

## 1 Introduction

This application note introduces the OTA progress based on the Alibaba Cloud IoT platform on the i.MX RT10XX series platform.

Secure Bootloader (SBL) is a second bootloader tool designed by the MCU SE team for the i.MX RT platform. SBL helps users to start the program safely.

Secure Firmware (SFW) is a project created based on FreeRTOS. Firmware is generated to cooperate with SBL to achieve a complete FOTA process. The Alibaba Cloud IoT platform OTA in this document is a part of SFW. SFW also supports U disk, SD card, and OTA upgrade of AWS platform.

## 2 Development platform

The Alibaba Cloud-based OTA is developed for all EVK boards (with Ethernet ports) of MIMXRT10XX series. The cloud platform we use is Alibaba Cloud and we use Alibaba Cloud C Link SDK 4.0.0 as the device-side SDK.

## 3 Configuring Alibaba cloud OTA upgrade code

### 3.1 Creating device in cloud

To implement the OTA upgrade of the Alibaba Cloud IoT platform, transplant the C Link SDK provided by the Alibaba Cloud IoT platform (Alibaba Cloud C-SDK 4.0.0 is used for this migration) into the project first. Log in to [Aliyun Internet of Things platform](#), enter the public instance section, and create your own product.

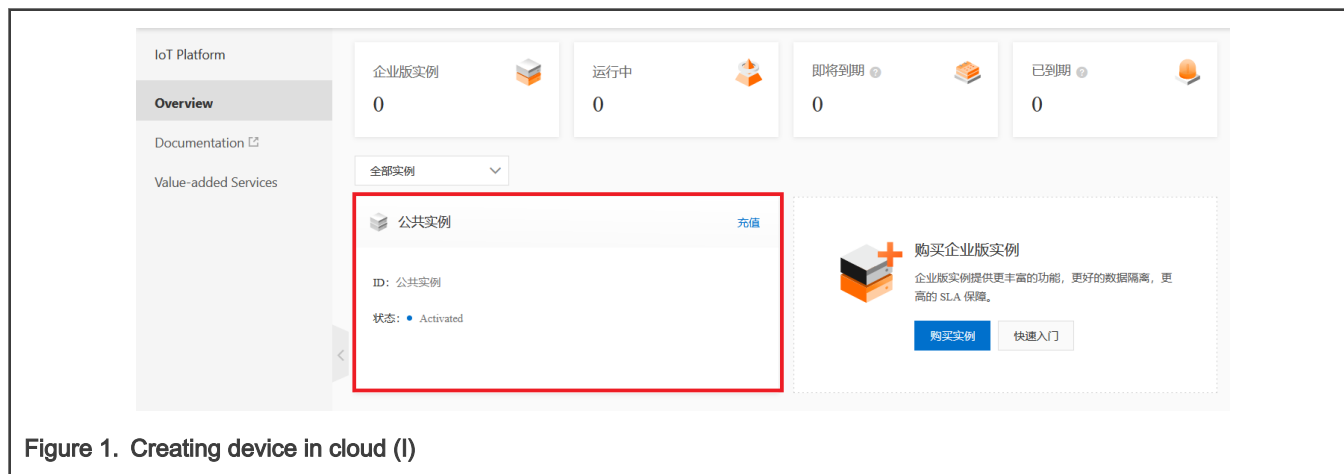


Figure 1. Creating device in cloud (I)

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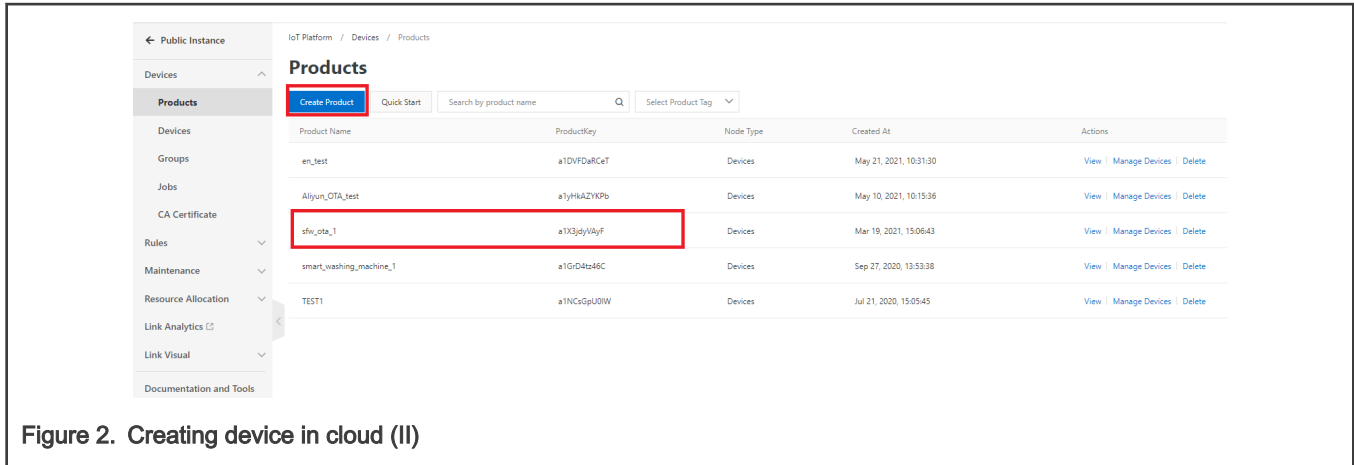


Figure 2. Creating device in cloud (II)

This example only realizes the OTA function of the i.MX RT platform, so no special requirements are required for the product category. Select any one in **Category**, **Direct Connect Device** for **Node Type**, **Ethernet** for **Networking Mode**, and keep default values for other options.

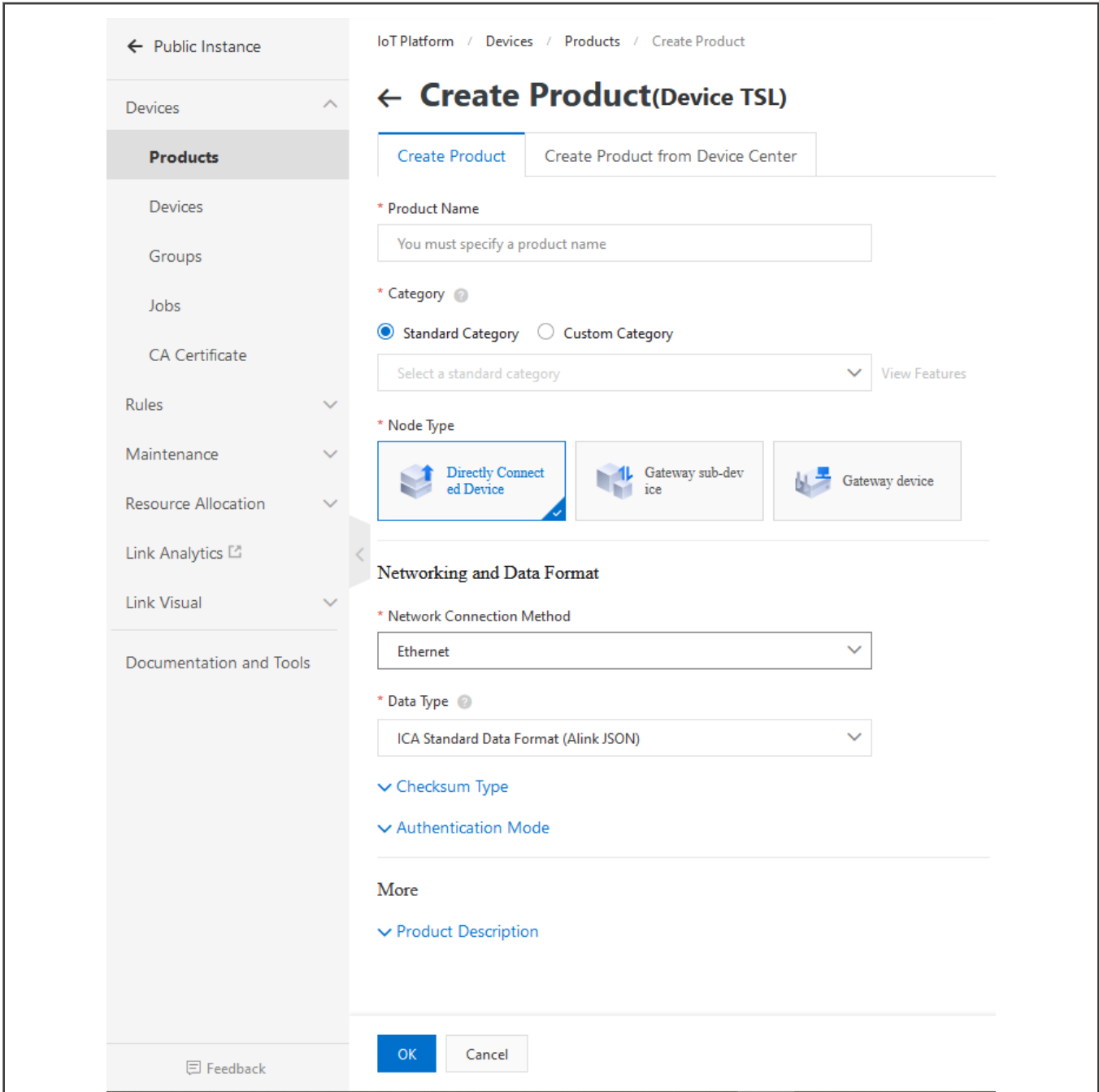


Figure 3. Creating device in cloud (III)

After completing the product creation, create the required equipment under the corresponding product. If you are not familiar with the Alibaba Cloud IoT platform, see *Alibaba Cloud IoT Platform Getting Started-Quick Start* for public examples. So far, we have obtained the triples: **ProductKey**, **DeviceName**, and **DeviceSecret**. They are very important for i.MX RT devices to connect to the Alibaba Cloud IOT platform.

### 3.2 Configuring device-side C-SDK

After creating the product and device, port the Link SDK of the Alibaba Cloud IoT platform to our device. In **Public Instance**, click **Documents and Tools** at the bottom of the left, select **SDK Customization** in **Device Access SDK**, and customize the SDK, as shown in [Figure 4](#). Click **Start Generation** to download the C-SDK.

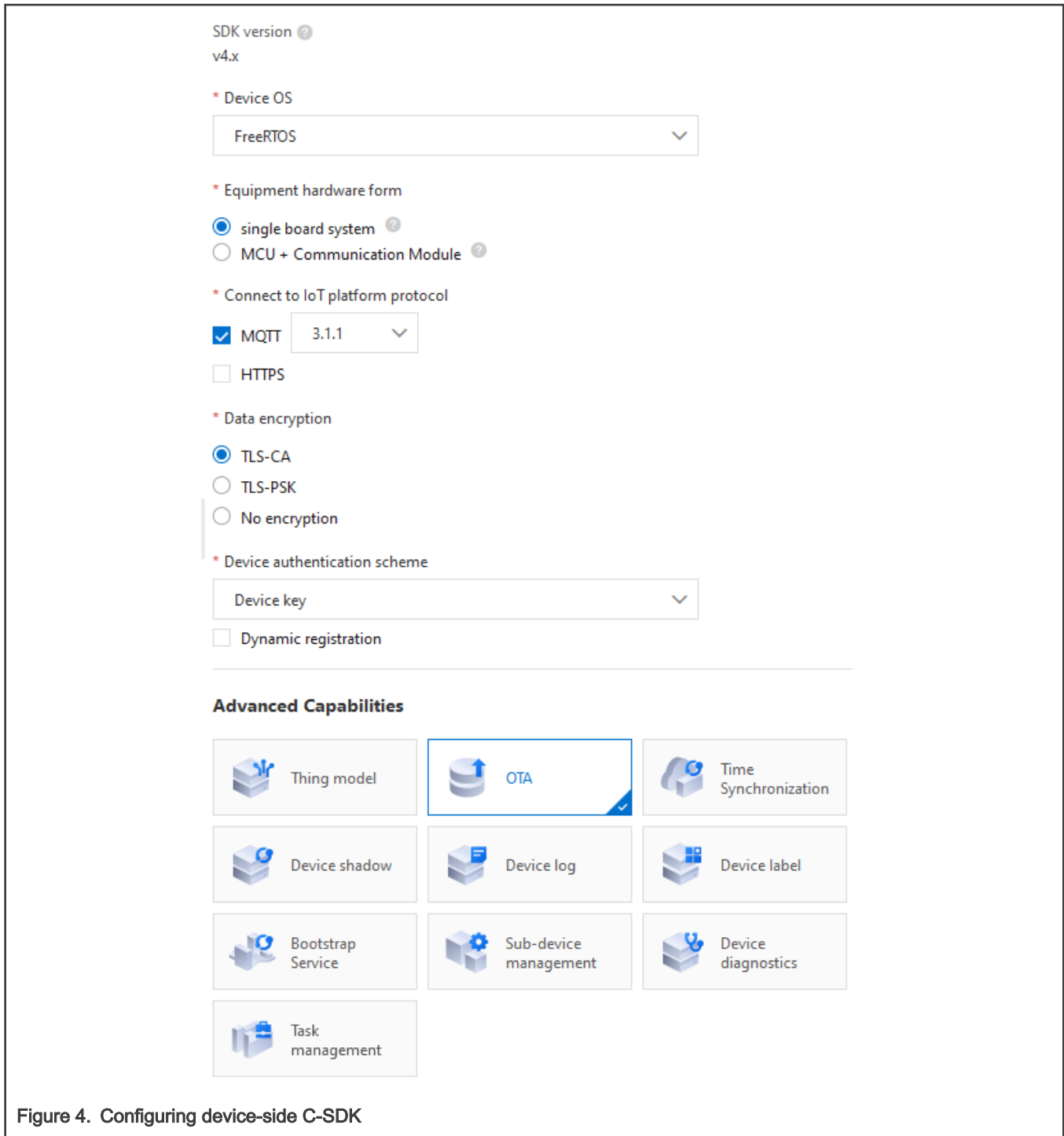


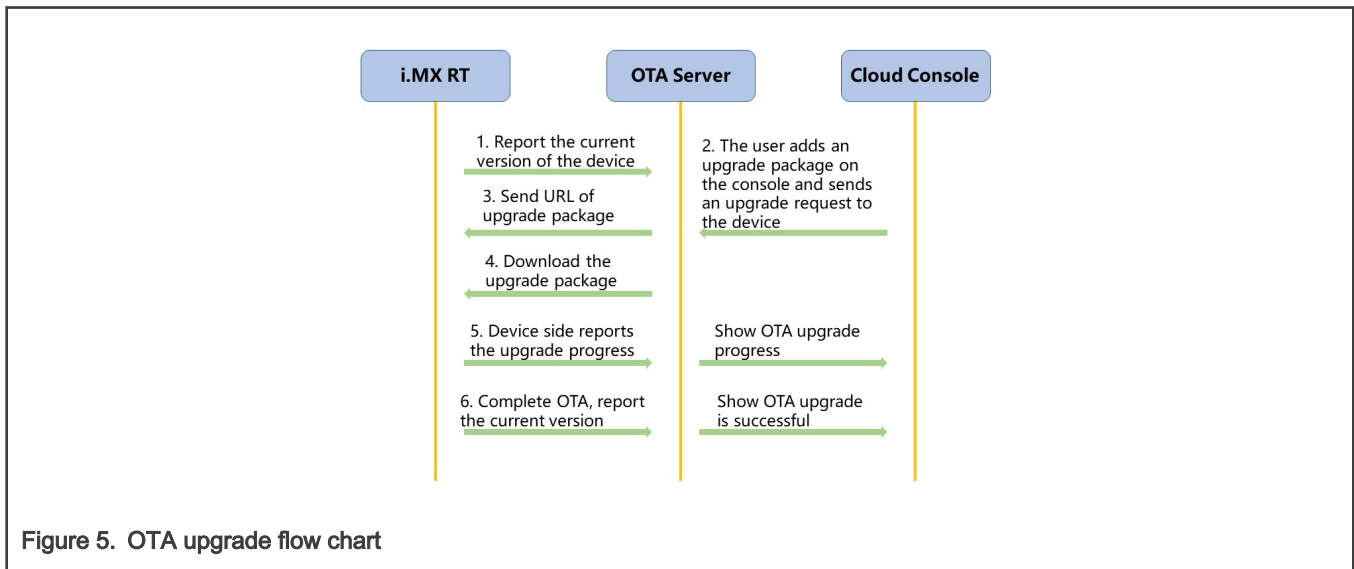
Figure 4. Configuring device-side C-SDK

For an easier modification later, add the following to the original project file.

- The *core*, *OTA* folder, and *certificate ali\_ca\_cert.c* file in the external folder to be used in the downloaded C-SDK package
- *freertos\_port.c* in the *portfiles* folder
- *fota\_basic\_demo.c* in the *demos* folder

The core module of C-SDK is stored in the core folder. It includes the functions of MQTT on the cloud. If you only connect to the cloud and do not need high-level capabilities such as OTA, it can be used. The OTA folder is a high-level function of the Alibaba Cloud IoT platform. After the device integrates the OTA capability in the C-SDK, upload the new firmware in the console and push

the firmware upgrade message to the device. The device can be upgraded online. In this example, the flow chart of OTA upgrade is as shown in Figure 5.



The *ali\_ca\_cert.c* file in the external folder is the root certificate used to verify the MQTT server. The *freertos\_port.c* file in the *portfiles* folder is a set of interface functions implemented in C language, called for the underlying software and hardware resources of the current IOT device. When the C-SDK is ported to embedded devices running different OSs, corresponding modifications are required. To obtain the OTA function, modify the *fota\_basic\_demo.c* file in the C-SDK example.

### 3.3 OTA upgrade program

In the OTA function, pay attention to the following items:

1. Version number of the current firmware

```

cur_version = "1.0.0"; //更改为所需要更新的版本, 如1.1.0

/* 演示MQTT连接建立起来之后, 就可以上报当前设备的版本号了 */
res = aiot_ota_report_version(ota_handle, cur_version);
if (res < STATE_SUCCESS) {
    PRINTF("report version failed, code is -0x%04X\r\n", -res);
}
    
```

During the OTA upgrade process, the cloud must verify the current firmware version number. If the firmware version needs to be upgraded, it sends an upgrade request and the upgrade package URL to the device and the OTA upgrade can continue.

2. Download the firmware at one time

```

uint32_t end = 0; //此处设为0, 代表一次性下载完整固件, 若要分两段下载, 可设为g_firmware_size / 2;
    
```

The callback function, *user\_ota\_rcv\_handler()*, contains preparations for downloading the firmware. The default download method of Alibaba Cloud C-SDK is two-stage download. During the development process, the two-stage download was unstable. I changed to download the entire firmware at one time and the download succeeded.

3. Erase the flash

```

/* 将要写入的地址, 之后size_total大小的区域, 利用sfw_flash_erase擦一下 */
status_t status;
volatile uint32_t primask;

primask = DisableGlobalIRQ();
status = sfw_flash_erase(dstAddr, FLASH_AREA_IMAGE_1_SIZE);
EnableGlobalIRQ(primask);

```

After receiving the MQTT message of the OTA upgrade on the device side, it downloads the new firmware and the device side is burned to the designated flash location. Before that, wipe the area first.

4. Burn the downloaded firmware to the flash, download in sections, and save each section one by one.

```

/*
 * 如果烧写flash失败, 还应该调用 aiot_download_report_progress(handle, -4) 将失败上报给云平台
 * 备注: 协议中, 与云平台商定的错误码在 aiot_ota_protocol_errcode_t 类型中, 例如
 *       -1: 表示升级失败
 *       -2: 表示下载失败
 *       -3: 表示校验失败
 *       -4: 表示烧写失败
 */
// 将下载的固件保存到flash上, 分段下载, 每一段一保存
status_t status;
volatile uint32_t primask;

primask = DisableGlobalIRQ();
status = sfw_flash_write(dstAddr, packet->data.buffer, packet->data.len);
if (status)
{
    aiot_download_report_progress(handle, -4);
}
dstAddr += packet->data.len;
EnableGlobalIRQ(primask);

```

For details of other areas that can be changed, see Alibaba Cloud C-SDK.

## 4 OTA demo

The Alibaba Cloud OTA upgrade project cooperates with the SBL project. The platform is i.MX RT1064EVK. It uses Ethernet to connect to the network and users can also configure the wireless module to connect to the network.

1. Modify the current version and generate the bin file.

```
cur_version = "1.0.0"; //更改为所需要更新的版本, 如1.1.0
```

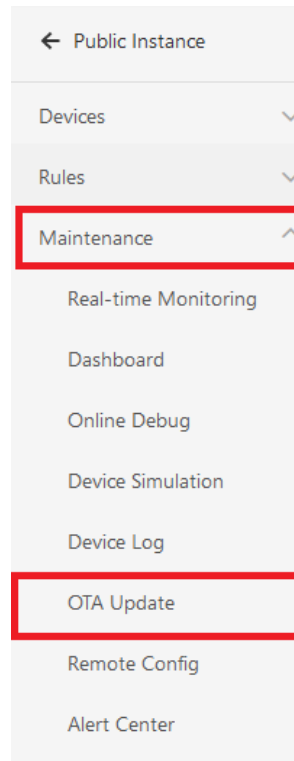
```
cur_version = "1.4.0"; //更改为所需要更新的版本, 如1.1.0
```

Modify the current version in IAR to 1.0.0 and 1.4.0. Generate the corresponding bin files. The IAR project is used as an example here.

2. In SBL project, use the signature script to add the header signature operation of the bin file.

Copy the two bin files generated in [Step 1](#) to the `sbl/component/secure/mcuboot/scripts` folder in the SBL project and use PowerShell to sign the two bin files.

3. Create OTA task.



On the cloud console page, in the monitoring operation and maintenance under the public instance, select **OTA upgrade**. Click **Add Upgrade Package** to add the upgrade package, enter the upgrade package name, and select the corresponding upgrade option.

**NOTE**

The upgrade package version must be consistent with the version in the uploaded bin file. Otherwise, the subsequent OTA fails.

Add Update Package
✕

\* Types of Update Packages ?

Full

Differential

\* Update Package Name ?

sfw\_1064\_140

\* Product

en\_test
▼

\* Update Package Module

default
▼

[+ Add Module](#)

\* Update Package Version ?

1.4.0

\* Signature Algorithm

MD5
▼

\* Select Update Package ?

Re-upload
✕

✔ 1064\_ali\_140.bin (266.21 KB)
✕

\* Verify Update Package? ?

Yes  No

Update Package Description

Please enter upgrade package description

0/1024

[Security Check Service of Update Package](#)

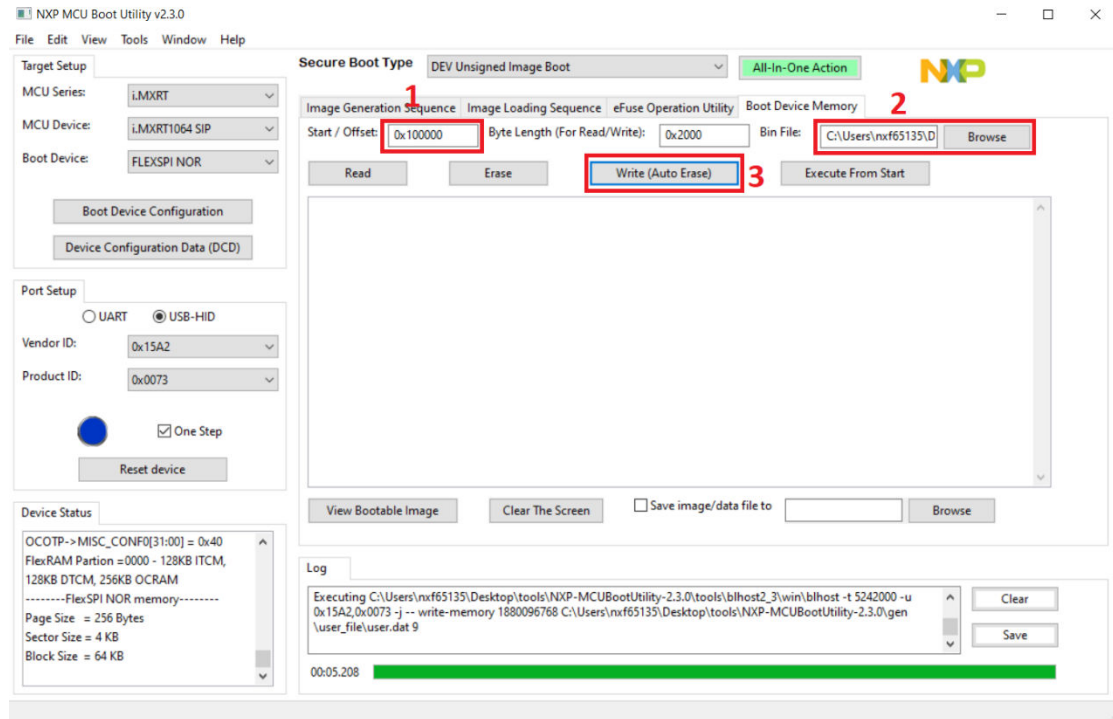
OK

Cancel

4. Start running OTA project.

- a. Use the MCUBootUtility tool to download the signed *1064\_ali\_100.bin* to the first slot of the board. The default location of Slot1 is the **flash\_offset+0x100000** to **flash\_offset+0x200000** and the whole slot size is 1 MB.





b. Run the secure Bootloader.

In SBL project, enter the `sbl/target/evkmimxrt1064` path and open `env.bat`. In the `menuconfig` interface of Scons, uncheck **Enable single image function** to disable single image mode and uncheck **Enable mcu isp support** to disable MCU ISP support.

Compile the i.MX RT1064 SBL project and download it to the target board. Now the whole preparation is done.

Insert the Ethernet cable on the development board and press the **Reset** button to start the project. The serial port displays **The image now in PRIMARY\_SLOT slot** and **Getting IP address from DHCP**, indicating that the program in Slot 1 is running successfully. **IPv4 Address:** and **version:1.0.0** indicate that the network connection is successful and the version of the current device received by Alibaba Cloud is 1.0.0.

```

hello sbl.
Bootloader Version 0.0.1
Remap type: none
The image now in PRIMARY_SLOT slot
Bootloader chainload address offset: 0x100000
Reset_Handler address offset: 0x100400
Jumping to the first image slot
hello sfw.
host init done
This example to demonstrate how to use U-Disk to implement ota.
Hello world1.
This example to demonstrate how to use AliCloud to implement ota.
Initializing PHY...
Hello world2.
This example to demonstrate how to use SD card to implement ota.
Please plug in a u-disk to board.
Hello world1.
Hello world1.
Hello world1.
Getting IP address from DHCP ...
Hello world2.
Please insert a card into board.

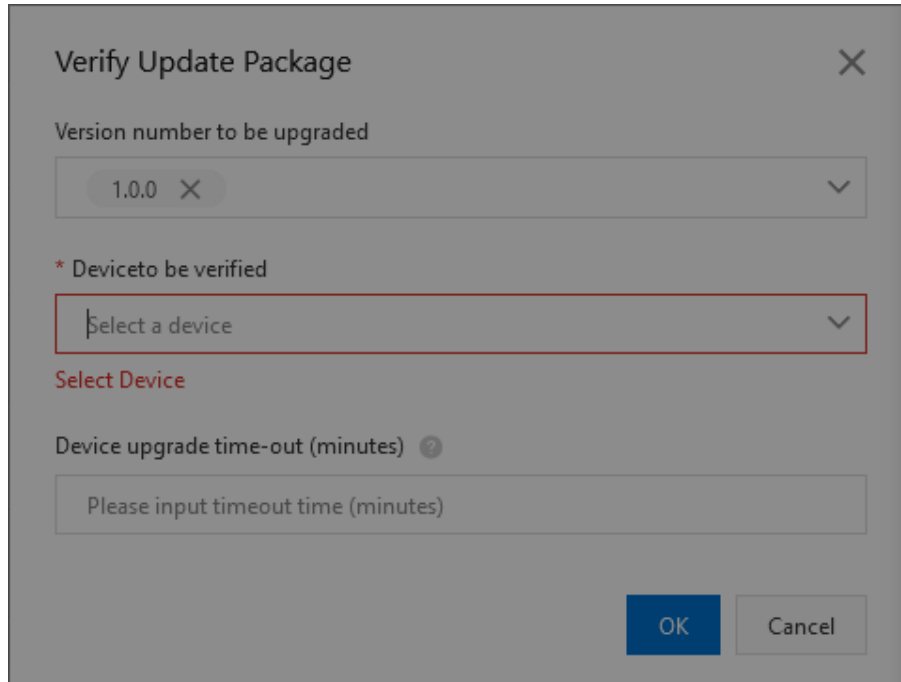
```

```

IPv4 Address: 192.168.8.109
UNCF OK
[17.999][LK-0313] MQTT user calls aiot_mqtt_connect api, connect
[17.999][LK-0317] SFW_K_1&a1X3jdyVayF
[17.999][LK-0318] 988FDf6E4D0cC6D726D63867DA18EDCFD89E1B8DFA9A41D4B9AA66B9F98E6127
unknown option
unknown option
    establish tcp connection with server(host='a1X3jdyVayF.iot-as-mqtt.cn-shanghai.aliyuncs.com', port=[443])
Hello world1.
success to establish tcp, fd=0
[18.222][LK-0313] MQTT connect success in 264 ms
AIOT_MQTT_EVT_CONNECT
[18.222][LK-0309] pub: /ota/device/inform/a1X3jdyVayF/SFW_K_1
[LK-030A] > 78 22 69 64 22 3A 31 2C 20 22 70 61 72 61 6D 73 | {"id":1, "params
[LK-030A] > 22 3A 78 22 76 65 72 73 69 6F 6E 22 3A 22 31 2E | ":{"version":1.
[LK-030A] > 30 2E 30 22 7D 70 | 0.0}}
Hello world2.
Hello world1.

```

When uploading the upgrade package, because the upgrade package verification is selected, the verification operation is required after the current version information is received in the cloud. Go back to the console, click **Verify**, fill in the version number that must be upgraded, and select the currently upgraded device.



After the selection, the serial port displays the upgrade package information. The OTA target version is 1.4.0 and the size information is also displayed.

```

Hello world!.
[21.888][LK-0309] pub: /ota/device/upgrade/a1X3jdyVAYF/SFW_K_1

[LK-030A] < 7B 22 63 6F 64 65 22 3A 22 31 30 30 30 22 2C 22 | {"code":"1000", "
[LK-030A] < 64 61 74 61 22 3A 7B 22 73 69 7A 65 22 3A 32 37 | data":{"size":27
[LK-030A] < 32 36 30 30 2C 22 64 69 67 65 73 74 53 69 67 6E | 2600,"digestSign
[LK-030A] < 22 3A 22 45 34 45 4F 72 42 6D 4C 37 77 55 46 6B | ":"E4E0rBmL7wUfK
[LK-030A] < 41 78 39 66 6E 57 67 62 39 35 33 30 67 2F 37 51 | Ax9fnWgb9530g/7Q
[LK-030A] < 64 48 78 4F 6C 51 31 32 6C 4C 63 7A 6E 46 45 4F | dHx0lQ12lLcZnFE0
[LK-030A] < 46 4C 62 58 5A 66 42 4F 58 76 76 30 55 77 63 6A | FLbXzFb0Xvv0Uwcj
[LK-030A] < 73 7A 65 75 56 6B 66 72 77 38 30 38 62 6B 76 43 | sZeuVkfRw808bkvC
[LK-030A] < 38 33 57 71 52 4A 58 6C 2F 6D 67 6A 73 50 36 54 | 83WqRjXl/mgjsP6T
[LK-030A] < 45 33 62 6A 41 51 7A 50 32 7A 2F 2F 45 52 67 36 | E3bjAQzP2z//ERg6
[LK-030A] < 31 56 6B 4B 7A 37 6B 70 75 44 58 48 6D 59 50 66 | 1VkJz7kpuDXHmYPf
[LK-030A] < 35 37 6B 6A 49 32 54 53 42 65 6A 51 77 50 71 6E | 57kjI2TSBejQwPqn
[LK-030A] < 58 2F 2F 44 59 53 56 2B 76 49 78 63 37 6D 6E 32 | X//DYSV+vIxc7mn2
[LK-030A] < 71 57 73 35 6A 43 49 69 6B 37 41 42 72 33 31 58 | qWs5jCIik7ABr3lX
[LK-030A] < 7A 5A 34 67 48 36 55 77 53 69 2B 53 50 62 72 56 | zZ4gH6UwSi+SPbrV
[LK-030A] < 6A 32 48 4E 6C 49 31 6C 4F 43 4B 4C 37 59 57 55 | j2HNlI1lOCKL7YWU
[LK-030A] < 61 65 38 76 51 58 61 43 62 56 50 73 72 2F 4F 79 | ae8vQXaCbVPsr/Oy
[LK-030A] < 50 64 68 5A 4B 51 52 62 39 4A 62 78 54 38 72 61 | PdhZKQRb9JbxT8ra
[LK-030A] < 4F 55 43 64 52 37 37 68 57 39 65 45 6D 6B 50 47 | OUCdR77hW9eEmkPG
[LK-030A] < 68 2F 6A 50 57 37 39 45 50 30 6F 6D 53 38 33 4B | h/jPW79EP0omS83K
[LK-030A] < 49 4A 54 71 34 56 6D 45 6B 4E 44 72 5A 49 69 4D | IJTq4VmEkNdrZiIM
[LK-030A] < 71 74 68 4A 45 79 38 54 59 71 72 46 79 59 46 5A | qthJEy8TYqrFyFZ
[LK-030A] < 64 6E 77 79 63 48 50 4E 53 64 41 4E 37 37 71 4D | dnwycHPNSdAN77qM
[LK-030A] < 6B 66 5A 52 66 4F 4E 49 4E 66 6C 55 39 78 6A 33 | kfZRfONINflU9xj3
[LK-030A] < 68 39 79 6A 36 2B 63 79 77 3D 3D Hello world!.
22 2C 22 73 69 | h9yj6+cyw==" , "si
[LK-030A] < 67 6E 22 3A 22 35 32 61 35 63 30 32 61 65 37 61 | gn":"52a5c02ae7a
[LK-030A] < 66 63 64 64 63 35 33 62 38 63 66 36 34 62 61 34 | fcddc53b8cf64ba4
[LK-030A] < 36 31 34 34 64 22 2C 22 76 65 72 73 69 6F 6E 22 | 6144d", "version"
[LK-030A] < 3A 22 31 2E 34 2E 30 22 2C 22 75 72 6C 22 3A 22 | : "1.4.0", "url": "
[LK-030A] < 68 74 74 70 73 3A 2F 2F 69 6F 74 78 2D 6F 74 61 | https://iotx-ota
[LK-030A] < 2E 6F 73 73 2D 63 6E 2D 73 68 61 6E 67 68 61 69 | .oss-cn-shanghai
[LK-030A] < 2E 61 6C 69 79 75 6E 63 73 2E 63 6F 6D 2F 6F 74 | .aliyuncs.com/ot
[LK-030A] < 61 2F 66 66 35 64 39 30 33 32 33 34 37 39 33 31 | a/ff5d9032347931
[LK-030A] < 39 37 65 61 37 63 31 62 66 64 61 36 37 31 38 64 | 97ea7c1bfda6718d
[LK-030A] < 30 39 2F 63 6B 6F 6D 61 33 6D 35 71 30 30 30 30 | 09/ckoma3m5q0000
[LK-030A] < 33 61 38 65 34 65 35 30 77 38 38 6B 2E 62 69 6E | 3a8e4e50w88k.bin

[LK-030A] < 61 74 75 72 65 3D 59 64 59 69 6C 75 6F 77 4E 58 | ature=YdYiluowNX
[LK-030A] < 25 32 42 70 6C 61 77 52 59 66 64 4C 4B 4A 70 47 | %2BplawRYfdLKJpG
[LK-030A] < 74 5A 59 25 33 44 22 2C 22 73 69 67 6E 4D 65 74 | tZY%3D", "signMet
[LK-030A] < 68 6F 64 22 3A 22 4D 64 35 22 2C 22 6D 64 35 22 | hod": "Md5", "md5"
[LK-030A] < 3A 22 35 32 61 35 63 30 32 61 65 37 61 66 63 64 | : "52a5c02ae7afcd
[LK-030A] < 64 63 35 33 62 38 63 66 36 34 62 61 34 36 31 34 | dc53b8cf64ba4614
[LK-030A] < 34 64 22 7D 2C 22 69 64 22 3A 31 36 32 30 38 37 | 4d"), "id":162087
[LK-030A] < 35 37 33 35 37 30 38 2C 22 6D 65 73 73 61 67 65 | 5735708,"message
[LK-030A] < 22 3A 22 73 75 63 63 65 73 73 22 7D | ":"success"}

OTA target firmware version: 1.4.0, size: 272600 Bytes
unknown option
establish tcp connection with server(host='iotx-ota.oss-cn-shanghai.aliyuncs.com', port=[80])
success to establish tcp, fd=1
[22.222][LK-040B] > GET /ota/ff5d903234793197ea7c1bfda6718d09/ckoma3m5q00003a8e4
LTAI4G1TuWwSirnbAzUHfL3e&Signature
[22.333][LK-040B] > Host: iotx-ota.oss-cn-shanghai.aliyuncs.com
[22.333][LK-040B] > Accept: text/html, application/xhtml+xml, application/xml;q=0.9, */*;q=0.8
[22.333][LK-040B] > Range: bytes=0-
[22.333][LK-040B] > Content-Length: 0
[22.333][LK-040B] >
[22.333][LK-0309] pub: /ota/device/progress/a1X3jdyVAYF/SFW_K_1

[LK-030A] > 7B 22 69 64 22 3A 32 2C 20 22 70 61 72 61 6D 73 | {"id":2, "params
[LK-030A] > 22 3A 7B 22 73 74 65 70 22 3A 22 30 22 2C 22 64 | "":{"step":"0", "d
[LK-030A] > 65 73 63 22 3A 22 22 7D 7D | esc":""}

```

The following print information shows that the download request is sent successfully and the download process is started.

```

download renewal request has been sent successfully
[22.888][LK-040D] < HTTP/1.1 206 Partial Content
[22.888][LK-040D] < Server: AliyunOSS
[22.888][LK-040D] < Date: Thu, 13 May 2021 03:15:46 GMT
[22.999][LK-040D] < Content-Type: application/octet-stream
[22.999][LK-040D] < Content-Length: 272600
[22.999][LK-040D] < Connection: keep-alive
[22.999][LK-040D] < x-oss-request-id: 609C99E21B27393636E1E89F
[22.999][LK-040D] < Content-Range: bytes 0-272599/272600
[22.999][LK-040D] < Accept-Ranges: bytes
[22.999][LK-040D] < ETag: "52A5C02AE7AFCD53B8CF64BA46144D"
[22.999][LK-040D] < Last-Modified: Thu, 13 May 2021 02:34:39 GMT
[22.999][LK-040D] < x-oss-object-type: Normal
[22.999][LK-040D] < x-oss-hash-crc64ecma: 5693646425570967251
[22.999][LK-040D] < x-oss-storage-class: Standard
[22.999][LK-040D] < Content-MD5: UqXAKuevdxTuM9kukYUTQ==
[22.999][LK-040D] < x-oss-server-time: 13
[22.999][LK-040D] <
Hello world1.
Hello world2.
download 5% done, +2048 bytes
[23.666][LK-0309] pub: /ota/device/progress/a1X3jdyVAyF/SFW_K_1
[LK-030A] > 7B 22 69 64 22 3A 34 2C 20 22 70 61 72 61 6D 73 | {"id":4, "params
[LK-030A] > 22 3A 7B 22 73 74 65 70 22 3A 22 35 22 2C 22 64 | ": {"step": "5", "d
[LK-030A] > 65 73 63 22 3A 22 22 7D 7D | esc": ""}}
Hello world1.
Hello world2.
download 10% done, +2048 bytes
[24.444][LK-0309] pub: /ota/device/progress/a1X3jdyVAyF/SFW_K_1
[LK-030A] > 7B 22 69 64 22 3A 35 2C 20 22 70 61 72 61 6D 73 | {"id":5, "params
[LK-030A] > 22 3A 7B 22 73 74 65 70 22 3A 22 31 30 22 2C 22 | ": {"step": "10", "
[LK-030A] > 64 65 73 63 22 3A 22 22 7D 7D | desc": ""}}
    
```

After the download completes, the following print information is displayed and the system restarts. After the system restarts successfully, the upgrade package program in Slot 2 starts. The current version information can be seen and the OTA upgrade is verified in the console.

```

[39.666][LK-0901] digest matched
download 100% done, +216 bytes
[39.666][LK-0309] pub: /ota/device/progress/a1X3jdyVAyF/SFW_K_1
[LK-030A] > 7B 22 69 64 22 3A 32 33 2C 20 22 70 61 72 61 6D | {"id":23, "param
[LK-030A] > 73 22 3A 7B 22 73 74 65 70 22 3A 22 31 30 30 22 | s":{"step": "100"
[LK-030A] > 2C 22 64 65 73 63 22 3A 22 22 7D 7D | , "desc": ""}}
write update type = 0x4
write magic number offset = 0xffff0
Down finished all.SystemReset Now...hello sbl.
Bootloader Version 0.0.1
Remap type: test
The image now in SECONDARY_SLOT slot
    
```

← **sfw\_1064\_140** Verified

Types of Update Packages: Full      Update Package Signature: 52a5c02ae7afcd53b8cf64ba46144d      Download

Signature Algorithm: MD5      Module Name: default

Total number of target devices: 1      Number of target successes: 1      Number of target failures: 0      Number of Canceled Tasks: 0

Batch Management: Device List      Update Package Information

Verify Update Package      Batch Update      Please enter the batch ID:

| Batch ID          | Batch type            | Upgrade policy | Status       | Created At             | Actions |
|-------------------|-----------------------|----------------|--------------|------------------------|---------|
| ZcCm6rHxHD8qdz... | Verify Update Package | Static Update  | Has complete | May 21, 2021, 11:10:40 | View    |

## 5 Summary

This application note introduces the OTA upgrade of Alibaba Cloud on the i.MX RT platform. Although it is only a simple version number upgrade demonstration, this document introduces the steps to upgrade the firmware of an IOT device based on i.MX RT. While upgrading the function code of your device, add the OTA upgrade part and Alibaba Cloud IoT platform easily helps to upgrade the device firmware.

## 6 Reference

[Alibaba Cloud C Link SDK](#)

## 7 Revision history

| Rev. | Date           | Description     |
|------|----------------|-----------------|
| 0    | 31 August 2021 | Initial release |

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