



MediaTek LinkIt™ Development Platform for RTOS Memory Layout Developer's Guide

Version: 3.0

Release date: 4 November 2016

© 2015 - 2016 MediaTek Inc.

This document contains information that is proprietary to MediaTek Inc. ("MediaTek") and/or its licensor(s). MediaTek cannot grant you permission for any material that is owned by third parties. You may only use or reproduce this document if you have agreed to and been bound by the applicable license agreement with MediaTek ("License Agreement") and been granted explicit permission within the License Agreement ("Permitted User"). If you are not a Permitted User, please cease any access or use of this document immediately. Any unauthorized use, reproduction or disclosure of this document in whole or in part is strictly prohibited. THIS DOCUMENT IS PROVIDED ON AN "AS-IS" BASIS ONLY. MEDIATEK EXPRESSLY DISCLAIMS ANY AND ALL WARRANTIES OF ANY KIND AND SHALL IN NO EVENT BE LIABLE FOR ANY CLAIMS RELATING TO OR ARISING OUT OF THIS DOCUMENT OR ANY USE OR INABILITY TO USE THEREOF. Specifications contained herein are subject to change without notice.

Document Revision History

Revision	Date	Description
1.0	7 March 2016	Initial version.
1.1	31 March 2016	Add MT2523x memory layout description.
2.0	30 June 2016	Add 4MB memory layout of MT76x7.
2.1	2 September 2016	MT76x7 layout adjustment
3.0	4 November 2016	Added MT2533 memory layout description.

Table of contents

1.	Overview	1
2.	Memory Layout and Configuration for MT76x7.....	2
2.1.	2MB memory layout view	2
2.2.	4MB memory layout view	4
2.3.	Programming guide	6
2.4.	Memory layout adjustment with a linker script	7
2.5.	Memory layout adjustment with a scatter File	9
3.	Memory Layout and Configuration for MT2523x.....	10
3.1.	Memory layout without FOTA	11
3.2.	Memory layout with FOTA of full binary update	13
3.3.	Programming guide	15
3.4.	Memory layout adjustment with a linker script	17
3.5.	Memory layout adjustment with a scatter file	20

Lists of tables and figures

Table 1. Tips for changing the memory layout of MT76x7 platform.....	7
Figure 1. The load view of the 2MB flash memory layout	3
Figure 2. The execution view of the 2MB flash memory layout	4
Figure 3. The load view of the 4MB flash memory layout	5
Figure 4. The execution view of the 4MB flash memory layout	6
Figure 5. MT2523x virtual memory mapping	10
Figure 6. Load view of the MT2523D and MT2523G memory layout without FOTA	11
Figure 7. Load view of the MT2533 memory layout without FOTA	12
Figure 8. Execution view of the MT2523D and MT2523G memory layout without FOTA	13
Figure 9 Execution view of the MT2533 memory layout without FOTA.....	13
Figure 10. Load view of the MT2523D and MT2523G memory layout with full binary FOTA	14
Figure 11 Load view of the MT2533 memory layout with full binary FOTA.....	14
Figure 12. Execution view of the MT2523D and MT2523G memory layout with full binary FOTA.....	15
Figure 13. Execution view of the MT2533 memory layout with full binary FOTA	15

1. Overview

This document provides details on the memory layout design and configuration of MediaTek LinkIt™ development platform for real-time operating system (RTOS). The platform includes:

- MT76x7 chipsets: MT7687F, MT7697, and MT7697D
- MT2523x chipsets: MT2523D, MT2523G, and MT2533

Each memory layout has two types of views, load view and an execution view. The design concept will be described based on the two views:

- Load view describes a memory region and section of each image in terms of the address it is located at before the image is processed.
- Execution view describes a memory region and section of each image in terms of the address it is located at during the image execution.

Different toolchains have different layout configuration files. The GCC toolchain uses a linker script, the ARMCC toolchain uses a scatter file. The memory layout configuration will be described separately for each toolchain.

2. Memory Layout and Configuration for MT76x7

The memory layout for MediaTek LinkIt™ Development Platform for RTOS is based on a type of memory available on the supported SOCs. MT76x7 is equipped with three types of memory storage: Serial Flash, SYSRAM and Tightly Coupled Memory (TCM). This document guides you through the details of the memory layout and its use.

2.1. 2MB memory layout view

2.1.1. Load view

MT7687F has 2MB internal serial flash memory. The load view on the flash memory of the HDK is shown in Figure 1.

- **Bootloader.** The first 32kB of memory is allocated for the bootloader. The bootloader binary is located at `out/<board>/<project>/`. The bootloader is not configurable.
- **Non-Volatile Data Management (NVDM) buffer.** There are two blocks reserved for the NVDM buffer management. The first NVDM buffer after the Bootloader (see Figure 1) is not configurable, but the second NVDM buffer is configurable, see section 2.4, “Memory layout adjustment with a linker script” for more details.
- **N9 RAM Code.** The N9 binary is located under `out/<board>/<project>/`. The N9 RAM Code is not configurable.
- **ARM Cortex-M4 firmware.** The application binary is located under `out/<board>/<project>/`. ARM Cortex-M4 firmware is configurable see section 2.4, “Memory layout adjustment with a linker script” for more details.
- **FOTA buffer.** Firmware update over the air (FOTA) buffer is reserved for FOTA memory management. The FOTA buffer is configurable see section 2.4, “Memory layout adjustment with a linker script” for more details.



Note: For more information about FOTA, please refer to MediaTek LinkIt™ Development Platform for RTOS Firmware Update Developer's Guide located under SDK /doc folder.

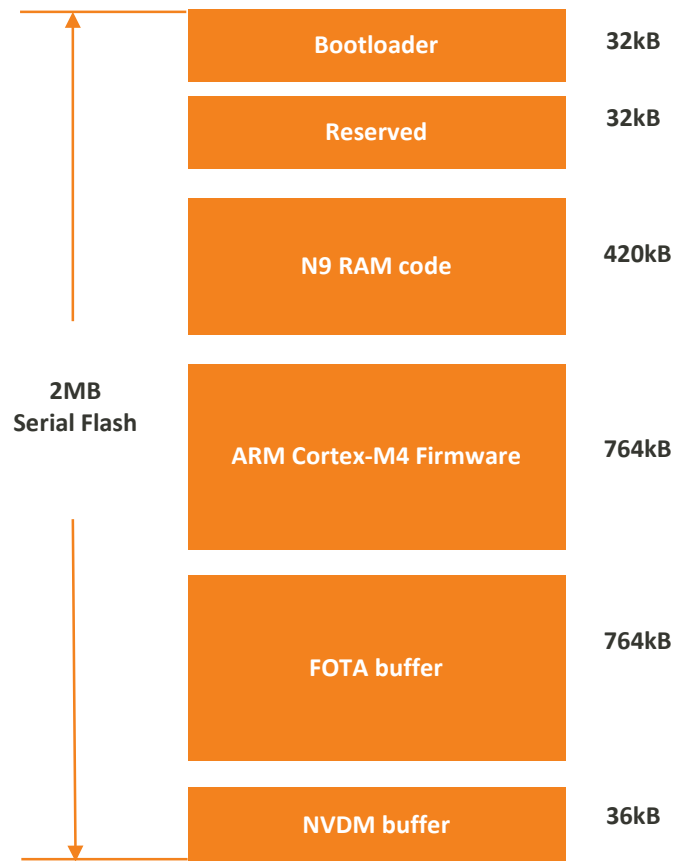


Figure 1. The load view of the 2MB flash memory layout

2.1.2. Execution view

Execution view describes where the code and data are located during the program execution. The execution view is based on the Serial Flash, SYSRAM and TCM, as described below:

- Serial Flash. The code and read-only (RO) data are located in the flash memory during runtime.
- SYSRAM. Vector table, read-write (RW) data, zero initialized (ZI) data will be moved to SYSRAM during runtime.
- TCM. Some special code and ZI data can be placed into the TCM during runtime, see section 2.3, "Programming " for more details about placing the code and the data into the TCM.

The detailed execution view of the memory layout is shown in Figure 2.

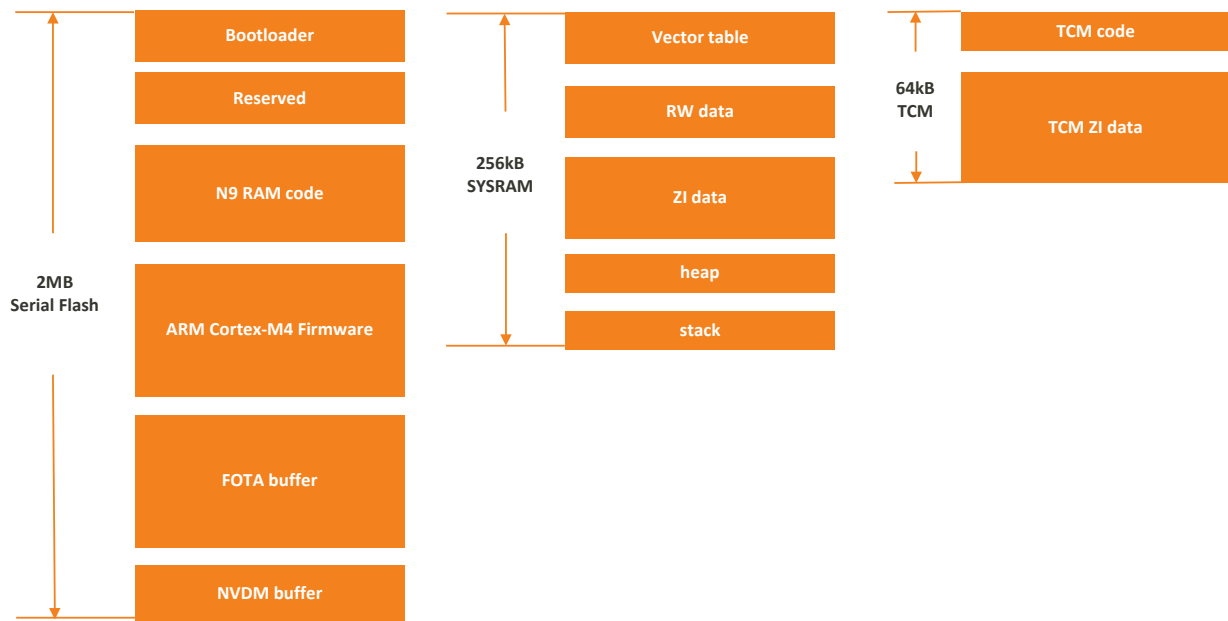


Figure 2. The execution view of the 2MB flash memory layout

The size and address of the flash layout are not configurable. A user defined memory layout could be created by modifying or customizing the flash layout with two restrictions applied as follows:

- Load view: The bootloader must be located at the beginning of the flash.
- Execution view: Vector table must be located at the beginning of the SYSRAM.

2.2. 4MB memory layout view

MT7697 or MT7697D has a 4MB external flash. This section will introduce the memory layout based on the 4MB flash.

2.2.1. Load view

The load view on the flash memory of the HDK is shown in Figure 3.

- Bootloader. The first 32kB of memory is allocated for the bootloader. The bootloader binary is located at `out/<board>/<project>/`. The bootloader is not configurable.
- N9 RAM Code. The N9 binary is located under `out/<board>/<project>/`. The N9 RAM Code is not configurable.
- ARM Cortex-M4 firmware. The application binary is located under `out/<board>/<project>/`. The ARM Cortex-M4 firmware is configurable. See section 2.4, “Memory layout adjustment with a linker script” for more details.
- FOTA buffer. Firmware update over the air (FOTA) buffer is reserved for FOTA memory management. The FOTA buffer is configurable. See section 2.4, “Memory layout adjustment with a linker script” for more details.
- Non-Volatile Data Management (NVDM) buffer is reserved for NVDM management. The NVDM buffer is configurable. See section 2.4, “Memory layout adjustment with a linker script” for more details.



Note: For more information about FOTA, please refer to MediaTek LinkIt™ Development Platform for RTOS Firmware Update Developer's Guide located under SDK /doc folder.

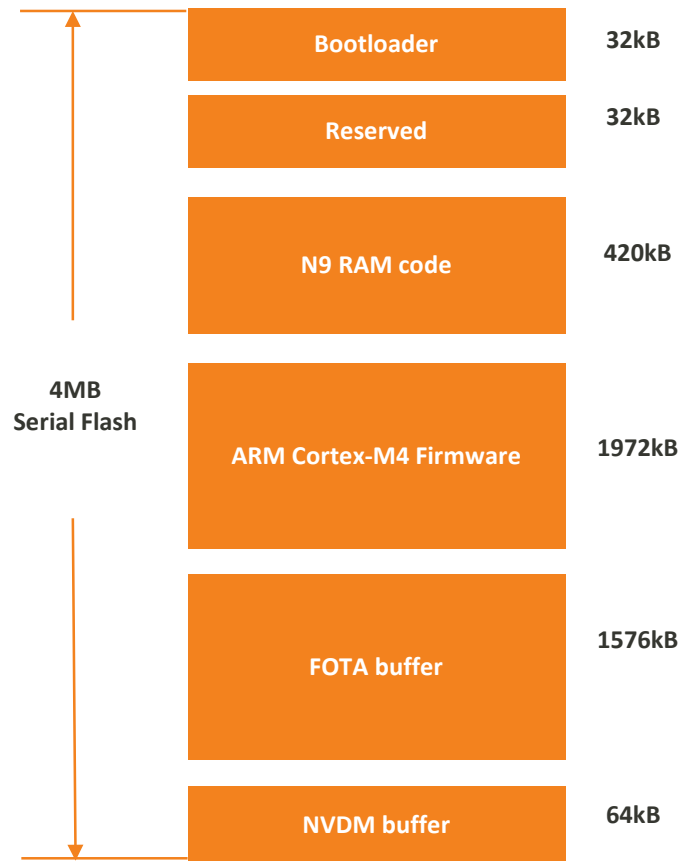


Figure 3. The load view of the 4MB flash memory layout

2.2.2. Execution view

Execution view describes where the code and data are located during the program execution. The execution view is based on the Serial Flash, SYSRAM and TCM, as described below:

- Serial Flash. The code and read-only (RO) data are located in the flash memory during runtime.
- SYSRAM. Vector table, read-write (RW) data, zero initialized (ZI) data will be moved to SYSRAM during runtime.
- TCM. Some special code and ZI data can be placed into the TCM during runtime, see section 2.3, "Programming guide" for more details about placing the code and the data into the TCM.

The detailed execution view of the memory layout is shown in Figure 4.

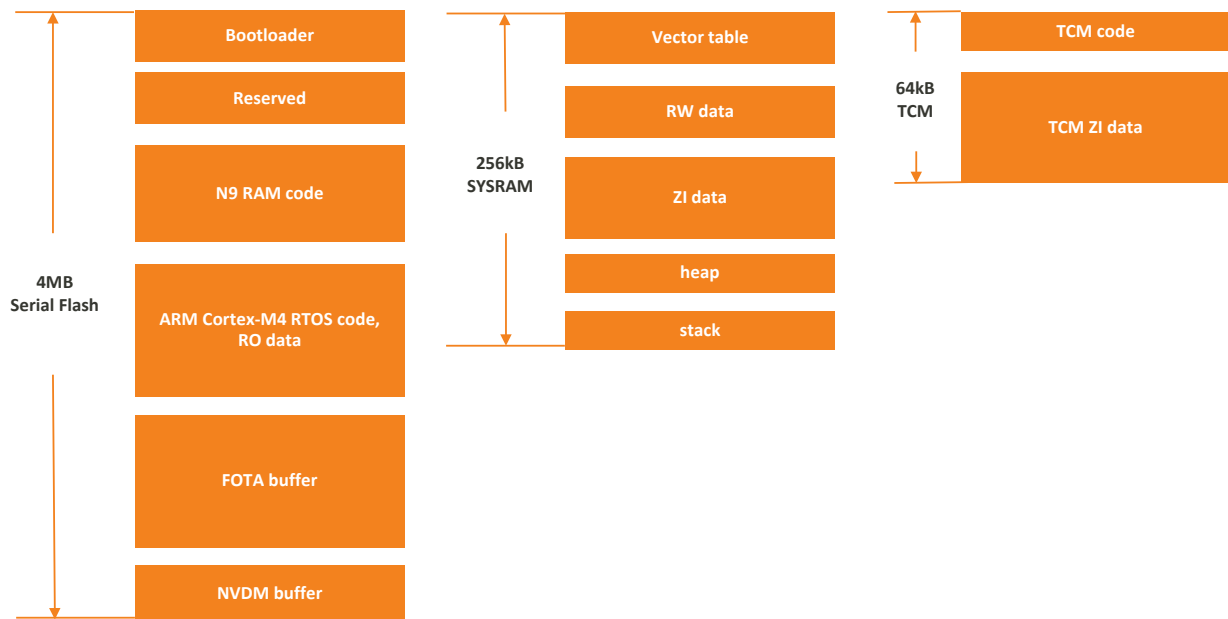


Figure 4. The execution view of the 4MB flash memory layout

The size and address of the flash layout are not configurable. A user defined memory layout could be created by modifying or customizing the flash layout with two restrictions applied as follows:

- Load view: The bootloader must be located at the beginning of the flash.
- Execution view: Vector table must be located at the beginning of the SYSRAM.

2.3. Programming guide

This programming guide is based on the memory layout described in section 2.1, “2MB memory layout view” and section 2.2, “4MB memory layout view”. The following recommendations allow the developers to place the code successfully to the desired memory location during runtime.

- 1) Place the code or the RO data to the Serial Flash at runtime.

By default, the code or the RO data is placed in the flash (XIP - Execute in Place), no need to modify.

- 2) Place the code or RO data to TCM at run time.

To run the code or access the data in the TCM with better performance, specify the attribute explicitly in your code, as shown in the example below.

```
//code: The function func will be put into TCM by linker.
ATTR_TEXT_IN_TCM int func(int par)
{
    int s;
    s = par;
    //....
}
//ro-data: The variable b will be put into TCM by linker.
ATTR TEXT_IN_TCM const int b = 8;
```

For comparison, if the attribute is not explicitly defined, during the function call the code will be placed in the SYSRAM instead of the TCM.

```
//code: The function func will NOT be put into TCM by linker. It will be
```

```
put //into FLASH.
int func(int par)
{
    int s;
    s = par;
    //....
}
//ro-data: The variable b will NOT be placed into TCM by linker. It will
be placed //into the SYSRAM.
int b = 8;
```

3) Place ZI data into TCM at runtime.

The code below declares an attribute to place the ZI data into the TCM.

```
// zi-data: The variable b will be put into TCM by linker.
ATTR_ZIDATA_IN_TCM int b;
```

For comparison, if the attribute is not explicitly defined, during the function call the ZI data will be placed in the SYSRAM instead of the TCM.

```
// zi-data: The variable b will NOT be put into TCM by linker. It will be
put //into SYSRAM.
int b;
```

2.4. Memory layout adjustment with a linker script

The memory layout can be configured with different toolchains. When the code is built based on the GCC toolchain, the memory layout description file called a linker script is required. When the code is built based on the ARMCC toolchain, the memory layout description file called a scatter file is used.

This section describes how to use the linker script provided by MediaTek and how to configure the linker script when building code with GCC toolchain. The scatter file will be introduced in see section 2.5.1, "Adjusting the memory layout".

The linker script is located under /project/<board>/apps/<project>/GCC/. Each application has its own linker script based on the preferred memory layout.

2.4.1. Memory layout configuration

By default, there is no need to modify the linker script. To create a new memory layout, a new linker script should be written.

The layout configuration information you can use in the modules is shown in Table 1.

Table 1. Tips for changing the memory layout of MT76x7 platform

Modules	Tips
Bootloader	The starting address and size of the bootloader are fixed, no need to modify.
N9 RAM	The starting address and size of the N9 RAM are fixed, no need to modify.
ARM Cortex-M4 firmware	The starting address of the ARM Cortex-M4 firmware is fixed, but the size is configurable.
FOTA buffer	The starting address and size of the FOTA buffer are configurable.
NVDM buffer	The first NVDM buffer located after the Bootloader is not

Modules	Tips
	configurable, no need to modify. The second NVDM buffer starting address and size are configurable (see Figure 1).

2.4.2. Rules to adjust the memory layout

2.4.2.1. Adjusting the layout for ARM Cortex-M4 firmware

If the FOTA feature is not in use, you can increase the size of the ARM Cortex-M4 firmware for your application usage. The steps to increase the size of the ARM Cortex-M4 firmware are shown below:

- 1) Modify the XIP_CODE length in the MT76x7_flash.ld.

```
MEMORY
{
    ...
    XIP_CODE          (arx) : ORIGIN = 0x10079000, LENGTH = 0x000BF000
    ...
}
```

- 2) Modify the macro definition FLASH_CM4_XIP_CODE_SIZE in project\<board>\apps\<application>\inc\flash_map.h.
- 3) Rebuild the bootloader and the ARM Cortex-M4 firmware.

2.4.2.2. Adjusting the FOTA buffer size

The steps to adjust the FOTA buffer are shown below:

- 1) Modify the size of the ARM Cortex-M4 firmware, if necessary. See section 2.4.2.1, “Adjusting the layout for ARM Cortex-M4 firmware”.
- 2) Modify the macro definition for FOTA buffer size FLASH_TMP_SIZE in project\<board>\apps\<application>\inc\flash_map.h.



Note: For more information about FOTA buffer, please refer to MediaTek LinkIt™ Development Platform for RTOS Firmware Update Developer's Guide located under the SDK/doc folder.

2.4.2.3. Adjusting the NVDM buffer size

The steps to adjust NVDM buffer size are shown below;

- 1) Modify size of the ARM Cortex-M4 firmware if necessary. Please see section 2.4.2.1, “Adjusting the layout for ARM Cortex-M4 firmware”.
- 2) Modify FOTA buffer size if necessary. Please see section 2.4.2.2, “Adjusting the FOTA buffer size”.
- 3) Modify the macro definition for the NVDM buffer size FLASH_USR_CONF_SIZE in the project\<board>\apps\<application>\inc\flash_map.h. This macro represents the NVDM buffer size.

For more details, please refer to the NVDM module of HAL in the MediaTek LinkIt™ Development Platform for RTOS API reference.

2.5. Memory layout adjustment with a scatter File

The scatter file is located under `/project/<board>/apps/<project>/MDK-ARM/`. Each application has its own scatter file and each scatter file can have different memory layout based on the specific application, see section 2.4, “Memory layout adjustment with a linker script” for a difference between the linker script and the scatter file.

2.5.1. Adjusting the memory layout

By default, there is no need to modify the scatter file. To create a new memory layout, a new scatter files should be written. For more information about writing a scatter file, please refer to chapter 5 of the [RealView® Compilation Tools, Linker and Utilities Guide](#).

For more details about how to adjust the memory layout, see section 2.4.2, “Rules to adjust the memory layout”.

3. Memory Layout and Configuration for MT2523x

The MT2523x chipsets support three types of physical memory, Serial Flash, Pseudo Static Random Access Memory (PSRAM) and Tightly Coupled Memory (TCM). The memory layouts are designed based on the three types of memory.

The virtual memory on the MT2523x is provided for cacheable memory and is implemented based on the memory mapping mechanism of ARM Cortex-M4. The virtual address range from 0x10000000 to 0x14000000 is mapped to the PSRAM address range from 0x00000000 to 0x04000000, as shown in Figure 5. The virtual memory region (0x10000000 ~ 0x14000000) is used as cacheable memory. All read-write (RW) data is stored in this region by default.

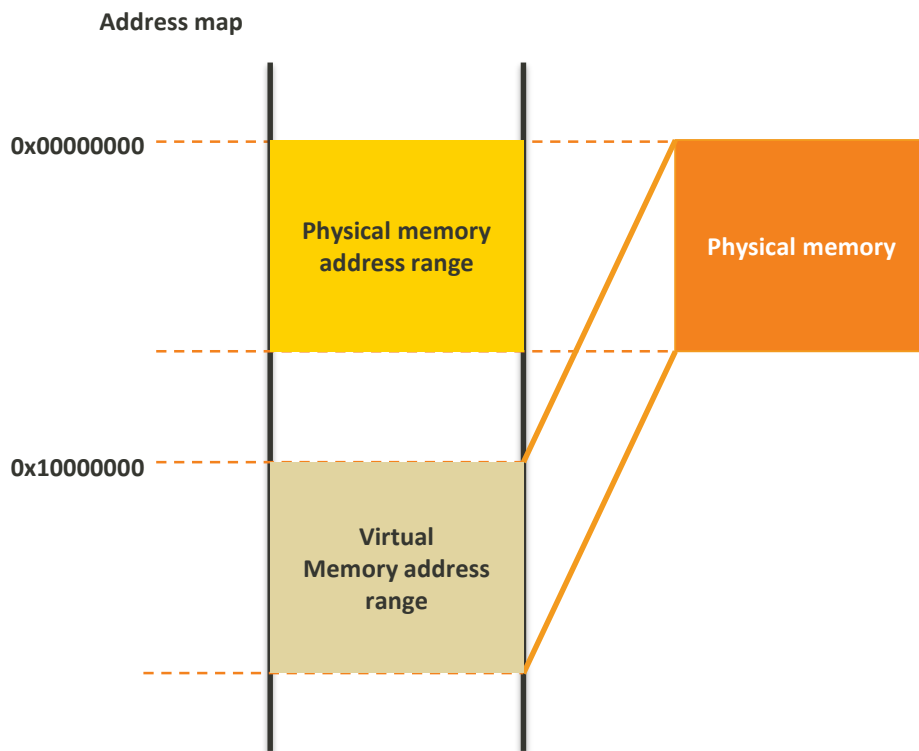


Figure 5. MT2523x virtual memory mapping



Note, that the address 0x04000000 doesn't limit the PSRAM size to 64MB. It only specifies the maximum range of the PSRAM region supported by the LinkIt 2523 HDK.

The memory layout can be defined with the firmware update over the air (FOTA) and without FOTA. Each of the layouts has two views described above.

This section guides you through:

- Types of the memory layout
- Programming guide
- Memory Layout Adjustment with a

- Linker Script
- Scatter File

3.1. Memory layout without FOTA

3.1.1. Load view

MT2523x has 4MB internal serial flash memory. The load view on the flash memory with disabled FOTA for MT2523D and MT2523G is shown in Figure 6. The load view on the flash memory with disabled FOTA for MT2533 is shown in Figure 7.

- Bootloader. The bootloader binary is always located at the very beginning of the flash memory. The size of the bootloader is not configurable and is fixed to 64kB size.
- ARM Cortex-M4 firmware. This section of the memory is reserved for the RTOS binary.
- External DSP buffer. This section is only available on MT2533 and it's reserved for external DSP image. External DSP is a third-party DSP which provides voice recognition and advanced noise suppression technologies. Other third-party audio/speech handling algorithms can also be integrated in this external DSP, if needed.
- The end of the flash is a reserved buffer for NVDM buffer and Extended Prediction Orbit (EPO) buffer. For more information about the EPO, please refer to MediaTek LinkIt™ Development Platform for RTOS GNSS Developers Guide under SDK/doc folder. The size of the NVDM is configurable, but the size of the EPO buffer is not configurable.

The start address and the maximum size of each binary and reserved buffer are configurable, see section 3.4, "Memory layout adjustment with a linker script" for more details.

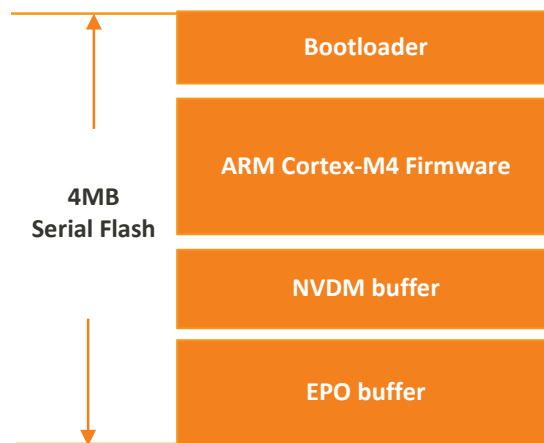


Figure 6. Load view of the MT2523D and MT2523G memory layout without FOTA

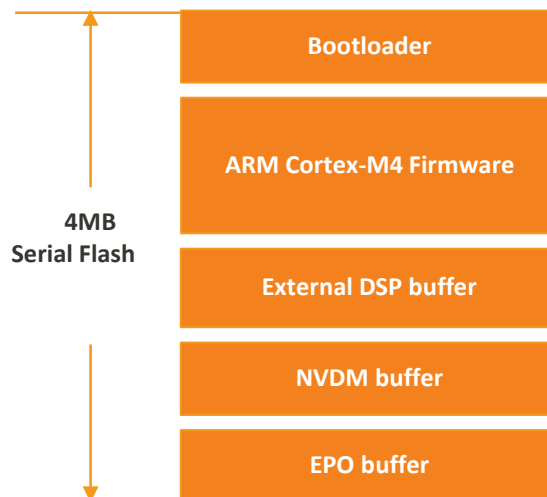


Figure 7. Load view of the MT2533 memory layout without FOTA

For more information about FOTA, refer to MediaTek LinkIt™ Development Platform for RTOS Firmware Update Developer's Guide located under SDK/doc folder.

For more information about NVDM, refer to MediaTek LinkIt™ Development Platform for RTOS API reference guide.

For more information about EPO, refer to the MediaTek LinkIt™ Development Platform for RTOS GNSS Developers Guide under SDK/doc folder.

3.1.2. Execution view

Execution view describes where the code and data are located during the program runtime, as shown in Figure 8 for MT2523D and MT2523G, and Figure 9 for MT2533. The execution view is based on the Serial Flash, PSRAM and TCM, as described below:

- Serial Flash. The code and read-only (RO) data are located in the flash memory during runtime.
- PSRAM.
 - Vector table, single bank code, and some high-performance code and data are stored at the beginning of PSRAM.
 - Non-cacheable read-write (RW) data and zero-initialized (ZI) data.
 - Cacheable RW data and ZI data.
- TCM. Some critical and high-performance code or data can be stored into the TCM. See section 3.3, "Programming guide" to learn how to put code or data to the TCM.
 - Code and RO data.
 - RW data and ZI data.
 - The system stack.

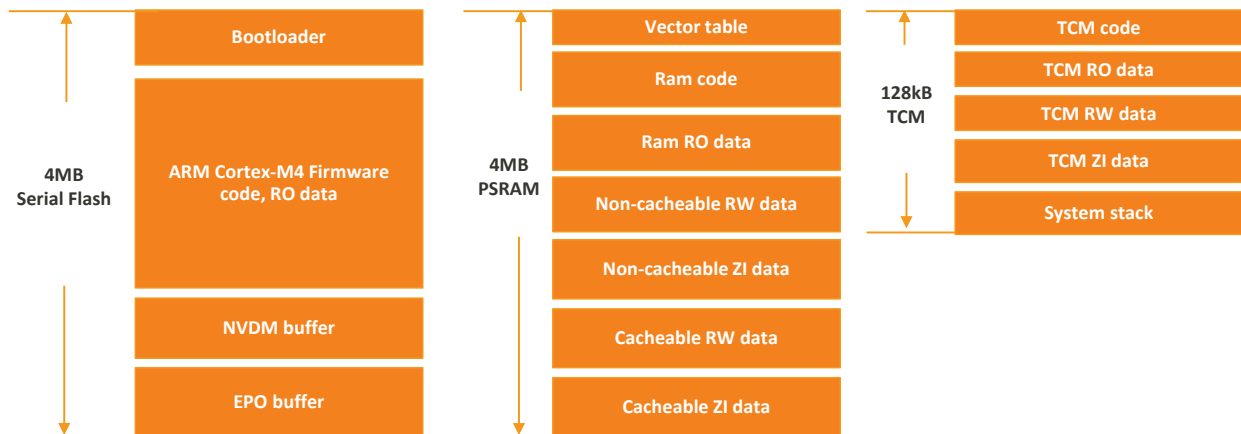


Figure 8. Execution view of the MT2523D and MT2523G memory layout without FOTA

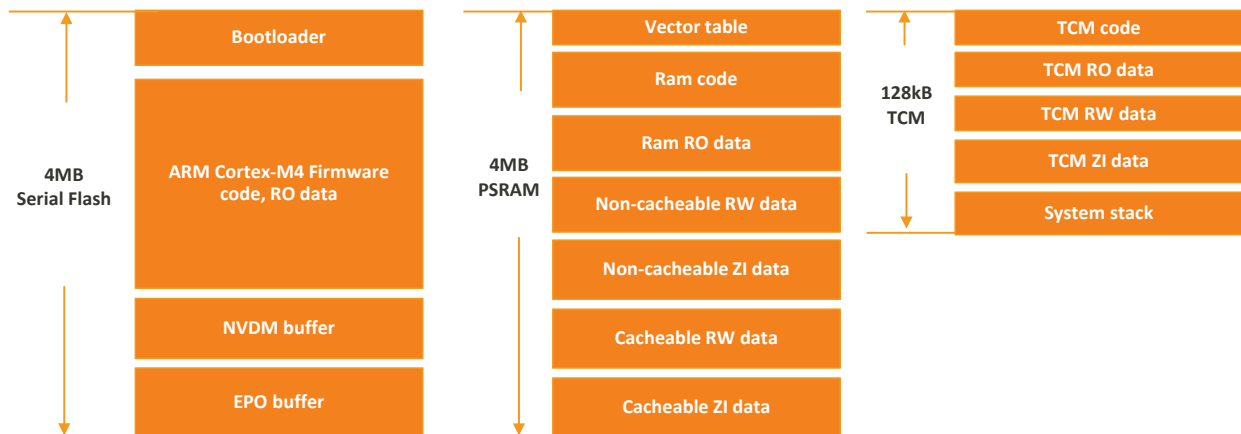


Figure 9 Execution view of the MT2533 memory layout without FOTA

3.2. Memory layout with FOTA of full binary update

3.2.1. Load view

If FOTA is enabled, the memory flash layout's load view is, as shown in Figure 10 for MT2523D and MT2523G, and Figure 11 for MT2533. A FOTA buffer is added for temporary storage of the binary that will be used to update the current ARM Cortex-M4 firmware. The start address and maximum size of each binary and the reserved space of certain memory layouts are configurable, see section 3.4, "Memory layout adjustment with a linker script" for more details. To enable FOTA, please refer to the MediaTek LinkIt™ Development Platform for RTOS Firmware Update Developer's Guide located under the SDK /doc folder.

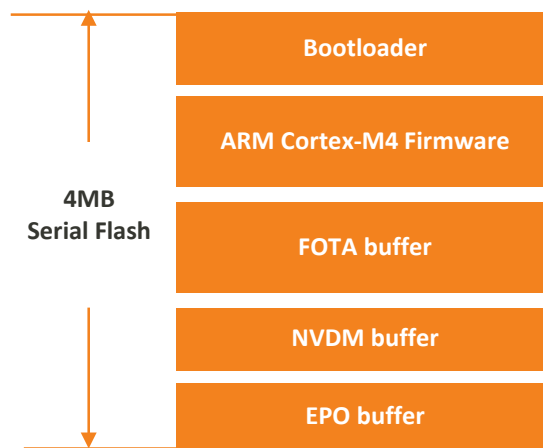


Figure 10. Load view of the MT2523D and MT2523G memory layout with full binary FOTA

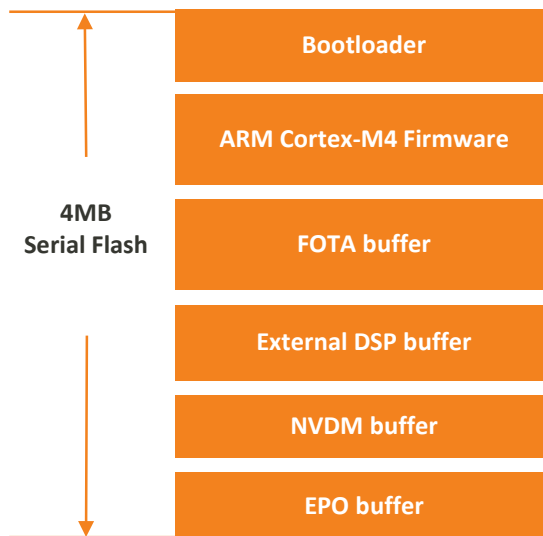


Figure 11 Load view of the MT2533 memory layout with full binary FOTA

3.2.2. Execution view

The execution view (see Figure 12 for MT2523D and MT2523G, and Figure 13 for MT2533) at runtime is described below.

- Serial Flash. The code and RO data are located in the flash memory during runtime.
- PSRAM.
 - Vector table, single bank code, and some high-performance code and data are stored at the beginning of the PSRAM.
 - Non-cacheable RW data.
 - Cacheable RW data.
- TCM. Some critical and high-performance code and data can be stored in the TCM. See section 3.3, “Programming guide” to learn how to put code or data to the TCM.

- Code and RO data.
- RW data, ZI data.
- The system stack.

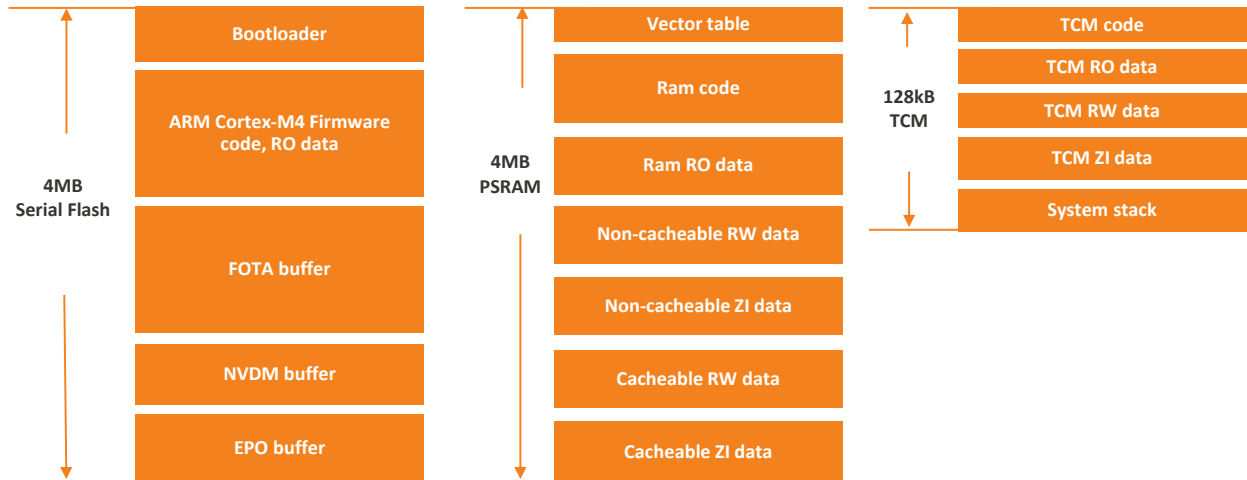


Figure 12. Execution view of the MT2523D and MT2523G memory layout with full binary FOTA

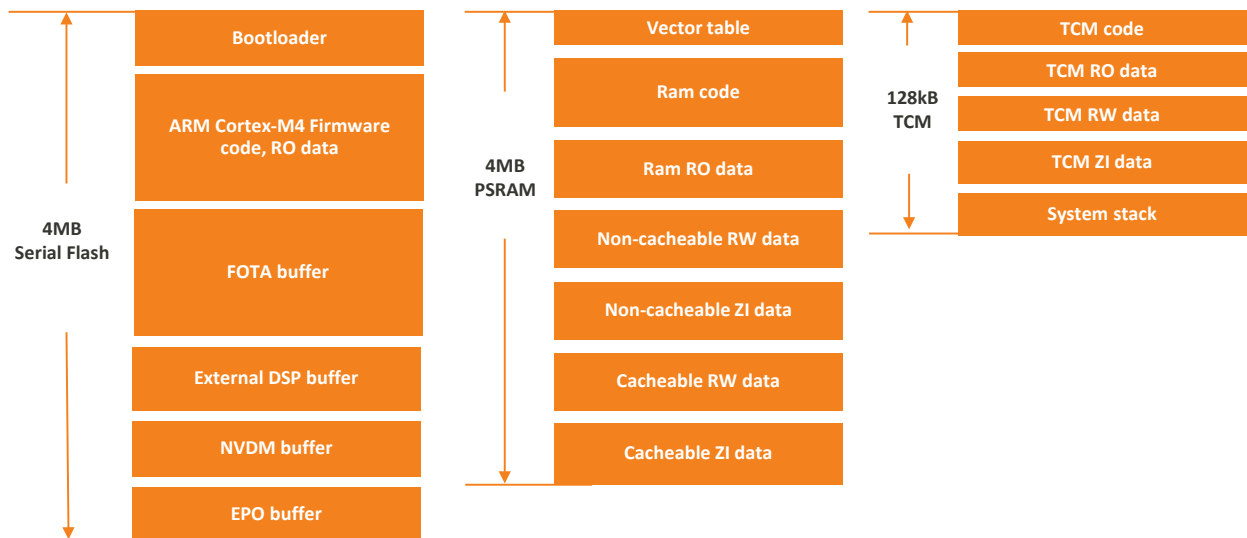


Figure 13. Execution view of the MT2533 memory layout with full binary FOTA

3.3. Programming guide

This programming guide is based on the memory layout described in see section 3.1.2, “Execution view”. The following recommendations allow the developers to place the code successfully to the desired memory location during runtime.

- 1) Place the code or RO data to the Serial Flash at runtime.

By default, the code or RO data is placed in the flash, execute in place (XIP), no need to modify.

- 2) Place the code or RO data to the PSRAM at runtime.

To run the code or access RO data in the PSRAM with better performance, specify the attribute explicitly in your code, as shown in the example below.

```
//code
ATTR_TEXT_IN_RAM int func(int par)
{
    int s;
    s = par;
    //....
}
//RO data
ATTR_RODATA_IN_RAM const int b = 8;
```

For comparison, if the attribute is not explicitly defined, during the function call the code will be placed in the Serial Flash instead of the PSRAM.

```
//code
int func(int par)
{
    int s;
    s = par;
    //....
}
//RO data
const int b = 8;
```

3) Place RW data or ZI data to non-cacheable memory at runtime.

To access RW data and ZI data in the non-cacheable memory with special purpose such as direct memory access (DMA) buffer, specify the attribute explicitly in your code, as shown in the example below.

```
//RW data
ATTR_RWDATA_IN_NONCACHED_RAM int b = 8;
//ZI data
ATTR_ZIDATA_IN_NONCACHED_RAM int b;
```

For comparison, if the attribute is not explicitly defined, the data will be placed in the cacheable memory instead of the non-cacheable memory.

```
//RW data
int b = 8;

//ZI data
int b;
```

4) Place RW data or ZI data to cacheable memory at runtime.

By default, RW data/ZI data are placed in the cacheable memory, no need to modify.

5) Place code or RO data to the TCM at runtime.

To run the code or access RO data in the TCM with better performance, specify the attribute explicitly in your code, as shown in the example below.

```
//code
ATTR_TEXT_IN_TCM int func(int par)
{
    int s;
    s = par;
    //....
}
//RO data
```

```
ATTR RODATA IN_TCM const int b = 8;
```

For comparison, if the attribute is not explicitly defined, during the function call the code will be placed in the Serial Flash instead of the TCM.

```
//code
int func(int par)
{
    int s;
    s = par;
    //....
}
//RO data
const int b = 8;
```

6) Put RW data/ZI data to TCM at runtime.

To access RW data and ZI data in the TCM with better performance, you should specify the attribute explicitly in your code, as shown in the example below.

```
//rw-data
ATTR RWDATA_IN_TCM int b = 8;
//zi-data
ATTR ZIDATA_IN_TCM int b;
```

For comparison, if the attribute is not explicitly defined, the data will be placed in the PSRAM instead of the TCM.

```
//RW data
int b = 8;
//ZI data
int b;
```

3.4. Memory layout adjustment with a linker script

The memory layout can be configured with different toolchains. When the code is built based on the GCC toolchain, the memory layout description file called a linker script is required. When the code is built based on ARMCC toolchain, the memory layout description file called a scatter file is used.

This section describes how to use the linker script provided by MediaTek and how to configure the linker script when building code with the GCC toolchain. The scatter file will be introduced in see section 3.5, "Memory layout adjustment with a scatter file".

3.4.1. Types of linker scripts

Two kinds of linker scripts are provided:

- Template linker script – every application linker script should be based on the template linker script.
- Application linker script – every application has its particular linker script. This linker script is passed to the linker during linking stage.

3.4.1.1. Template linker script

Template linker scripts are based on the memory layout see section 3.1 and 3.2. If the memory layout is modified, the linker script should also be modified manually. It's recommended to use the layout and linker scripts provided by MediaTek as a reference for your customizations.

The template linker scripts are located under /driver/CMSIS/Device/MTK/<chip>/linkerscript/GCC/ folder.

The folder includes:

- **default.** This folder contains a template linker script to build a project without FOTA memory layout, see section 3.1, “Memory layout without FOTA”.
- **full_bin_fota.** This folder contains a template linker script to build a project with full binary FOTA memory layout, see section 3.2, “Memory layout with FOTA of full binary update”
- **ram.** This folder contains a template linker script to enable RAM debugging. To place all your code into PSRAM, use this linker script as a reference.

3.4.1.2. Application linker script

The application linker script is located under `/project/<board>/apps/<project>/GCC/` folder. Each application has its own linker script and each linker script can have a different memory layout configuration based on the application requirements.

3.4.2. How to use the linker script

To create a new linker script file for your application:

- Clone a linker script from the template folder.
- Create a new linker script manually. The memory layout in this case should also be user-defined to match your linker script.

3.4.2.1. Cloning the linker script

To clone a linker script from the template:

- 1) Specify the memory layout feature for your application development, such as without FOTA, full binary FOTA see section 3.1 and 3.2.
- 2) Copy the template linker script from template folder to your application project’s folder, see section 3.4.1, “Types of linker scripts”.
- 3) Memory layout without FOTA.

Copy `/driver/CMSIS/Device/MTK/<chip>/linkerscript/GCC/default`
to `/project/<board>/apps/<project>/GCC/`.

- 4) Memory layout with FOTA full binary update.

Copy `/driver/CMSIS/Device/MTK/<chip>/linkerscript/GCC/full_bin_fota`
to `/project/<board>/apps/<project>/GCC/`.

- 5) Memory layout with RAM debugging.

Copy `/driver/CMSIS/Device/MTK/<chip>/linkerscript/GCC/ram` to `/project/<board>/apps/<project>/GCC/`.

- 6) Modify the linker script according to the application requirements.

3.4.3. Rules to adjust the memory layout

The memory layout can be customized to fit the application requirements. However, the bootloader and EPO buffer is not configurable. The rest of the memory layout can be adjusted as follows.

Common rules for different memory layout adjustment settings are described below.

- 1) The address and size must be block aligned. The default block size is 4kB and is defined in `driver/chip/<chip>/inc/flash_opt_gen.h` header file.
- 2) To configure the size or the address, make sure there is no overlap between two adjacent memory regions. The total size of all the regions should not exceed the physical flash size.

3.4.3.1. Adjusting the layout for ARM Cortex-M4 firmware

To adjust the memory assigned to ARM Cortex-M4 firmware:

- 1) Modify the `ROM_RTOS` length and starting address in the `flash.ld` linker script under the GCC folder of the project.

```
MEMORY
{
    ...
    ROM_RTOS(rx)          : ORIGIN = 0x08010000, LENGTH = 3072K
    ...
}
```

- 2) Modify the macro definitions for `RTOS_BASE` and `RTOS_LENGTH` in `project/<board>/apps/<application>/inc/memory_map.h` header file.
- 3) Rebuild the bootloader and the ARM Cortex-M4 firmware.

Execute the following command under the root folder of the SDK.

```
./build.sh project_board example_name BL
```

The `project_board` is the project folder of a specific hardware board and `example_name` is the name of the example. For example, to build the `hal_adc` of `mt2523_hdk`, the command will be:

```
./build.sh mt2523_hdk hal_adc BL
```

- 4) Make sure the length of ROM region doesn't exceed the flash size of the system and for MT2523 the internal flash is 4MB.

3.4.3.2. Adjusting the memory layout with FOTA full binary update

- 1) Modify ARM Cortex-M4 firmware size if needed see section 3.4.3.1, "Adjusting the layout for ARM Cortex-M4 firmware".
- 2) Modify the `ROM_FOTA_RESERVED` length and starting address in the `flash.ld` linker script under the GCC folder of a project.

```
MEMORY
{
    ...
    ROM_FOTA_RESERVED(rx) : ORIGIN = 0x08200000, LENGTH = 1920K
    ...
}
```

- 3) Modify the macro definitions for `FOTA_RESERVED_BASE` and `FOTA_RESERVED_LENGTH` in `project/<board>/apps/<application>/inc/memory_map.h` header file.



Note, refer to the SDK Firmware Upgrade Developer's Guide located under SDK /doc folder for more details about how to adjust the FOTA buffer.

3.4.3.3. Adjusting the NVDM buffer

To adjust the NVDM buffer layout:

- 1) Modify size of the ARM Cortex-M4 firmware if needed see section 3.4.3.1, "Adjusting the layout for ARM Cortex-M4 firmware".
- 2) Modify FOTA buffer size if needed see section 3.4.3.2, "Adjusting the memory layout with FOTA full binary update".
- 3) Modify the ROM_NVDM_RESERVED length and starting address in the `flash.ld` if no FOTA or full binary FOTA feature is enabled

```
MEMORY
{
    ...
    ROM_NVDM_RESERVED(rx) : ORIGIN = 0x083E0000, LENGTH = 64K
    ...
}
```

- 4) Modify the macro definitions for ROM_NVDM_BASE, ROM_NVDM_LENGTH in `project\<board>\apps\<application>\inc\memory_map.h` header file.



Note, to adjust the NVDM buffer, please refer to the NVDM module of HAL in the MediaTek LinkIt™ development platform for RTOS API reference.

3.5. Memory layout adjustment with a scatter file

3.5.1. Types of scatter files

Two types of scatter files are provided:

- Template scatter file – every application scatter file should be based on the template scatter file.
- Application scatter file – every application has its particular scatter file. This scatter file will be passed to the linker during linking stage.

3.5.1.1. Template scatter file

Template scatter files are based on the memory layout, see section 3.1 and 3.2. If you've changed the memory layout, you should also modify the scatter file manually. It's recommended to use the layout and scatter files provided by MediaTek as a reference for your customizations.

The template scatter files are located under `/driver/CMSIS/Device/MTK/<chip>/linkerscript/RVCT/` folder. The folder includes:

- `default`. This folder contains a template scatter file to build a project without FOTA memory layout, see section 3.1, "Memory layout without FOTA".

- `full_bin_fota`. This folder contains a template scatter file to build a project with full binary FOTA memory layout, see section 3.2, “Memory layout with FOTA of full binary update”
- `ram`. This folder contains a template scatter file to enable RAM debugging. To place all your code into PSRAM, you can use this scatter file as a reference.

3.5.1.2. Application scatter file

The application scatter file is located under `/project/<board>/apps/<project>/MDK-ARM/` folder. Each application has its own scatter file and each scatter file can have a different memory layout configuration based on the application requirements.

3.5.2. How to use the scatter file

To create a new scatter file for your application:

- Clone a scatter file from the MDK-ARM folder of the template folder.
- Create a new scatter file manually. The memory layout in this case should also be user-defined to match your scatter file.

3.5.2.1. Cloning the scatter file

To clone a scatter file from the template:

- 1) Specify the memory layout feature for your application development, such as without FOTA, full binary FOTA see section 3.1 and 3.2.
- 2) Copy the template scatter file from template folder to your application project’s folder, see section 3.5.1, “Types of scatter files”.
- 3) Memory layout without FOTA.

Copy `/driver/CMSIS/Device/MTK/<chip>/linkerscript/rvct/default`
to `/project/<board>/apps/<project>/MDK-ARM/`.

- 4) Memory layout with FOTA full binary update.

Copy `/driver/CMSIS/Device/MTK/<chip>/linkerscript/rvct/full_bin_fota`
to `/project/<board>/apps/<project>/MDK-ARM/`.

- 5) Memory layout with RAM debugging.

Copy `/driver/CMSIS/Device/MTK/<chip>/linkerscript/rvct/ram` to `/project/<board>/apps/<project>/MDK-ARM/`.

- 6) Modify the scatter file according to the application requirements.

3.5.3. How to configure the scatter file

The configuration is the same; see section 3.4.3, “Rules to adjust the memory layout”.