



NRC7292 Evaluation Kit

User Guide

(OpenWrt)

Ultra-low power & Long-range Wi-Fi

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NEWRACOM, Inc.

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Ultra-low power & Long-range Wi-Fi

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1 Overview

1.1 Introduction

OpenWrt (OPEN Wireless RouTer) is an open source project for embedded operating systems based on Linux, primarily used on embedded devices to route network traffic. All components have been optimized to be small enough to fit into the limited storage and memory available in home routers.

OpenWrt is configured using a command-line interface (ash shell), or a web interface (LuCI). There are about 3500 optional software packages available for installation via the opkg package management system.

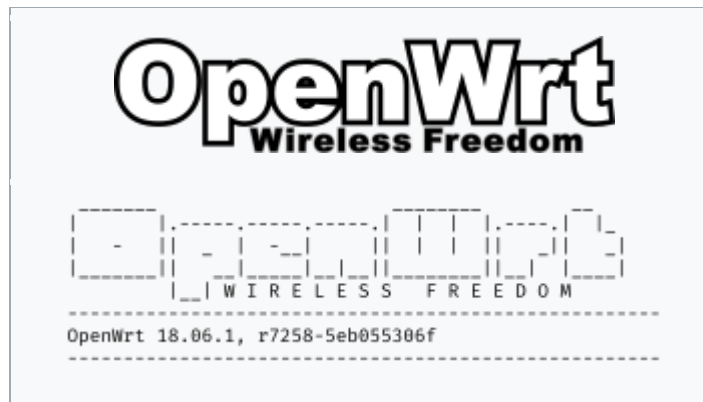


Figure 1.1 OpenWrt login screen

1.2 Device configuration

An RPi3 host is required to run OpenWrt on an NRC7292 module. The DIP switch on the module must be set to HHLLHH.

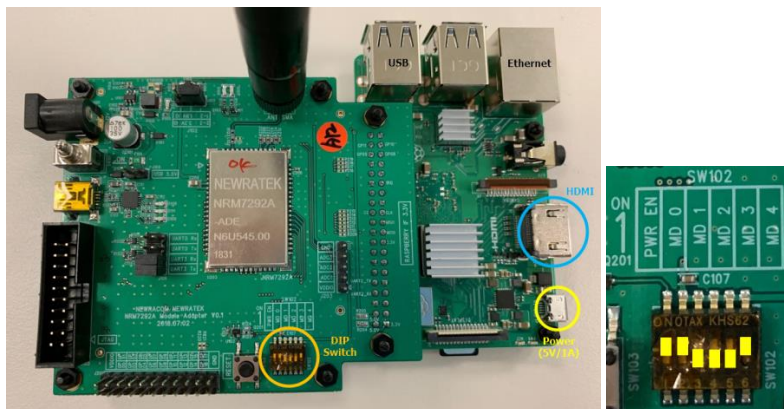


Figure 1.2 OpenWrt Device and DIP Switch Configuration

2 Start Guide for Image Building

2.1 Dependencies

Make sure all the required dependencies are installed (on Debian/Ubuntu):

```
$ sudo apt-get update
$ sudo apt-get install subversion g++ zlib1g-dev build-essential git python
python3 python3-distutils libncurses5-dev gawk gettext unzip file libssl-dev
wget libelf-dev ecj fastjar java-propose-classpath
```

For Ubuntu 18.04 or later:

```
$ sudo apt-get install build-essential libncursesw5-dev python unzip gawk
```

2.2 Get the OpenWrt source code

Clone the OpenWrt repository and check out the release version.

```
$ cd ~
$ git clone https://git.openwrt.org/openwrt/openwrt.git
$ cd openwrt
$ git tag
$ git checkout -b tag-v19.07.7 v19.07.7
```

2.3 Patch

Apply the Newracom patch files.

```
$ cp newracom-openwrt-19.07.7-patches.tar.bz2 ~/openwrt
$ cd ~/openwrt
$ tar --overwrite -xjvf newracom-openwrt-19.07.7-patches.tar.bz2
```

※ "--overwrite" option is required.

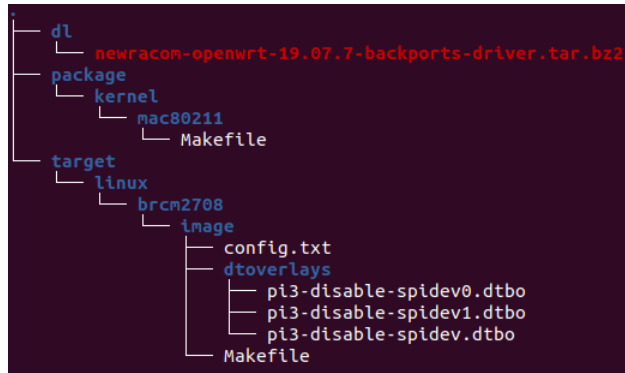


Figure 2.1 Patch file lists

- dl/newracom-openwrt-19.07.7-backports-driver.tar.bz2



NRC7292 host driver sources for the Backports package.

This file is extracted into "build_dir/target-aarch64_cortex-a53_musl/linux-brcm2708_bcm2710/backports-4.19.98-1" directory by "pacakge/kernel/mac80211/Makefile" file.

The original files in the Backports package are modified to build the NRC7292 host driver.

drivers/net/wireless/Kconfig

```
41 source "drivers/net/wireless/mediatek/Kconfig"
42 source "drivers/net/wireless/newracom/Kconfig"
43 source "drivers/net/wireless/ralink/Kconfig"
```

drivers/net/wireless/Makefile

```
14 obj-$(CPTCFG_WLAN_VENDOR_MEDIATEK) += mediatek/
15 obj-$(CPTCFG_WLAN_VENDOR_NEWRACOM) += newracom/
16 obj-$(CPTCFG_WLAN_VENDOR_RALINK) += ralink/
```

- package/kernel/mac80211/Makefile

The original file in the OpenWRT is modified to build the NRC7292 host driver.

Line 35

```
24 PKG_DRIVERS = \
25   adm8211 \
26   airo \
27   hermes hermes-pci hermes-pcmcia hermes-plx\
28   lib80211 \
29   mac80211-hwsim \
30   mt7601u \
31   p54-common p54-pci p54-usb \
32   rsi91x rsi91x-usb rsi91x-sdio\
33   wlcore wl12xx wl18xx \
34   zd1211rw \
35   nrc7292
```

Line 82

```
58 config-y:= \
59   WLAN \
60   NL80211_TESTMODE \
61   CFG80211_WEXT \
62   CFG80211_CERTIFICATION_ONUS \
63   MAC80211_RC_MINSTREL \
64   MAC80211_RC_MINSTREL_HT \
65   MAC80211_RC_MINSTREL_VHT \
66   MAC80211_RC_DEFAULT_MINSTREL \
67   WLAN_VENDOR_ADMTEK \
68   WLAN_VENDOR_ATH \
69   WLAN_VENDOR_ATMEL \
70   WLAN_VENDOR_BROADCOM \
71   WLAN_VENDOR_CISCO \
72   WLAN_VENDOR_INTEL \
73   WLAN_VENDOR_INTERSIL \
74   WLAN_VENDOR_MARVELL \
75   WLAN_VENDOR_MEDIATEK \
76   WLAN_VENDOR_RALINK \
77   WLAN_VENDOR_REALTEK \
78   WLAN_VENDOR_RSI \
79   WLAN_VENDOR_ST \
80   WLAN_VENDOR_TI \
81   WLAN_VENDOR_ZYDAS \
82   WLAN_VENDOR_NEWRACOM \
```

Line 383 .. 389

```
383 define KernelPackage/nrc7292
384     $(call KernelPackage/mac80211/Default)
385     TITLE:=Newracom 802.11ah Wi-Fi halow driver
386     DEPENDS+= @TARGET_brcm2708 +kmod-mac80211 +kmod-spi-bcm2835 +@DRIVER_11N_SUPPORT
387     FILES:=$(PKG_BUILD_DIR)/drivers/net/wireless/newracom/nrc7292/nrc7292.ko
388     AUTOLOAD:=$(call AutoProbe,nrc7292)
389 endif
```

Line 460

```
457 $(TAR) -C $(PKG_BUILD_DIR) -xzf $(DL_DIR)/$(IPW2100_NAME)-$(IPW2100_VERSION).tgz
458 $(TAR) -C $(PKG_BUILD_DIR) -xzf $(DL_DIR)/$(IPW2200_NAME)-$(IPW2200_VERSION).tgz
459 $(TAR) -C $(PKG_BUILD_DIR) -xjf $(DL_DIR)/$(ZD1211FW_NAME)-$(ZD1211FW_VERSION).tar.bz2
460 $(TAR) -C $(PKG_BUILD_DIR) --overwrite -xjf $(DL_DIR)/newracom-openwrt-19.07.2-backports-driver.tar.bz2
```

Line 571 .. 574

```
571 define KernelPackage/nrc7292/install
572     $(INSTALL_DIR) $(1)/lib/firmware
573     $(INSTALL_DATA) $(PKG_BUILD_DIR)/drivers/net/wireless/newracom/nrc7292/firmware/* $(1)/lib/firmware
574 endif
```

- **target/linux/brcm2708/image/config.txt**

The original file in the OpenWRT is modified to disable Broadcom Wi-Fi/BT driver and User mode SPI driver.

```
963 #
964 # newracom
965 #
966 dtoverlay=pi3-disable-bt
967 dtoverlay=pi3-disable-wifi
968 dtoverlay=pi3-disable-spidev
```

- **target/linux/brcm2708/image/dtoverlays**

Device Tree Blob Overlay files

- **target/linux/brcm2708/image/Makefile**

The original file in the OpenWRT is modified to copy the Device Tree Blob Overlay files to /boot/overlays directory in Root File system.

```
39 $(foreach dts,$(shell echo $(DEVICE_DTS)),mcopy -i $@.boot $(DTS_DIR)/$(dts).dtb ::;)
40 mmd -i $@.boot ::/overlays
41 mcopy -i $@.boot $(DTS_DIR)/overlays/*.dtbo ::/overlays/
42 mcopy -i $@.boot $(DTS_DIR)/overlays/README ::/overlays/
43 mcopy -i $@.boot ./dtoverlays/* ::/overlays/
```

2.4 Update

Update and install package information.

```
$ ./scripts/feeds update -a
$ ./scripts/feeds install -a
```

2.5 Configuration

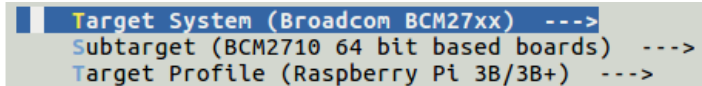
Configure the target system.

```
$ make menuconfig
```

(Target System -> Broadcom BCM27xx)

(Subtarget -> BCM2710 64 bit based boards)

(Target Profile -> Raspberry pi 3B/3B+)



```
Target System (Broadcom BCM27xx) --->
Subtarget (BCM2710 64 bit based boards) --->
Target Profile (Raspberry Pi 3B/3B+) --->
```

Create a ".config" file with default options from the ARCH supplied defconfig.

```
$ make defconfig
```

Additional setup:

- Disable Broadcom Wi-Fi driver module
- Enable Newracom Wi-Fi Halow driver module
- Enable LuCI for WebUI
- Enable lperf for performance measurement

```
$ make menuconfig
```

(Kernel modules -> Wireless Drivers)

```
< > kmod-ath9k-htc..... Atheros 802.11n USB device support
< > kmod-brcmfmac..... Broadcom IEEE802.11n USB FullMAC WLAN driver
< > kmod-brcmutil..... Broadcom IEEE802.11n common driver parts
< > kmod-carl9170..... Driver for Atheros AR9170 USB sticks
-* kmod-cfg80211..... cfg80211 - wireless configuration API
< > kmod-lib80211..... 802.11 Networking stack
< > kmod-libertas-sdio..... Marvell 88W8686 Wireless Driver
< > kmod-libertas-spi..... Marvell 88W8686 SPI Wireless Driver
< > kmod-libertas-usb..... Marvell 88W8015 Wireless Driver
-* kmod-mac80211..... Linux 802.11 Wireless Networking Stack
< > kmod-mac80211-hwsim..... mac80211 HW simulation device
< > kmod-mt7601u..... MT7601U-based USB dongles Wireless Driver
< > kmod-mt76x0u..... MediaTek MT76x0U wireless driver
< > kmod-mt76x2u..... MediaTek MT76x2U wireless driver
< > kmod-mwifiex-sdio
< > kmod-net-rtl8192su..... RTL8192SU support (staging)
< > kmod-nrc7292..... Newracom 802.11ah Wi-Fi halow driver
< > kmod-p54-common..... Prism54 Drivers (COMMON)
```

(LuCI -> 1. Collections)

```
<*> luci..... LuCI interface with Uhttpd as Webserver (default)
< > luci-nginx..... LuCI interface with Nginx as Webserver
< > luci-ssl..... LuCI with HTTPS support (mbedtls as SSL backend)
< > luci-ssl-nginx. LuCI with HTTPS support on Nginx (OpenSSL as SSL backend)
< > luci-ssl-openssl..... LuCI with HTTPS support (OpenSSL as SSL backend)
```

(Network)

```
<*> iperf..... Internet Protocol bandwidth measuring tool
<*> iperf3..... Internet Protocol bandwidth measuring tool
```

2.6 Build

```
$ make download
$ make
```

Package and patch files are saved in 'dl' directory

Build image path: bin/targets/brcm2708/bcm2710

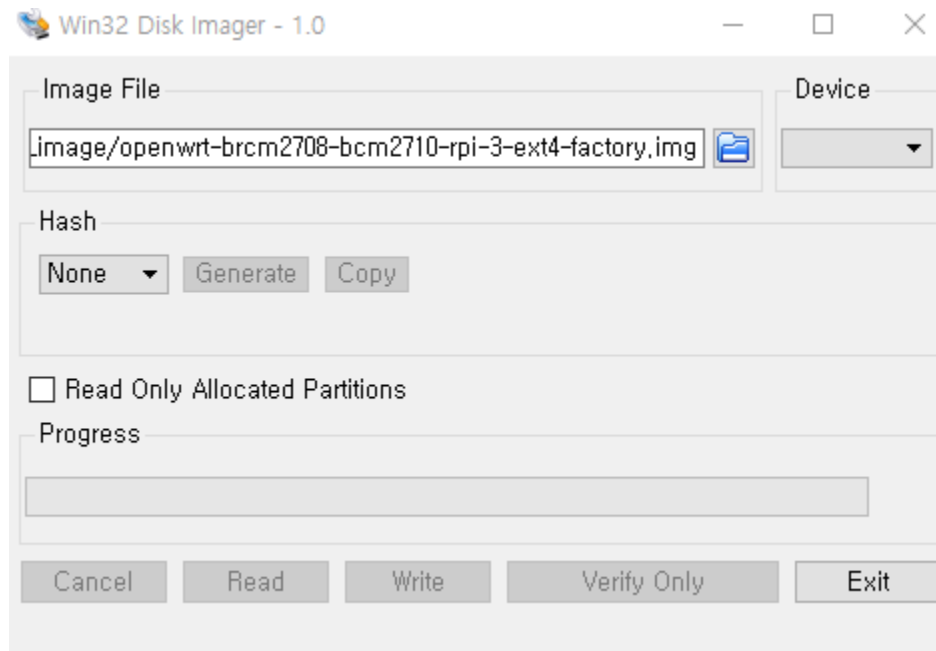
Name: openwrt-brcm2708-bcm2710-rpi-3-ext4-factory.img.gz

```
— config.buildinfo
— feeds.buildinfo
— openwrt-brcm2708-bcm2710-device-rpi-3.manifest
— openwrt-brcm2708-bcm2710-rpi-3-ext4-factory.img.gz
— openwrt-brcm2708-bcm2710-rpi-3-ext4-sysupgrade.img.gz
— openwrt-brcm2708-bcm2710-rpi-3-squashfs-factory.img.gz
— openwrt-brcm2708-bcm2710-rpi-3-squashfs-sysupgrade.img.gz
— packages
— sha256sums
— version.buildinfo
```

Figure 2.2 Build images

2.7 Cloning the SD card

Launch Win32DiskImager and provide the path to the image file.
Click the "Write" button to start writing the image to the SD card.

**Figure 2.3 Cloning the image**

2.8 Run

The Newracom Wi-Fi Halow driver module (wlan0) will be loaded during kernel loading.

```
$ ifconfig -a
```

```
br-lan Link encap:Ethernet HWaddr B8:27:EB:EB:60:AA
       inet addr:192.168.123.24 Bcast:192.168.123.255 Mask:255.255.255.0
       inet6 addr: fe80::ba27:ebff:feeb:60aa/64 Scope:Link
       inet6 addr: fd7b:14ab:8b12::1/60 Scope:Global
       UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
       RX packets:483 errors:0 dropped:0 overruns:0 frame:0
       TX packets:121 errors:0 dropped:0 overruns:0 carrier:0
       collisions:0 txqueuelen:1000
       RX bytes:201230 (196.5 KiB) TX bytes:31632 (30.8 KiB)

eth0 Link encap:Ethernet HWaddr B8:27:EB:EB:60:AA
      UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
      RX packets:494 errors:0 dropped:1 overruns:0 frame:0
      TX packets:137 errors:0 dropped:0 overruns:0 carrier:0
      collisions:0 txqueuelen:1000
      RX bytes:212170 (207.1 KiB) TX bytes:33712 (32.9 KiB)

lo Link encap:Local Loopback
   inet addr:127.0.0.1 Mask:255.0.0.0
   inet6 addr: ::1/128 Scope:Host
   UP LOOPBACK RUNNING MTU:65536 Metric:1
   RX packets:88 errors:0 dropped:0 overruns:0 frame:0
   TX packets:88 errors:0 dropped:0 overruns:0 carrier:0
   collisions:0 txqueuelen:1000
   RX bytes:6517 (6.3 KiB) TX bytes:6517 (6.3 KiB)

wlan0 Link encap:Ethernet HWaddr 02:00:EB:EB:60:AB
      BROADCAST MULTICAST MTU:1500 Metric:1
      RX packets:0 errors:0 dropped:0 overruns:0 frame:0
      TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
      collisions:0 txqueuelen:1000
      RX bytes:0 (0.0 B) TX bytes:0 (0.0 B)
```

Figure 2.4 interface after kernel loading

Default IP of the bridge network is 192.168.1.1

A dynamic Ethernet IP can be allocated by enabling the DHCP client:

```
$ uci set network.lan.proto=dhcp
$ uci commit
$ /etc/init.d/network restart
```

2.9 Configuration via Web UI

Open a browser and navigate to the web server (default address: <http://192.168.1.1>). The default Username is "root", and the default Password is blank.

OpenWrt

No password set!
There is no password set on this router. Please configure a root password to protect the web interface.

Authorization Required
Please enter your username and password.

Username

root

Password

Login

Reset

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Move the "Network -> Wireless" page.


OpenWrt

Status ▾ System ▾ Network ▾ Logout

REFRESHING

No password set!
There is no password set on this router. Please configure a root password to protect the web interface.

Wireless Overview


 radio0

Generic 802.11abgn
Device is not active

Restart

Scan

Add

 disabled

SSID: OpenWrt | Mode: Master
Wireless is disabled

Enable

Edit

Remove

Associated Stations

Network	MAC-Address	Host	Signal / Noise	RX Rate / TX Rate
No information available				

Save & Apply ▾

Save

Reset


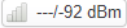
Powered by LuCI openwrt-19.07 branch ([git-21.044.30835-34e0d65](#)) / OpenWrt 19.07.7 r11306-c4a6851c72

Press the "Enable" button to enable the wireless network.

OpenWrt Status System Network Logout REFRESHING

No password set!
There is no password set on this router. Please configure a root password to protect the web interface.

Wireless Overview

 radio0	Generic 802.11abgn Channel: 36 (5.180 GHz) Bitrate: ? Mbit/s	Restart	Scan	Add
 --/-92 dBm	SSID: OpenWrt Mode: Master BSSID: 8C:0F:FA:00:27:D0 Encryption: None	Disable	Edit	Remove

Associated Stations

Network	MAC-Address	Host	Signal / Noise	RX Rate / TX Rate
No information available				


Save & Apply Save Reset

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On the same page, press the "Edit" button to configure the wireless network.


Device Configuration

General Setup Advanced Settings

Status  Mode: Master | SSID: OpenWrt
7/-92 dBm BSSID: 8C:0F:FA:00:27:D0
Encryption: None
Channel: 36 (5.180 GHz)
Tx-Power: 30 dBm
Signal: 7 dBm | Noise: -92 dBm
Bitrate: 6.0 Mbit/s | Country: 00

Wireless network is enabled Disable

Operating frequency Mode Band Channel Width
N 5 GHz 36 (5180 Mhz) 20 MHz



Maximum transmit power driver default - Current power: 30 dBm
 Specifies the maximum transmit power the wireless radio may use. Depending on regulatory requirements and wireless usage, the actual transmit power may be reduced by the driver.

Interface Configuration

General Setup Wireless Security MAC-Filter Advanced Settings

Mode Access Point ▼

ESSID OpenWrt

Network lan:   ▼

Choose the network(s) you want to attach to this wireless interface or fill out the *custom* field to define a new network.

Hide ESSID ☐

WMM Mode ☒

Next, select and configure as follows:

Country Code : Device Configuration -> Advanced Settings

Country Code US - United States ▼

Operation frequency : Device Configuration -> General Setup

	Mode	Band	Channel	Width
Operating frequency	N ▼	5 GHz ▼	165 (5825 Mhz) ▼	20 MHz ▼


ESSID : Interface Configuration -> General Setup

ESSID OpenWrt

Encryption/Cypher/Key : Interface Configuration -> Wireless Security

Encryption WPA2-PSK (strong security) ▼

Cipher auto ▼


Key 

Save and apply the changes.

OpenWrt Status ▾ System ▾ Network ▾ Logout REFRESHING

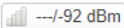
No password set!
There is no password set on this router. Please configure a root password to protect the web interface.

Wireless Overview

radio0

Generic 802.11abgn
Channel: 165 (5.825 GHz) | Bitrate: ? Mbit/s

RestartScanAdd

-92 dBm

SSID: OpenWrt | Mode: Master
BSSID: 8C:0F:FA:00:27:D0 | Encryption: WPA2 PSK (CCMP)

DisableEditRemove

Associated Stations

Network	MAC-Address	Host	Signal / Noise	RX Rate / TX Rate
No information available				

Save & Apply ▾ Save Reset

Powered by LuCI openwrt-19.07 branch (git-21.044.30835-34e0d65) / OpenWrt 19.07.7 r11306-c4a6851c72

3 Channel Table (US)

The current release supports additional US channels. Table 3.1 lists supported US channels and their corresponding channel indices.

Table 3.1 Available frequency band and corresponding channel for US

Available frequency band index	Bandwidth (MHz)	Sub-1GHz frequency	2.4 / 5G frequency
1	1	902.5	2412
3	1	903.5	2422
5	1	904.5	2432
7	1	905.5	2442
9	1	906.5	2452
11	1	907.5	2462
36	1	908.5	5180
37	1	909.5	5185
38	1	910.5	5190
39	1	911.5	5195
40	1	912.5	5200
41	1	913.5	5205
42	1	914.5	5210
43	1	915.5	5215
44	1	916.5	5220
45	1	917.5	5225
46	1	918.5	5230
47	1	919.5	5235
48	1	920.5	5240
149	1	921.5	5745
150	1	922.5	5750
151	1	923.5	5755
152	1	924.5	5760
100	1	925.5	5500
104	1	926.5	5520
108	1	927.5	5540
2	2	903	2417
6	2	905	2437
10	2	907	2457
153	2	909	5765
154	2	911	5770
155	2	913	5775
156	2	915	5780

157	2	917	5785
158	2	919	5790
159	2	921	5795
160	2	923	5800
161 (Default)	2	925	5805
112	2	927	5560
8	4	906	2447
162	4	910	5810
163	4	914	5815
164	4	918	5820
165	4	922	5825
116	4	926	5580

4 Reference

OpenWRT Build system: <https://openwrt.org/docs/guide-developer/build-system/start>

- Install: <https://openwrt.org/docs/guide-developer/build-system/install-buildsystem>
- Usage: <https://openwrt.org/docs/guide-developer/build-system/use-buildsystem>

OpenWRT Wiki: <https://en.wikipedia.org/wiki/OpenWrt>

5 Revision history

Revision No	Date	Comments
Ver 1.0	5/1/2020	Initial version for customer release created
Ver 1.1	8/2/2021	OpenWrt version changed (19.07.2 -> 19.07.7)