

AN14001

RW61x TCP Throughput Optimization

Rev. 2.0 — 23 July 2026

Application note

Document information

Information	Content
Keywords	AN14001, Wireless MCU RW610/RW612, RW610 EVK board, throughput, TCP send buffer, TCP window size, PBUF_POOL, SRAM
Abstract	This document provides the justification and method to optimize TCP throughput for RW61x.



1 About this document

This section describes the scope, assumptions, and prerequisite context for using this application note effectively.

1.1 Purpose and scope

This document explains how to optimize TCP throughput for RW61X with MCUXpresso SDK and analyze the test results after tuning with different parameter combinations.

1.2 Considerations

The RW61x is powered by the NXP MCUXpresso SDK. RW61x features integrated Wi-Fi 6, Bluetooth Low Energy and 802.15.4. This document does not include wireless information, RW61x product information, hardware interconnection, board settings, bring-up, IDE setup, and SDK download. For information on these topics, refer to [ref.\[1\]](#). The user must have an RW61X platform-related IDE and tools installed before going through the throughput tuning process.

2 TCP throughput optimization

This section explains the TCP throughput constraints in the RW61x environment and outlines the configurable parameters used to improve performance.

2.1 Why throughput optimization

With the default configuration in the MCUXpresso SDK for RW61X, the values of TCP and UDP throughput are different for the same test mode. [Table 1](#) shows an example.

Table 1. STA throughput for 5 GHz band, 802.11ax mode, and 20 MHz (HE)

Protocol	TCP (Mbit/s)		UDP (Mbit/s)	
Direction	TX	RX	TX	RX
Open security	40	45	99	102
WPA2-AES	40	44	97	101
WPA3-SAE	40	44	97	101

- TCP throughput is only about 40 % of UDP throughput in 5 GHz 802.11AX mode.
- TCP throughput must be about 75 % of UDP throughput.

2.2 Limitations of TCP throughput

RW61X MCUXpresso SDK integrates open source lightweight IP (lwIP) as the default network stack. Due to the limited SRAM space with RW61X, lwIP applies conservative TCP network parameters to yield more SRAM to other SDK components and to the user application.

Note: The default SDK configuration is to enable the `CONFIG_network_high_perf` macro in the lwIP config files. This increases the TCP throughput at the cost of increasing the SRAM utilization of the code.

In TX path, lwIP supports 12 send buffers of 1460 bytes in length. The TCP layer stops sending TCP frames after consuming all the TCP send buffers. The TCP layer does not send new frames until TCP send buffers are freed after receiving TCP ACK from a peer.

In RX path, the TCP window size and TCP RX buffer number combination impact RX throughput significantly. The default TCP windows size is 15, meaning that the TCP layer cannot receive more RX frames until it sends out TCP ACK frames to a peer.

2.3 Throughput optimization method

To improve TCP throughput for RW61X, four parameters in the lwIP layer can be modified. The four parameters are all defined in the file *lwipopts.h* at:

<MCUXpresso SDK folder>/boards/rdrw612bga/wifi_examples/wifi_app

The four parameters are defined by default as:

- TCP sends buffer (TCP_SND_BUF)

```
#ifndef CONFIG_NETWORK_HIGH_PERF
#define TCP_SND_BUF (12 * TCP_MSS)
#else
#define TCP_SND_BUF (TCP_SND_BUF_COUNT * TCP_MSS)
#endif
```

- TCP TX memory pool buffer (MEMP_NUM_PBUF)

```
#ifndef CONFIG_NETWORK_HIGH_PERF
#define MEMP_NUM_PBUF 20
#else
#define MEMP_NUM_PBUF 10
#endif
```

- TCP RX window size (TCP_WND)

```
#ifndef CONFIG_NETWORK_HIGH_PERF
#ifdef RW610
#define TCP_WND (15 * TCP_MSS)
#else
#define TCP_WND (32 * TCP_MSS)
#endif
#else
#define TCP_WND (10 * TCP_MSS)
#endif
```

- TCP RX buffer number (PBUF_POOL_SIZE)

```
/**
 * PBUF_POOL_SIZE: the number of buffers in the pbuf pool.
 */
#define PBUF_POOL_SIZE 40
```

Note: Increasing the four parameter values consumes more SRAM space. Maintain a balance between TCP throughput and the SRAM size that can be used for application.

If after the modification of the parameter values, the compilation of the application fails (because of some sanity check), apply the following changes.

- Changes to *lwip/src/core/init.c*

```
ifndef LWIP_DISABLE_TCP_SANITY_CHECKS
#define LWIP_DISABLE_TCP_SANITY_CHECKS 0 --> 1
#endif
```

- Changes to *lwip/src/include/lwip/opt.h*

```
#if !defined LWIP_WND_SCALE || defined __DOXYGEN__
#define LWIP_WND_SCALE 0 --> 1
#define TCP_RCV_SCALE 0 --> 1
#endif
```

2.4 Test results after optimization

The throughput test setup is as follows:

- Environment: Shielding room – Over the air
- External access point: ASUS RT-AX88U
- DUT: RW610 RD board
- Channel: 36
- Bandwidth: HE20
- NSS: 1ss
- Wi-Fi application: wifi_cli

Table 2. TCP throughput test results

TCP_SND_BUF (TCP-send buffer number)	MEMP_NUM_PBUF (TCP TX memory buffer number)	TCP_WND (TCP RX Window size)	PBUF_POOL_SIZE (TCP RX buffer number)	TCP TX (Mbit/s)	TCP RX (Mbit/s)	Other SRAM size
12	20	15	40	41	47	64 kB
44	80	32	80	60	58	128 kB
80	80	80	80	67	68	128 kB

The values in [Table 2](#) show that TCP throughput increases with higher TCP TX and RX parameters but the SRAM space is larger. To allocate more SRAM for lwIP TCP according to your application when high TCP throughput is required, customize the parameter values.

3 Acronyms

[Table 3](#) lists the acronyms used in this document.

Table 3. Acronyms

Acronym	Definition
CLI	Command-line interface
EVK	Evaluation kit
FW	Firmware
IDE	Integrated development environment
TCP	Transmission control protocol
SDK	Software development kit
SW	Software

4 Contact Us

For more product details, queries, and support, refer to the following links.

- Homepage: nxp.com
- Web Support: nxp.com/support
- NXP Community: <https://community.nxp.com/>

5 References

- [1] User manual - UM11798 - Getting Started with Wireless on RW61x Evaluation board Running RTOS ([link](#))

6 Note about the source code in the document

The example code shown in this document has the following copyright and BSD-3-Clause license:

Copyright 2023-2026 NXP Redistribution and use in source and binary forms, with or without modification, are permitted provided that the following conditions are met:

1. Redistributions of source code must retain the above copyright notice, this list of conditions and the following disclaimer.
2. Redistributions in binary form must reproduce the above copyright notice, this list of conditions and the following disclaimer in the documentation and/or other materials must be provided with the distribution.
3. Neither the name of the copyright holder nor the names of its contributors may be used to endorse or promote products derived from this software without specific prior written permission.

THIS SOFTWARE IS PROVIDED BY THE COPYRIGHT HOLDERS AND CONTRIBUTORS "AS IS" AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE DISCLAIMED. IN NO EVENT SHALL THE COPYRIGHT HOLDER OR CONTRIBUTORS BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

7 Revision history

[Table 4](#) summarizes the revisions made to this document.

Revision history

Document ID	Release date	Description
AN14001 v.2.0	23 July 2026	Updated access to public
AN14001 v.1.0	18 July 2023	Initial version

Legal information

Definitions

Draft — A draft status on a document indicates that the content is still under internal review and subject to formal approval, which may result in modifications or additions. NXP Semiconductors does not give any representations or warranties as to the accuracy or completeness of information included in a draft version of a document and shall have no liability for the consequences of use of such information.

Disclaimers

Limited warranty and liability — Information in this document is believed to be accurate and reliable. However, NXP Semiconductors does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information. NXP Semiconductors takes no responsibility for the content in this document if provided by an information source outside of NXP Semiconductors.

In no event shall NXP Semiconductors be liable for any indirect, incidental, punitive, special or consequential damages (including - without limitation - lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Notwithstanding any damages that customer might incur for any reason whatsoever, NXP Semiconductors' aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the Terms and conditions of commercial sale of NXP Semiconductors.

Right to make changes — NXP Semiconductors reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

Suitability for use — NXP Semiconductors products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or malfunction of an NXP Semiconductors product can reasonably be expected to result in personal injury, death or severe property or environmental damage. NXP Semiconductors and its suppliers accept no liability for inclusion and/or use of NXP Semiconductors products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

Applications — Applications that are described herein for any of these products are for illustrative purposes only. NXP Semiconductors makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using NXP Semiconductors products, and NXP Semiconductors accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the NXP Semiconductors product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

NXP Semiconductors does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using NXP Semiconductors products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). NXP does not accept any liability in this respect.

Terms and conditions of commercial sale — NXP Semiconductors products are sold subject to the general terms and conditions of commercial sale, as published at <https://www.nxp.com/profile/terms>, unless otherwise agreed in a valid written individual agreement. In case an individual agreement is concluded only the terms and conditions of the respective agreement shall apply. NXP Semiconductors hereby expressly objects to applying the customer's general terms and conditions with regard to the purchase of NXP Semiconductors products by customer.

Export control — This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from competent authorities.

Suitability for use in non-automotive qualified products — Unless this document expressly states that this specific NXP Semiconductors product is automotive qualified, the product is not suitable for automotive use. It is neither qualified nor tested in accordance with automotive testing or application requirements. NXP Semiconductors accepts no liability for inclusion and/or use of non-automotive qualified products in automotive equipment or applications.

In the event that customer uses the product for design-in and use in automotive applications to automotive specifications and standards, customer (a) shall use the product without NXP Semiconductors' warranty of the product for such automotive applications, use and specifications, and (b) whenever customer uses the product for automotive applications beyond NXP Semiconductors' specifications such use shall be solely at customer's own risk, and (c) customer fully indemnifies NXP Semiconductors for any liability, damages or failed product claims resulting from customer design and use of the product for automotive applications beyond NXP Semiconductors' standard warranty and NXP Semiconductors' product specifications.

HTML publications — An HTML version, if available, of this document is provided as a courtesy. Definitive information is contained in the applicable document in PDF format. If there is a discrepancy between the HTML document and the PDF document, the PDF document has priority.

Translations — A non-English (translated) version of a document, including the legal information in that document, is for reference only. The English version shall prevail in case of any discrepancy between the translated and English versions.

Security — Customer understands that all NXP products may be subject to unidentified vulnerabilities or may support established security standards or specifications with known limitations. Customer is responsible for the design and operation of its applications and products throughout their lifecycles to reduce the effect of these vulnerabilities on customer's applications and products. Customer's responsibility also extends to other open and/or proprietary technologies supported by NXP products for use in customer's applications. NXP accepts no liability for any vulnerability. Customer should regularly check security updates from NXP and follow up appropriately. Customer shall select products with security features that best meet rules, regulations, and standards of the intended application and make the ultimate design decisions regarding its products and is solely responsible for compliance with all legal, regulatory, and security related requirements concerning its products, regardless of any information or support that may be provided by NXP.

NXP has a Product Security Incident Response Team (PSIRT) (reachable at PSIRT@nxp.com) that manages the investigation, reporting, and solution release to security vulnerabilities of NXP products.

NXP B.V. — NXP B.V. is not an operating company and it does not distribute or sell products.

Trademarks

Notice: All referenced brands, product names, service names, and trademarks are the property of their respective owners.

NXP — wordmark and logo are trademarks of NXP B.V.

Bluetooth — the Bluetooth wordmark and logos are registered trademarks owned by Bluetooth SIG, Inc. and any use of such marks by NXP Semiconductors is under license.

Tables

Tab. 1.	STA throughput for 5 GHz band, 802.11ax mode, and 20 MHz (HE)	3	Tab. 2.	TCP throughput test results	5
			Tab. 3.	Acronyms	6

Contents

1 **About this document2**

1.1 Purpose and scope 2

1.2 Considerations 2

2 **TCP throughput optimization 3**

2.1 Why throughput optimization 3

2.2 Limitations of TCP throughput 3

2.3 Throughput optimization method 4

2.4 Test results after optimization 5

3 **Acronyms 6**

4 **Contact Us 6**

5 **References 6**

6 **Note about the source code in the**
document 7

7 **Revision history 7**

Legal information 8

Please be aware that important notices concerning this document and the product(s) described herein, have been included in section 'Legal information'.