NEW RADIO COMMUNICATION FOR NEW ERA

NRC7394 SW PKG Release Note (v1.3)

Ultra-low power & Long-range Wi-Fi

Dec. 27, 2024

NEWRACOM, Inc.

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Ultra-low power & Long-range Wi-Fi

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1 Overview

The IEEE 802.11ah is a new Wi-Fi standard created to fulfill the requirements of a variety of IoT applications. Newracom's NRC7394 chip provides two modes of operation: host mode and standalone mode. Host mode necessitates an external host device, like the Raspberry Pi4 included in Newracom's EVK, to supply 11ah Wi-Fi connectivity. On the other hand, standalone mode enables users to develop their own applications using the APIs provided in the standalone package, compile binaries with the SDK, and execute them on the NRC7394. In standalone mode, users can use the NRC7394's various peripheral interfaces to collect sensor data and transmit it to the server over the 11ah network. Furthermore, the NRC7394 offers an AT commands application in standalone mode, allowing users to utilize the 11ah Wi-Fi network.

This document outlines the NRC7394 software package for host mode.

2 Contents of software release package

The software release package encompasses all the necessary components for utilizing the most recent features, including firmware libraries, header files, APIs, sample codes, downloader tool, makefile, and documentation. Figure 2.1 illustrates the directory structure of the package, while Table 2.1 presents a summary of its contents.

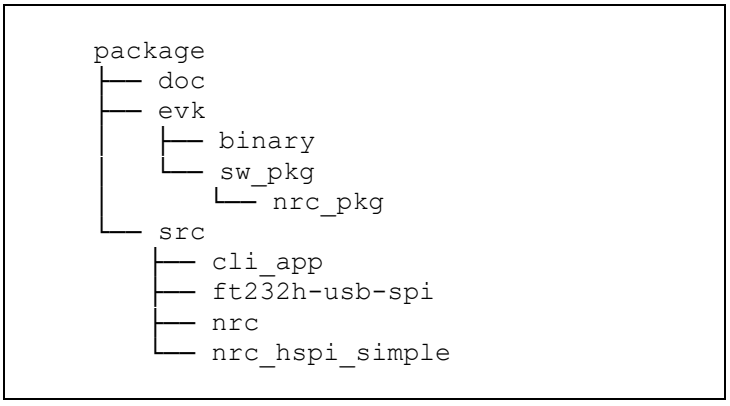

Figure 2.1 NRC7394 software release package directory

Table 2.1 Contents of NRC7394 software release package

Directory	Description
src/cli_app	The cli_app is a C-based application program. The user can use CLI commands on Raspberry PI4 by using this app. The application document and source code are included so user can build and apply it to their host platform.
src/nrc	The nrc is Linux driver for NRC7394 and its source code is included, so user can modify the source code for their own host platform.
src/ft232h-usb-spi	The FT232H USB-SPI bridge driver codes.
src/nrc_hspi_simple	The simple nrc driver codes for SPI interface testing.
evk/sw_pkg	This directory contains user guide documents and software package nrc_pkg is for 11ah. All the scripts, driver and firmware for host-mode EVK are included in the package.
evk/binary	This directory contains firmware, driver and cli_app.
doc	This directory contains document files.

The information of the binaries released in this package is as follows.

- Firmware
  - Name : nrc7394_cspi.bin (MD5Sum: 121853743fd73ce92ca03978b8ee9969)
  - Location : evk/binary
  - Version : 1.3
  - Build date : Dec. 27, 2024
- Linux driver
  - Name : nrc.ko (MD5Sum: 6614f1f9c1c1423532a6ee6f932c1374)
  - Location : evk/binary
  - Version : 5.10.17 (Linux Kernel Version)
  - Build date : Dec. 27, 2024
- CLI application
  - Name : cli_app (MD5Sum: 3251002e0a062997ca223032dd2058f4)
  - Location : evk/binary
  - Version : 2.24.0
  - Build date : Dec. 27, 2024

3 SW Release Package

3.1 Features

The NRC7394 software release package contains the following features.

- **HaLow certification features**
  - HaLow R1 mandatory features (v1.0)
  - HaLow R1 optional features (v1.0)

    - AP optional features: BSS color, fragmentation

    - STA optional features: MCS 3-7, NDP probing, A-MPDU TX, power save
- **Security feature**
  - WPA3-SAE (v1.0)
  - OWE (v1.0)
  - Kr00k vulnerability (v1.0)
- **Network stack features**
  - Channel switch announcement (CSA) (v1.0)
  - Dynamic vendor IE (v1.0)
  - WPS-PBC (v1.0)
  - IEEE 802.11s mesh network (v1.0)
  - Tree-based relay network (v1.0)
  - Network bridge (v1.0)
  - Self-configuration (v1.0)
  - RSSI-based roaming (v1.0)
  - Passive scan (v1.0)
  - Distributed authentication control (v1.3) (Experimental)
- **Regulation features**
  - Duty cycle (v1.0)
- **System features**
  - Power save – deep sleep (v1.0)

- WDT/Recovery (v1.0)
- Mutiple country code RF calibration support: US/JP/K1/K2 (v1.1)
- Temperature sensor and power offset compensation (v1.1)
- GPIO configuration for deep sleep (v1.1)
- ~~Multi-STA rate control (RC) for AP (v1.2) (obsolete)~~
- ~~RSSI-based rate control (RC) for STA (v1.2) (obsolete)~~
- Enhanced rate control (RC) (v1.2.1)

3.2 Resolved issues

Table 3.1 Resolved issues

Version	Description
v1.1	**Bug fix for following issues** (1) Unstable power consumption under deep sleep mode (2) Duplicate TIM checking (3) AP's downlink throughput is abnormally high under LBT condition of KR domain (4) AP sends 1/2/4M probe response frame according to bandwidth of probe request from STA (5) Delayed response for 'iw scan' command under the heavy traffic (6) Multicast frame's SN is not sequential when duty cycle is on (7) Kernel panic caused when beacon_bypass_enable of start.py is 1 (8) Invalid secondary CCA on JP 2/4MHz channels (9) Occaionsal WDT reset occurs when performing frequent ifconfig up/down operations on AP (10) 1MHz primary channel location compliance issue: device should follow the location of the 1MHz primary channel (11) frame format compliance issue: the same frame format should be used within a single frame sequence (12) RI of RTS compliance issue: legacy CTS frame format was used in open mode AP
v1.2	**Bug fix for following issues** (1) Throughput degradation by fragmented A-MPDU MAC frame (2) NDP CTS compliance for RTS with response indication (RI) 1 on AP (3) Not to send WIM message when target is in deep sleep

	(4) Delayed ping issue triggerd by powering off the STA (5) Long beacon only duty cycle setting issue (6) Null pointer dereference triggerd by a keep alive frame after the disassociation (7) Bandwidth misconfiguration in the MCS10 frame triggered by fragmentation cancellation under strong RSSI (8) Kernel panic triggerd by the inaccessable vif address when hostapd is disabled in 4-address (bridge) mode (9) Fail to enable hybrid security on the relay node (10) Occasional modem recovery operation on the bridged relay node (11) Prohibit scan operations during deep sleep mode (12) Flush the mac80211 TX queue in Kernel 4.x. (The mac80211 TX queue scheduling function is not supported in Kernel 4.x. Therefore, flush the mac80211 TX queue and clean the NRC TX queue.) (13) Set an invalid AID in the AID response element when sending an association response
v1.2.1	**Hotfix for slow rate adaptation in specific RF environments** (1) Enhanced RC scheme
v1.2.2	**Hotfix for corner cases related to 1MHz primary channel location**
v1.3	**Bug fix for following issues** (1) Passive scan connection error issue (only for kernel version 5.10 or higher) (2) High MCS index of fragmented frame in weak RF fields (3) Rarely intermittent invalid RSSI readings in weak RF fields (4) Remove the assert and add some exception handling to check the AID consistency (5) STA kernel panic due to corrupted STA information when the BSS max idle timer expires during deauthentication processing (6) STA kernel panic triggered by a race condition caused by consecutive cli_app commands (7) Duplicate BSSIDs in scan results (8) Packet drop issue due to SN miss-match after reassociation (9) AP kernel panic triggered by a race condition involving STA info occurred during the disassociation process (10) Remove the unnecessary modem recovery detection, which is designed solely for NRC7292 (11) Incorrect encryption/decryption key handling during modem recovery

	(12) RX SN variable corruption due to overwriting by TX SN in shared struct (13) 5th vendor IE failure in SAE mode (14) Modify the short guard interval to apply only in 4M bandwidth and high modulation states (15) Issue where EAPOL fails during WPA2/WPA3 setup, resulting in failure to generate PTK/GTK (non-periodic) (16) CCA threshold being set to -60 upon waking up from deep sleep (17) Intermittent dropping of management frames by the AP for duplicated sequence number (non-periodic) (18) Intermittent RX stoppage in the system (non-periodic) (19) System freezing during scanning (non-periodic) (20) Issue where the TX Power is coming out weaker than the TX Power set in the actual BD (non-periodic) (21) Issue where a watchdog reset occurs during EAPOL operation when RELAY and duty cycle are enabled (non-periodic)

3.3 Changed items

Table 3.2 Changed items

Version	Description
v1.1	**Update cli_app commands** refer to UG-7394-007-Commnad line application document
	Update KR/CN channels refer to UG-7394-003-S1G_Channel document
	Enable MIC detection in the mesh device on KR-USN5 band
	Apply 128usec CS time and 2sec pause time for all JP channels
	Duty cycle 2.8% support only for EU STA
	Support kernel 6.1.21 (32-bit/64-bit)
	Support iwconfig wlan0 frag <threshold value>
	Add vendor IE in probe request/response and assoc request frames
	Add retransmission scheme about sending QoS Null with PM1 for power save operation

	Optimize the initialization process of uCode
	Change module parameter of the host driver for the configuration of A-MPDU (0:disable, 1:manual, 2:auto(default))
	Support 'iw scan' command on the mesh node
v1.2	**Update cli_app commands: refer to UG-7394-007-Commnad line application document**
	Coverage enhancement by using 1/2MHz MCS0 frame on 2/4MHz channels
	1/2MHz STA support at 4MHz AP
	DTS update for SPI interface: enable spidev0.1
	Enhance auto guard interval (GI) with peer node's GI capability check
	Add auto RX gain control
	Increase buffer pool and credit number of AC_BE for flow control between host and target (from 40 to 80 and it's not configurable anymore via the module parameter)
	WDT reset recovery support on MAP
	Enhance to discard frames with corrupted host interface header
	Check traveling pilot support field of S1G capabilities element
	Enhance to conduct TRX operation during the background scanning
	Improve routing at the low RSSI on the mesh node
	Recover 'rxskb' error through the reset HSPI controller
	Mesh inactivity timer off by default
	China channel update: 749.0MHz ~ 757.0MHz
	Multi-STA support change: up to 484 STAs (due to the increased memory usage of multi-STA RC)
	PS Pretend mode to maintain network performance and minimize the impact of non-responsive STAs
v1.2.1	**BDF update: K1 max power update**
	Enable RTS/CTS for all data frames
v1.2.2	**RTS default disable**

	Clean up obsolete feature-related parts of the start.py script
v1.3	**Reduce the frequency of interrupts to enhance performance on the low-end system**
	Eliminate 'DCONFIG_MAC80211_MESH' from the Makefile to ensure compliance with the kernel configuration
	Introduce module parameters for configuring duty cycle and CCA threshold settings
	Improve the calculation of RSSI moving average in nrc driver
	Eliminate the assert and implement additional exception handling to verify the consistency of the AID
	Update the maximum listen interval value from 65535 to 65530 to ensure compliance with the USF scheme
	Worldwide calibration support
	Support EU-compliant country codes
	Support Singapore channel (S8/S9)
	Support for EEPROM-based system configuration and RF calibration data To enable this feature, set "use_eeprom_config = 1" in the start.py. By default, use_eeprom_config is set to 0
	Extended STA support (up to 600)
	RTS is disabled by default
	S1G Short Beacon is disabled by default To enable this feature, set "short_bcn_enable=1" in the start.py
	Apply the additional duty cycle condition which is defined in ARIB Standard, chapter 3.4.1
	Optimizing the wake-up time after deep sleep