will get a “bin” folder with the following contents:

* **Firmware**: includes firmwares you can flash into your boards.

bin/targets/

└── mediatek/

└── mt7622-glibc/

├── config.seed

├── lede-mediatek-mt7622-device-mtk-ac2600-rfb1.manifest

├── lede-mediatek-mt7622-MTK-AC2600-RFB1-squashfs-sysupgrade.bin

├── mt7622-ac2600rfb1.dtb

├── packages/

└── sha256sums

* + **config.seed**: SDK configuration.
  + **lede-xxxx.manifest**: a text file that keep record of revision of current firmware’s components.
  + **lede-xxxx-sysupgrade.bin**: the firmware you can flash into your board.
  + **xxxx.dtb**: binary format of dts file of corresponding firmware.
  + **packages**/ : platform specific ipks.
  + **sha256sum**: a text file that keep record of sha256sum values of some important files. You can use “sha256sum <filename>” to check if the file was unexpectly changed.
* **Packages**: IPKs that you can install into a running system via “opkg”. They are usually platform independent.

## Install

There are several ways of flashing new firmware into your device.

### Upgrade via uboot

MediaTek’s uboot provides various ways of flashing new firmware.

Normally option 2 is your best choice. You need to setup a TFTP server on your PC, and connect your PC’s net cable with the board’s LAN port.

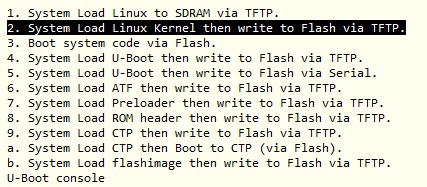


Figure ‑ Upgrade via u-boot

### Upgrade via “sysupgrade”

OpenWrt has a built-in command “sysupgrade” which can upgrade the firmware in one line.

**/**sbin/sysupgrade [<upgrade-option>...] <image file or UR**L>**

Check the help message of “sysupgrade” for advanced usage.

### Upgrade via WEB UI

**Precondition**: You have LuCI installed properly.

**Step 1**: Visit <http://192.168.1.1> , “System” -> “Backup/Flash Firmware”

**Step 2**: Find the “Flash new firmware image” section, choose your firmware, then click “Flash image” button.

See the images below.

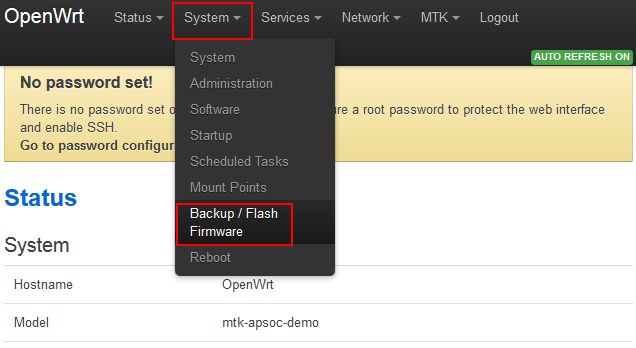


Figure ‑ Upgrade via LuCI Step 1



Figure ‑ Upgrade via LuCI Step 2

### Install packages (ipk)

An ipk file can be installed into a running system via “opkg” command.

**opkg install <ipk path or url>**

If you are developing an application, combining “partial build” and “opkg” together are quite handy.

# SDK components introduction

## Components Overview

## Toolchain

Usually you don’t need to configure OpenWrt’s toolchain.

Once you choose a platform, corresponding toolchain configuration will be generated for you. Everything you need to cross-compile a firmware for you platform has been integrated into OpenWrt’s built framework.

Toolchains will be built the first time you build the project, then be saved under “staging\_dir” for further use.

**Note that “make clean” will not clean up the “staging\_dir”, but “make distclean” does.**

### C/C++ Libraries

OpenWrt can be built with multiple C/C++ implementations.

* **uClibc** : uClibc (<https://www.uclibc.org/>) is a small C standard library intended for Linux kernel-based operating systems for embedded systems and mobile devices. *uClibc* was created to support μClinux, a version of Linux not requiring a memory management unit and thus suited for microcontrollers.
* **Musl** : musl (<https://www.musl-libc.org/>) is a C standard library intended for operating systems based on the Linux kernel, released under the MIT License. It was developed by Rich Felker with the goal to write a clean, efficient and standards-conformant libc implementation
* **Glibc** : The GNU C Library (<https://www.gnu.org/s/libc/>)project provides the core libraries for the GNU system and GNU/Linux systems, as well as many other systems that use Linux as the kernel.

You can choose the implementations by “**make menuconfig**”:

make menuconfig

--> Advanced configuration options (for developers)

--> Toolchain options

--> C library implementations

--> (x) Use glibc

--> ( ) Use musl

By default, MT7622 uses “glibc”, while MT7623 uses “musl”.

## Peripherals

### PCI

#### Kernel configuration:

CONFIG\_PCIE\_MEDIATEK=y

#### Source code:

<linux>/drivers/pci/host/pcie-mediatek.c

#### DTS section:

pcie: pcie@1a140000 {

compatible = "mediatek,mt7622-pcie";

device\_type = "pci";

reg = <0 0x1a140000 0 0x1000>,

<0 0x1a143000 0 0x1000>,

<0 0x1a145000 0 0x1000>;

reg-names = "subsys", "port0", "port1";

#address-cells = <3>;

#size-cells = <2>;

interrupts = <GIC\_SPI 228 IRQ\_TYPE\_LEVEL\_LOW>,

<GIC\_SPI 229 IRQ\_TYPE\_LEVEL\_LOW>;

clocks = <&pciesys CLK\_PCIE\_P0\_MAC\_EN>,

<&pciesys CLK\_PCIE\_P1\_MAC\_EN>,

<&pciesys CLK\_PCIE\_P0\_AHB\_EN>, /\* designer has connect rc1 with p0\_ahb clock \*/

<&pciesys CLK\_PCIE\_P0\_AHB\_EN>,

<&pciesys CLK\_PCIE\_P0\_AUX\_EN>,

<&pciesys CLK\_PCIE\_P1\_AUX\_EN>,

<&pciesys CLK\_PCIE\_P0\_AXI\_EN>,

<&pciesys CLK\_PCIE\_P1\_AXI\_EN>,

<&pciesys CLK\_PCIE\_P0\_OBFF\_EN>,

<&pciesys CLK\_PCIE\_P1\_OBFF\_EN>,

<&pciesys CLK\_PCIE\_P0\_PIPE\_EN>,

<&pciesys CLK\_PCIE\_P1\_PIPE\_EN>;

clock-names = "sys\_ck0", "sys\_ck1", "ahb\_ck0", "ahb\_ck1",

"aux\_ck0", "aux\_ck1", "axi\_ck0", "axi\_ck1",

"obff\_ck0", "obff\_ck1", "pipe\_ck0", "pipe\_ck1";

power-domains = <&scpsys MT7622\_POWER\_DOMAIN\_HIF0>;

bus-range = <0x00 0xff>;

ranges = <0x82000000 0 0x20000000 0x0 0x20000000 0 0x10000000>;

pcie0: pcie@0,0 {

device\_type = "pci";

reg = <0x0000 0 0 0 0>;

#address-cells = <3>;

#size-cells = <2>;

#interrupt-cells = <1>;

ranges;

num-lanes = <1>;

interrupt-map-mask = <0 0 0 7>;

interrupt-map = <0 0 0 1 &pcie\_intc0 0>,

<0 0 0 2 &pcie\_intc0 1>,

<0 0 0 3 &pcie\_intc0 2>,

<0 0 0 4 &pcie\_intc0 3>;

pcie\_intc0: interrupt-controller {

interrupt-controller;

#address-cells = <0>;

#interrupt-cells = <1>;

};

};

pcie1: pcie@1,0 { device\_type = "pci";

reg = <0x0800 0 0 0 0>;

#address-cells = <3>;

#size-cells = <2>;

#interrupt-cells = <1>;

ranges;

num-lanes = <1>;

interrupt-map-mask = <0 0 0 7>;

interrupt-map = <0 0 0 1 &pcie\_intc1 0>,

<0 0 0 2 &pcie\_intc1 1>,

<0 0 0 3 &pcie\_intc1 2>,

<0 0 0 4 &pcie\_intc1 3>;

pcie\_intc1: interrupt-controller {

interrupt-controller;

#address-cells = <0>;

#interrupt-cells = <1>;

};

};

};

#### Usage and testing:

lspci -v

### I2C

#### Kernel configuration:

CONFIG\_I2C=y

CONFIG\_I2C\_MT65XX=y

#### Source code:

<linux>/drivers/i2c/busses/i2c-mt65xx.c

#### DTS section:

In dtsi:

i2c0: i2c@11007000 {

compatible = "mediatek,mt7622-i2c";

reg = <0 0x11007000 0 0x90>,

<0 0x11000100 0 0x80>;

interrupts = <GIC\_SPI 84 IRQ\_TYPE\_LEVEL\_LOW>;

clock-div = <16>;

clocks = <&pericfg CLK\_PERI\_I2C0\_PD>,

<&pericfg CLK\_PERI\_AP\_DMA\_PD>;

clock-names = "main", "dma";

#address-cells = <1>;

#size-cells = <0>;

status = "disabled";

};

In dts

&i2c0 {

pinctrl-names = "default";

pinctrl-0 = <&i2c0\_pins>;

status = "okay";

};

#### Usage and testing:

<none>

### GPIO

#### Kernel configuration:

CONFIG\_PINCTRL\_MTK\_COMMON=y

CONFIG\_PINCTRL\_MT7622=y

#### Source code:

<linux>/ drivers/pinctrl/mediatek/pinctrl-mtk-common.c

<linux>/ drivers/pinctrl/mediatek/pinctrl-mt7622.c

#### DTS section:

&pio {

pinctrl-names = "default";

pinctrl-0 = <&state\_default>;

state\_default:pinconf\_default {

};

/\* more pinctrl sections \*/

}

#### Usage and testing:

For example, to configure gpio75:

cd /sys/devices/platform/10005000.pinctrl/

echo mode 75 1 > mt\_gpio # set GPIO mode

echo dir 75 1 > mt\_gpio # set Output mode

echo out 75 1 > mt\_gpio # set Output High

echo out 75 0 > mt\_gpio # set Output Low

### SPI

#### Kernel configuration:

CONFIG\_SPI\_SPIDEV=y

CONFIG\_SPI\_MT65XX=y

#### Source code:

<linux>/drivers/spi/spi-mt65xx.c

#### DTS section:

&spi0 {

status = "okay";

spidev: spidev@0 {

compatible = "spidev";

spi-max-frequency = <1000000>;

reg = <0>;

};

};

#### Usage and testing:

1. Build spidev\_test.c to a binary file (an ELF file), and copy to board.
2. Run the command in linux shell(10000000 means 10Mhz, 30000000 means 30M):

./spidev\_test -s 10000000 –D　/dev/spidevxxx

1. 3. After type step2 command, it loopback pass if SPI bus get the same values that spidev\_test.c sent

### PMIC

#### Kernel configuration:

CONFIG\_REGULATOR=y

CONFIG\_REGULATOR\_FIXED\_VOLTAGE=y

#### Source code:

<linux>/drivers/regulator/mt6380-regulator.c

<linux>/drivers/soc/mediatek/mtk-pmic-wrap.c

<linux>/drivers/misc/mediatek/base/power/mt7622/pmic\_mt6380.c

#### DTS section:

<linux>/arch/arm64/boot/dts/mediatek/mt6380.dtsi

&pwrap {

status = "okay";

pmic: mt6380 {

compatible = "mediatek,mt6380";

};

mt6380regulator: mt6380regulator {

compatible = "mediatek,mt6380-regulator";

mt6380\_vcpu\_reg: buck\_vcore1 {

regulator-name = "vcpu";

regulator-min-microvolt = < 600000>;

regulator-max-microvolt = <1393750>;

regulator-ramp-delay = <6250>;

regulator-always-on;

regulator-boot-on;

};

mt6380\_vcore\_reg: buck\_vcore {

regulator-name = "vcore";

regulator-min-microvolt = <600000>;

regulator-max-microvolt = <1393750>;

regulator-ramp-delay = <6250>;

regulator-always-on;

regulator-boot-on;

};

mt6380\_vrf\_reg: buck\_vrf {

regulator-name = "vrf";

regulator-min-microvolt = <1200000>;

regulator-max-microvolt = <1575000>;

regulator-ramp-delay = <0>;

regulator-always-on;

regulator-boot-on;

};

mt6380\_vm\_reg: ldo\_vmldo {

regulator-name = "vmldo";

regulator-min-microvolt = <1050000>;

regulator-max-microvolt = <1400000>;

regulator-ramp-delay = <0>;

regulator-always-on;

regulator-boot-on;

};

mt6380\_va\_reg: ldo\_valdo {

regulator-name = "valdo";

regulator-min-microvolt = <2200000>;

regulator-max-microvolt = <3300000>;

regulator-ramp-delay = <0>;

regulator-always-on;

regulator-boot-on;

};

mt6380\_vphy\_reg: ldo\_vphyldo {

regulator-name = "vphyldo";

regulator-min-microvolt = <1800000>;

regulator-max-microvolt = <1800000>;

regulator-ramp-delay = <0>;

regulator-always-on;

regulator-boot-on;

};

mt6380\_vddr\_reg: ldo\_vddrldo {

regulator-name = "vddr";

regulator-min-microvolt = <1240000>;

regulator-max-microvolt = <1840000>;

regulator-ramp-delay = <0>;

regulator-always-on;

regulator-boot-on;

};

mt6380\_vt\_reg: ldo\_vtldo {

regulator-name = "vadc18";

regulator-min-microvolt = <2200000>;

regulator-max-microvolt = <3300000>;

regulator-ramp-delay = <0>;

regulator-always-on;

regulator-boot-on;

};

};

};

#### Usage and testing:

<none>

### UART

#### Kernel configuration:

CONFIG\_SERIAL\_8250\_MT6577=y

CONFIG\_DMA\_MTK\_UART=y

#### Source code:

<linux>/drivers/tty/serial/8250/8250\_mtk.c

#### DTS section:

&uart1 {

status="okay"

}

#### Usage and testing:

1. confirm the TX,RX pin whether UART mode at device tree;
2. make TX, RX PIN loopback by use cable;
3. build the uart autotest program and then run it to check the result.

### PWM

#### Kernel configuration:

CONFIG\_PWM=y

CONFIG\_PWM\_MEDIATEK=y

#### Source code:

<linux>/drivers/pwm/pwm-mediatek.c

#### DTS section:

&pwm {

status="okay"

}

#### Usage and testing:

PWM driver export a few sysfs entries:

/sys/class/pwm/

├── pwmchipN/ #for each PWM chip

├── export (w/o) #ask the kernel to export a PWM channel

├── npwm (r/o) #number of PWM channels in this PWM chip

├── pwmX/ #for each exported PWM channel

│ ├── duty (r/w) #duty cycle (in nanoseconds)

│ ├── enable (r/w) #enable/disable PWM

│ ├── period (r/w) #period (in nanoseconds)

│ └─── polarity (r/w) #polarity of PWM (normal/inversed)

└─── unexport (w/o) #return a PWM channel to the kernel

The following commands will make PWM4 generate squre wave:

echo 3 >/sys/class/pwm/pwmchip0/export

echo 200000 >/sys/class/pwm/pwmchip0/pwm3/period

echo 100000 >/sys/class/pwm/pwmchip0/pwm3/duty\_cycle

echo 1 >/sys/class/pwm/pwmchip0/pwm3/enable

### USB

#### Kernel configuration:

CONFIG\_USB\_XHCI\_MTK=y # usb3

CONFIG\_PHY\_MTK\_TPHY=y # u3phy

#### Source code:

<linux>/drivers/usb/host/xhci-mtk.c

<linux>/drivers/usb/host/xhci-mtk-sch.c

#### DTS section:

&usb1 {

status = "okay";

};

&u3phy1 {

status = "okay";

};

#### Usage and testing:

Mount a USB disk, then do reading and writing test with dd command.

### SATA

#### Kernel configuration:

CONFIG\_AHCI\_MTK=y

#### Source code:

drivers/ata/ahci\_mtk.c

#### DTS section:

&sata {

status = "okay";

};

&sata\_phy {

status = "okay";

};

#### Usage and testing:

Connect SSD/HDD to the board, you will find a new device “/dev/block/sda1” occurs, then try to mount it.

### Ethernet

#### Kernel configuration:

CONFIG\_RAETH=y

#### Source code:

<liunux>/drivers/net/ethernet/raeth/

#### DTS section:

ethsys: syscon@1b000000 {

#address-cells = <1>;

#size-cells = <1>;

compatible = "mediatek,mt7622-ethsys", "syscon";

reg = <0 0x1b000000 0 0x1000>;

#clock-cells = <1>;

};

eth: ethernet@1b100000 {

compatible = "mediatek,mt7622-eth";

reg = <0 0x1b100000 0 0x20000>;

interrupts = <GIC\_SPI 223 IRQ\_TYPE\_LEVEL\_LOW>,

<GIC\_SPI 224 IRQ\_TYPE\_LEVEL\_LOW>,

<GIC\_SPI 225 IRQ\_TYPE\_LEVEL\_LOW>,

<GIC\_SPI 240 IRQ\_TYPE\_LEVEL\_LOW>;

clocks = <&topckgen CLK\_TOP\_ETH\_SEL>,

<&apmixedsys CLK\_APMIXED\_ETH1PLL>,

<&apmixedsys CLK\_APMIXED\_ETH2PLL>,

<&apmixedsys CLK\_APMIXED\_SGMIPLL>,

<&clk25m>,

<&ethsys CLK\_ETH\_ESW\_EN>,

<&ethsys CLK\_ETH\_GP2\_EN>,

<&ethsys CLK\_ETH\_GP1\_EN>,

<&ethsys CLK\_ETH\_GP0\_EN>,

<&sgmiisys CLK\_SGMII\_TX250M\_EN>,

<&sgmiisys CLK\_SGMII\_RX250M\_EN>,

<&sgmiisys CLK\_SGMII\_CDR\_REF>,

<&sgmiisys CLK\_SGMII\_CDR\_FB>;

clock-names = "ethif", "eth1pll", "eth2pll",

"sgmipll", "trgpll", "esw", "gp2",

"gp1", "gp0", "sgmii\_tx250m",

"sgmii\_rx250m", "sgmii\_cdr\_ref",

"sgmii\_cdr\_fb";

power-domains = <&scpsys MT7622\_POWER\_DOMAIN\_ETHSYS>;

mediatek,ethsys = <&ethsys>;

mediatek,switch = <&gsw>;

#reset-cells = <1>;

#address-cells = <1>;

#size-cells = <0>;

status = "disabled";

};

#### Usage and testing:

<none>

### Timer

#### Kernel configuration:

CONFIG\_ARM\_ARCH\_TIMER=y # arm timer

CONFIG\_MTK\_TIMER=y # mtk timer

#### Source code:

drivers/clocksource/arm\_arch\_timer.c # arm timer

drivers/clocksource/mtk\_timer.c # mtk timer

#### DTS section:

/\* arm timer \*/

timer {

compatible = "arm,armv8-timer";

interrupt-parent = <&gic>;

interrupts = <GIC\_PPI 13 (GIC\_CPU\_MASK\_SIMPLE(4) | IRQ\_TYPE\_LEVEL\_HIGH)>,

<GIC\_PPI 14 (GIC\_CPU\_MASK\_SIMPLE(4) | IRQ\_TYPE\_LEVEL\_HIGH)>,

<GIC\_PPI 11 (GIC\_CPU\_MASK\_SIMPLE(4) | IRQ\_TYPE\_LEVEL\_HIGH)>,

<GIC\_PPI 10 (GIC\_CPU\_MASK\_SIMPLE(4) | IRQ\_TYPE\_LEVEL\_HIGH)>;

};

/\* mtk timer \*/

timer: timer@10004000 {

compatible = "mediatek,mt7622-timer",

"mediatek,mt6577-timer";

reg = <0 0x10004000 0 0x80>;

interrupts = <GIC\_SPI 152 IRQ\_TYPE\_LEVEL\_LOW>;

clocks = <&infracfg CLK\_INFRA\_APXGPT\_PD>,

<&topckgen CLK\_TOP\_RTC>;

clock-names = "clk13m", "clk32k";

};

#### Usage and testing:

If arm timer is not ready, the system will not run.

As for MTK timer, you check the interrupt info via:

cat /proc/interrupts

### Watchdog

#### Kernel configuration:

CONFIG\_WATCHDOG=y

CONFIG\_MEDIATEK\_WATCHDOG=y

#### Source code:

<linux>/drivers/watchdog/mtk\_wdt.c

#### DTS section:

watchdog: watchdog@10212000 {

compatible = "mediatek,mt7622-wdt",

"mediatek,mt6589-wdt";

reg = <0 0x10212000 0 0x1000>;

interrupts = <GIC\_SPI 128 IRQ\_TYPE\_EDGE\_FALLING>;

#reset-cells = <1>;

};

#### Usage and testing:

MT7622’s reseting is done by watchdog, so you just need:

reboot

To verify if watchdog is working.

### eMMC

#### Kernel configuration:

CONFIG\_MMC=y

CONFIG\_MMC\_MTK=y

#### Source code:

<linux>/drivers/mmc/host/mtk-sd.c

#### DTS section:

&mmc0 {

pinctrl-names = "default", "state\_uhs";

pinctrl-0 = <&mmc0\_pins\_default>;

pinctrl-1 = <&mmc0\_pins\_uhs>;

status = "okay";

bus\_width = <8>;

max-frequency = <50000000>;

cap-mmc-highspeed;

mmc-hs200-1\_8v;

vmmc-supply = <&mmc\_fixed\_3v3\_power>;

vqmmc-supply = <&mmc\_fixed\_1v8\_io>;

assigned-clocks = <&topckgen CLK\_TOP\_MSDC30\_0\_SEL>;

assigned-clock-parents = <&topckgen CLK\_TOP\_UNIV48M>;

non-removable;

};

#### Usage and testing:

Check if eMMC nodes exists:

cat /proc/partitions

Then use **dd** or **hexdump** to test **/dev/mmcblk0pX** (X is the partition index).

### SDXC

#### Kernel configuration:

CONFIG\_MMC=y

CONFIG\_MMC\_MTK=y

#### Source code:

<linux>/drivers/mmc/host/mtk-sd.c

#### DTS section:

&mmc1 {

pinctrl-names = "default", "state\_uhs";

pinctrl-0 = <&mmc1\_pins\_default>;

pinctrl-1 = <&mmc1\_pins\_uhs>;

status = "okay";

bus\_width = <4>;

max-frequency = <50000000>;

cap-sd-highspeed;

r\_smpl = <1>;

cd-gpios = <&pio 81 0>;

vmmc-supply = <&mmc\_fixed\_3v3\_power>;

vqmmc-supply = <&mmc\_fixed\_3v3\_power>;

assigned-clocks = <&topckgen CLK\_TOP\_MSDC30\_1\_SEL>;

assigned-clock-parents = <&topckgen CLK\_TOP\_UNIV48M>;

};

#### Usage and testing:

if eMMC available, **/dev/mmcblk0** is emmc block device, and **/dev/mmcblk1** is sdcard block device.

if eMMC not availble, **/dev/mmcblk0** is sdcard block device.

You can use **dd** or **eMMC** to test sdcard device.

### Flash

#### Kernel configurations:

CONFIG\_MTD\_MT81xx\_NOR=y # spi-nor flash

CONFIG\_MTD\_NAND\_MTK=y # nand flash

#### Source code:

| Flash Type | **DTS Section** | **Driver** |
| --- | --- | --- |
| spi-nand | &snand | drivers/mtd/nand/mtk\_snand.c |
| parallel-nand | &nandc | drivers/mtd/nand/mtk\_nand.c |
| spi-nor | &nor\_flash | drivers/mtd/spi-nor/mtk-quadspi.c |

Table ‑ Flash Type - DTS – Driver

#### DTS section:

/\* spi-nor flash \*/

&nor\_flash {

status = "okay";

};

/\* spi-nand flash \*/

&snand {

pinctrl-0 = <&snand\_pins\_default>;

status = "okay";

flash@0 {

partitions {

compatible = "fixed-partitions";

#address-cells = <1>;

#size-cells = <1>;

partition@0 {

label = "preloader";

reg=<0x00000 0x0080000>;

read-only;

}

/\* more patitions \*/

}

}

}

#### Usage and testing:

Check if flash device is properly detected:

cat /proc/mtd

Then use **dd** & **hexdump** to test **/dev/mtd\***.

#### Flash layout

Since SDK V4.x, flash layout is defined in dts files.

For example: **<linux>arch/arm64/boot/dts/mediatek/<profile>.dts**

&snand {

pinctrl-0 = <&snand\_pins\_default>;

status = "okay";

flash@0 {

partitions {

compatible = "fixed-partitions";

#address-cells = <1>;

#size-cells = <1>;

partition@0 {

label = "Preloader";

reg = <0x00000 0x0080000>;

read-only;

};

/\* more partitions \*/

};

};

};

Predefined partitions are:

* **Preloader:** preloader code
* **ATF**: Configuration for “Air Time Fairness”
* **Bootloader**: uboot code
* **Config**: nvram configurations, including uboot’s parameters.
* **Factory**: Factory data, like calibration data, RF parameters.
* **Kernel**: Firmware partition, your firmware will be flashed into this partition. During OpenWrt/LEDE booting, this partition will be split into 3 partitions automatically:
  1. **firmware**, Linux kernel image starts here.
  2. **rootfs**: rootfs resides here.
  3. **rootfs\_data**: This partition takes the rest of space that is not taken by your firmware. OpenWrt uses it to store user data. It’s usually formatted as JFFS2.
* **User\_data**: reserved, make use of it as you wish.

#### Bad block management

* **MT7622**

MT7622’s nand driver will take cares of bad blocks. It will setup an internal table that maps bad blocks to a reserved area in the end of flash storage.

So, above the driver, you don’t have to worry about bad blocks at all. All you got are all good blocks. The only thing you need to do is to ensure you have reserved enough space (at least 2% of the full size) for the mapping.

You can change the size of reserved area by modifying the flash partition table in dts files.

#### Jffs2 compatibility

### Thermal

#### Kernel configuration:

CONFIG\_MTK\_TURNKEY\_THERMAL=y

CONFIG\_THERMAL=y

#### Source code:

<linux>/drivers/misc/mediatek/thermal/

#### DTS section:

thermal: thermal@1100b000 {

compatible = "mediatek,mt7622-thermal";

reg = <0 0x1100b000 0 0x1000>;

interrupts = <GIC\_SPI 110 IRQ\_TYPE\_LEVEL\_LOW>;

clocks = <&pericfg CLK\_PERI\_THERM\_PD>,

<&pericfg CLK\_PERI\_AUXADC\_PD>;

clock-names = "therm", "auxadc";

auxadc = <&auxadc>;

apmixedsys = <&apmixedsys>;

pericfg = <&pericfg>;

};

#### Usage and testing:

1. get thermal temperature:

cat /proc/mtktz/mtktscpu

1. change the thermal throttle policy, for example, to set CPU01 at 105 degree:

echo 1 117000 0 mtktscpu-sysrst 105000 0 cpu01 0 0 no-cooler 0 0 no-cooler 0 0 no-cooler 0 0 no-cooler 0 0 no-cooler 0 0 no-cooler 0 0 no-cooler 0 0 no-cooler 250 1 > /proc/driver/thermal/tzcpu

## Feeds

In OpenWrt, a "feed" is a collection of packages which share a common location. Feeds may reside on a remote server, in a version control system, on the local filesystem, or in any other location addressable by a single name (path/URL) over a protocol with a supported feed method.

### Search and install package from feeds

Pretty simple:

scripts/feeds update # update the index and save it into <openwrt>/feeds

scripts/feeds search <keywords>

scripts/feeds install <package-name>

After “**scripts/feeds install**”, you will be able to find the package entry in “**make menuconfig**”.

For advanced usage, please read its help message and refer to : <https://wiki.openwrt.org/doc/devel/feeds>

### Add new feeds

Feeds URLs are recorded in a text file, “**<openwrt>/feeds.conf.default**”.

src-git packages https://git.lede-project.org/feed/packages.git;lede-17.01

src-git luci https://git.lede-project.org/project/luci.git;lede-17.01

src-git routing https://git.lede-project.org/feed/routing.git;lede-17.01

src-git telephony https://git.lede-project.org/feed/telephony.git;lede-17.01

You can add your own feeds by add new lines into it.

<src-method> <feeds-name> <feeds-url>[;<branch-name>]

“scripts/feeds” command supports a lot of methods to get feeds:

* **src-svn** : subversion vcs
* **src-cpy** : file copy.
* **src-link** : symbol link
* **src-git** : git vcs (shallow clone)
* **src-git-full** : git vcs (full clone)
* **src-gitsvn** : gitsvn fusion
* **src-bzr** : GNU bazaar vcs.
* **src-hg** : mecury vcs
* **src-darcs** : darcs vcs

### Make your own feeds

The easiest way of building your own feeds is to fork from existing feeds.

<https://github.com/openwrt/packages> would be a good example to follow.

Download this repo, take a look inside, and put your package into it just like other did.

## Web Interface (LuCi)

### Install LuCi

Since SDK V3.x, LuCi is already integrated within the SDK. If you cannot find it, you can install it via “feeds”.

/scripts/feeds update

/scripts/feeds install luci

To enable LuCi in your firmware, at least you should select these 2 modules in LuC’s configuration:

LuCI

--> Collections

--> luci (\*)

--> Applications

--> luci-app-mtk (\*)

### Luci-app-mtk

This is a LuCI plugin written by MediaTek to manipulate MediaTek’s wifi configurations. It uses a lua library “/usr/lib/lua/mtkwifi.lua” to read and write wifi’s profile directly.

## MTK proprietary packages

### mii\_mgr

**Description**: mii\_mgr is an application to read and write mii registers. It uses **ioctl** to communicate with kernel’s ethernet drivers.

**Usage**:

Get:

mii\_mgr -g -p [phy number] -r [register number]

Set:

mii\_mgr -s -p [phy number] -r [register number] -v [0xvalue]

Examples 1:

mii\_mgr -g -p 3 -r 4

Example 2:

mii\_mgr -s -p 4 -r 1 -v 0xff11

### qdma

### regs

**Description**: An application to read and write registers.

**Usage**:

regs [Type] [ Offset:Hex ] [ Data:Hex ] [StartBit:Dec] [DataLen:Dec]

Type : access operation type : [m]odify, [w]wite, [d]ump

Offset : offset into memory region to act upon

Data : data to be written

Startbit: Startbit of Addr that want to be modified

DataLen : Data length of Data

Example 1, dump 0x1b100000~0x1b1000f0

regs d 0x1b100000

Example 2, write 0x1b100000=0x1234

regs w 0x1b100000 0x1234

Example 3, modify 0x1b100000[29:31]=0

regs m 0x1b100000 0x0 29 3

### switch

**Description**:

**Usage**:

switch mib - dump mib counter

switch dump - dump switch table

switch clear - clear switch table

switch ingress-rate on [port] [Kbps] - set ingress rate limit on port 0~4

switch egress-rate on [port] [Kbps] - set egress rate limit on port 0~4

switch ingress-rate off [port] - del ingress rate limit on port 0~4

switch egress-rate off [port] - del egress rate limit on port 0~4

switch igmpsnoop on - enable hw igmp snoop

switch igmpsnoop off - disable hw igmp snoop

switch mirror [monitor\_port] [target\_rx\_portmask] [target\_tx\_portmask] - set port mirror

switch phy [phy\_addr] - get phy link status

switch regs r [offset] - register read from offset

switch regs w [offset] [value] - register write value to offset

switch vlan dump - dump switch vlan setting

- portmap is the order of port 0~4, port16, port17.

switch vlan clear - clear switch vlan setting

switch vlan set [vlan idx] [vid] [portmap] - set vlan id and associated member.

- portmap is the order of port 0~4, port16, port17.

switch tag on [port] [vid] - keep vlan tag for egress packet on prot 0~4, 16, 17

switch tag off [port] [vid] - remove vlan tag for egress packet on port 0~4, 16, 17

switch test\_mode [port] [mode] - set phy test mode. port: 0~4; mode: 1 or 4

switch qos on - enable switch qos

switch qos off - disable switch qos

switch qos set\_table2type [table] [type] - set table qos type

switch qos get\_table2type [table] - get table qos type

switch qos set\_port2table [port] [table] - set port to table mapping

switch qos get\_port2table [port] - get port to table mapping

### ufsd\_tools

### 802.1x

### ated\_ext

**Description**:

**Usage**:

ated [-huvd][-b<br\_ifname>] [-i<driver\_ifname>]

options:

-b = bridge interface name

-h = show this help text

-u = respond to QA by unicast frame

-f = daemonize ATED

-i = driver interface name

-v = show version

-d = increase debugging verbosity (-dd even more)

-q = decrease debugging verbosity (-qq even less)

-l = path of l1profile.dat

-x = disable mtd flash read/write by ATED feature

-c = CLI mode to process predefined command(s)

**Examples**:

1. example 2:

ated -b br1 -i ra1 -v

1. example 3:

ated -u

1. example 4:

ated -d

1. example 5 for Dual Adapter and QA support Dual Adapter:

ated -i ra0 -i ra1

1. example 6 change dev mac address:

ated -b br0 -i ra0 -m mac\_addr

1. example 7 change path of l1profile:

ated -l/etc/wireless/l1profile.dat

1. example 8 disable mtd flash read/write by ATED feature

ated -x

1. example 9 cli mode with interface, ated -irai0 -c"sync eeprom 2f00[20:2f]" (w/o l1profile.dat)

ated -irai0 -c"sync eeprom all"

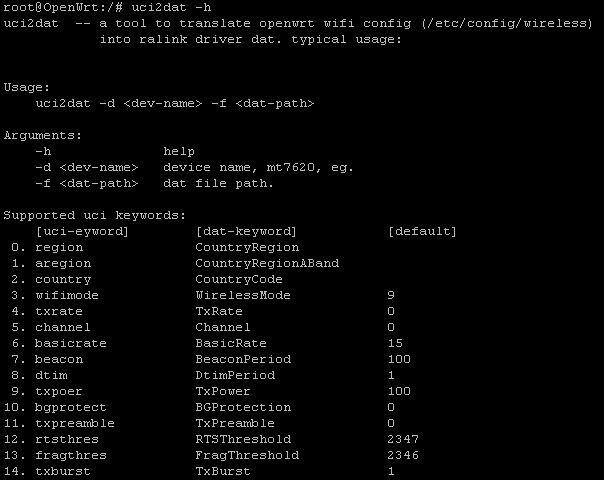
1. example 10 with interface and eeprom infomation: (w/o l1profile.dat) , eeprom locate at flash offset 0x0 with length, 0x4000

ated -ira0 -e[0:4000]

### uci2dat

**Description**: MediaTek’s wifi drivers do not read OpenWrt’s uci configuration, they use a unique configure syntax in “\*.dat” files. “uci2dat” is the tool to translate OpenWrt’s uci configuration into MediaTek’s wifi profile.

Since SDK V4.0, “uci2dat” is deprecated because a new configuration mechanism is available for MediaTek’s wifi drivers (read more from “luci-app-mtk” section). We just keep it for back compatibility.

**Usage**: 

**Examples**:

1. dadfa
2. setasfa

## WiFi Drivers

### Install WiFi drivers into SDK

Since SDK V4.0, MediaTek’s wifi drivers are not released along with OpenWrt SDK. You need to install drivers according to the driver’s user manual.

### Init flow

There are 4 scripts involved:

* **/etc/init.d/network**, a script to operate network subsystem. Network subsystem’s initialization is registered to rcS via “/etc/init.d/network”. During system initialization, this script takes charge of bringing up the network subsystem, including wifi devices and drivers. This script can be called individually.
* **/sbin/wifi**, a script to operate wifi devices and drivers, it is invoked by “/etc/init.d/network”. It can be called individually too.
* **/lib/wifi/<chip-specific>.lua**, chip specific operating script, it is supporting library of “/sbin/wifi” that defines how to “up/down/reload” the specific chip. This file is supposed to be be imported into “/sbin/wifi”.
* **/usr/lib/lua/mtkwifi.lua**, a lua library to manipulate Mediatek wifi drivers’ profile. It is used in “luci-app-mtk” and “<chip specific>.lua”.

So, the overall init flow is:

Init process (procd) 🡪 rcS 🡪 /etc/rcs.d/S20network 🡪 /etc/init.d/network 🡪 /sbin/wifi 🡪 /lib/wifi/<chip-specific>.lua

### /sbin/wifi and /sbin/wifi.legacy

OpenWrt’s original wifi init script is located at “**<openwrt>/package/base-files/files/sbin/wifi**“, it is written in shell. Since MTK’s SDK v4.0, a different MediaTek implemtation (in lua) has replaced the original script. The original scripts is backed up at “package/base-files/files/sbin/wifi.legacy”.

### l1profile

MTK’s SDK v4.0 introduces a global configuration files for MediaTek wifi drivers: **/etc/wireless/l1profile.dat**.

Default

INDEX0=MT7622

INDEX0\_profile\_path=/etc/wireless/mt7615e/mt7615e.1.dat

INDEX0\_init\_script=/lib/wifi/mt7615e.lua

INDEX0\_init\_compatible=mt7615e

INDEX0\_EEPROM\_offset=0x0

INDEX0\_EEPROM\_size=0x4000

INDEX0\_EEPROM\_name=e2p

INDEX0\_main\_ifname=ra0

INDEX0\_ext\_ifname=ra

INDEX0\_wds\_ifname=wds

INDEX0\_apcli\_ifname=apcli

INDEX0\_mesh\_ifname=mesh

INDEX0\_nvram\_zone=dev1

INDEX0\_single\_sku\_path=/etc/wireless/mt7615e/mt7615e-sku.dat

INDEX0\_bf\_sku\_path=/etc/wireless/mt7615e/mt7615e-sku-bf.dat

……………………………………

This file is read both by wifi drivers and “/usr/lib/lua/mtkwifi.lua”, fields are explaines as below:

|  |  |  |  |
| --- | --- | --- | --- |
| Field Name | Type | Description | Example |
| profile\_path | Mandatory | L2 profile file path | INDEX0\_profile\_path=/etc/Wireless/MT7622AP.dat INDEX1\_profile\_path=/etc/Wireless/MT7615\_2G.dat; /etc/Wireless/MT7615\_5G.dat (DBDC mode) |
| EEPROM\_offset | 7622 Driver Mandatory | Apply on flash mode support | INDEX0\_EEPROM\_offset=0x0000 INDEX1\_EEPROM\_offset=0x4000 |
| EEPROM\_size | 7622 Driver Mandatory | Apply on flash mode support | INDEX2\_EEPROM\_size=0x4000 |
| EEPROM\_name | 7622 Driver Mandatory | Apply on flash mode support | INDEX2\_EEPROM\_size=0x4000 |
| main\_ifname | Mandatory | Main interface name | INDEX0\_if\_name=wlan0 INDEX1\_if\_name=wlan1;wlan2 (DBDC mode) |
| ext\_ifname | Mandatory | MBSS interface name | INDEX0\_if\_name=wlan0\_ INDEX1\_if\_name=wlan1\_;wlan2\_ (DBDC mode) result: wlan0\_1, wlan0\_2, …, wlan0\_15 |
| wds\_ifname | Optional | WDS interface name | INDEX0\_wds\_name=wds0\_ INDEX1\_wds\_name=wds1\_;wds2\_ (DBDC mode) result: wds0\_0, wds0\_1, …, wds0\_3 |
| apcli\_ifname | Optional | AP client interface name | INDEX0\_apcli\_name=apcli0\_ INDEX1\_apcli\_name=apcli1\_; apcli2\_ (DBDC mode) result: apcli0\_0, apcli0\_1, ... |
| mesh\_ifname | Optional | Mesh interface name | INDEX0\_mesh\_name=mesh0\_ INDEX1\_mesh\_name=mesh1\_; mesh2\_ (DBDC mode) result: mesh0\_0, mesh0\_1, …, mesh0\_3 |
| init\_script | LEDE APP Mandatory | OpenWRT network scripts path for specific MTK Wi-Fi chip. | INDEX0\_init\_script=/lib/wifi/mt7615e.lua |
| init\_compatible | LEDE APP Mandatory | Compatible chipset name for OpenWRT network setting | INDEX0\_init\_compatible=mt7615emt7615e |
| nvram\_zone | LSDK APP Mandatory | Specify the sequence order and the nvram zone storage of this Wi-Fi device. | INDEX0\_nvram\_zone=dev1  value scope: [dev1, dev2, dev3] |

Table ‑ L1profile fields

# Development with MTK OpenWrt SDK

## Creating a new package

Take the following “helloworld” application as an example.

helloworld

├─ Makefile # openwrt’s “package makefile”

└─ src

   ├─ Makefile # helloworld’s makefile

    └─ helloworld.c # helloworld source code

* src/helloworld.c

#include<stdio.h>  
int main(void)  
{  
 printf("HelloWorld!\n");  
 printf("This is my first package rogram\n");  
 return 0;  
}

* src/Makefile

OBJ = helloWorld

OBJS = helloWorld.o

CC = gcc

CFLAGS = -c -Wall –O

RM = rm -rf

$(OBJ):$(OBJS)

$(CC) -o $(OBJ) $(OBJS)

$(OBJS): helloWorld.c

$(CC) $(CFLAGS) helloWorld.c

clean:

$(RM) \*.o $(OBJ)

* Package Makefile

# Import common build rules  
include $(TOPDIR)/rules.mk

PKG\_NAME:=helloWorld

PKG\_RELEASE:=1

PKG\_BUILD\_DIR:=$(BUILD\_DIR)/$(PKG\_NAME)

# Import package definitions

include $(INCLUDE\_DIR)/package.mk

# Define a new package

define Package/helloWorld

SECTION:=MTK Properties

CATEGORY:=MTK Properties

SUBMENU:=Applications

TITLE:=helloWorld – learn from example.

endef

define Package/helloWorld/description

It's my first package demo

endef

# Prepare source code. use tabs, not spaces.

define Build/Prepare

echo "Here is Build/Prepare"

mkdir -p $(PKG\_BUILD\_DIR)

$(CP) ./src/\* $(PKG\_BUILD\_DIR)/  
endef

# Install scripts. use tabs, not spaces.

define Package/helloWorld/install

echo "Here is Package/install"

$(INSTALL\_DIR) $(1)/bin

$(INSTALL\_BIN) $(PKG\_BUILD\_DIR)/helloWorld $(1)/bin/

endef

# In the end, call build command.

$(eval $(call BuildPackage, helloWorld))

Put this “helloworld” folder under “**<openwrt>/package/**” or its subfolder. Then execute “make menuconfig”, you will find a new configurable option turns up under “MTK properties ---> Applications”. Select it as either “\*” or “m”, now you can build “helloworld” with:

make package/helloworld/{clean,prepare,compile} V=s

## Using device tree (\*.dts and \*.dtb) (hua)

## Work with patches

Here’s a much better version of working with patches in OpenWrt SDK.

<https://lede-project.org/docs/guide-developer/use-patches-with-buildsystem>

### The “quilt” utility

Quilt is a powerful tool that help you to create, apply, modify a big number of patches. It is based on “diff & patch” utility, and provides stack-style management for all your patches.

You can get the basic usage here:

* <https://wiki.debian.org/UsingQuilt>
* <https://linux.die.net/man/1/quilt>

### Make patch for the kernel

For example, if we want to modify (or add) the file “drivers/mtd/xxx.c” in kernel, let’s do it step by step:

1. make target/linux/{clean,prepare} QUILT=1
2. cd <LINUX\_DIR>
3. quilt new platform/001-test.patch
4. quilt add drivers/mtd/xxx.c
5. vim drivers/mtd/xxx.c
6. quilt diff
7. quilt refresh
8. cd <OPENWRT\_ROOTDIR>
9. make target/linux/update
10. [optional] Reinstall the kernel to get a clean kernel source tree. “**QUILT=1**” makes sure you can use quilt utility with the source code.
11. Enter kernel source folder. It is usually located at: “build\_dir/target-<toolchain info>/linux-<platform>-<model>/linux-<version>”
12. Use “**quilt new**” command to create a new patch. After this command, a new empty patch file will be generated under “.patches” folder.
    1. Normally you should choose a number prefix that is greater than any other patches for the component, because the build script will apply patches one after another according to the numbers.
    2. The prefix “platform” means the patch is platform specific, then the patch will be saved into “target/linux/<platform>/patches” later, for generic patches, you can use prefix “generic”, then the patch will go to “target/linux/generic/patches”.
13. Use “**quilt add**” command to add the file you want to change or create. This tells the quilt utility to keep track of every changes that you are going to made on this file.
14. Edit the file as you wish. You can use what every editors you like. You can also remove the file.
15. Use “**quilt diff**” command to check the modification you just made. If you are not happy with current code, just go back to step 5.
16. Use “**quilt refresh**” to flush all the changes you made into a patch file.
17. Go back to OpenWrt’s root dir.
18. “**make target/linux/update**” will copy all the patches into corresponding folders. Afte updating, you will find a new patch occurs in “target/linux/<platform>/patches”.

### Make patch for a package

It’s pretty much the same as to make a patch for the kernel.

1. make package/<package name>/{clean,prepare} QUILT=1
2. cd <PACKAGE\_BUILD\_DIR>
3. quilt new 001-test.patch
4. quilt add xxx.c
5. vim xxx.c
6. quilt diff
7. quilt refresh
8. cd <OPENWRT\_ROOTDIR>
9. make package/<package name>/update

## Customize booting sequence

### “/etc/inittab”

If you want your init job been invoked by **init process** directly, you should turn to “**/etc/inittab**”.

The inittab file describes which processes are started at bootup and during normal operation (e.g. /etc/init.d/boot, /etc/init.d/rc, gettys...). It is read by the “init process”. Init process distinguishes multiple runlevels, each of which can have its own set of processes that are started.

By default, you will find the following lines in “/etc/inittab”

::sysinit:/etc/init.d/rcS S boot # invoke rcS boot scripts

::shutdown:/etc/init.d/rcS K shutdown # invoke rcS shutdown scripts

ttyS0::respawnlate:/usr/libexec/login.sh # start login via console

During system booting, Init process will read “[**/etc/inittab**](https://wiki.openwrt.org/doc/howto/notuci.config#etcinittab)” for the "sysinit" entries (default is "::sysinit:/etc/init.d/rcS S boot"). So, in the example above, init process will call “[**/etc/init.d/rcS**](https://wiki.openwrt.org/doc/howto/notuci.config#etcinitdrcs) **S boot**”.

There are more methods supported by OpenWrt’s “init process”.

* **respawn** - this works just like you expect it. It starts a process and will respawn it once it has completed.
* **respawnlate** - this works like the respawn but will start the process only when the procd init is completed.
* **askfirst** - this works just like respawn but will print the line “Please press Enter to activate this console.” before starting the process
* **askconsole** - this works like askfirst but, instead of running on the tty passed as a parameter, it will look for the tty defined in the kernel command line using “console=”
* **askconsolelate** - this works like the askconsole but will start the process only when the procd init is completed.
* **sysinit** - this will trigger procd to run the command, given as a parameter, only once. This is usually used to trigger execution of /etc/rc.d/

### /etc/init.d and /etc/rcs.d

“/etc/inittab” will invoke the rcS scripts during system booting. rcS executes the symlinks to the actual startup scripts located in /etc/init.d/S##xxxxxx with option "start".

After rcS finishes, system should be up and running.

Here’s an example from “**<openwrt>/package/mtk/applications/hwnat/Makefile**” shows how to install your jobs into rcS.

define Package/hwnat/install

$(INSTALL\_DIR) $(1)/bin

$(INSTALL\_DIR) $(1)/etc/init.d/

$(INSTALL\_BIN) $(PKG\_BUILD\_DIR)/hwnat $(1)/bin

$(INSTALL\_BIN) ./files/\* $(1)/etc/init.d

endef

### /etc/rc.local

This file is a shell script that will be invoked at the end of **rcS**. If you want a job being done after the system’s fully started, you can put your job script here.

For example, the follow “rc.local” script will print how many times the set has been rebooted on the console..

# Put your custom commands here that should be executed once

# the system init finished. By default this file does nothing.

echo 1 >> /etc/reboot-times

cat /etc/reboot-times | wc –l > /dev/console

exit 0

# FAQ

## Q: Which SDK version should I use?

You are not always recommended to use the latest SDK. It depends on which chips you are using.

Here’s a summary of recommended SDK release for every SoC chips.

| Revision | **Latest SDK** | **OpenWrt SDK Code Base** | **Linux Kernel** | **Release Date** |
| --- | --- | --- | --- | --- |
| MT7620 | V3.4.1.0 | OpenWrt 14.07 | 3.10.14 | 2016-03-24 |
| MT7621 | V3.4.1.0 | OpenWrt 14.07 | 3.10.14 | 2016-03-24 |
| MT7628 | V3.4.1.0 | OpenWrt 14.07 | 3.10.14 | 2016-03-24 |
| MT7623 | V4.0.0.0 | Lede 17.01 | 4.4.92 | 2017-12-31 |
| MT7622 | V4.0.0.0 | Lede 17.01 | 4.4.92 | 2017-12-31 |

Table 5‑ SoC Chips and Recommended SDK revision

If you have special concerns, you can consult your technical supporting window from MediaTek.

## Q: What is factory.bin, when should I use it?

Sometimes there is a image file with the word ***factory*** in the name. If there is one, you have to flash this one over an OEM firmware (aka factory firmware, which is originally shipped with the product.). After that, you can use normal sysupgrade bin.

This reason for using factory firmware is mainly because:

* OpenWrt may use a different partition layout from OEM firmware, a specialized firmware is necessary to preserve important factory data.
* The original firmware may have some firmware verification that a normal openwrt firmware cannot pass.

## Q: What’s the difference between initramfs.bin and squashfs.bin? Which one should I use?

The main differences between squashfs firmware and initramfs firmware are:

* Squashfs firmware put the rootfs on flash and linux kernel will mount it during booting, while initramfs put the linux rootfs as initramfs, which is linked with the kernel.
* Squashfs firmware takes flash partition “rootfs\_data” as its backend storage, while initramfs firmware uses a tmpfs (which is part of your ram) as the backend storage. So, **initramfs firmware does not preserve your data , you will lost the changes you’ve made after reboot.**
* Squashfs firmware is supposed to be actually written into the flash storage, while initramfs firmware is supposed to be stay in RAM. You should choose the right option in uboot menu.

Normally you should use squashfs, but sometimes you may need the initramfs:

* Your firmware does not work properly because of some flash-related errors, such as kernel failed to find rootfs.
* You want to analize the flash data on the device.
* You want to try new firmware but you don't want to erase current firmware.

## Q: How to install some files into rootfs?

### Option 1: Put your file under “base-files“.

Files under “base-files” folder will be copied into rootfs during build. There are several folders named “base-files”, all of them will do.

* **package/base-files**, generic files, can be used for all platforms.
* **target/linux/mediatek/base-files**, for mediatek specific files.

### Option 2: “Package/<package name>/install” section in a package Makefile

define Package/<package name>/install

$(INSTALL\_DIR) $(1)/etc/init.d/

$(INSTALL\_BIN) ./myfile $(1)/etc/init.d

endef

* This section will be executed as “make install” after the package is successfully built.
* **$(INSTALL\_DIR)** will create the folders, and **$(INSTALL\_BIN)** copies the your files into rootfs. $(1) is the target rootfs path during build.
* This script take package’s path as its working dir, so you can use relative path to access package’s files.

## Q: Where is the DTS file?

All dts files are located under “**<linux >/arch/arm64/mediate/dts/**”.

Which one is the one I am using? You should refer to the image make file.

Take MT7622 as an example, check “**<openwrt>/target/linux/mediatek/images/mt7622.mk**”

define Device/MTK-AC2600-RFB1

DEVICE\_TITLE := MTK7622 ac2600 rfb1 AP

DEVICE\_DTS := mt7622-ac2600rfb1

DEVICE\_DTS\_DIR := $(DTS\_DIR)/mediatek

SUPPORTED\_DEVICES := mt7622

DEVICE\_PACKAGES := kmod-usb-core kmod-usb-ohci kmod-usb-storage

endef

TARGET\_DEVICES += MTK-AC2600-RFB1

The red line points out the dts name. Then you will find the right dts file at: “**<linux>/arch/arm64/mediate/dts/ mt7622-ac2600rfb1.dts**”