AN14310 NXP Bluetooth UART Driver Integration Rev. 2.0 — 27 November 2024

Application note

Document information

Information	Content
Keywords	NXP Bluetooth UART Driver, i.MX
Abstract	Describes the procedure for compiling and integrating the NXP Bluetooth UART driver.



1 Introduction

This document explains how to compile and integrate the new NXP Bluetooth UART Driver. For i.MX kernel versions 6.1.22 and lower, this update is required.

Note: This document does not apply to Linux kernel version 6.1.22 or lower.

For third party ARM-based Linux BSP, a Linux kernel version 6.1.x and above is required. Older Linux kernel versions 5.x are known to have some compilation issues.

The users who are not using i.MX Linux BSP host systems must have kernel version 6.1.x or later to use the BT NXP UART driver. Kernel versions 5.x and older are having compatibility issues due to some APIs not being present.

1.1 Supported devices

The application note applies to the following Wireless SoCs:

- 88W8987 [1]
- 88W8997 [2]
- 88Q9098 [3]
- 88W9098 [4]
- IW416 [5]
- AW611 [6]
- IW611 [7]
- IW612 [8]

1.2 Advantages of using the NXP Bluetooth UART driver

Advantages of using the NXP Bluetooth UART driver includes:

- Bringing up the HCI interface without "hciattach" command When the NXP Bluetooth UART driver is loaded, it can detect whether Bluetooth FW is downloaded. If the Bluetooth FW is not downloaded, then the driver will download automatically.
- Enable Bluetooth Deep sleep mode The NXP Bluetooth driver reduces power consumption by waking up the Bluetooth controller or set the Bluetooth controller to sleep.

More information about these above features of NXP Bluetooth UART driver can be found in [9].

2 Compile and integrate NXP Bluetooth UART driver

This section describes the compilation and integration procedure of NXP Bluetooth UART driver on i.MX Linux BSP and on other non-i.MX-ARM-architecture-based Linux host platforms.

2.1 i.MX Linux BSP

Follow the steps to compile and integrate a new NXP Bluetooth driver on an i.MX 8 platform:

Note: Skip this section if you use the BSP release with kernel version v6.1.22 and later.

Step 1 – Clone NXP Linux kernel source code from [10] using Git clone command on the Linux system.

Step 2 – Download NXP Bluetooth UART driver patches from [11] and apply to a kernel source code.

For example:

```
git apply patch.diff
```

Step 3 – Edit the kernel configuration file available in the kernel source code.

• Add the following line to the .config file:

CONFIG_BT_NXPUART=m

Step 4 – Update the DTS file.

The .dts file is in the arch/arm64/boot/dts/freescale/ directory of the kernel build environment.

• Add a "bluetooth" node with a device compatibility string to the attached UART node.

```
&uart1 {
    bluetooth {
        compatibility = "nxp,88w8987-bt";
        fw-init-baudrate = <3000000>; # Optional. Default is considered 115200
        if this parameter not defined.
    };
};
```

Note: The fw-init-baudrate parameter depends on the product OTP configuration. Contact your NXP representative for more information.

<u>Table 1</u> lists the compatibility option values for the supported products.

Compatibility option	Description	Supported products
nxp,88w8987-bt	The binary file <i>helper_xxx.bin</i> is not required to download the Bluetooth firmware. Bluetooth UART driver checks the availability of Bluetooth firmware binary and downloads the firmware.	88W8987, 88Q9098, 88W9098, IW416, AW611, IW611, IW612
nxp,88w8997-bt	The binary file <i>helper_xxx.bin</i> is required to download the Bluetooth firmware. Bluetooth UART driver checks the availability of <i>helper_xxx.bin</i> and Bluetooth firmware binary, and downloads the <i>helper_xx.bin</i> file followed by the firmware binary.	88W8997

Table 1. Compatibility option values

NXP Bluetooth UART Driver Integration

Step 5 – Compile the kernel and the .dts file.

make -j32 ARCH=arm64 CROSS COMPILE=aarch64-poky-linux-

Step 6 - Locate the generated files in the compiled kernel source.

- Path to the kernel image: arch/arm64/boot/Image
- Path to NXP Bluetooth UART driver module (btnxpuart.ko): drivers/bluetooth/btnxpuart.ko
- Path to xxx.dtb file: arch/arm64/boot/dts/freescale/xxx.dtb

Step 7 – Copy the compiled kernel Image, *xxx.dtb* and *btnxpuart.ko* files to the i.MX 8M platform and reboot the system.

Example for i.MX 8M Quad platform:

```
cp xxx.dtb /run/media/boot-mmcblk0p1/imx8mq-evk.dtb
cp Image /run/media/boot-mmcblk0p1/Image
cp btnxpuart.ko /home/root
sync
reboot
```

Step 8 – Follow the steps in <u>Section 3</u> to load the NXP UART driver module.

2.2 Third party ARM-based Linux BSP

Note: This driver is supported on ARM-based architectures. Other architectures such as x86 will not work.

Follow the steps to compile and integrate a new NXP Bluetooth driver on a third party ARM-based Linux kernel:

Step 1 – Apply BT NXP UART driver patches on kernel source code.

- Download NXP Bluetooth UART driver patches from [13] and apply to your specific kernel source code.
- Then download other NXP Bluetooth UART driver patches from [14] and apply to a kernel source code. Command example:

git apply patch.diff

Note: Skip this step if Linux kernel version 6.4 or higher is in use as these patches are already included.

Step 2 – Edit the kernel configuration file available in the kernel source code.

• Add the following line to the .config file:

CONFIG BT NXPUART=m

Step 3 - Update the DTS file.

The .dts file is in the arch/arm64/boot/dts/freescale/ directory of the kernel build environment.

Add a "bluetooth" node with a device compatibility string to the attached UART node.

```
&uart1 {
        bluetooth {
                compatibility = "nxp,88w8987-bt";
                fw-init-baudrate = <3000000>; # Optional. Default is considered 115200
                if this parameter not defined.
        };
};
```

Note: Fw-init-baudrate parameter depends on the product OTP configuration. Contact your NXP representative for more information.

Table 2 lists the compatibility option values for the supported products.

Compatibility option	Description	Supported products
nxp,88w8987-bt	The binary file <i>helper_xxx.bin</i> is not required to download the Bluetooth firmware. Bluetooth UART driver checks the availability of Bluetooth firmware binary and downloads the firmware.	88W8987, 88Q9098, 88W9098, IW416, AW611, IW611, IW612
nxp,88w8997-bt	The binary file <i>helper_xxx.bin</i> is required to download the Bluetooth firmware. Bluetooth UART driver checks the availability of <i>helper_xxx.bin</i> and Bluetooth firmware binary, and downloads the <i>helper_xx.bin</i> file followed by the firmware binary.	88W8997

Step 4 – Compile the kernel and the .dts file.

make

AN14310 **Application note**

Step 5 – Locate the generated files in the compiled kernel source.

- Path to the kernel image: *arch/arm64/boot/Image*
- Path to NXP Bluetooth UART driver module (btnxpuart.ko): drivers/bluetooth/btnxpuart.ko
- Path to xxx.dtb file: arch/arm64/boot/dts/freescale/xxx.dtb

Step 6 - Copy the compiled kernel Image, xxx.dtb, and btnxpuart.ko files to the platform and reboot the system.

Command example for i.MX 8M Quad platform:

```
cp xxx.dtb /run/media/boot-mmcblk0p1/imx8mq-evk.dtb
cp Image /run/media/boot-mmcblk0p1/Image
cp btnxpuart.ko /home/root
sync
reboot
```

Step 7 – Follow the steps in <u>Section 3</u> to load the NXP UART driver module.

3 Load NXP UART driver module

This section shows how to load NXP Bluetooth UART driver module (*btnxpuart.ko*).

By default, the NXP Bluetooth UART driver (*btnxpuart.ko*) is loaded. To disable the auto load option for NXP Bluetooth UART driver, edit the */etc/modprobe.d/blacklist.conf* file to add one line as below and reboot the system.

blacklist btnxpuart

Note: If user does not blacklist the btnxpuart driver, the BT NXP driver will be auto loaded on every reboot and will download BT only FW. If any user wants to use the Wi-Fi and BT Combo FW, then blacklisting the btnxpuart driver is required.

Step 1 - Load the Wi-Fi driver firmware.

Note: Skip this step if Wi-Fi is not used.

• Use the insmod/modprobe command to load either the Wi-Fi and Bluetooth combo firmware or the Wi-Fi only firmware.

```
Example command:
```

```
modprobe mlan
modprobe moal mod_para=nxp/wifi_mod_para.conf
```

- Refer to [12] for detailed instructions in case i.MX Linux BSP is used.
- Verify the kernel debug messages in the command output.

Note: For Wi-Fi only or Combo FW loading, the type of firmware defined in wifi_mod_para.conf determines which FW will be used. For Bluetooth only FW, btnxpuart.ko will load it within 5 seconds. For Wi-Fi and Bluetooth Combo Firmware, btnxpuart.ko will not load any firmware. Moal.ko or another driver will load the combo firmware.

Step 2 - Load NXP UART Bluetooth driver.

- Download Bluetooth UART only firmware binary from the [10].
- For Linux kernel v6.1.22 and lower:

insmod btnxpuart.ko

• For Linux kernel v6.1.22 and higher:

modprobe btnxpuart

• Verify that the Bluetooth interface is up and running.

hciconfig -a

Note: The command hciattach is not required to bring up Bluetooth.

4 Load the open-source UART driver

Linux open source UART driver is a standard UART driver available in the Linux open source directory. The driver does not support the Bluetooth deep sleep feature.

This section shows how to revert the changes for the NXP UART driver when i.MX BSP source code has kernel version 6.1.22 and later.

Step 1 – Update the .dtb file

The .dts file is located in the arch/arm64/boot/dts/freescale/ directory of the kernel source build environment.

• Edit the .dts file to remove the Bluetooth node for UART1:

```
&uart1 {
    bluetooth {
        compatibility = "nxp,88w8987-bt";
        fw-init-baudrate = <3000000>; # Optional. Default is considered 115200
        if this parameter is not defined.
    };
};
```

Step 2 – Compile the .dts file in the build environment.

dtc -O dtb -o imx8xx-evk-xxx.dtb imx8xx-evk-xxx.dts

Step 3 – Copy the newly generated .dtb file on Linux platform.

Example for i.MX 8M Quartz platform:

```
cp imx8xx-evk-xxx.dtb /run/media/boot-mmcblk0p1/imx8mq-evk.dtb
sync
reboot
```

Step 4 – Bring-up Bluetooth.

hciattach /dev/ttymxc2 any 115200 flow hciconfig hci0 up

Note: Refer to the section Bring-up of Bluetooth interfaces in [12].

NXP Bluetooth UART Driver Integration

5 References

- [1] Webpage 88W8987 2.4/5 GHz Dual-Band 1x1 Wi-Fi[®] 5 (802.11ac) + Bluetooth[®] 5.2 Solution (<u>link</u>)
- [2] Webpage 88W8997 2.4/5 GHz Dual-Band 2x2 Wi-Fi[®] 5 (802.11ac) + Bluetooth[®] 5.3 Solution (link)
- [3] Webpage 88Q9098/88Q9098S 2.4/5 GHz Dual-Band 2x2 Wi-Fi[®] 6 (802.11ax) + Bluetooth[®] 5.3 Automotive Solution (link)
- [4] Webpage 88W9098 2.4/5 GHz Dual-Band 2x2 Wi-Fi[®] 6 (802.11ax) + Bluetooth[®] 5.3 (<u>link</u>)
- [5] Webpage IW416 2.4/5 GHz Dual-Band 1x1 Wi-Fi[®] 4 (802.11n) + Bluetooth[®] 5.2 Solution (link)
- [6] Webpage AW611 2.4/5 GHz Dual-Band 1x1 Wi-Fi[®] 6 (802.11ax) + Bluetooth[®] 5.4 Automotive Solution (link)
- [7] Webpage IW611 2.4/5 GHz Dual-band 1x1 Wi-Fi[®] 6 (802.11ax) + Bluetooth[®] 5.4 Solution (<u>link</u>)
- [8] Webpage IW612 2.4/5 GHz Dual-Band 1x1 Wi-Fi[®] 6 (802.11ax) + Bluetooth[®] 5.4 + 802.15.4 Tri-Radio Solution (link)
- [9] Application note AN13920 Enabling Bluetooth Deep-sleep with NXP Bluetooth UART Driver (link)
- [10] Resources NXP Online Git Repository for NXP Kernel Source code (link)
- [11] Resources NXP Bluetooth UART driver patches for kernel version lower than 6.1.22 (link)
- [12] User Manual UM11483 Getting Started with NXP-based Wireless Modules on i.MX 8M Quad EVK Running Linux OS (link)
- [13] Resources NXP Bluetooth UART driver patches for non-IMX Linux kernel (link)
- [14] Resources NXP Bluetooth UART driver additional improvement patches with some bug fixes (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 2024 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 3. Revision history			
Document ID	Release date	Description	
AN14310 v.2.0	27 November 2024	Security status changed to public.	
AN14310 v.1.0	16 September 2024	Initial version	

NXP Bluetooth UART Driver Integration

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 <u>PSIRT@nxp.com</u>) that manages the investigation, reporting, and solution release to security vulnerabilities of NXP products.

 $\ensuremath{\mathsf{NXP}}\xspace$ 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.

NXP Bluetooth UART Driver Integration

AMBA, Arm, Arm7, Arm7TDMI, Arm9, Arm11, Artisan, big.LITTLE, Cordio, CoreLink, CoreSight, Cortex, DesignStart, DynamIQ, Jazelle, Keil, Mali, Mbed, Mbed Enabled, NEON, POP, RealView, SecurCore, Socrates, Thumb, TrustZone, ULINK, ULINK2, ULINK-ME, ULINK-PLUS, ULINKpro, µVision, Versatile — are trademarks and/or registered trademarks of Arm Limited (or its subsidiaries or affiliates) in the US and/or elsewhere. The related technology may be protected by any or all of patents, copyrights, designs and trade secrets. All rights reserved. **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.

NXP Bluetooth UART Driver Integration

Tables

Tab. 1.	Compatibility option values	Tab. 3
Tab. 2.	Compatibility option values5	

 Fab. 3.
 Revision history

Contents

1	Introduction	2
1.1	Supported devices	2
1.2	Advantages of using the NXP Bluetooth	
	UART driver	2
2	Compile and integrate NXP Bluetooth	
	UART driver	3
2.1	i.MX Linux BSP	3
2.2	Third party ARM-based Linux BSP	5
3	Load NXP UART driver module	7
4	Load the open-source UART driver	8
5	References	9
6	Note about the source code in the	
	document	10
7	Revision history	11
	Legal information	12

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

© 2024 NXP B.V.

All rights reserved.

Document feedback

For more information, please visit: https://www.nxp.com

Date of release: 27 November 2024 Document identifier: AN14310