User Guide

User Guide for N32WB03x Firmware Update

Introduction

This document presents the principle of N32WB03X firmware update and examples to help users familiarize with the firmware update process for rapid development.

Functional features of N32WB03X firmware update:

- Support firmware update through serial port.
- Support firmware update through BLE.
- Support BLE MTU 20-244 bytes.
- In order to ensure security, ECC digital signature is used to verify the firmware validity for BLE update.
- In order to speed up the update and support version rollback, we provide BLE “dual bank” update.
- In order to address the large space occupied by user programs, we also provide BLE “single bank” update.
- The system will automatically select “dual bank” or “single bank” update, without input from users.
- In order to maintain the compatibility with smart phone BLE from all manufacturers, it can control the update speed through mobile APP.

国民技术股份有限公司 Nations Technologies Inc.
地址：深圳市南山区高新北区宝深路109号国民技术大厦
电话：+86-755-86309900 传真：+86-755-86169100
邮箱：info@nationz.com.cn 邮编：518057

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国民技术股份有限公司 Nations Technologies Inc.
地址：深圳市南山区高新北区宝深路109号国民技术大厦
电话：+86-755-86309900 传真：+86-755-86169100
邮箱：info@nationz.com.cn 邮编：518057

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地址：深圳市南山区高新北区宝深路109号国民技术大厦
电话：+86-755-86309900 传真：+86-755-86169100
邮箱：info@nationz.com.cn 邮编：518057

1 Demonstration by Examples

1.1 Demonstration of JLINK Programming

Enter the directory *Demonstration of N32WB03x_SDK\utilities\dfu\Image\JLINKProgrammingDemo*.

Double click the script file *JLINKProgramming.bat* to view the Command Prompt information, as shown below.

```
========================BootSetting.bin============================
00000000: 52 19 34 43 FF FF FF FF  00 40 00 01 B8 49 00 00  R.4C.....@...I..
00000010: F7 5C 36 95 01 00 00 00  01 00 00 00 FF FF FF FF  .\6.............
00000020: FF FF FF FF FF FF FF FF  FF FF FF FF FF FF FF FF  ................
00000030: 00 00 02 01 30 4A 00 00  3A 87 34 26 01 00 00 00  ....0J..:.4&....
00000040: FF FF FF FF FF FF FF FF  FF FF FF FF FF FF FF FF  ................
00000050: FF FF FF FF FF FF FF FF  00 C0 03 01 EC 36 00 00  .............6..
00000060: 1D D3 2D D9 01 00 00 00  FF FF FF FF FF FF FF FF  ..-.............
00000070: FF FF FF FF FF FF FF FF  FF FF FF FF FF FF FF FF  ................
00000080: AE 1C 41 A5 F4 35 DD 3D  89 C8 00 D8 0F 8D 2A C2  ..A..5.=......*.
00000090: 63 3A 02 37 24 5D 2D DB  F0 46 A1 6A 5E 43 26 44  c:.7$]-..F.j^C&D
000000A0: 73 20 7D 16 86 EA 41 6B  A3 8D 0D 60 DA 61 CD 98  s }...Ak...`.a..
000000B0: 53 D5 22 A5 14 6A EE 64  BB B4 7E 40 39 A6 B5 29  S."..j.d..~@9..)
Bootsetting created successfully!
SEGGER J-Link Commander V6.32 (Compiled Apr 20 2018 17:25:19)
DLL version V6.32, compiled Apr 20 2018 17:25:02
```

Step 1: BootSetting Bin is generated by NSUtil tool, and “Bootsetting created successfully!” is displayed in the command line, indicating that the file is generated successfully.

```
Erasing device (N32WB031KEQ6-2)...
J-Link: Flash download: Total time needed: 1.521s
Erasing done.
```

Step 2: JLink erases the chip’s Flash.

```
Downloading file [Image\MasterBoot.bin]...
J-Link: Flash download: Bank 0 @ 0x01000000: 1 range affected (8192 bytes)
J-Link: Flash download: Total time needed: 0.620s (Prepare: 0.040s, Compare
O.K.
```

Step 3: Program MasterBoot.bin to the chip’s Flash.

```
Downloading file [Image\Bootsetting.bin]...
J-Link: Flash download: Bank 0 @ 0x01000000: 1 range affected (4096 bytes)
J-Link: Flash download: Total time needed: 0.285s (Prepare: 0.037s, Compare
O.K.
```

Step 4: Program Bootsetting.bin to the chip’s Flash.

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电话：+86-755-86309900 传真：+86-755-86169100
邮箱：info@nationz.com.cn 邮编：518057

```
Downloading file [Image\APP1.bin]...
J-Link: Flash download: Bank 0 @ 0x01000000: 1 range affected (20480 bytes)
J-Link: Flash download: Total time needed: 1.715s (Prepare: 0.045s, Compare:
O.K.
```

Step 5: Program APP1.bin to the chip's Flash.

```
Downloading file [Image\APP2.bin]...
J-Link: Flash download: Bank 0 @ 0x01000000: 1 range affected (20480 bytes)
J-Link: Flash download: Total time needed: 1.703s (Prepare: 0.040s, Compare
O.K.
```

Step 6: Program APP2.bin to the chip's Flash.

```
Downloading file [Image\ImageUpdate.bin]...
J-Link: Flash download: Bank 0 @ 0x01000000: 1 range affected (16384 bytes)
J-Link: Flash download: Total time needed: 1.339s (Prepare: 0.054s, Compare:
O.K.
```

Step 7: Program ImageUpdate.bin to the chip's Flash.

```
Reset delay: 0 ms
Reset type NORMAL: Resets core & peripherals via SYSRESETREQ & VECTRESET bit.
Reset: Halt core after reset via DEMCR.VC_CORERESET.
Reset: Reset device via AIRCR.SYSRESETREQ.
```

Step 8: Reset the chip.

JLINK successively executes, erases, and writes in MasterBoot.bin, Bootsetting.bin, APP1.bin, APP2.bin, ImageUpdate Bin, reset command and completes Programming in batch. Programming failure, if any, may be caused by the chip in DEEP SLEEP. We can try to execute the *JLINKProgramming.bat* first before power up the chip.

MasterBoot.bin is generated by the MasterBoot Keil Project. The path is generated to view routine Keil→ option for target →User →Run # 2.

Bootsetting.bin is generated by the NSUtil python tool. Refer to Section 1 of Chapter 3 for the bootsetting data structure.

APP1.bin and APP2.bin are generated by the AppOTA Keil Project. The path is generated to view routine keil → option for target → User → Run #2.

ImageUpdate.bin is generated by the ImageUpdater Keil Project. The path is generated to view routine keil → option for target → User → Run #2.

Chapter II provides detailed description of the different bin executing address and function of Bin file.

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地址：深圳市南山区高新北区宝深路109号国民技术大厦
电话：+86-755-86309900 传真：+86-755-86169100
邮箱：info@nationz.com.cn 邮编：518057

```
set JLink_path=..\..\JLink\JLink_V632\JLink.exe
set JLink_script_path=..\..\JLink\JLink_Script\download.jlink
set NSUtil_path=..\..\NSUtil\NSUtil.exe

::Creating bootsetting file
::bootsetting.bin path
set output_bootsetting=.\Image\bootsetting.bin
::bank1 parameters, nonoptional
set bank1_start_address=0x1004000
set bank1_version=0x00000001
set bank1_bin=.\Image\APP1.bin
set bank1_activation=yes
::bank2 parameters, optional
set bank2_start_address=0x1020000
set bank2_version=0x00000001
set bank2_bin=.\Image\APP2.bin
set bank2_activation=no
::ImageUpdate parameters, optional
set image_update_start_address=0x0103C000
set image_update_version=0x00000001
::set image_update_bin=.\Image\ImageUpdate.bin
set image_update_activation=no
::Public key, optional
::set public_key_file=.\keys\public_key.bin
```

Users can modify bank1_activation=no, bank2_ Activation=yes, power on and start the bank2 program, and can view the printing output through the serial port connecting to the chip PB1 (115200 N 8 1), or through the blinking frequency of LED1 and LED2. APP1 and APP2 flash in 100 and 500 milliseconds, respectively. Users can search for the Bluetooth device with NATION broadcast name .

Users can also modify bank1_ activation=no, image_ update_ Activation=yes, check the serial port printing output, or search for the Bluetooth device with ImageUpdate device broadcast.

It should be noted that only one program can enable activation.

1.2 Demonstration of serial port update

Enter the directory *Demonstration of N32WB03x_SDK\utilities\dfu\Image\UartProgrammingDemo*.

By double clicking the script file *JLINKProgramming.Bat*, users can view the Command Prompt information.

```
=========================BootSetting.bin==============================
00000000: 13 1F 64 9F FF FF FF FF  00 40 00 01 58 0E 00 00  ..d......@..X...
00000010: 0D 1D BC 89 01 00 00 00  01 00 00 00 FF FF FF FF  ................
00000020: FF FF FF FF FF FF FF FF  FF FF FF FF FF FF FF FF  ................
00000030: 00 00 02 01 58 0E 00 00  CF F8 F2 0C 01 00 00 00  ....X...........
00000040: FF FF FF FF FF FF FF FF  FF FF FF FF FF FF FF FF  ................
00000050: FF FF FF FF FF FF FF FF  FF FF FF FF FF FF FF FF  ................
00000060: FF FF FF FF FF FF FF FF  FF FF FF FF FF FF FF FF  ................
00000070: FF FF FF FF FF FF FF FF  FF FF FF FF FF FF FF FF  ................
00000080: FF FF FF FF FF FF FF FF  FF FF FF FF FF FF FF FF  ................
00000090: FF FF FF FF FF FF FF FF  FF FF FF FF FF FF FF FF  ................
000000A0: FF FF FF FF FF FF FF FF  FF FF FF FF FF FF FF FF  ................
000000B0: FF FF FF FF FF FF FF FF  FF FF FF FF FF FF FF FF  ................
Bootsetting created successfully!
```

Bootsetting.bin reveals that in the chip, only bank1 and bank2 have programs and bank1 program is activated.

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地址：深圳市南山区高新北区宝深路109号国民技术大厦
电话：+86-755-86309900 传真：+86-755-86169100
邮箱：info@nationz.com.cn 邮编：518057

APP1.bin and APP2.bin are generated by the AppUsart Keil project, and path is generated to view the routine keil → option for target → User → Run #2.

The file *Serial Port Update. bat* can be opened by a text tool.

```
set NSUtil_path=..\..\NSUtil\NSUtil.exe
:: APP.bin is the update firmware
:: --app_start_address is the address of update firmware
:: --app_version is the version of update firmware
:: --serial_port is the serial port number
set app_bin=.\Image\APP2.bin
set app_start_address=0x1020000
set app_version=0x01020304
set serial_port=COM3


%NSUtil_path% ius serial %app_bin%                                    ^
                         --app_start_address %app_start_address%
                         --app_version %app_version%
                         --serial_port %serial_port%
```

Modify serial_ Port=serial port number of own computer (obtained by viewing the device manager), USB serial port is connected to chip PB6 (chip TX) and PB7 (chip RX), save and close.

Double click the script file *UartFirmwareUpdate.bat* to view the print results in the Command Prompt.

JLINK program the bin file into bank1 by default (with PB0 pin pulled up), and if update via the serial port, the new program is loaded into bank2 by default (with PA6 pin pulled up). Users can also modify the app_bin=.\Image\APP1.bin，app_start_address=0x01004000, so that the serial port updates program to bank1 by default.

1.3 Demonstration of Bluetooth "Dual Bank" update

Enter *N32WB03x_SDK\utilities\dfu\NSAndroidUtil\directory*, and install the file *NSAndroidUtil.apk* on the mobile phone. Enter *N32WB03x_SDK\utilities\dfu\Image\dual Bank update demo\directory*, double-click *JLINK Download at One Click. Bat*, and burn the firmware to the chip.

Enter *N32WB03x_SDK\utilities\dfu\Image\Dual Bank Update Demo\Image\directory*, and copy the file *ota_dual_bank.zip* to the phone's internal storage device.

Click Connect, and then select the NATIONS (MAC: 66:55:44:77:22:99) device.

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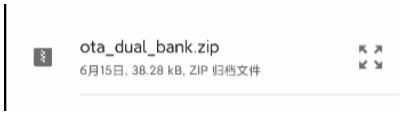
地址：深圳市南山区高新北区宝深路109号国民技术大厦
电话：+86-755-86309900 传真：+86-755-86169100
邮箱：info@nationz.com.cn 邮编：518057

Wait until the Bluetooth in the upper right corner is Connected, then click the file and select *ota_ dual_ Bank.zip*.



We can view the size of update package in the update package information. After we click Update, the update status changes and the progress bar increases.

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电话：+86-755-86309900 传真：+86-755-86169100
邮箱：info@nationz.com.cn 邮编：518057

As the update finishes, the Bluetooth will automatically disconnect, and the update status displays the update time consumed.

By double-clicking *Generate Update Package at One Click. bat*, users can view the information in the Command Prompt.

```
=========================dfu_setting.dat==============================
00000000: 19 E5 23 DF 00 40 00 01  B8 49 00 00 F7 5C 36 95  ..#..@...I...\6.
00000010: 02 00 00 00 00 00 02 01  30 4A 00 00 3A 87 34 26  ........0J..:.4&
00000020: 02 00 00 00 00 C0 03 01  EC 36 00 00 1D D3 2D D9  .........6....-.
00000030: 02 00 00 00 5C 2C 11 44  E8 A3 37 6C 2E D5 54 EE  ....\,.D..71..T.
00000040: 2A 90 AA 07 08 7B 48 B2  8F 78 2E FA E8 E6 E3 1D  *....{H..x......
00000050: 66 75 AA A3 54 C2 27 C2  EE ED 98 0A EC DB 1A 42  fu..T.'........B
00000060: 79 36 32 D3 A8 7C 53 69  C2 15 FC E8 D4 F7 51 A1  y62..|Si......Q.
00000070: B2 73 EF 22                                       .s."
=========================config.txt===============================
APP1_START_ADDRESS : 0x01004000
APP1_VERSION : 0x00000002
APP1_SIZE : 0x000049b8
APP2_START_ADDRESS : 0x01020000
APP2_VERSION : 0x00000002
APP2_SIZE : 0x00004a30
IMAGE_UPDATE_START_ADDRESS : 0x0103c000
IMAGE_UPDATE_VERSION : 0x00000002
IMAGE_UPDATE_SIZE : 0x000036ec
```

The batch file will create a Bluetooth update package according to the parameters configured in the file and the bin file in the Image folder, and simultaneously the Command Prompt displays the file data of dfu_setting.dat and Config.txt.

1.4 Demonstration of Bluetooth "Single Bank" update

Enter *N32WB03x_SDK\utilities\dfu\NSAndroidUtil\directory*, and install the file *NSAndroidUtil.apk* on the mobile phone.

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地址：深圳市南山区高新北区宝深路109号国民技术大厦
电话：+86-755-86309900 传真：+86-755-86169100
邮箱：info@nationz.com.cn 邮编：518057

Enter *N32WB03x_SDK\utilities\dfu\Image\single Bank update demo\directory*, double-click *JLINK Download at One Click. bat*, and burn the firmware to the chip.

Enter *N32WB03x_SDK\utilities\dfu\Image\Single Bank Update Demo\Image\directory*, and copy the file *ota_single_bank.zip* to the phone's internal storage device.

Click Connect, and then select the NATIONS (MAC: 66:55:44:77:22:99) device.

Wait until the Bluetooth in the upper right corner is Connected, click the file and select file *ota_ single_ Bank.zip*.

We can view the size of update package in the update package information. After we click Update, the update status changes and the progress bar increases.

The single bank update Bluetooth will be disconnected and reconnected once. A dialog box will pop up on the interface to ask the user to wait for the automatic reconnection of Bluetooth.

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地址：深圳市南山区高新北区宝深路109号国民技术大厦
电话：+86-755-86309900 传真：+86-755-86169100
邮箱：info@nationz.com.cn 邮编：518057

The update continues after the Bluetooth is reconnected, and the update time consumed will be displayed as long as the update finishes.

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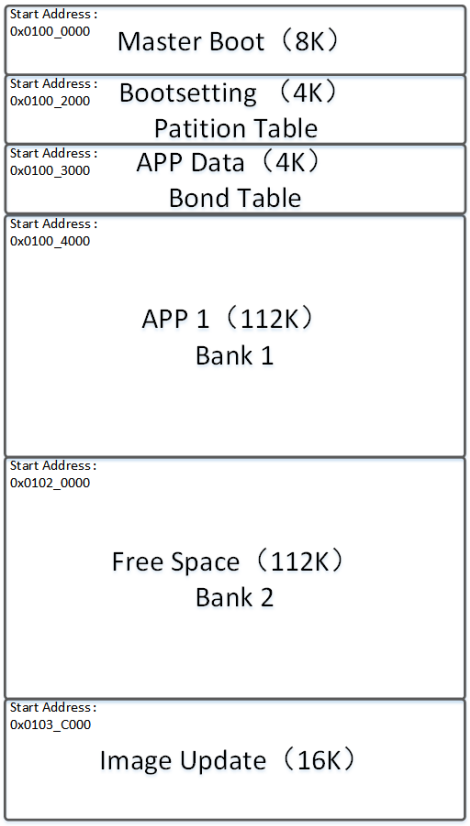
地址：深圳市南山区高新北区宝深路109号国民技术大厦
电话：+86-755-86309900 传真：+86-755-86169100
邮箱：info@nationz.com.cn 邮编：518057

2 Distribution of FLASH Memory

FLASH address range of N32WB03x chip is 0x0100_ 0000 - 0x0103_ FFFF and the free space is 256K bytes.

The program and data FLASH is distributed as follows:



Name	N32WB03X FLASH address	Description
Master Boot (program)	0x0100_0000 – 0x0100_1FFF (8K)	Program entry after power on; Read the partition table and jump the program; Serial port update function;
Bootsetting (data) (Patition Table)	0x0100_2000 -0x0100_2FFF (4K)	FLASH partition table;
APP Data (data) (Bond Table) (User Data)	0x0100_3000 -0x0100_3FFF (4K)	APP data storage area; Storage binding list (about 500 bytes for 5 devices); The remaining space stores user-defined data;
APP 1 (program) (Bank 1)	0x0100_4000 -0x0101_FFFF (112K)	User program 1 storage area;
Free Space/APP2 (program) (Bank 2)	0x0102_0000 -0x0103_BFFF (112K)	Reserved space; or user program 2 storage area;

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地址：深圳市南山区高新北区宝深路109号国民技术大厦
电话：+86-755-86309900 传真：+86-755-86169100
邮箱：info@nationz.com.cn 邮编：518057

Image Update (program)	0x0103_C000 -0x0103_FFFF (16K)	Reserved space; or update “single BANK”;

The MasterBoot program provides program jump entry and serial port update.

Bootsetting data provides program jump and updates shared data.

If more space is required by the APP Data in storage area, it is recommended to use external storage or modify the FLASH memory distribution (users are welcome to contact technical support for specific modification methods).

APP1 is a user program.

APP2 is a user program compiled on Bank2.

ImageUpdate is a program for “single bank” update.

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地址：深圳市南山区高新北区宝深路109号国民技术大厦
电话：+86-755-86309900 传真：+86-755-86169100
邮箱：info@nationz.com.cn 邮编：518057

3 Data Structure

3.1 Bootsetting

Size (Bytes)	Name	Description
4	Bootsetting CRC	Bootsetting data check value
4	MasterBoot Force Update	Forced serial port update for MasterBoot 1: serial port update By default: 0xFFFFFFFF
4*10	Bank 1 partition	4 bytes: start address of program 4 bytes: size of program 4 bytes: crc of program 4 bytes: version of program 4 bytes: activation code of program: 1 activation, others 4*5 bytes: reserve
4*10	Bank 2 partition	4 bytes: start address of program 4 bytes: size of program 4 bytes: crc of program 4 bytes: version of program 4 bytes: activation code of program: 1 activation, others 4*5 bytes: reserve
4*10	Image Update partition	4 bytes: start address of program 4 bytes: size of program 4 bytes: crc of program 4 bytes: version of program 4 bytes: activation code of program: 1 activation, others 4*5 bytes: reserve
64	Public key	Used for ECC signature verification.

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地址：深圳市南山区高新北区宝深路109号国民技术大厦
电话：+86-755-86309900 传真：+86-755-86169100
邮箱：info@nationz.com.cn 邮编：518057

Bootsetting crc=CRC32 (MasterBoot Force Update+Bank 1 partition+Bank 2 partition+Image Update partition+public key)

MasterBoot Force Update: MasterBoot program decides whether to enter the serial port update mode by judging this variable.

Bank 1 partition: record the start address, program size, CRC32 value, and activation status of APP1 program.

Bank 2 partition: record the start address, program size, CRC32 value, and activation status of APP2 program.

Image Update partition: record the start address, program size, CRC32 value, and activation status of Image Update program.

Public key: generated by the NSUTIL tool, and used for updating signature verification.

Reserve: reserved field for extension.

3.2 init packet

Serial port update for Init packet

Size (Byte)	Name	Description
4	CRC	Data check value
4	App_start_address	First address of new firmware
4	App_size	Size of new firmware (in bytes)
4	App_crc	Check value of new firmware
4	App_version	Version of new firmware
4*10	Reserve	Reserve

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电话：+86-755-86309900 传真：+86-755-86169100
邮箱：info@nationz.com.cn 邮编：518057

3.3 dfu_setting

NSUTIL. exe update package, which is automatically generated, is used for Bluetooth update. In addition, it finds its application in the signature verification and integrity check of updated firmware.

Size (Byte)	Name	Description
4	CRC	DFU_SETTING data check value
4*4	APP 1 parameter	4 bytes: start address of program 4 bytes: size of program 4 bytes: crc of program 4 bytes: version of program
4*4	APP 2 parameter	4 bytes: start address of program 4 bytes: size of program 4 bytes: crc of program 4 bytes: version of program
4*4	Image Update parameter	4 bytes: start address of program 4 bytes: size of program 4 bytes: crc of program 4 bytes: version of program
64	Signature	HASH data+signature file based on private key

CRC=CRC32 (APP 1 parameter+APP 2 parameter+Image Update parameter+Signature)

APP 1 parameter: start address, size, CRC, and version number of update firmware APP1 program.

APP 2 parameter: start address, size, CRC, and version number of update firmware APP2 program.

Image Update parameters: starting address, size, CRC, and version number of the Image Update program for firmware update.

Signature = ECC_ ECDSA_ SHA256_ NIST256P (APP 1 parameter+APP 2 parameter+Image Update parameter)

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地址：深圳市南山区高新北区宝深路109号国民技术大厦
电话：+86-755-86309900 传真：+86-755-86169100
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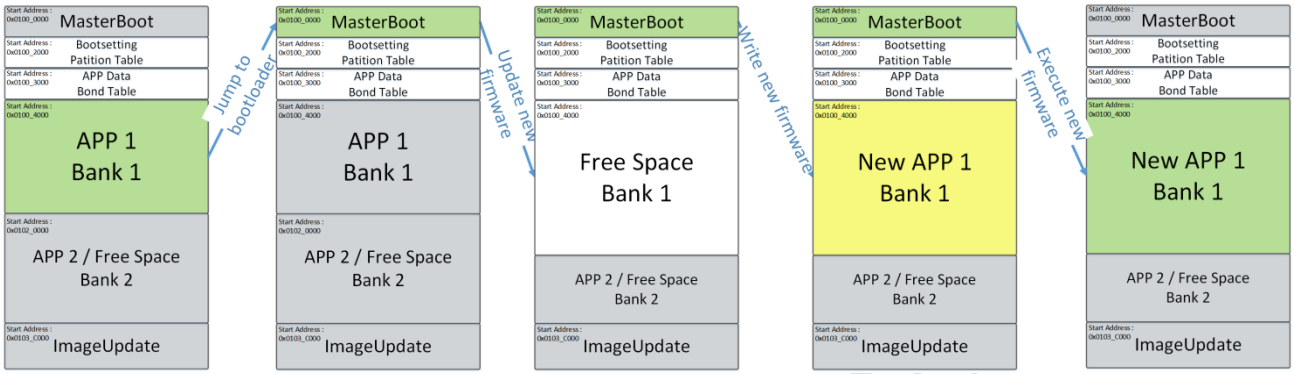
4 Update Process

4.1 Serial port update process

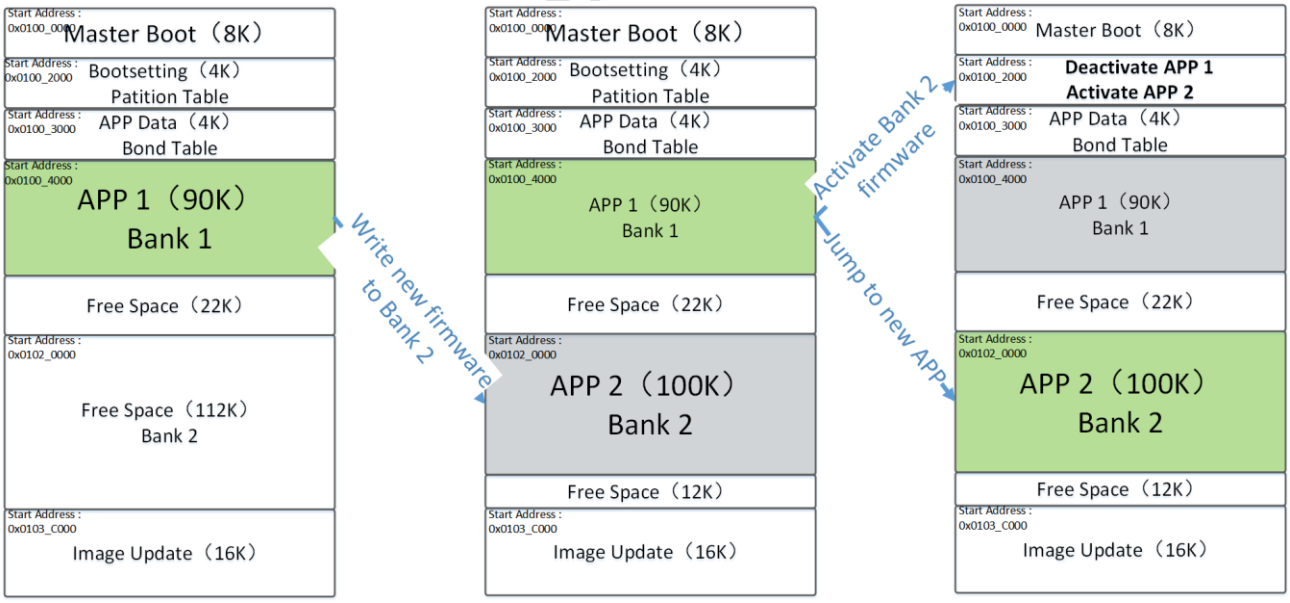


The user's application program sets the MasterBootForceUpdate variable in the bootsetting data, resets the software, and enables the MasterBoot program.

Set the MasterBoot Force Update variable and activate the serial port update process.

The MasterBoot receives new firmware through serial port, erases the original firmware in the bank 1 area, writes in the new firmware, and afterwards activates them, and finally jumps to new firmware for execution.

4.2 Update process of Bluetooth dual bank



The “dual bank” update is implemented by updating APP1 with APP2, or vice versa. It features faster update speed and higher stability. However, it also faces the disadvantage that the user program can only use half of the FLASH area. An additional bin file of bank2 needs to be generated when we make the update package.

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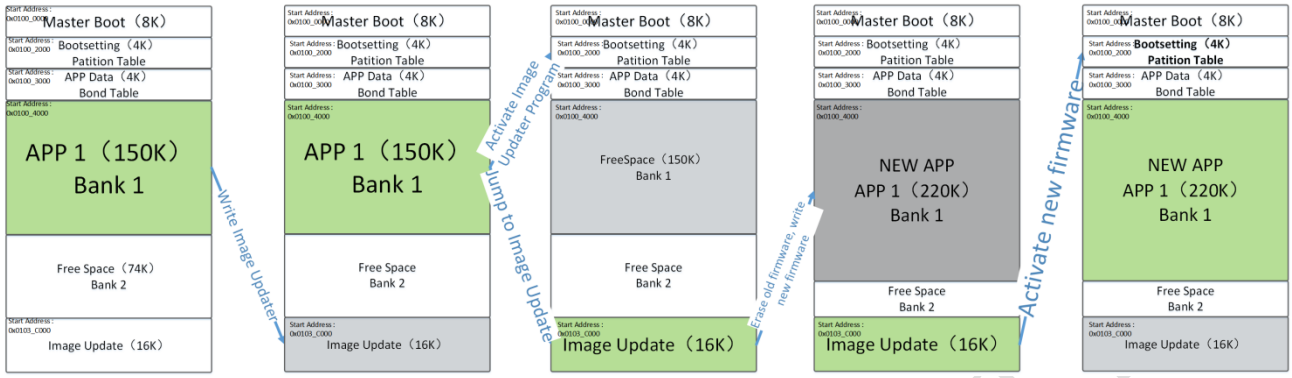
地址：深圳市南山区高新北区宝深路109号国民技术大厦
电话：+86-755-86309900 传真：+86-755-86169100
邮箱：info@nationz.com.cn 邮编：518057

4.3 Update process of Bluetooth single bank



"single bank" update is implemented by updating APP1 program with ImageUpdate program. It has the advantage that the user program can use all FLASH regions, but it also faces the disadvantage of slow update speed, because Bluetooth will disconnection then re-connect causing possible unstable connection and there is no backup when the update fails.

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电话：+86-755-86309900 传真：+86-755-86169100
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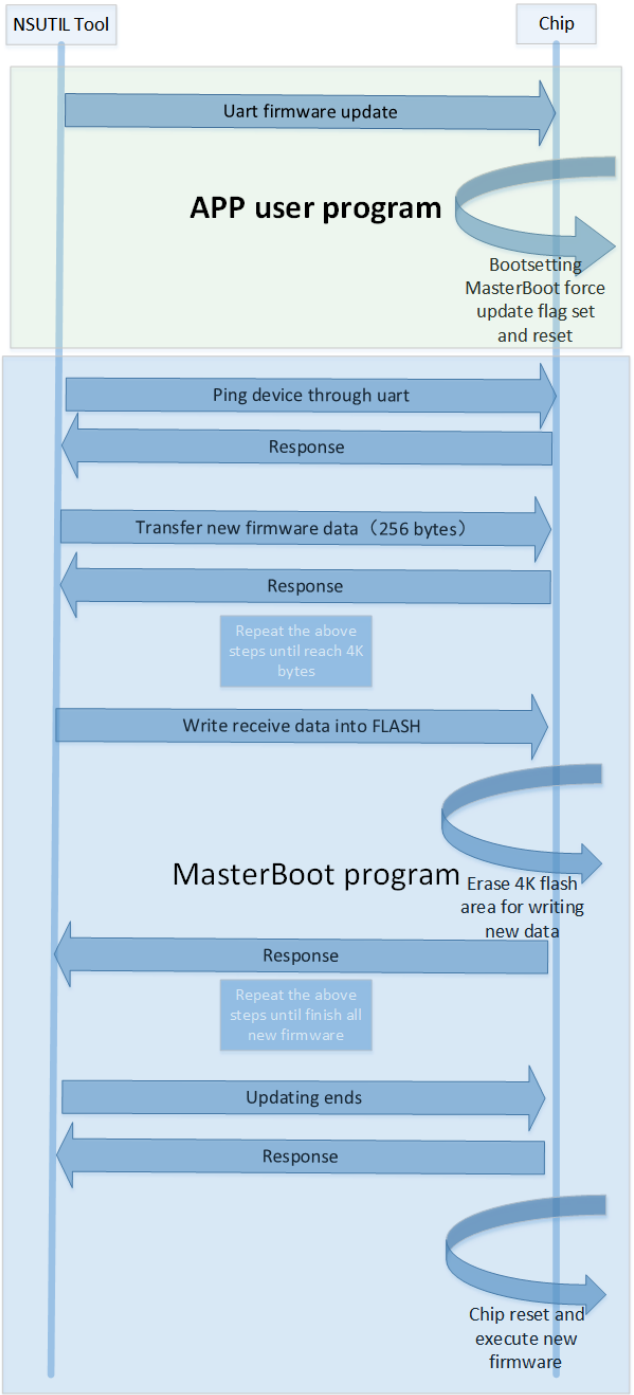
5 Update Command

5.1 Commands for serial port update



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5.1.1 Usart dfu

PC upper computer instructs the chip to enter serial port update mode, and the chip will be reset to enter the MasterBoot serial port update mode.

Name	Size (Byte)	Value	Description
Packet header	1	0xAA	(PC->chip)
Command number	1	0x07	Forced serial port update
Parameter	3	0x01,0x02,0x03	Prevent false judgment

Name	Size (Byte)	Value	Description
Packet header	1	0xAA	(Chip->PC)
Response number	1	0x07	

5.1.2 Ping

Name	Size (Byte)	Value	Description
Packet header	1	0xAA	(PC->chip)
Command number	1	0x01	PC upper computer attempts to communicate with chip

Name	Size (Byte)	Value	Description
Packet header	1	0xAA	(Chip->PC)
Response number	1	0x01	

5.1.3 Init packet

Name	Size (Byte)	Value	Description
Packet header	1	0xAA	(PC->chip)
Command number	1	0x02	Entire new firmware header file
INIT PACKET	Init packet size		Detailed in: init packet

Name	Size (Byte)	Value	Description
Packet header	1	0xAA	(Chip->PC)
Response number	1	0x02	
Error code	1		Detailed in: error code

5.1.4 Packet header

Name	Size (Byte)	Value	Description
Packet header	1	0xAA	(PC->chip)
Command number	1	0x03	A package of header files
OFFSET	4		Offset of the current update file

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SIZE	4		Size of update data to be sent
CRC	4		Data check value of the update package to be sent

Name	Size (Byte)	Value	Description
Packet header	1	0xAA	(Chip->PC)
Response number	1	0x03	
Error code	1		Detailed in: error code

5.1.5 Packet

Name	Size (Byte)	Value	Description
Packet header	1	0xAA	(PC->chip)
Command number	1	0x04	Update Package Data
Data	<=256-3		Update package data offset based on package header

Name	Size (Byte)	Value	Description
Packet header	1	0xAA	(Chip->PC)
Response number	1	0x04	
Error code	1		Detailed in: error code

5.1.6 Postvalidate

Name	Size (Byte)	Value	Description
Packet header	1	0xAA	(PC->chip)
Command number	1	0x05	Verify the received data

Name	Size (Byte)	Value	Description
Packet header	1	0xAA	(Chip->PC)
Response number	1	0x05	
Error code	1		Detailed in: error code

5.1.7 Activate&Reset

Name	Size (Byte)	Value	Description
Packet header	1	0xAA	(PC->chip)
Command number	1	0x06	Activate new firmware and reset software

Name	Size (Byte)	Value	Description

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Packet header	1	0xAA	(Chip->PC)
Response number	1	0x06	
Error code	1		Detailed in: error code

5.2 Commands for Bluetooth update

- The mobile terminal initiates commands and receives response through CC.
- The data flow of update package is sent to the equipment through RC.
- Services and features

Type	Name	UUID (Hexadecimal)	Attribute	MTU	Function Description
Service	IUS (Image Update Service)	11-11-11-11-11-11-11-11-11-11-11-11-00-01-11-11	Primary		Firmware update service
Characteristic	RC (Receive Characteristic)	11-11-11-11-11-11-11-11-11-11-11-11-00-02-11-11	Write Without Response	20-244	Firmware reception characteristics
Characteristic	CC (Command Characteristic)	11-11-11-11-11-11-11-11-11-11-11-11-00-03-11-11	Notify, Write	20	Command receiving and sending characteristics

- Bluetooth dual bank update

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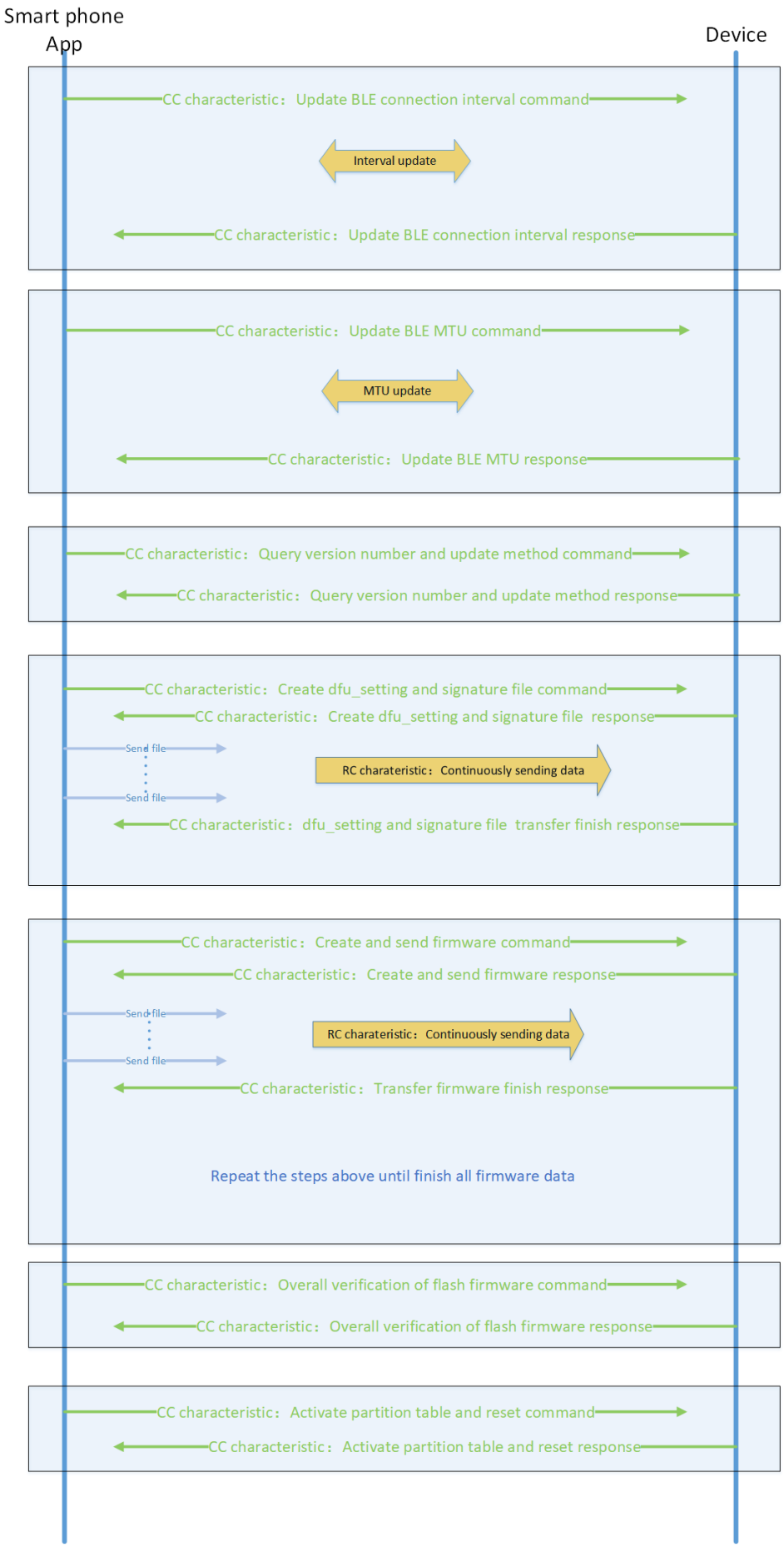

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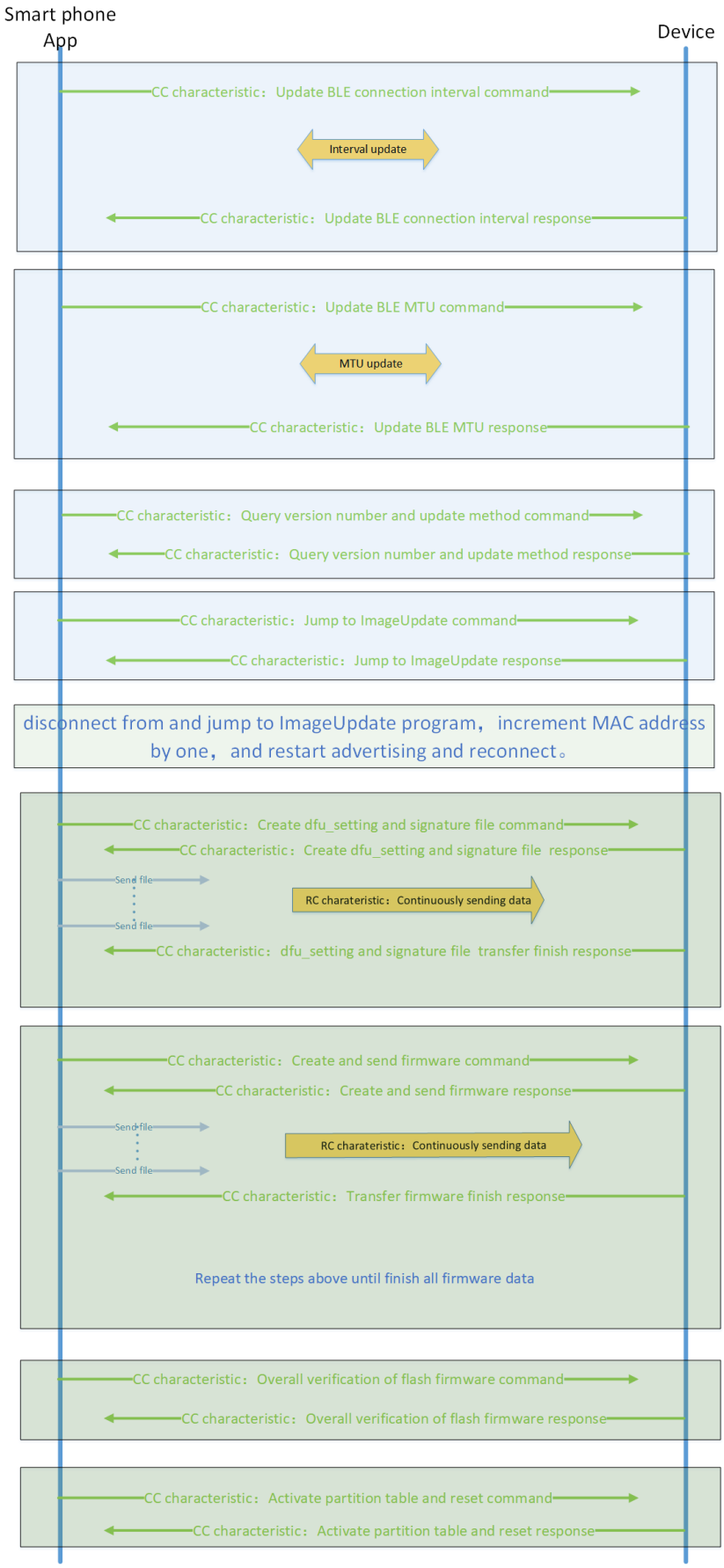
- Single bank update



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5.2.1 Update BLE connection interval

- During update, BLE connection interval is reduced and BLE transmission speed is increased. The mobile phone sends the connection interval parameters to the slave device which in turn initiates the command of updating connection interval parameters.
- Reason: it is uncertain whether Android and IOS have enabled the upper layer command of updating connection interval parameters.
- Command format: (CC)

Name	Size (Byte)	Value	Description
Command number	1	1	(Mobile ->Device)
Minimum connection interval	2		Unit: 1.25 MS
Maximum connection interval	2		Unit: 1.25 MS
SLAVE LATENCY	2		Reduced number of responses from slave devices
Connection timed out	2		Unit: 10 MS

- Command format: (CC)

Name	Size (Byte)	Value	Description
Response number	1	1	(Device->Mobile)
Error code	1		Detailed in: error code

5.2.2 Update BLE MTU

- Increase the MTU with RC. The mobile phone sends new MTU size to the slave device which in turn initiates the command of MTU update.
- Reason: it is uncertain whether the IOS has enabled the upper layer command of MTU update.
- Command format: (CC)

Name	Size (Byte)	Value	Description
Command number	1	2	(Mobile->Device)
Size of new MTU	2		Defined by phone model

- Command format: (CC)

Name	Size (Byte)	Value	Description
Response number	1	2	(Device->Mobile)
Error code	1		Detailed in: error code

5.2.3 Query version number and update method

- Command format: (CC)

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Name	Size (Byte)	Value	Description
Command number	1	3	(Mobile->Device)
Size of the new APP1 firmware	4		Unit (byte)
Size of the new APP1 firmware	4		Unit (byte)
Size of the new IMAGE UPDATE firmware	4		Unit (byte)
Version of the new IMAGE UPDATE firmware	4		

- Command format: (CC)

Name	Size (Byte)	Value	Description
Response number	1	3	(Device->Mobile)
Version of APP1	4		Partition table Bank 1 Version
Version of APP2	4		Partition table Bank 2 Version
Version of IMAGE UPDATE	4		Partition table IMAGE UPDATE Version
Update mode	1	Value / Meaning 1 / Select APP1 2 / Select APP2 3 / Select IMAGE UPDATE 4 / Jump to IMAGE UPDATE	Device reads partition table, and calculates whether the remaining space can accommodate the new firmware. If yes, select dual bank update, otherwise select single bank update.

5.2.4 Create the dfu_Setting and signature file

- Perform signature verification on the file dfu_setting received at the device side to determine whether the signature file is legal.
- After the update, the device side can update its own local partition table by using the one in dfu_setting.
- Command format: (CC)

Name	Size (Byte)	Value	Description
Command number	1	4	(Mobile->Device)
Size of new DFU SETTING	4		After receiving the data of this size through the RC, the device side notifies the mobile phone of the completed reception through the CC.

- Command of receiving new Bootsetting and signature file
- It is required to, at device side, perform CRC32 integrity verification on Bootsetting, and legitimacy verification on electronic signatures.

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- Command format: (CC)

Name	Size (Byte)	Value	Description
Response number	1	4	(Device->Mobile)
Error code	1		Detailed in: error code

5.2.5 Create and sending firmware data

- The mobile terminal notifies the device of the data offset value, data size, and data CRC check value that the RC will receive.
- After receiving RC, the device side notifies mobile phone through CC whether the data is successfully received.
- Command format: (CC)

Name	Size (Byte)	Value	Description
Command number	1	5	(Mobile->Device)
Offset address of firmware data	4		
Transfer size of firmware data	4		Less than or equal to 2048
Verification CRC of firmware data	4		

- Command of completing firmware data reception
- After reception, perform CRC verification on the received data at device side, verify and write in FLASH. If it reaches 4K offset address, it is required to erase 4K for FLASH backward.
- Command format: (CC)

Name	Size (Byte)	Value	Description
Response number	1	5	(Device->Mobile)
Error code	1		Detailed in: error code

5.2.6 Overall verification of FLASH firmware

- Perform CRC verification on the copied firmware at device side, compare it with the firmware CRC in the new partition table, and return the results to the mobile phone.
- Command format: (CC)

Name	Size (Byte)	Value	Description
Command number	1	6	(Mobile->Device)

- Command format: (CC)

Name	Size (Byte)	Value	Description
Response number	1	6	(Device->Mobile)
Error code	1		Detailed in: error code

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5.2.7 Activate partition table and reset

- Modify the firmware corresponding to the local partition table to the active state at device side, respond to the command of mobile phone, and then execute software reset.
- Command format: (CC)

Name	Size (Byte)	Value	Description
Command number	1	7	(Mobile->Device)

- Command format: (CC)

Name	Size (Byte)	Value	Description
Response number	1	7	(Device->Mobile)
Error code	1		Detailed in: error code

5.2.8 Jump to ImageUpdate

- Command format: (CC)

Name	Size (Byte)	Value	Description
Command number	1	8	(Mobile->Device)

- Command format: (CC)

Name	Size (Byte)	Value	Description
Response number	1	8	(Device->Mobile)
Error code	1		Detailed in: error code

5.3 Error code

Value	Description
0	Success
1	Parameter error
2	CRC error
3	Electronic signature error

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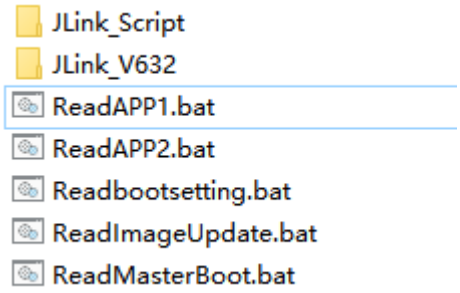
6 Tool Explanation

6.1 JLINK tool

Enter N32WB03x_SDK\utilities\dfu\JLink\directory



JLink_V632 folder contains a JLINK tool manufactured by SEGGER. Users need to install a JLINK driver before use.

JLink_Script folder contains a JLink script file. Users can read the data in the chip's Flash by double-clicking the file *Read XX.bat*.

JLink also supports chip FLASH erasure and programming, and the file *JLINK Download at one click.bat* used in the previous chapter is exactly used to implement such functions.

6.2 NSUTIL tool

Enter N32WB03x_SDK\utilities\dfu\NSUtil\folder.

- NSUtil. Exe Windows platform execution program.
- Source folder stores the python source code of NSUtil.exe.
- Small number of the Python code and short development time.

The functions implemented by this tool include:

- Generate bootsetting.bin file
- Serial port update via PC upper computer
- Packaging tool for Bluetooth update package
- Generate ECC key, digital signature tool

6.3 NSANDROIDUTIL tool

Enter *N32WB03x_SDK\utilities\dfu\NSAndroidUtil\folder*.

- NSAndroidUtil. Apk Android installation package.

This tool implements the following functions:

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- Bluetooth OTA update.

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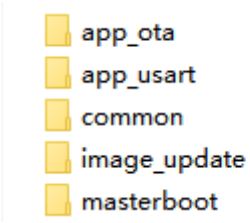
7 Examples Explanation

Enter N32WB03x_SDK\projects\n32wb03x_EVAL\dfu\directory.



7.1 MasterBoot Explanation

```
int main(void)
{
  masterboot();

  *(uint32_t*)0x40007014 = 0x0000080F;
  *(uint32_t*)0x40007020 = 0x00020018;

  PWR->VTOR_REG = 0x81000000;//set vertor table
  RCC->CFG &= ~1;//set hsi as system clock
  while((RCC->CFG & (1<<2)));//wait for hsi as system clock

  dfu_leds_config();
  dfu_led_on(LED1_GPIO_PORT, LED_GPIO1_PIN);
  dfu_led_on(LED2_GPIO_PORT, LED_GPIO2_PIN);


  NS_SCHED_INIT(256, 16);
  ns_dfu_serial_init();

  while(1)
  {
    app_sched_execute();
    __WFE();
    __SEV();
    __WFE();
  }
}
```

- Masterboot (): Read the bootsetting partition table and directly jump to the activated firmware with complete verification.
- Illuminate two lights for indication.
- Initialize simple scheduling.
- Initialize the serial port.

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- Wait for the serial port to interrupt receiving data.

```
static void sched_evt(void * p_event_data, uint16_t event_size)
{
  switch(*(uint8_t *)p_event_data)
  {
    case SCHED_EVT_RX_DATA:{
      if(m_buffer[0] == 0xAA)
      {
        switch(m_buffer[1]){

          case DFU_SERIAL_CMD_Ping:{
            dfu_serial_cmd_ping();
          }break;
          case DFU_SERIAL_CMD_InitPkt:{
            dfu_serial_cmd_init_pkt();
          }break;
          case DFU_SERIAL_CMD_Pkt_header:{
            dfu_serial_cmd_pkt_header();
          }break;
          case DFU_SERIAL_CMD_Pkt:{
            dfu_serial_cmd_pkt();
          }break;
          case DFU_SERIAL_CMD_PostValidate:{
            dfu_serial_cmd_postvalidate();
          }break;
          case DFU_SERIAL_CMD_ActivateReset:{
            dfu_serial_cmd_activate_reset();
          }break;
          case DFU_SERIAL_CMD_JumpToMasterBoot:{
            dfu_serial_cmd_jump_to_master_boot();
          }break;
        }
      }
    }break;
  }
}
```

- Analyze and handle serial port commands, and respond to the upper computer.

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7.2 AppUsart Explanation

- Serial port update APP 1 program.

```
int main(void)
{
  *(uint32_t*)0x40007014 = 0x0000080F;
  *(uint32_t*)0x40007020 = 0x00020018;

  PWR->VTOR_REG = CURRENT_APP_START_ADDRESS | 0x80000000;

  dfu_leds_config();
  if(CURRENT_APP_START_ADDRESS == NS_APP1_START_ADDRESS){
    dfu_led_on(LED1_GPIO_PORT, LED_GPIO1_PIN);
  }else if(CURRENT_APP_START_ADDRESS == NS_APP2_START_ADDRESS){
    dfu_led_on(LED2_GPIO_PORT, LED_GPIO2_PIN);
  }

  NS_SCHED_INIT(256, 16);

  dfu_flash_init();
  dfu_usart1_interrupt_config();
  dfu_usart1_enable();
  while(1)
  {
    app_sched_execute();
    __WFE();
    __SEV();
    __WFI();
  }
}
```

- Judge whether it is currently in bank 1 or bank 2. LED1 and LED2 will be ON respectively when it is in Bank 1 or bank 2
- Initialize the serial port.
- Wait for the serial port to interrupt receiving data.

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```
static void sched_evt(void * p_event_data, uint16_t event_size)
{
    switch(*(uint8_t *)p_event_data)
    {
        case SCHED_EVT_RX_DATA:{
            if(m_buffer[0] == 0xAA)
            {
                switch(m_buffer[1]){
                    case DFU_SERIAL_CMD_JumpToMasterBoot:{
                        if(m_buffer[2] == 0x01 && m_buffer[3] == 0x02 && m_buffer[4] == 0x03)
                        {
                            uint8_t cmd[] = {0xAA,DFU_SERIAL_CMD_JumpToMasterBoot,0};
                            serial_send_data(cmd, sizeof(cmd));

                            if(ns_dfu_boot_force_usart_dfu() == false){
                                uint8_t cmd[] = {0xAA,DFU_SERIAL_CMD_JumpToMasterBoot,2};
                                serial_send_data(cmd, sizeof(cmd));

                            }
                        }else
                        {
                            uint8_t cmd[] = {0xAA,DFU_SERIAL_CMD_JumpToMasterBoot,1};
                            serial_send_data(cmd, sizeof(cmd));

                        }
                    }break;
                }
            }
        }break;
    }
}
```

- Handle the serial port command, respond to the PC upper computer, write in forced serial port update flag, and the service jumps to the MasterBoot program.

7.3 AppOTA Explanation

```
/**
 * @brief  ble initialization
 * @param
 * @return
 * @note
 */
void app_ble_init(void)
{
    struct ns_stack_cfg_t app_handler;
    app_handler.ble_msg_handler  = app_ble_msg_handler;
    app_handler.user_msg_handler = app_user_msg_handler;
    //initialization ble stack
    ns_ble_stack_init(&app_handler);

    app_ble_gap_params_init();
    app_ble_sec_init();
    app_ble_adv_init();
    app_ble_prf_init();
    //start adv
    ns_ble_adv_start();
}
```


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- Configure MAC address of Bluetooth.
- Configure the name of Bluetooth broadcast.
- Add IUS service.

main.c* | app_user_config.h | app_ns_ius.c | ns_dfu_ble.c

```
void ns_dfu_ble_handler_cc(uint8_t const *input, uint8_t input_len, uint8_t *output, uint8_t *output_len)
{

  switch(input[0]){

    case OTA_CMD_CONN_PARAM_UPDATE:{
      struct gapc_conn_param conn_param;
      conn_param.intv_min = input[1]<<8 | input[2];
      conn_param.intv_max = input[3]<<8 | input[4];
      conn_param.latency = input[5]<<8 | input[6];
      conn_param.time_out = input[7]<<8 | input[8];
      app_env.manual_conn_param_update = 1;
      app_update_param(&conn_param);
      *output_len = 0;
    }break;
    case OTA_CMD_MTU_UPDATE:{
      app_env.manual_mtu_update = 1;
      app_mtu_set(input[1]<<8 | input[2]);
      *output_len = 0;
    }break;

    case OTA_CMD_VERSION:{
      rc_mtu_offset = 0;
      memset(&m_ota_image,0,sizeof(m_ota_image));
      uint32_t new_app1_size = input[1]<<24 | input[2]<<16 | input[3]<<8 | input[4];
      uint32_t new_app2_size = input[5]<<24 | input[6]<<16 | input[7]<<8 | input[8];
      uint32_t new_image_update_size = input[9]<<24 | input[10]<<16 | input[11]<<8 | input[12];
      uint32_t new_image_update_version = input[13]<<24 | input[14]<<16 | input[15]<<8 | input[16];

      #ifdef APPLICATION

        ota_selection = 0;

        if(CURRENT_APP_START_ADDRESS == NS_APP1_START_ADDRESS){
          if(ns_bootsetting.app1.size > NS_APP1_DEFAULT_SIZE || new_app1_size > NS_APP1_DEFAULT_SIZE || new_
            if(ns_bootsetting.ImageUpdate.crc == dfu_crc32((uint8_t *)((uint32_t *)ns_bootsetting.ImageUpdat
              if(new_image_update_version > ns_bootsetting.ImageUpdate.version){
```

- Handle CC commands

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main.c* | app_user_config.h | app_ns_ius.c | ns_dfu_ble.c

```c
void ns_dfu_ble_handler_rc(uint8_t const *input, uint32_t input_len)
{
  switch(m_rc_state){

    case OTA_RC_STATE_DFU_SETTING:{
      m_rc_state = OTA_RC_STATE_NONE;
      memcpy(&m_dfu_setting, input, sizeof(Dfu_setting_t));
      uint32_t crc = dfu_crc32((uint8_t *)&m_dfu_setting.crc + 4, sizeof(Dfu_setting_t) - 4);
      if(crc == m_dfu_setting.crc){
        uint8_t error = 0;

        #if OTA_ECC_ECDSA_SHA256_ENABLE
          uint8_t raw_data[sizeof(Dfu_setting_bank_t)*3];
          memcpy(raw_data,&m_dfu_setting.app1,sizeof(Dfu_setting_bank_t));
          memcpy(raw_data+sizeof(Dfu_setting_bank_t),&m_dfu_setting.app2,sizeof(Dfu_setting_bank_t));
          memcpy(raw_data+sizeof(Dfu_setting_bank_t)*2,&m_dfu_setting.image_update,sizeof(Dfu_setting_bank_t
          uint8_t hash_digest[32];
          if(ERROR_SUCCESS == ns_lib_ecc_hash_sha256(raw_data, sizeof(Dfu_setting_bank_t)*3, hash_digest)){
            if(ERROR_SUCCESS != ns_lib_ecc_ecdsa_verify(ns_bootsetting.public_key, hash_digest, 32, m_dfu_se
              error = 3;
            }
          }else{
            error = 3;
          }
        #endif


        uint8_t response[2] = {OTA_CMD_CREATE_OTA_SETTING};
        response[1] = error;
        ns_ble_ius_app_cc_send(response,sizeof(response));
      }else{
        uint8_t response[2] = {OTA_CMD_CREATE_OTA_SETTING};
        response[1] = 2;
        ns_ble_ius_app_cc_send(response,sizeof(response));
      }
```

- Handle RC commands and data
- To create an update package, users need to modify the IROM1 in Keil's Options for Target and the number after APP and After Build Run # 2. The specific method is described as follows.

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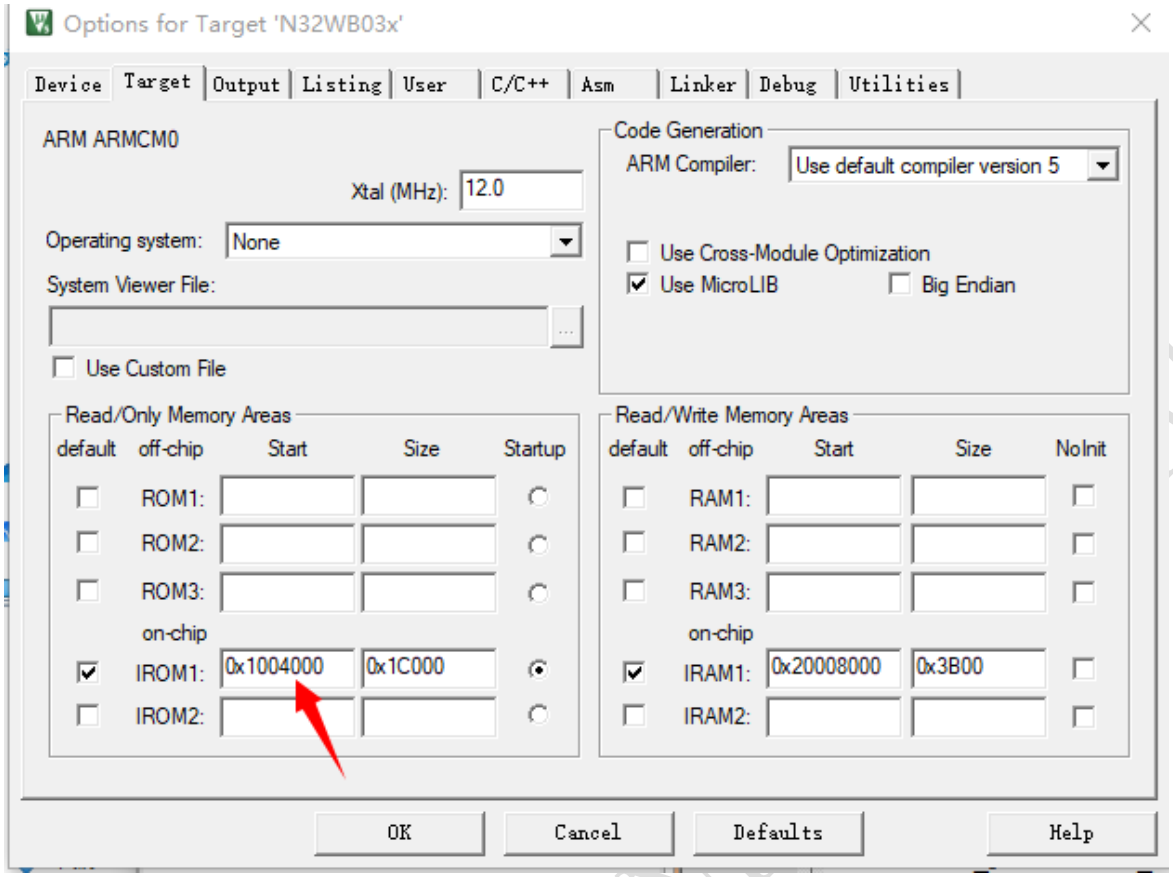
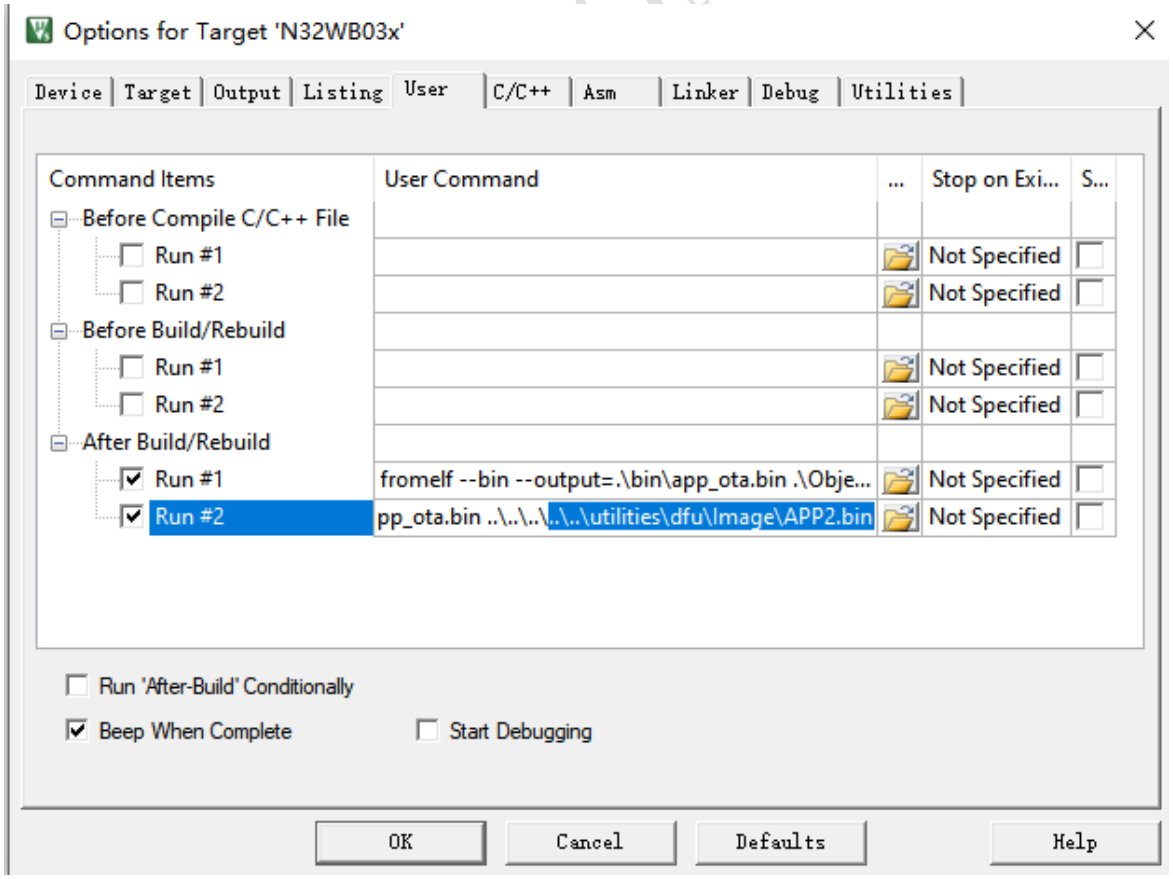
地址：深圳市南山区高新北区宝深路109号国民技术大厦
电话：+86-755-86309900 传真：+86-755-86169100
邮箱：info@nationz.com.cn 邮编：518057





- IROM1: 0x1004000 corresponds to the APP 1 program address of Bank 1; Run # 2 is modified to APP1 (the

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电话：+86-755-86309900 传真：+86-755-86169100
邮箱：info@nationz.com.cn 邮编：518057

corresponding APP1.bin file is generated under the Image folder)

- IROM1: 0x1020000 corresponds to the APP 1 program address of Bank 1; Run # 2 is modified to APP2 (the corresponding APP2. bin file is generated under the Image folder)

7.4 ImageUpdate Explanation

```
int main(void)
{
  *(uint32_t*)0x40007014 = 0x0000080F;
  *(uint32_t*)0x40007020 = 0x00020018;

  PWR->VTOR_REG = 0x00000000;
  NS_BLE_STACK_INIT();


  RCC->CFG &= ~1;
  while((RCC->CFG & (1<<2)));

  bootsetting_reset();

  app_init();
  prf_init(RWIP_INIT);

  while(1)
  {
    rwip_schedule();
  }
}
```

ain.c* | app_user_config.h | ns_iuss_task.c | app_ns_ius.c | ns_dfu_ble.c

```
#ifndef _APP_USER_CONFIG_H_
#define _APP_USER_CONFIG_H_

#include "ns_adv_data_def.h"
//#include "app.h"
//#include "user_profiles_config.h"

/* Device name */
#define CUSTOM_DEVICE_NAME                  "ImageUpdate"
#define CUSTOM_BLE_MAC_ADDRESS              "\x9A\x22\x77\x44\x55\x66"

//DIS server configer
#define MANUFACTURER_NAME                   "Nations"
```

- Add one to the last bit of the Bluetooth MAC address.

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电话：+86-755-86309900 传真：+86-755-86169100
邮箱：info@nationz.com.cn 邮编：518057

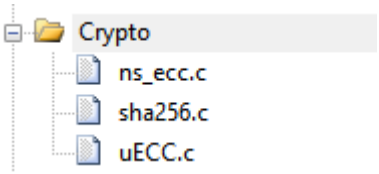
8 Explanation of Encryption

```
#define OTA_ECC_ECDSA_SHA256_ENABLE

#if OTA_ECC_ECDSA_SHA256_ENABLE
#include "ns_ecc.h"
#endif
```

Figure 1

- Enable the macro OTA_ECC_ECDSA_SHA256_ENABLE in AppOTA and ImageUpdate program, so as to enables update and signature verification.



- The project includes these files to realize the verification interface.

```
#if OTA_ECC_ECDSA_SHA256_ENABLE
  uint8_t raw_data[sizeof(Dfu_setting_bank_t)*3];
  memcpy(raw_data,&m_dfu_setting.app1,sizeof(Dfu_setting_bank_t));
  memcpy(raw_data+sizeof(Dfu_setting_bank_t),&m_dfu_setting.app2,sizeof(Dfu_setting_bank_t));
  memcpy(raw_data+sizeof(Dfu_setting_bank_t)*2,&m_dfu_setting.image_update,sizeof(Dfu_setting_bank_t));
  uint8_t hash_digest[32];
  if(ERROR_SUCCESS == ns_lib_ecc_hash_sha256(raw_data, sizeof(Dfu_setting_bank_t)*3, hash_digest)){
    if(ERROR_SUCCESS != ns_lib_ecc_ecdsa_verify(ns_bootsetting.public_key, hash_digest, 32, m_dfu_setting.signature)){
      error = 3;
    }
  }else{
    error = 3;
  }
#endif
```

- When receiving the dfu_setting data, the embedded side uses the above method for signature verification.
- Generate an update package, use ECC to sign and encrypt the firmware parameters, including CRC, size, and others, and save them in dfu_setting. After receiving the dfu_setting, the embedded side uses known public key to verify the signature. You can indeed start the update (that is, erasing and writing FLASH) when the signature verification is successful.
- Only the unique information of the firmware is encrypted and signed, so that the signature verification at the embedded side is accelerated and the firmware update is well protected.

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地址：深圳市南山区高新北区宝深路109号国民技术大厦
电话：+86-755-86309900 传真：+86-755-86169100
邮箱：info@nationz.com.cn 邮编：518057

9 Common Problems

9.1 Run <JLINKProgramming.bat> problems in WIN7

WIN7 shows that api-ms-win-core-path-l1-1-0.dll is lost and the dll file will be stored in the directory C:\Windows\System32.

Users can find this dll file in the same directory of other genuine Windows computers or consult the Technical Support Department.

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地址：深圳市南山区高新北区宝深路109号国民技术大厦
电话：+86-755-86309900 传真：+86-755-86169100
邮箱：info@nationz.com.cn 邮编：518057

10 Version History

Date	Version	Modification	Author
2022/12/28	V1.2	Initial version	Chen Zhang

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地址：深圳市南山区高新北区宝深路109号国民技术大厦
电话：+86-755-86309900 传真：+86-755-86169100
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电话：+86-755-86309900 传真：+86-755-86169100
邮箱：info@nationz.com.cn 邮编：518057