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NRC7394 Standalone SDK Release Note (v1.3)

Ultra-low power & Long-range Wi-Fi

Nov. 22, 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 standalone 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.

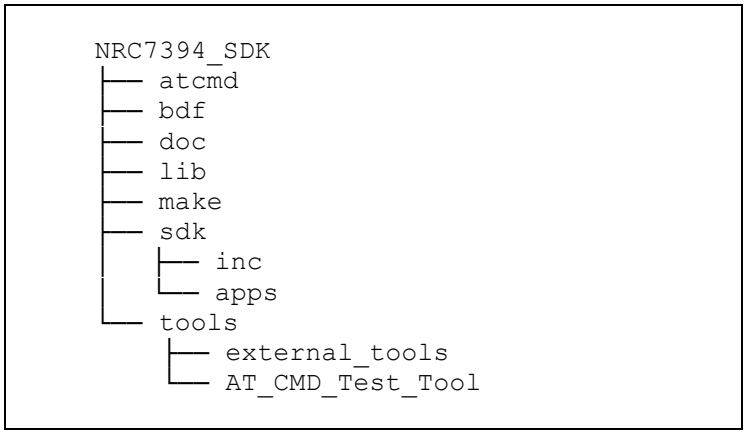

Figure 2.1 NRC7394 standalone SDK package directory

Table 2.1 Contents of NRC7394 standalone SDK package

Directory	Description
doc	Documents for standalone guide document and SDK API lists
lib	NRC7394 modem library and 3rd party libraries.
make	makefiles and configuration files
sdk/inc	SDK API header files and SDK common header files.
sdk/apps	Several kinds of reference sample applications.
atcmd	ATCMD binaries and reference codes for the host platform
bdf	A Board Data File (BDF) contains power tables based on a country, channel, target hardware version, MCS (Modulation Coding Scheme).
tools/AT_CMD_Test_Tool	AT command test tool for UART interface
tools/external_tools	The FirmwareFlashTool is a firmware uploader.

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

- Library (including 3rd party)
  - Name : libModem.a (MD5: 28950d16a1e7359ab21bf2981fed15f3)
  - Location : lib/modem
  - Version : 1.3
  - Build date : Nov. 22, 2024

3 Standalone SDK Package

3.1 General guide

To gain a broad understanding of the software package, developers can refer to the 'UG-7394-004-Standalone SDK.pdf' document. This resource offers instructions on configuring the software build environment, compiling standalone binaries, and downloading binary and sample applications. Furthermore, developers can utilize the 'UG-7394-005-Standalone SDK API.docx' document, which provides a list of supported APIs that can be used in conjunction with the NRC7394. These APIs enable users to implement services connected to Wi-Fi connections and peripherals. For additional assistance, the 'UG-7394-006-AT_Command.pdf' document offers a guide to AT commands.

3.2 Supported 3rd party libraries

The standalone SDK package for the NRC7394 contains numerous third-party libraries, which are detailed in the 'UG-7394-005-Standalone SDK API.docx' document along with their corresponding URLs. FreeRTOS, LwIP, and Mbed TLS are among these libraries, and they are essential for the standalone SDK to function properly.

- **FreeRTOS**
- **LwIP**
- **Mbed TLS**
- **MQTT**
- **cJSON**
- **Mini-XML**
- **AWS (Amazon web service)**
- **NVS (Non-volatile storage)**
- **Device libraries**
    - **BME680 (Gas, humidity, pressure, and temperature sensor)**
    - **SSD1306 (OLED/PLED controller)**
    - **SGP30 (Air quality sensor)**
    - **SHT30 (Temperature and humidity sensor)**
    - **w5500 (Ethernet controller)**

4 SW Release Package

4.1 Features

The NRC7394 software release package contains the following features.

- **AT-CMD features**
  - WPA3-SAE (v1.0)
  - OWE (v1.0)
  - FOTA (v1.0)
  - SoftAP (v1.0)
  - Power save TIM mode (v1.0)
  - Power save non-TIM mode (v1.0)
  - Continuous TX (v1.1)
  - Relay (v1.3)
  - Background scan for roaming (v1.3)
  - Wi-Fi Protected Setup (v1.3)
  - WPA3-SAE H2E support (v1.3)
- **Regulation features**
  - Duty cycle (v1.0)
- **System features**
  - Power save – deep sleep (v1.0)
  - WDT/Recovery (v1.0)
  - UART/UART-HFC/HSPI interface (v1.0)
  - ~~RSSI-based rate adaptation (v1.2) (obsolete)~~
  - Enhanced rate control (RC) (v1.2.1)
  - Distributed authentication control (v1.3) (Experimental)
- **Sample applications**
  - Refer to UG-7394-004-Standalone SDK document (v1.0)
    - Wi-Fi: Wi-Fi state, WPS-PBC, Ethernet bridge, SoftAP, FOTA
    - Protocol: TCP/UDP

- Power save
- Peripheral: GPIO, UART, ADC, NVS, PWM, sensors, etc.
- Middleware: XML, JSON, AWS, MQTT, HTTP
- Scenario: PS schedule, UART data handling

4.2 Resolved issues

Table 4.1 Resolved issues

Version	Description
v1.1	**Bug fix for following issues** (1) Intermittent scan failure on TW channel (2) AP's association grant for STA with listen interval exceeding BSS max idle period (3) CCA type of JP 2/4MHz channels (4) Inability to return to doze state in deep sleep mode for STA with static IP address (5) Scan failure on K2 channel (6) Incorrect peer MAC address copy at 4-address enabled W5500 device
v1.2	**Bug fix for following issues** (1) Prevent manipulating source MAC address when 4 address is used for W5500 sample (2) TX power setting failure when changing from FIXED mode to AUTO mode (AT-CMD) (3) TX power in LIMIT mode not limited to the set value (AT-CMD) (4) Fix the recovery of the listen interval setting upon waking from deep sleep (5) Remove echo check code from lwip (6) TCP client socket was closed when enabling TCP keep-alive (7) Invalid secondary CCA on JP 2/4MHz channels (8) NDP CTS compliance for RTS with response indication (RI) 1 on AP (9) Set an invalid AID in the AID response element when sending an association response (10) AT-CMD lwIP keepalive issue: TCP client socket would close when TCP keep-alive was enabled (11) Handling exceptions for the invalid temperature value of 0 (12) Invalid AID issue when forwarding a frame in the SoftAP (13) Delayed reconnection issue for the STA without deauthentication (14) Failure in setting the limit type for 'nrc_wifi_set_tx_power'

	(15) PN order mismatch during the packet retransmission
v1.2.1	**Hotfix for slow rate adaptation in specific RF environments** (1) Enhanced RC scheme **Bug fix for following issues** (1) AT-CMD: wifi_api prototype parameter order bugfix (2) Issue with corrupted heap free memory linked list
v1.2.2	**Hotfix for following issues** (1) Update GPIO direction setting in deep sleep (2) Fix issue with setting GTK/iGTK during connection (3) Fix issue with obtaining DHCP IP address on STA (vif_1)
v1.3	**Bug fix for following issues** (1) Modify the short guard interval to apply only in 4M bandwidth and high modulation states (always). (2) Issue where EAPOL fails during WPA2/WPA3 implementation, resulting in failure to generate PTK/GTK (non-periodic). (3) Memory leak issue occurring during repeated connect/disconnect actions (non-periodic). (4) Performance degradation in UDP/TCP (always). (5) CCA threshold being set to -60 upon waking up from deep sleep (always). (6) Failure of downlink (AP->STA) block acknowledgment session (for aggregation) (always). (7) Intermittent dropping of management frames by the AP for duplicated sequence number (non-periodic). (8) Beacon monitoring functionality not working properly when RELAY STA is assigned to vif1 (always). (9) Intermittent RX stoppage in the system (non-periodic). (10) Inaccurate scan results after scan completion (non-periodic). (11) System freezing during scanning (non-periodic). (12) Issues with interoperability with third-party APs at specific bandwidths and channels (always).

4.3 Changed items

Table 4.2 Changed items

Version	Description
v1.1	**Enhanced RSSI accuracy of system_api_get_rssi()**
v1.2	**Update SDK APIs: refer to UG-7394-005-Standalone SDK API document**
	Update AT-CMD APIs: refer to UG-7394-006-AT_Command document
	Update supported baudrate up to 2Mbps on UART without RTS/CTS (AT-CMD)
	Update samples o sample_sntp: Retrieve NTP(Network Time Protocol) data o sample_w5500_eth - Change the default address mode to 3 address - Incorrect peer MAC address copy at 4-address enabled W5500 device o sample_wifi_relay : Runs softap and sta for relay operation o sample_vendor_ie : Receive vendor IE from beacon
	Update AUXADC compensation
	Duty cycle 2.8% support only for EU STA
	Check traveling pilot support field of S1G capabilities element
	Set the default listen interval to 0 for wifi_config
	1/2MHz STA support at 4MHz SoftAP
	Add auto guard interval control
	Add auto RX gain control
	SoftAP's disable/enable sequence support
	Add API for setting max station number in SoftAP
	Hidden SSID support in SoftAP
	Support for floating-point values in the ping interval of the ping operation
	Add serial flash support: FM25W32A/GD25LQ16C/GD25WQ128E/W25Q16FW/XT25Q08B
	Set country code from RF CAL data (AT-CMD)

	Update Firwmare Flash Tool v6.3.0 (Multi v7.2.0) o Dynamic XIP boot erase size + max size check
v1.2.1	**BDF update: K1 max power update**
	Enable RTS/CTS for all data frames
	Open the UART port in non-blocking mode within the raspi-atcmd-cli application
v1.2.2	**N/A**
v1.3	**Support WPA3-SAE/WAP3-OWE in SoftAP**
	Extend STA support of SoftAP (up to 70)
	RTS default disable
	Apply the additional duty cycle condition which is defined in ARIB Standard, chapter 3.4.1
	SoftAP can support a bridged STA which uses 4-address
	Add sflash IS25XX series/MX25R8035F
	Support additional GPIO for waking-up from deep sleep. two differenct GPIOs can be used from now
	Support frame defrgamentation
	Optimizing the wake-up time after deep sleep