

NRC7394 Application Note

(Standalone Relay)

Ultra-low power & Long-range Wi-Fi

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NEWRACOM, Inc.

Application Note (Standalone Relay)

Ultra-low power & Long-range Wi-Fi

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1 Introduction

NRC7394 Halow standalone mode features two wireless interfaces, namely wlan0 and wlan1. Since the chip supports a single radio, both interfaces operate on the same radio frequency. Despite the fact that both wlan0 and wlan1 can be configured as either AP(Access Point) or STA(Station), the wlan0 interface acts as an AP while the wlan1 interface functions as a station interface in this document. To configure the chip as a Halow relay, it is necessary to set up both wlan0 and wlan1 interfaces simultaneously, then create a network bridge interface that includes both wlan0 and wlan1. While different network schemes, such as NAT (Network Address Translation), can create a communication path between wlan0 and wlan1, this document focuses on a bridged network setup for relay.

2 Network Setup Description

In a relay configuration, wlan0 acts as an AP to extend Halow network coverage by allowing other stations to connect. The wlan1 interface (station) connects to a parent AP, providing seamless network connectivity to end station devices. The following diagram illustrates the overall network connection.

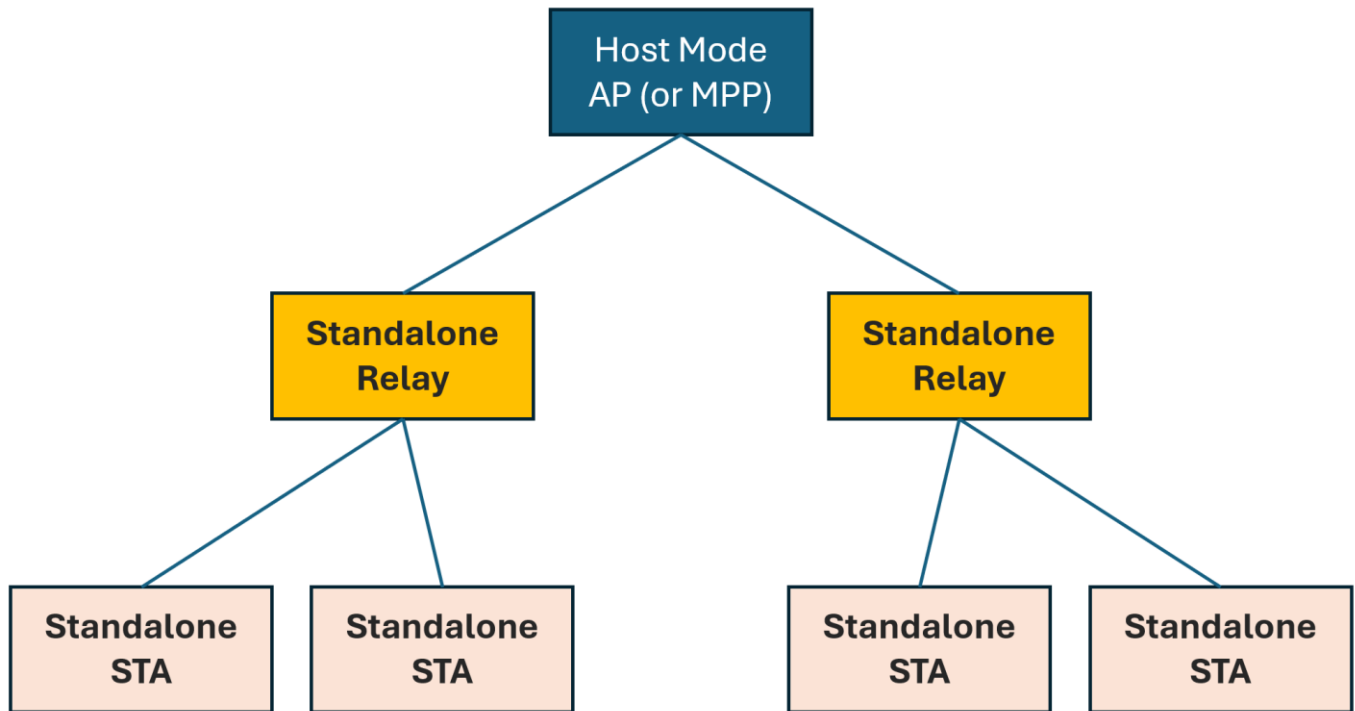


Figure 2.1 Standalone Relay Topology

3 Setting Up the Parent AP

This document assumes the user is using Host mode AP through SPI to set up an AP.

For initial setup and instructions on starting the Host mode AP, please refer to the following documents:

- UG-7394-001-EVK User Guide (Host Mode).pdf

[https://github.com/newracom/nrc7394_sw_pkg/blob/master/package/doc/UG-7394-001-EVK%20User%20Guide%20\(Host%20Mode\).pdf](https://github.com/newracom/nrc7394_sw_pkg/blob/master/package/doc/UG-7394-001-EVK%20User%20Guide%20(Host%20Mode).pdf)

To enable communication between the NRC Hallow standalone relay and the parent AP, it is necessary to enable WDS (Wireless Distribution System) on the parent AP.

When the bridge interface is configured for the relay, the underlying system will configure it to start using WDS. This is essential for seamless end-to-end communication (from/to the parent AP to/from the end station).

Assuming the user is familiar with the Python script (start.py) to start up the AP based on the Host Mode user guide; the configuration should now be modified.

First, install the `bridge-utils` software package on the Raspberry Pi Debian OS:

```
sudo apt install bridge-utils
```

This utility needs to be installed so that the startup script configures WDS to function properly.

The configuration file (used by hostapd) is available under
`nrc_pkg/script/conf/<country>/ap_hallow_<security>.conf`.

For example, if the country is US and the user prefers WPA2-PSK as wireless security, modify the file `nrc_pkg/script/conf/US/ap_hallow_wpa2.conf`.

In the configuration file, there are a couple of lines that are commented out using `#`:

```
#wds_sta=1  
#bridge=br0
```


Uncomment both lines so that when the device is started using `start.py`, the configuration is automatically generated.

```
wds_sta=1  
bridge=br0
```

Start the AP using the following command under `/home/pi/nrc_pkg/script``:

```
./start.py 1 1 US
```

Upon successful startup, the AP will begin using WDS.

When each station connects to this AP, `hostapd` will start creating `wlan0.x` interfaces (e.g., `wlan0.1`, `wlan0.2`, and so on). Each newly created interface will be added to the bridge interface created by `hostapd`.

4 Relay Configuration Steps

One can configure the standalone NRC7394 device to act as a relay via the console interface. The commands 'wpa' and 'wpa' are used to interface wlan0 and wlan1, respectively. Below are the steps to configure wlan0 as a SoftAP and wlan1 as a station interface, followed by bridging both interfaces.

4.1 SoftAP Configuration

These commands collectively configure and enable a Wi-Fi network using wpa , setting up the device to act as an AP with specified security and operational parameters.

| | Commands | Description |
|---|--|---|
| 1 | wpa set country US | Sets the regulatory domain to the United States, which ensures that the Wi-Fi operates within the legal frequency ranges and power limits for the US. |
| 2 | wpa add_network | Adds a new network configuration block in the wpa_supplicant configuration. This creates a new network entry with an identifier, typically starting from 0. |
| 3 | wpa set_network 0 ssid "halow_demo_relay_ap" | Sets the SSID (Service Set Identifier) for network 0 to "halow_demo_relay_ap". This is the name of the Wi-Fi network that will be broadcasted. |
| 4 | wpa set_network 0 pairwise CCMP | Sets the pairwise cipher suite to CCMP (Counter Mode with Cipher Block Chaining Message Authentication Code Protocol) for network 0. CCMP is an encryption protocol used in WPA2. |
| 5 | wpa set_network 0 group CCMP | Sets the group cipher suite to CCMP for network 0. This is used for broadcast and multicast traffic encryption. |
| 6 | wpa set_network 0 key_mgmt WPA-PSK | Sets the key management protocol to WPA-PSK (Wi-Fi Protected Access Pre-Shared Key) for network 0. This specifies that the network will use a pre-shared key for authentication. |
| 7 | wpa set_network 0 proto RSN | Sets the protocol to RSN (Robust Security Network) for network 0. RSN is another name for WPA2, which provides stronger security than WPA. |
| 8 | wpa set_network 0 ieee80211w 0 | Disables IEEE 802.11w (Protected Management Frames) for network 0. This setting protects management frames but is disabled here. |

| | | |
|----|-----------------------------------|---|
| 9 | wpa set_network 0 frequency 5795 | Sets the operating frequency for network 0 to 5795 MHz. This specifies the Wi-Fi channel to be used and should match the channel of the parent AP. (Note: The frequency will be internally converted to sub-1 GHz for Halow.) |
| 10 | wpa set_network 0 scan_freq 5795 | Sets the scan frequency to 5795 MHz for network 0. This restricts scanning to the specified frequency, speeding up the connection process. |
| 11 | wpa set_network 0 mode 2 | Sets the mode for network 0 to 2, which configures the interface to operate as an AP |
| 12 | wpa set_network 0 beacon_int 1000 | Sets the beacon interval for network 0 to 1000 milliseconds. This is the time interval between successive beacons sent by the AP. |
| 13 | wpa set_network 0 psk "12345678" | Sets the pre-shared key (password) for network 0 to "12345678". This key is used for WPA-PSK authentication. |
| 14 | wpa enable_network 0 | Enables network 0 in the wpa_supplicant configuration, making it active and ready to accept connections. |

Table 4.1 SoftAP configuration commands

Configure wlan0 as a SoftAP with the following commands:

```
wpa set country US
wpa add_network
wpa set_network 0 ssid "halow_demo_relay_ap"
wpa set_network 0 pairwise CCMP
wpa set_network 0 group CCMP
wpa set_network 0 key_mgmt WPA-PSK
wpa set_network 0 proto RSN
wpa set_network 0 ieee80211w 0
wpa set_network 0 frequency 5795
wpa set_network 0 scan_freq 5795
wpa set_network 0 mode 2
wpa set_network 0 beacon_int 1000
wpa set_network 0 psk "12345678"
wpa enable_network 0
```

4.2 Station Interface Configuration

These commands collectively configure and enable a Wi-Fi network connection for the station interface using wpb, setting up the device to connect to a specified Wi-Fi network with defined security and operational parameters.

| | Commands | Description |
|---|--|---|
| 1 | <code>wpb add_network</code> | Adds a new network configuration block in the wpa_supplicant configuration for the wpb interface. This creates a new network entry with an identifier, typically starting from 0. |
| 2 | <code>wpb set_network 0 ssid "halow_demo"</code> | Sets the SSID (Service Set Identifier) for network 0 to "halow_demo". This is the name of the Wi-Fi network that the station interface will use to connect to the AP. |
| 3 | <code>wpb set_network 0 proto RSN</code> | Sets the protocol to RSN (Robust Security Network) for network 0. RSN is another name for WPA2, which provides stronger security than WPA. |
| 4 | <code>wpb set_network 0 ieee80211w 0</code> | Disables IEEE 802.11w (Protected Management Frames) for network 0. This setting protects management frames but is disabled here. |
| 5 | <code>wpb set_network 0 key_mgmt WPA-PSK</code> | Sets the key management protocol to WPA-PSK (Wi-Fi Protected Access Pre-Shared Key) for network 0. This specifies that the network will use a pre-shared key for authentication. |
| 6 | <code>wpb set_network 0 psk "12345678"</code> | Sets the pre-shared key (password) for network 0 to "12345678". This key is used for WPA-PSK authentication, allowing the station to connect to the secured network. |
| 7 | <code>wpb enable_network 0</code> | Enables network 0 in the wpa_supplicant configuration for the wpb interface, making it active and ready to connect to the specified Wi-Fi network. |

Table 4.2 Station interface configuration commands

Configure wlan1 as a station interface with the following commands:

```
wpb add_network
wpb set_network 0 ssid "halow_demo"
wpb set_network 0 proto RSN
wpb set_network 0 ieee80211w 0
wpb set_network 0 key_mgmt WPA-PSK
wpb set_network 0 psk "12345678"
wpb enable_network 0
```

4.3 Bridge Configuration

A network bridge interface is used to connect multiple network interfaces together, allowing them to function as a single network.

In the context of the NRC Halow standalone relay setup, the bridge interface combines `wlan0` and `wlan1` so that devices connected to either interface can communicate seamlessly.

This setup is essential for extending network coverage and ensuring seamless connectivity across the Halow network.

In a relay configuration, the wlan0 interface acts as an AP to extend Halow network coverage by allowing other stations to connect.

The wlan1 interface (station) connects to a parent AP, providing seamless network connectivity to end station devices.

The bridge interface ensures that devices connected to the wlan0 interface can communicate with devices on the wlan1 interface, creating a unified network.

Set up the bridge for wlan0 and wlan1 with the following commands:

```
bridge addbr  
bridge addif -A
```

4.4 Assigning IP Address

An IP address can be assigned to the bridge interface either dynamically or statically.

Assign a dynamic IP address to the bridge interface (br) using the following command:

```
dhcp -i br
```

Assign a static IP address, use the following command:

```
ifconfig br <address> [-n <netmask>] [-g <gateway>] [-m <mtu>] [-d<dns1 dns2>]
```

5 Using the sample application

To simplify the relay setup process described in Chapter 3, a sample application is included in SDK that programmatically configures the relay.

The sample application can be found under 'sdk/apps/sample_wifi_relay' in the SDK.

The sample application first creates a bridge interface with wlan0 and wlan1. It then connects to the parent AP using the wlan1 interface as a station and creates an AP interface on wlan0 for other stations to connect to the AP.

6 Revision history

| Revision No | Date | Comments |
|-------------|------------|--|
| Ver 1.0 | 05/30/2024 | Initial version for customer release created |