AN14121

Coexistence Overview for RW61x

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Document information

Information	Content
Keywords	RW610, RW612, Wi-Fi radio, Bluetooth radio, 802.15.4 radio, coexistence, real time arbitration, interference avoidance, traffic priority, rules, central hardware Packet Traffic Arbiter (PTA), local hardware arbiter, coexistence software, request/grant
Abstract	Provides an overview of coexistence between Wi-Fi and Bluetooth LE or 802.15.4 radios.

1 Scope

This document provides an overview of coexistence between Wi-Fi and Bluetooth LE or 802.15.4 radios in RW61x. NXP's coexistence solution provides real time arbitration between on-chip radios on a per-packet basis.

Note: *RW61x refers to RW610 and RW612 where:*

- *RW610 is a highly integrated, low-power wireless MCU with an integrated MCU and Wi-Fi 6 + Bluetooth Low Energy (LE) radios.*
- *RW612 is a highly integrated, low-power tri-radio wireless MCU with an integrated MCU and Wi-Fi 6 + Bluetooth Low Energy (LE) / 802.15.4 radios.*

In this document and for RW612 only, Bluetooth LE/802.15.4 represents Bluetooth LE or 802.15.4 as both radios cannot coexist.

2 Coexistence architecture overview

The coexistence architecture has two major components:

- Central hardware Packet Traffic Arbiter (PTA): arbitrates between on-chip Wi-Fi and Bluetooth LE (RW610)—Bluetooth LE/802.15.4 (RW612)—radios.
  - All radios can be in 2.4 GHz.
  - Bluetooth LE (RW610)—Bluetooth LE/802.15.4 (RW612)— is in 2.4 GHz band, and Wi-Fi and the external radio are in 5 GHz band.
- Coexistence software: configures the central hardware PTA and works with Wi-Fi and Bluetooth LE (RW610)—Bluetooth LE/802.15.4 (RW612)—firmware.

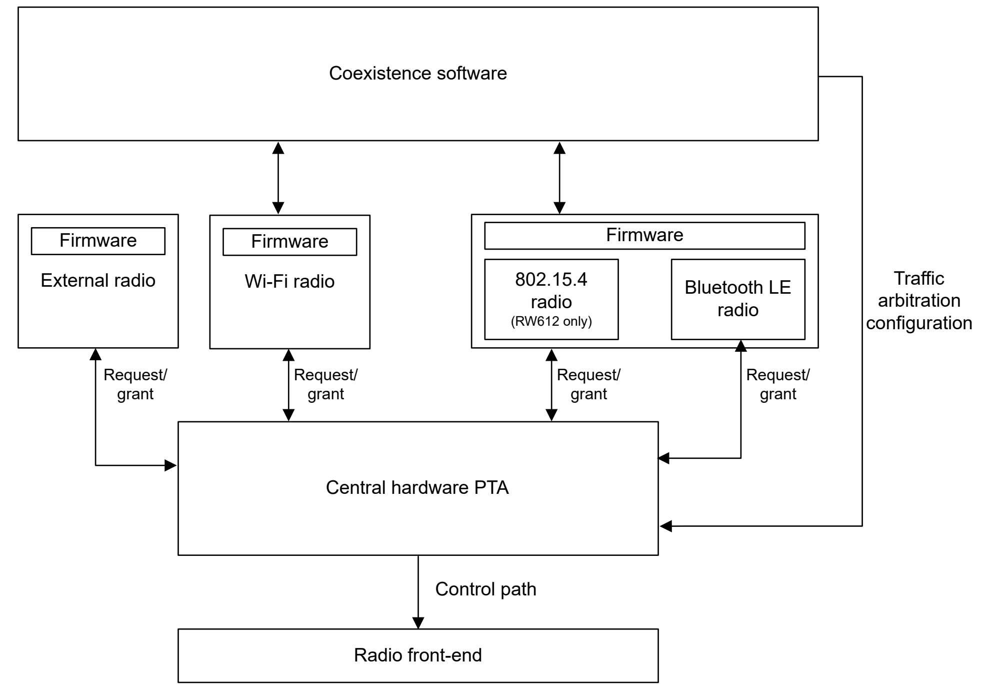

Figure 1. Coexistence subsystem

3 Coexistence mechanism

NXP's coexistence mechanism is a combination of interference avoidance and arbitration between Wi-Fi and Bluetooth LE (RW610)—Bluetooth LE/802.15.4 (RW612)—radios.

Interference avoidance between the Wi-Fi and Bluetooth LE (RW610)—Bluetooth LE/802.15.4 (RW612)—radios is achieved with frequency separation and/or isolation between the respective antennae.

The coordination between the Wi-Fi and Bluetooth LE radios helps Bluetooth LE to adapt the adaptive frequency hopping (AFH) map and avoid hopping into the Wi-Fi channel.

Unlike Bluetooth LE, 802.15.4 radio (RW612 only) operates on a fixed frequency based on the host configuration.

Note: *It is recommended that the host configures the 802.15.4 operating channel far from the Wi-Fi operating channel. The Bluetooth controller avoids the 802.15.4 channel by adapting its AFH map.*

In addition to interference avoidance, the central hardware PTA provides real-time arbitration between the Bluetooth LE (RW610)—Bluetooth LE/802.15.4 (RW612)—radios on a per-packet basis. This arbitration can be statically enabled/disabled. Each radio posts a request to the central hardware PTA to access the radio front-end. The hardware PTA grants access to each radio based on the configured priorities and on the grant rules.

3.1 Traffic priority

The traffic priority for each radio is assigned based on:

- The frame type and subtype of the Wi-Fi packets for Wi-Fi radio.
- The chosen profiles or operations for Bluetooth LE.
- The different operations for 802.15.4 (RW612 only).

The firmware statically configures the priorities for the traffic of Wi-Fi and Bluetooth LE (RW610)—Bluetooth LE/802.15.4 (RW612). The firmware also sets the arbitration rules in the central hardware PTA and local hardware arbiter.[1]

3.2 Arbitration request to the central hardware PTA

To transmit or receive, the Wi-Fi subsystem asserts a request with traffic priority and traffic direction to the central hardware PTA arbiter.

The Bluetooth LE subsystem asserts a request to the central hardware PTA in order to transmit or receive. The request is accompanied with priority, traffic direction, and frequency information.

To transmit or receive, the 802.15.4 subsystem (RW612 only) asserts a request to the central hardware PTA. The request is accompanied with priority and traffic direction information.

1 Any change to the current settings requires a firmware update.

3.3 Central hardware PTA grant rules

The central hardware PTA grants access based on the relative priority of the incoming requests when traffic collisions occur. This situation is illustrated in the following examples.

3.3.1 First example of traffic interference (RW612 only)

Context:

- Background ping on Wi-Fi radio
- Ping traffic on 802.15.4 radio

In this context, and as illustrated in Figure 2;

- The Wi-Fi controller sets priority level 1 to Wi-Fi web-browsing traffic.
- The 802.15.4 controller sets priority level 2 to 802.15.4 ping traffic.

Relative priority assignment - Based on the relative priority assignment in PTA, 802.15.4 priority level 2 is higher compared to Wi-Fi priority level 1.

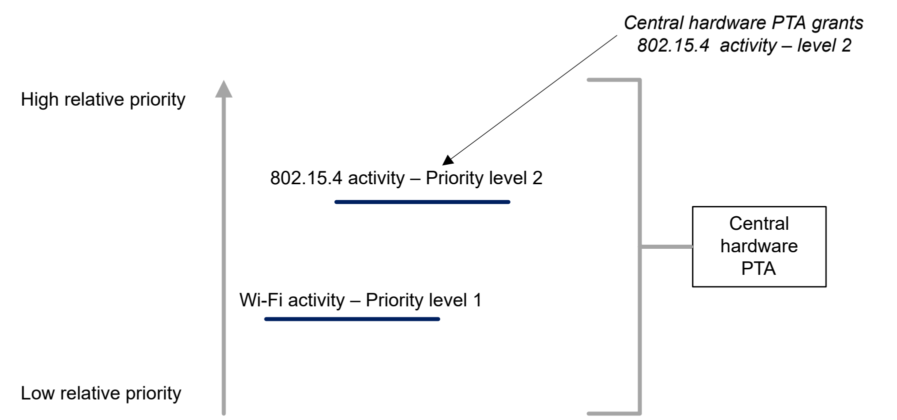

Figure 2. Central hardware PTA relative priority assignment - First example

Conflict resolution:

- **Case 1**: The central hardware PTA grants the traffic access to 802.15.4 traffic. In this case, the central hardware PTA stops the Wi-Fi traffic that causes an interference/conflict.
- **Case 2**: The central hardware PTA grants the traffic access to Wi-Fi traffic when there is no interference/ conflict with 802.15.4 traffic.

3.3.2 Second example of traffic interference

Context:

- Background ping on Wi-Fi radio
- Advertising of wireless UART service on Bluetooth LE radio

In this context, and as illustrated in Figure 3;

- The Wi-Fi controller sets priority level 2 to Wi-Fi web-browsing traffic.
- The 802.15.4 controller sets priority level 1 to Bluetooth LE advertisement.

Relative priority assignment - Based on the relative priority assignment in PTA, Wi-Fi priority level 2 is higher compared to Bluetooth LE priority level 1.

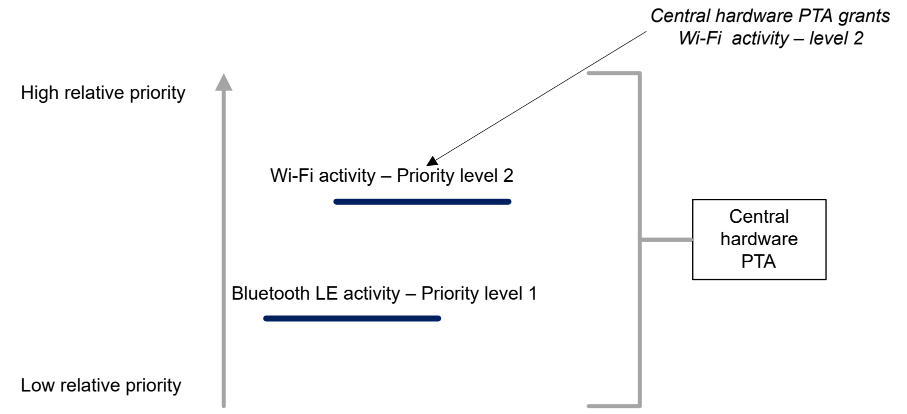

Figure 3. Central hardware PTA relative priority assignment - Second example

Conflict resolution:

- **Case 1**: The central hardware PTA grants the traffic access to Wi-Fi. In this case, the central hardware PTA stops the Bluetooth LE traffic that causes an interference/conflict.
- **Case 2**: The central hardware PTA grants the access to Wi-Fi traffic when there is no interference/conflict with Bluetooth traffic.

4 Coexistence operating mode - Antenna configuration

4.1 Single-antenna configuration

Table 1 shows the supported TX and/or RX operations in single-antenna configuration.

Table 1. Supported TX and or RX operations for Wi-Fi and Bluetooth LE (RW610)—Bluetooth LE or 802.15.4 (RW612)—in single-antenna configuration

Row #	Bluetooth LE (RW610) Bluetooth LE or 802.15.4 (RW612)	Wi-Fi 2.4 GHz	Wi-Fi 5 GHz
1	TX	—	TX/RX
2	—	TX	—
3	—	RX	—
4	RX	—	TX/RX

In single-antenna configuration:

- Wi-Fi 2.4 GHz and Bluetooth LE (RW610)—Bluetooth LE or 802.15.4 (RW612)—TX operations are arbitrated (rows 1 and 2).
- Wi-Fi 2.4 GHz and Bluetooth LE (RW610)—Bluetooth LE or 802.15.4 (RW612)—RX operations are arbitrated (rows 3 and 4).
- Wi-Fi 5 GHz TX/RX and Bluetooth LE (RW610)—Bluetooth LE or 802.15.4 (RW612)—RX or TX operations are simultaneous (rows 1 and 4).
- For RW612, only Bluetooth LE or 802.15.4 can perform TX or RX operation.

4.2 Dual-antenna configuration

The two separate antennas allow simultaneous independent operation of the Wi-Fi and Bluetooth LE (RW610)—Bluetooth LE/802.15.4 (RW612)—radios.

Table 2. Supported TX and or RX operations for Wi-Fi and Bluetooth LE (RW610) or Bluetooth LE/802.15.4 (RW612) radios in dual-antenna configuration

Bluetooth LE (RW610) Bluetooth LE or 802.15.4 (RW612)	Wi-Fi 2.4 GHz	Wi-Fi 5 GHz
TX/RX	TX/RX	—
TX/RX	—	TX/RX

In applications where Wi-Fi and Bluetooth LE (RW610)—Bluetooth LE/802.15.4 (RW612) have a dedicated antenna, the central hardware PTA arbitrates between the Wi-Fi and Bluetooth LE (RW610)—Bluetooth LE/802.15.4 (RW612)—radios. The need for arbitration between Wi-Fi and Bluetooth LE (RW610)—Bluetooth LE/802.15.4 (RW612)—radios depends on the antenna isolation, the target output powers levels for each radio, and the product operating environments.

5 Revision history

Table 3. Revision history

Document ID	Release date	Description
AN14121 v.2.0	1 November 2024	• Changed the access to public. No changes in the content.
AN14121 v.1.0	12 December 2023	• Initial version

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