Firmware Updates for Renesas MCU

Introduction for “FW UP Module”

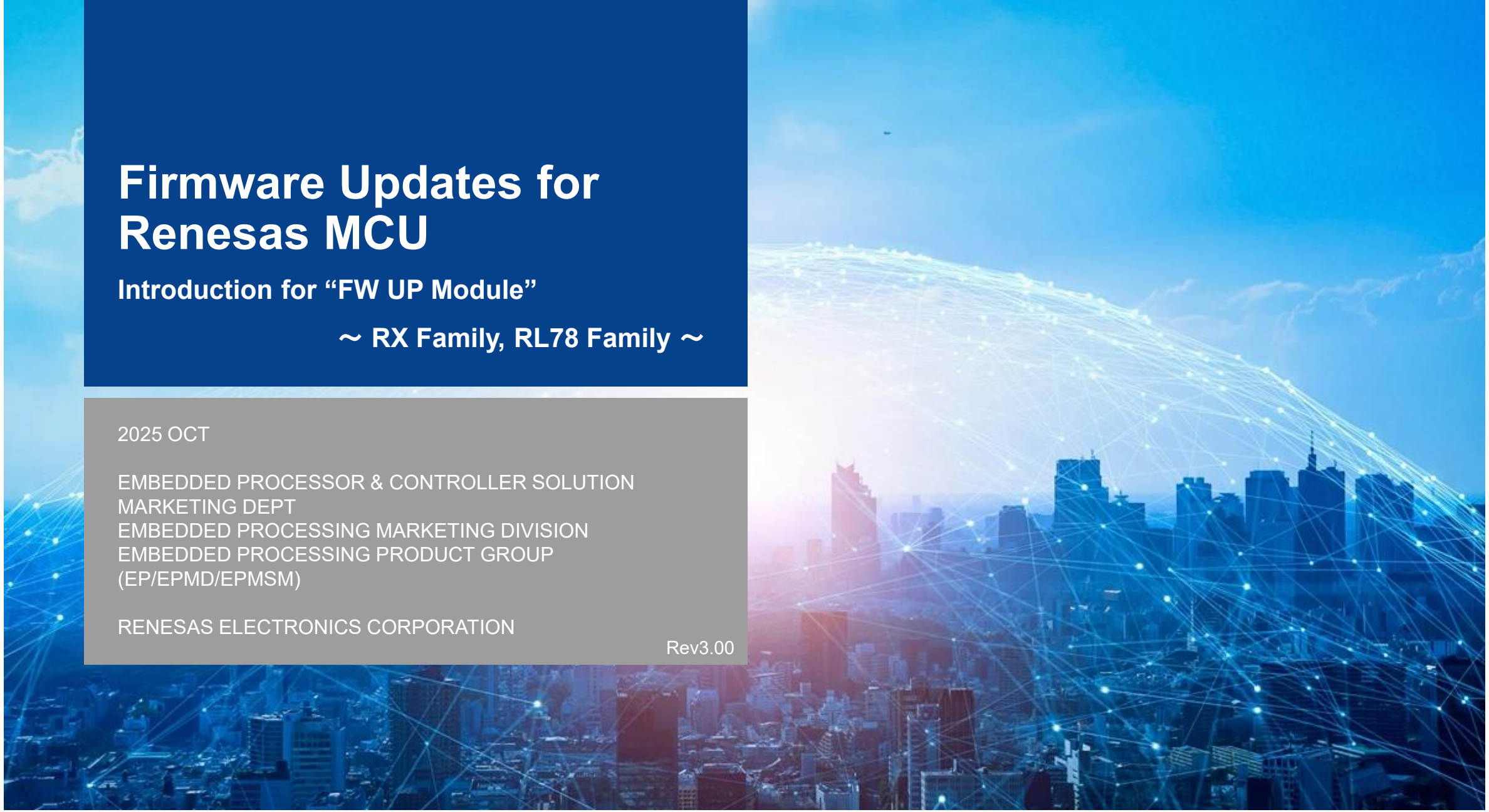
～ RX Family, RL78 Family ～

2025 OCT

EMBEDDED PROCESSOR & CONTROLLER SOLUTION MARKETING DEPT
EMBEDDED PROCESSING MARKETING DIVISION
EMBEDDED PROCESSING PRODUCT GROUP
(EP/EPMD/EPMSM)

RENESAS ELECTRONICS CORPORATION

Rev3.00



CONTENTS

Market Needs

Firmware Update feature be necessary for a rapidly growing various IoT applications

IoT x Segments

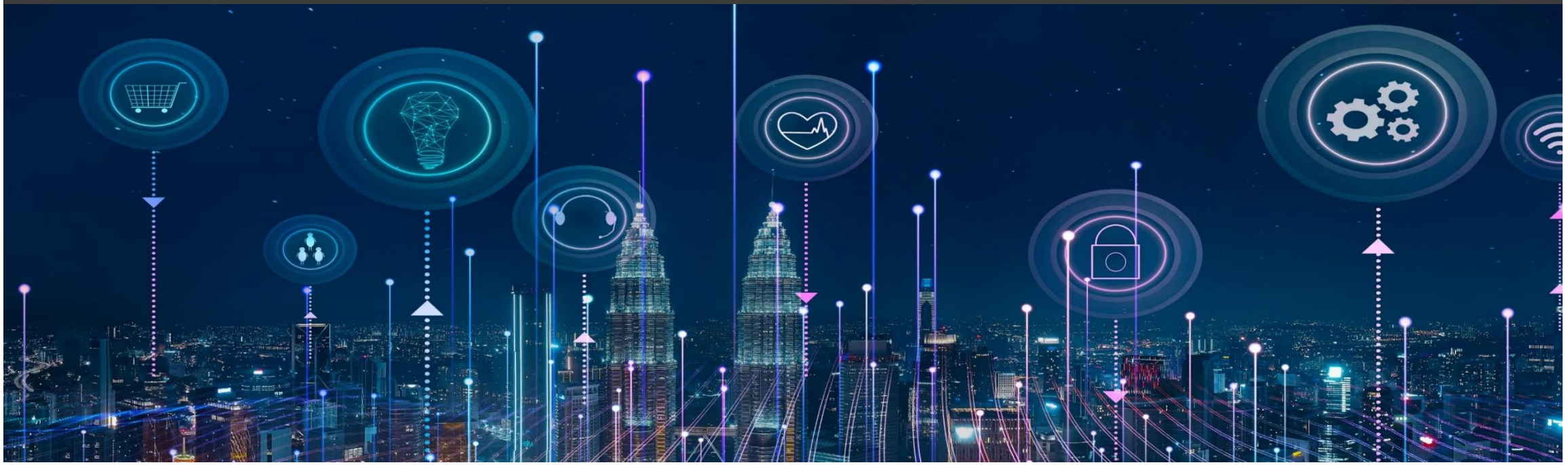
Common Technology for various application
(IA, FA, HA, BA, HC, Power Equipment, Social Infra…etc.)

Continuous Service

Maintain latest firmware by OTA (Over-the-Air) via Cloud

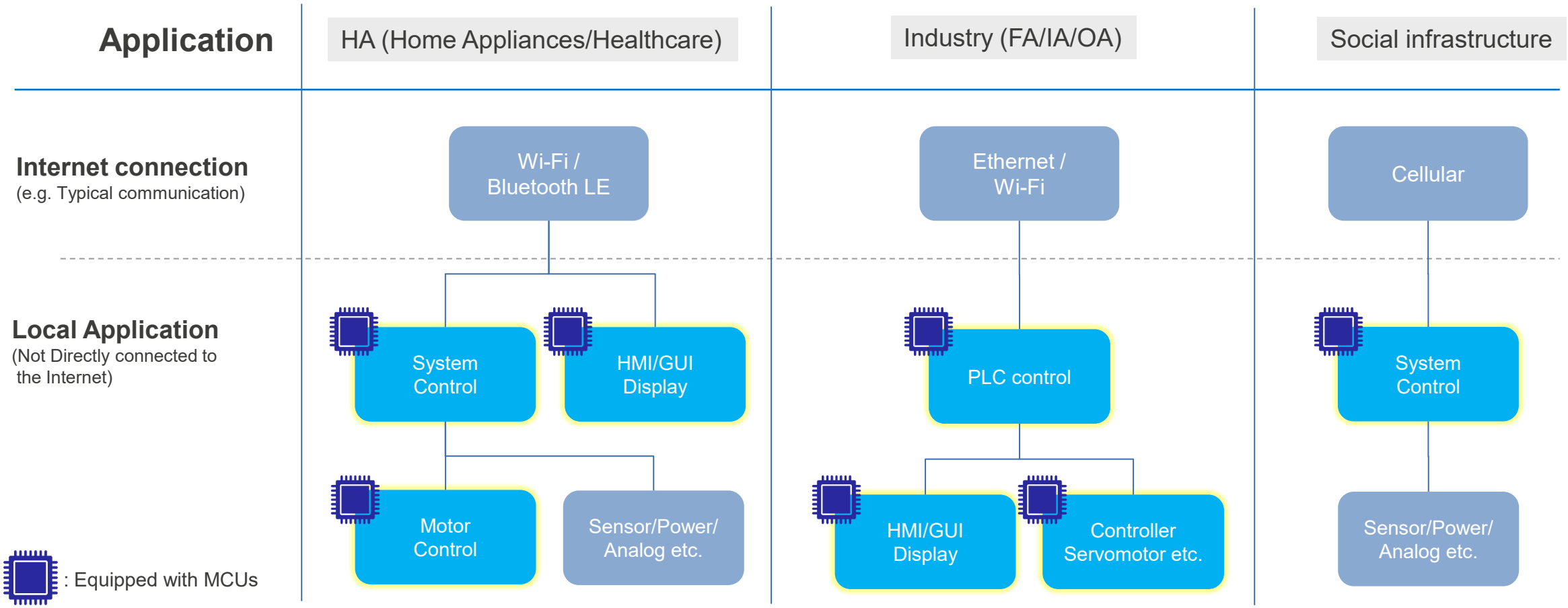
Vulnerability Threats

Security Integration and Legislation such as CRA, U.S. Cyber Trust Mark, Other IoT Guideline



Applications that require Firmware Updates

As shown the previous page, MCU ( ) Firmware Update function must be implemented in all system blocks of IoT products.



Renesas MCUs

Firmware Update Solution Introduction as “FW UP Module”

Features of Renesas “FW UP Module”

Firmware Update module

Your firmware update function can be easily incorporated using the FW UP Module!

Renesas Provide

Image Generator for Updating FW
Renesas Image Generator

+

Boot loader
Sample

+

FW UP Module

+

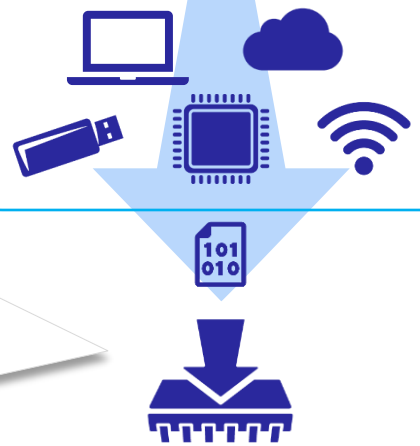
User apps

Pre-preparation : of the program
Creating mot Files and Key Pairs

Generates signed Update FW Image* by the Renesas Image Generator

* OpenSSL generates Key Pairs and Code Signature

Input Update FW Image via various Methods



Easy FW update with various system-configuration

The user application can implements how to acquire updated Images according to meet customer requirements.

Supports three FW Update Methods by Flash ROM type

1. Dual Mode : **Dual-bank Method** *1
2. Linear Mode : **Partial Update Method**
   - ➢ Easy recovery even if FW updating fails
3. Linear Mode : **Full Update Method** *2
   - ➢ FW can be updated in small memory footprint MCU

*1 Only some available for RX-Family and RL78-Family MCU
*2 RL78 Family supports a method of using also an external flash memory for the buffer area.

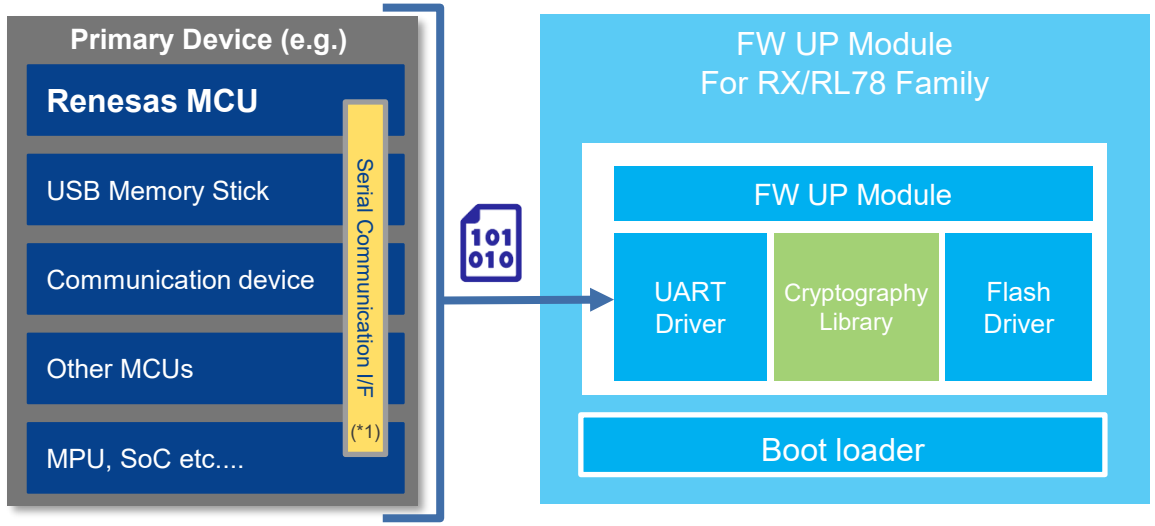
Realize secure FW Update by validating Code signature

Supports firmware validation (ECDSA NIST P-256 and SHA256) with Secure Boot feature

Sample system configuration using the FW UP Module

The FW UP Module is ideal for FW update over various Primary Devices

Get an Update FW via serial communication



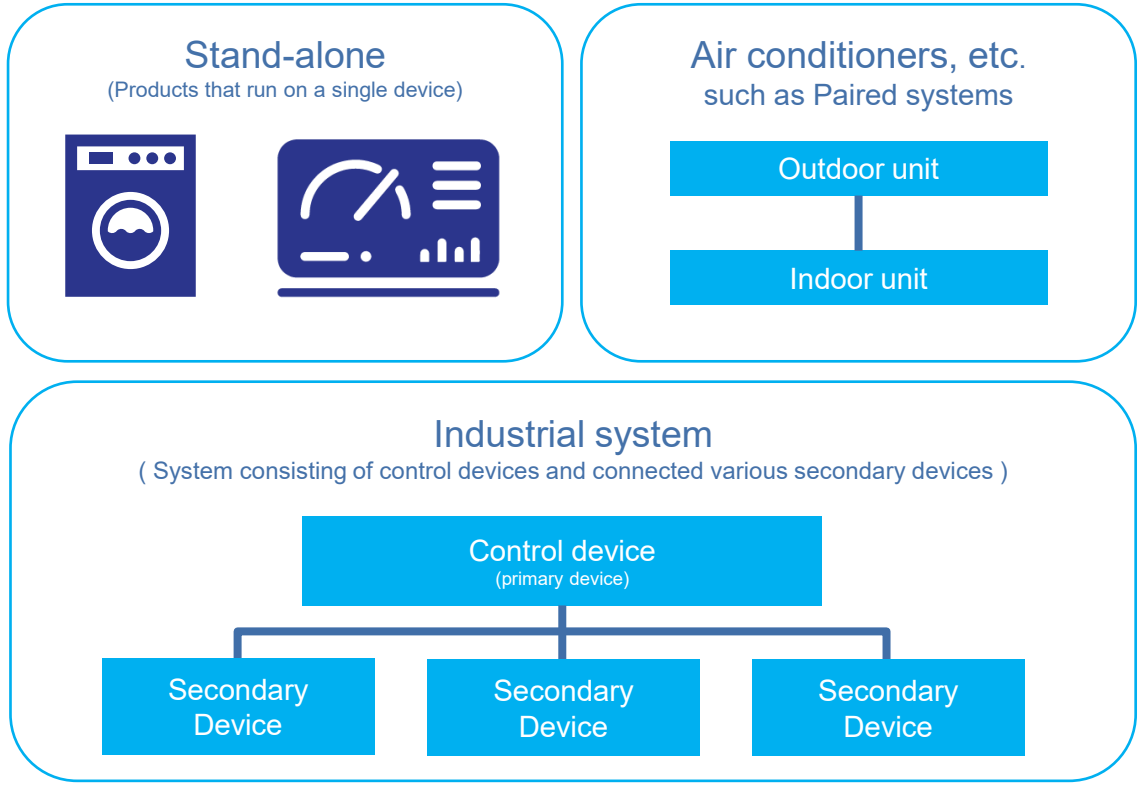
*1 : Firmware Updating Communications Module : (**RX**, **RL78**)

Application Notes

FW UP Module APN (Link) for RX Family

FW UP Module APN (Link) for RL78 Family

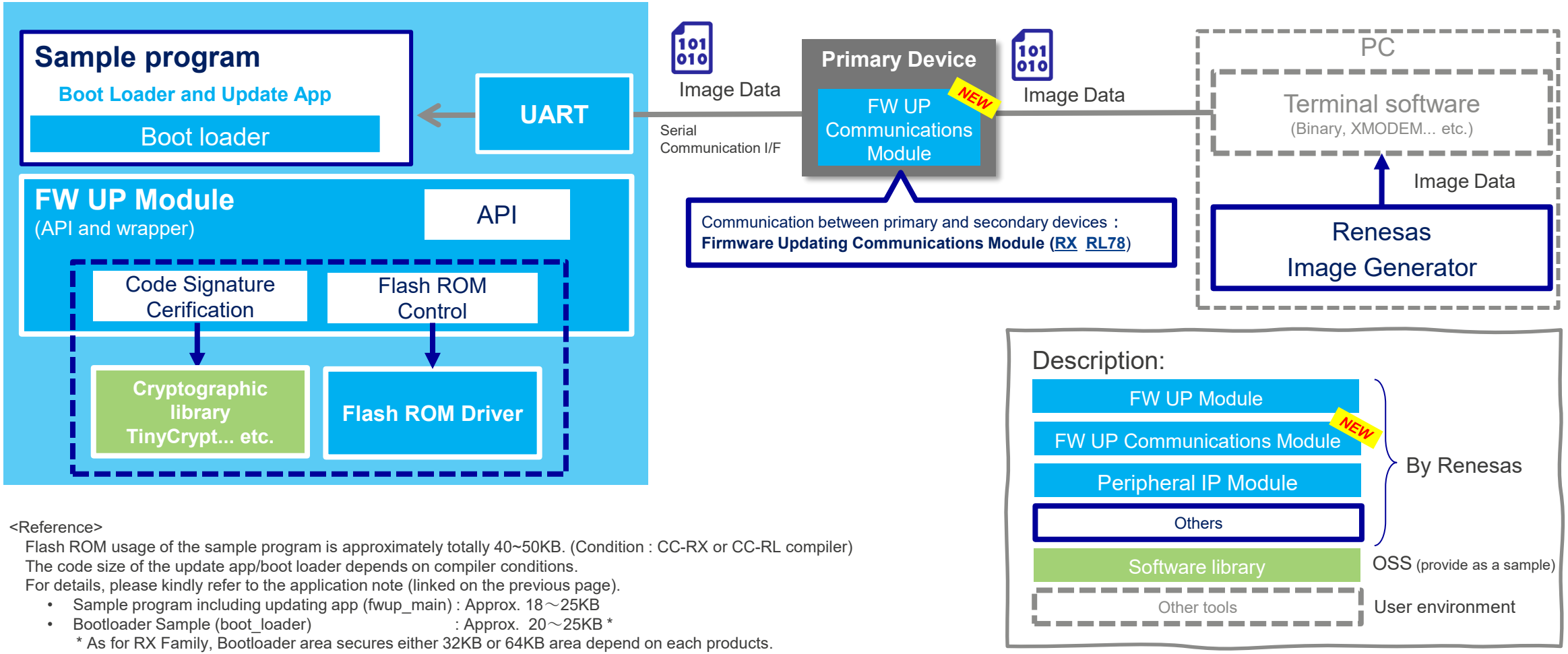
Compatible with various use cases



MCUs supported by FW UP Module : **RX Family** - All RX Family,
RL78 Family - RL78/G22, RL78/G23, RL78/G24, RL78/L23

System Configuration for Secondary Device Update with FW UP Module

➢ Secondary device firmware update



<Reference>
Flash ROM usage of the sample program is approximately totally 40~50KB. (Condition : CC-RX or CC-RL compiler)
The code size of the update app/boot loader depends on compiler conditions.
For details, please kindly refer to the application note (linked on the previous page).

- Sample program including updating app (fwup_main) : Approx. 18～25KB
- Bootloader Sample (boot_loader) : Approx. 20～25KB *

* As for RX Family, Bootloader area secures either 32KB or 64KB area depend on each products.

What is Boot loader and its role

- Bootloader is a kind of software that is responsible for verifying the firmware Update FW Image and writing the firmware into Flash Memory.
- The bootloader sample for this FW UP Module uses an open source TinyCrypt.
- The roles of this bootloader for each Method are listed in the table below.

Firmware Update Method	Boot loader	
	FW Image Validation	Write to Flash ROM
1. Dual Mode Dual Bank Method	✓	- *
2. Linear Mode Partial Update Method	✓	- *
3. Linear Mode Full Update Method	✓	✓

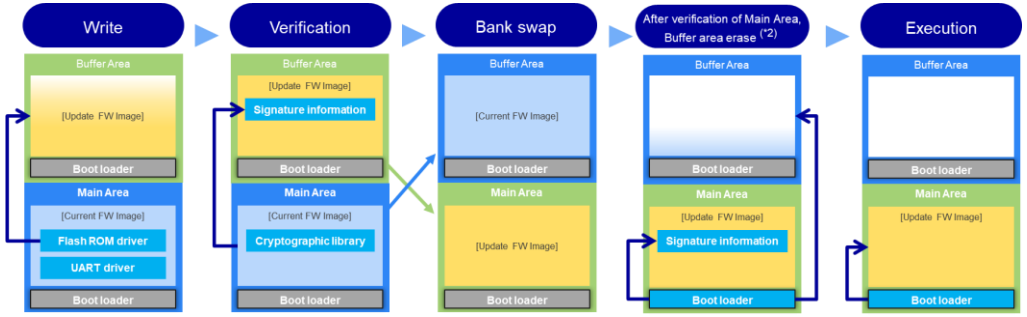
* : This bootloader also includes a specification to write an initial firmware image to Flash ROM in MCU at a factory site.
By writing only this bootloader in advance at the factory, the initial image is programed via UART communication into the Flash ROM.
In case users wish to use other communication methods than UART, the communication method can be customized by the users.

Selectable Update Method according to your MCU Flash ROM product

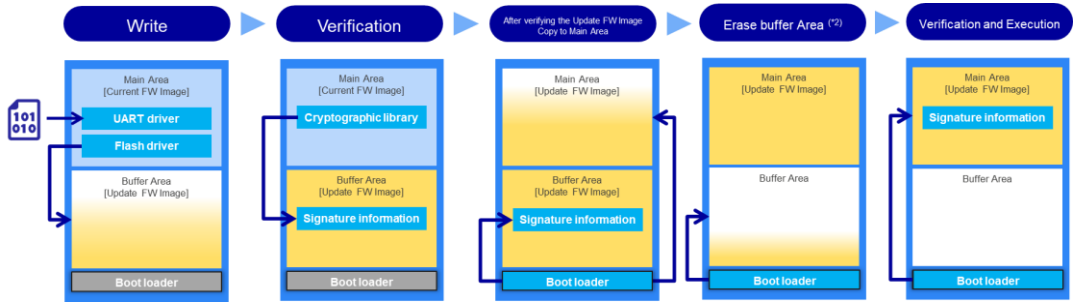
~ Support for development with sample programs of each Method ~

<Sample program>
RX : #R01AN6850 / Sample Zip
RL78 : #R01AN6374 / Sample Zip

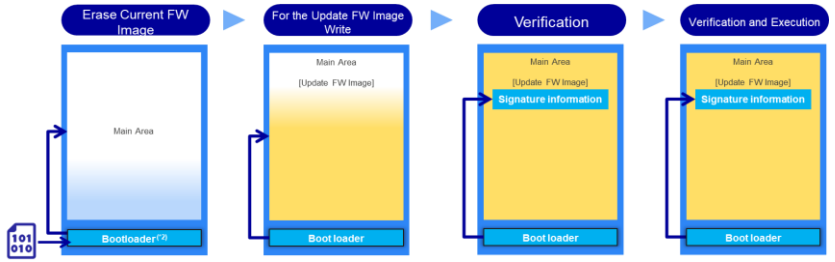
1. Dual Mode: Dual-bank * update operation



2. Linear Mode: Partial Update Method *



3. Linear Mode: Full Update Method * update operation



Modes and Device Correspondence Table

Flash Product	4MB	2MB	1.5MB	1MB	768KB	512KB	384KB	256KB	128KB	96KB	64KB
RX130	-	-	-	-	-	L	L	L	L	-	-
RX140	-	-	-	-	-	-	-	L	L	-	-
RX231/230	-	-	-	-	-	L	L	L	L	-	-
RX23E-A	-	-	-	-	-	-	-	L	L	-	-
RX23E-B	-	-	-	-	-	-	-	L	L	-	-
RX24T	-	-	-	-	-	L	L	L	L	-	-
RX26T	-	-	-	-	-	DB/L	-	L	L	-	-
RX65N/651	-	DB/L	DB/L	L	L	L	-	-	-	-	-
RX66N	DB/L	L	-	-	-	-	-	-	-	-	-
RX66T	-	-	-	L	-	L	-	L	-	-	-
RX660	-	-	-	L	-	L	-	-	-	-	-
RX671	-	DB/L	DB/L	L	-	-	-	-	-	-	-
RX72M	DB/L	L	-	-	-	-	-	-	-	-	-
RX72N	DB/L	L	-	-	-	-	-	-	-	-	-
RL78/G22	-	-	-	-	-	-	-	-	-	-	L
RL78/G23	-	-	-	-	L	L	L	L	L	L	-
RL78/G24	-	-	-	-	-	-	-	-	L	-	L
RL78/L23	-	-	-	-	-	DB/L	-	DB/L	L	L	L

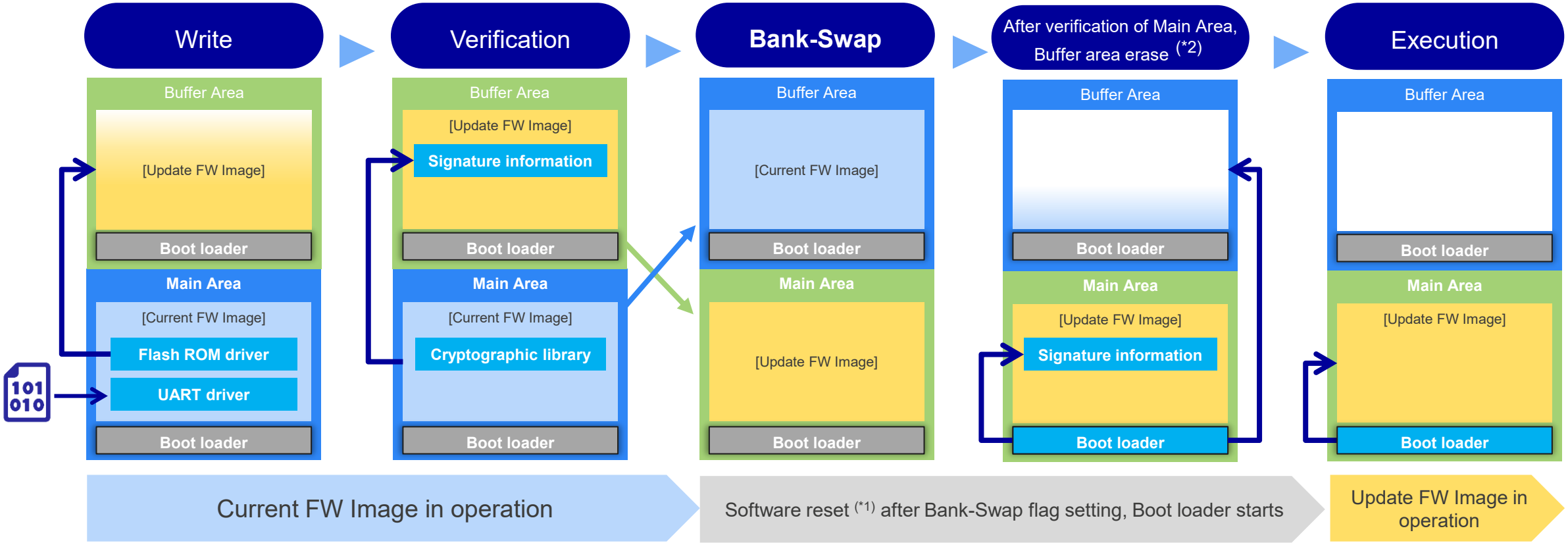
DB : Products supporting Dual Mode (1. Dual Bank Method)
L : Products supporting Linear mode (2. Partial Update / 3. Full Update Method)
- : Not supported
red text: Products supporting the sample program(Sample provided in zip)

* RL78 family currently does ***not*** support the dual-bank Method. Also, the updating Method name is partially different from the application note for RL78. No.2 means “Partial Update Method" and No.3 means “ Full Update Method (without buffer)."

1. Dual Mode
Dual Bank Method: Normal operation

For use case that doesn‘t want to stop user applications, Dual-bank supported MCUs are recommended !

For **Dual Bank** supported MCUs, Update FW Image can be written while the current program on the main is executing!
Address placement management of programs is also *not necessary* to utilize the **Bank-Swap** function.



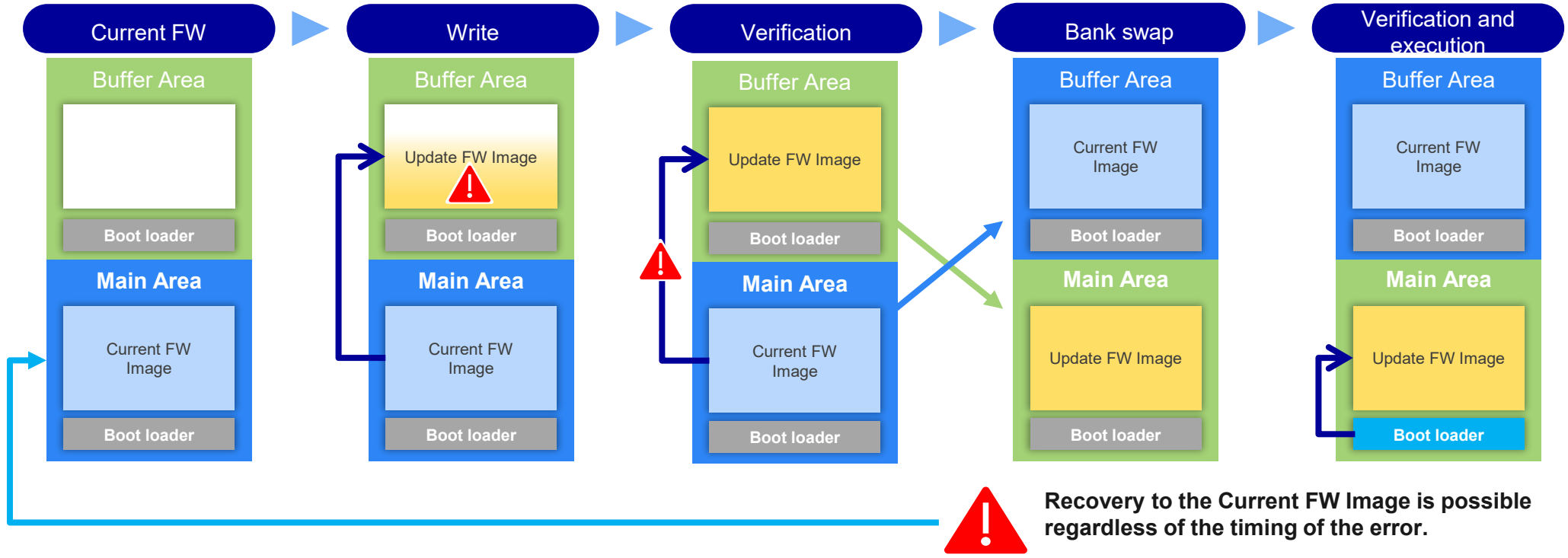
*1 : For initialization by a software reset, please see the "Reset Chapter" in the hardware manual of each MCU.
*2 : The demonstration program of the FW UP Module does not erase the buffer area. If it is necessary to erase the current(previous) Image before updating, users need to add the Image erase process of located the buffer side to prevent rollback.

1. Dual Mode
Dual Bank Method: Operation with error occurs

If the firmware update process fails due to a power-cut/signature verification failure as abnormal process, Enables to boot the Current FW Image and redo the firmware update,again.

Buffer area	Disabled	Disabled	Enable	Enable
Main Area	Enable	Enable	Enable	Enable

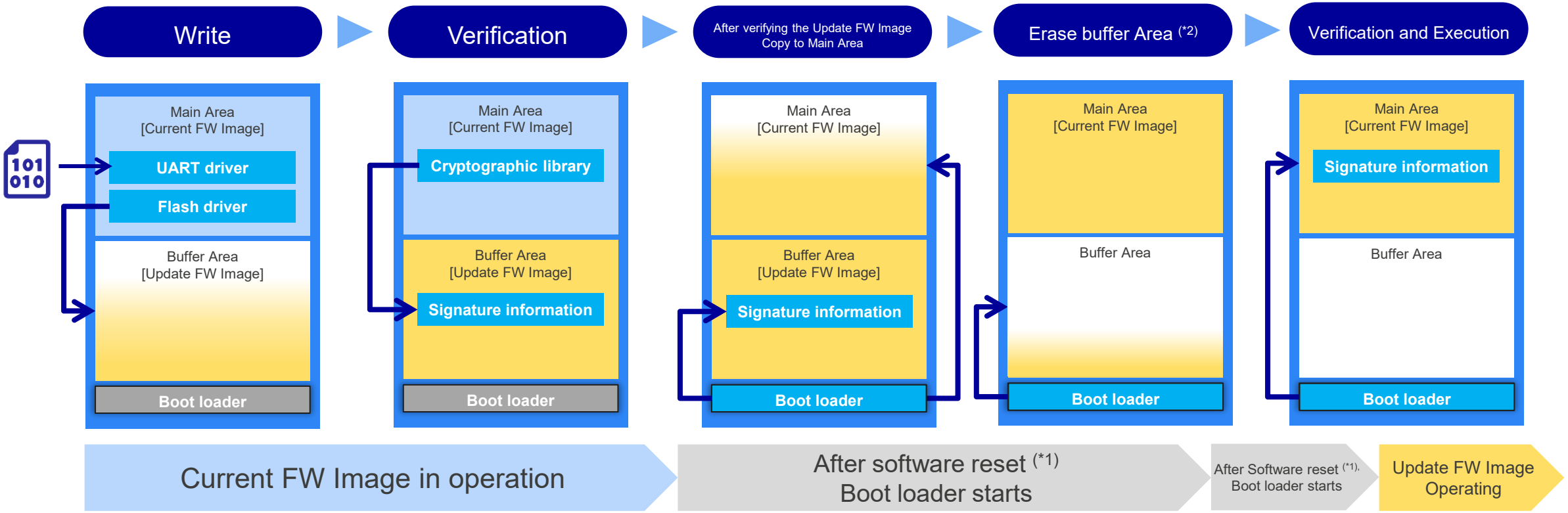
Green text: Startable state / **Black text:** Unbootable state



Recovery to the Current FW Image is possible regardless of the timing of the error.

2. Linear Mode
Partial Update Method: Normal operation

Even if MCU does not support Dual Bank, a firmware can be renewed with the previous FW Image retained by using the Partial Update Method.



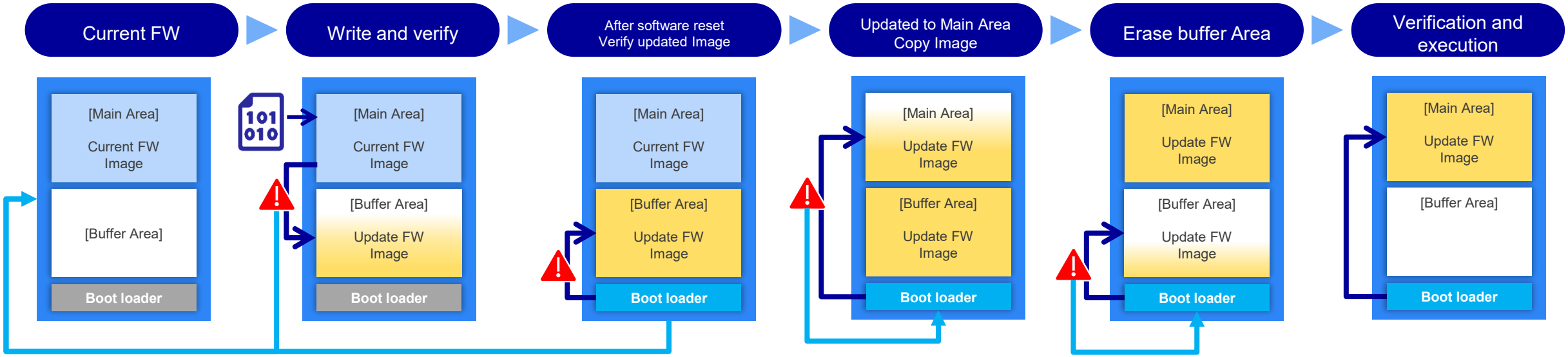
*1 : For initialization by a software reset, please see the "Reset Chapter" in the hardware manual of each MCU.
*2 : The demonstration program of the FW UP Module does not erase the buffer area. If it is necessary to erase the current(previous) Image before updating, users need to add the Image erase process of located the buffer side to prevent rollback.

2. Linear Mode
Partial Update Method: Operation when an error occurs

If the firmware update fails due to a power-off or signature verification failure,
You can start the Image before the update and start the firmware update again.

Main Area	**Enable**	**Enable**	**Disabled**	**Enable**	**Enable**
Buffer Area	**Disabled**	**Disabled**	**Enable**	**Disabled**	**Disabled**

Green text: Startable state / **Black text:** Unbootable state

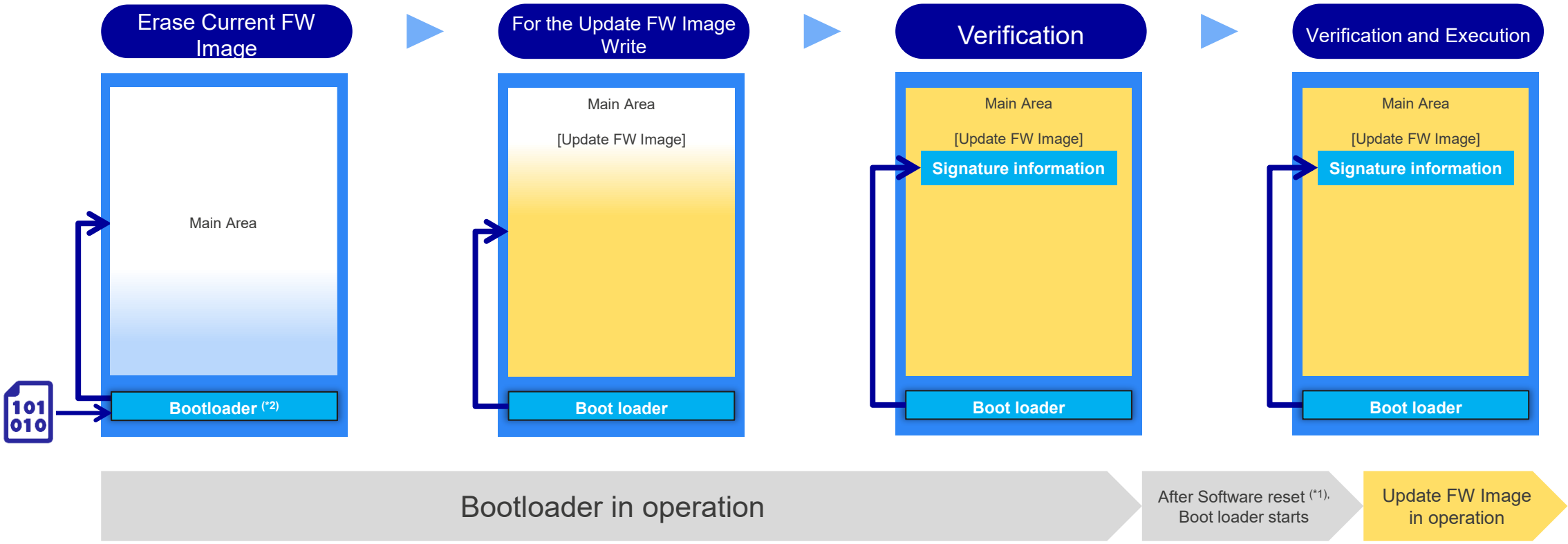


There is always a valid Image on either side,
And recovery is possible in case of an error.

3. Linear Mode
Full Update Method: Normal operation

If wants to secure the entire user program area of ROM at Low end MCU, Full Update Method is available.

Firmware updates can also be implemented for small ROM footprinted products using the Full Update Method.



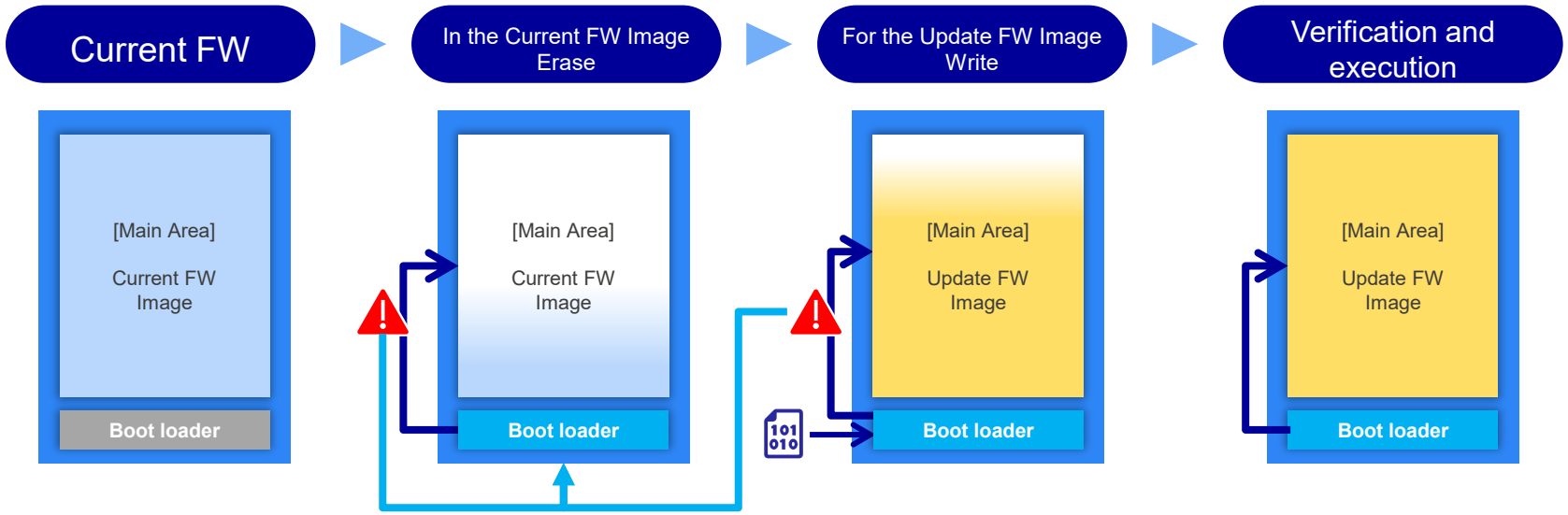
*1 : For initialization by a software reset, please see the "Reset Chapter" in the hardware manual of each MCU.
*2 : The demonstration program boot loader uses UART communication to obtain an updated Image. It is necessary to change it according to the communication Method customers want to use.

3. Linear Mode
Full Update Method: Operation when an error occurs

With the Full Update Method, if the firmware update fails, use the boot loader function to perform the firmware update again.

Main Area	Enable	Disabled	Disabled	Enable

Green text: Startable state / **Black text:** Unbootable state



Repeat until the firmware update is successful.

Generate Signed Initial FW and Updated FW Image using with Renesas Image Generator

Renesas Image Generator can easily realize for both "signing to firmware" and "binding with bootloader and user firmware "

1. Pre-Preparation

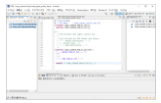
Generate Key and Signature Information

OpenSSL

Generating Public Key and Private Key Key Pairs with the Key Generator

Create a firmware

e² studio



Application Pub.

Boot loader Pub.

Including a Public Key for Validating Signatures in **Application** and **Bootloader**.

Generate a mot Files

e² studio

Application.mot

Bootloader.mot

Builde and Generate a mot file

2. Execute in the **Renesas Image Generator**

Create RSU※ Header Addresses

Create RSU Header address information according to the device using parameter file

RSU Header-Address Information

※RSU=Renesas Secure Update

Grant RSU Header-Signing Information

Signing RSU Header Addresses and Applications with Private Key

RSU Header-Address Information

Application.mot

Pvt.

RSU Header-Signing Information

Generate initial Image with bootloader

3. Complete of generating the initial Image

Initial Image of the Dual Bank Method (.mot Files)

Boot loader (Code flash data) [Buffer Area]

RSU Header-Signing Information (0x200 turning tool)

RSU Header-Address Information (0x100 turning tool)

Application Program data

Boot loader (Code flash data) [Main Area]

Renesas.com

Appendix :

Introduction to Firmware Update Solutions

Renesas IoT Cloud

For optimal Firmware Updates on IoT products by Renesas MCU Family

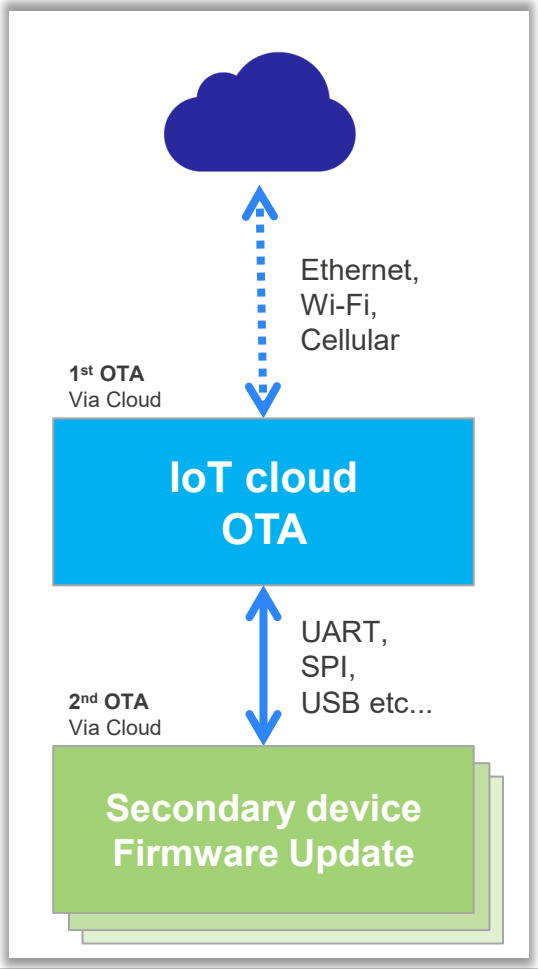
Support for firmware updates via OTA(Over the Air) through the cloud!

MCU Family	Secondary device Firmware Update	IoT cloud OTA
RENESAS RA	RA0, RA2, RA4 Series Non-RTOS	RA6, RA8 Series MQTT / OTA / TLS / TCP/IP*1, Fleet Provisioning (Coming soon) FreeRTOS
RENESAS RX	RX100/200 Series Non-RTOS	RX65N MQTT / OTA / TLS / TCP/IP*1 / Fleet Provisioning FreeRTOS
RENESAS RL78	RL78/G22, RL78/G23, RL78/G24, RL78/L23 Non-RTOS	RL78/G23 MQTT / OTA / FreeRTOS *2

Introduced in this material

*1 : Ethernet(MCU) Only

*2 : When using with these components with RL78/G23 (max ROM 768KB, RAM 48KB), RAM available for your app may be less than 10KB.



Firmware Update Solutions List

		RX	RL78
Secondary Device Firmware Update	FW UP Module Sample code	✓ RX Family Firmware Update Module Using Firmware Integration Technology Application Notes - Sample Code	✓ RL78/G22, RL78/G23, RL78/G24, RL78/L23 Firmware Update Module
	Firmware Updating Communications Module	✓ RX Family Firmware Updating Communications Module Using Firmware Integration Technology	✓ RL78/G23 Firmware Updating Communications Module
IoT Cloud OTA	Secondary device OTA Firmware Update Sample code	✓ RX65N Group Sample Code for OTA Update of a Secondary Device by Amazon Web Services with the Use of FreeRTOS	✓ RL78/G23 Sample Code for OTA Update of a Secondary Device by Amazon Web Services with the Use of FreeRTOS
	OTA firmware Update sample code	✓ RX Family How to Implement FreeRTOS OTA Using Amazon Web Services (202406-LTS Version)	✓ Getting Started Guide for Connecting Amazon Web Services in Wi-Fi Communication: RL78/G23-128p Fast Prototyping Board + FreeRTOS
	Development product	✓ QE for OTA: Development Assistance Tool for Firmware Update	

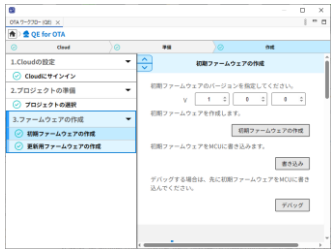
QE for OTA: Development Assistance Tool for Firmware Update

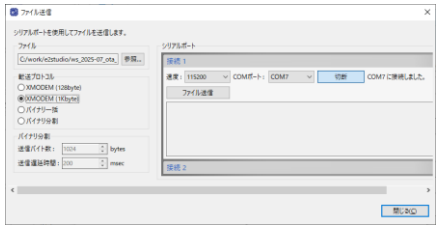
From Over the Air (OTA) to Local application
Firmware update with various system structure can be executed with simple GUI

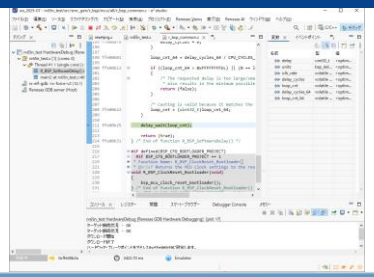
With/Without Cloud(AWS)		Update Target		Update Method		
With Cloud	Without Cloud	Primary	Secondary (NEW from V.2.2.0)	Dual Bank	Partial update	Full Update
Wi-Fi / Ethernet	Serial Communication	FreeRTOS / non-OS	non-OS	Bank0: main / Bank1: buffer	Single Bank: main, buffer	Single Bank: main

Quick and Effective tool solution

Reduce time required for 1 IoT device OTA by 86%! Support smooth PoC development!







Create Firmware, Bootloader → Generate & implement Signature verification info → Execute Firmware Update → Debug

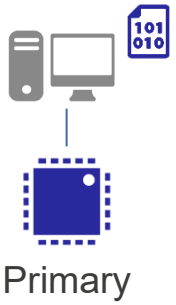
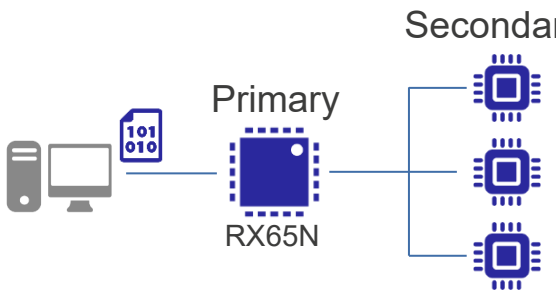
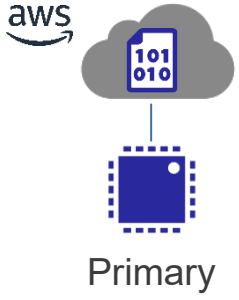
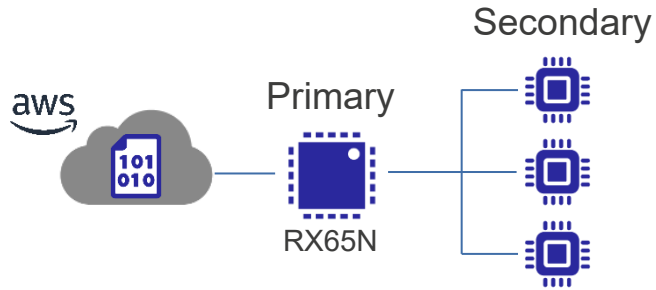
QE for OTA

Firmware Update Structures supported by QE FOR OTA V.2.2.0

QE for OTA

< More information >
- QE for OTA: Development Assistance for Cloud
- Firmware Update module

: Update FW Placeholder

	Firmware Update NOT via the cloud			Firmware Update via the cloud		
						
Update target	Primary	Primary	Secondary	Primary	Primary	Secondary
Supported Devices	**<RA>** RA6M4, RA6M5 **<RX, RL78>** FW UP Module-compatible devices	**<RX>** RX65N	**<RX>** RX23E-B, RX66T, RX660, RX261, RX140 **<RL78>** RL78/G23	**<RA>** RA6M5 **<RX>** RX65N **<RL78>** RL78/G23	**<RX>** RX65N	**<RX>** RX23E-B, RX66T, RX660, RX261, RX140 **<RL78>** RL78/G23
Presence of RTOS	non-OS	FreeRTOS, non-OS	non-OS	FreeRTOS	FreeRTOS	non-OS
Update Method	**< RA, RX >** Dual Bank Method **< RL78 >** Partial Update Method	Support for Primary MCU FW update is planned for 1Q/2026*3	Dual Bank Method*1, Partial Update Method, Full update method	**< RA, RX >** Dual Bank Method **< RL78 >** Partial Update Method	Dual Bank Method	Dual Bank Method*1, Partial Update Method, Full update method
Communication method	Serial Communication*2			**< RA, RX >** Ethernet **< RL78 >** Cellular		Serial Communication*2

*1: Only supported by Dual Bank mode-compatible devices. *2: Using " Serial Communication Firmware Updating Communications Module (RX, RL78) " for communication between MCUs.
*3: In Ver.2.2.0, only FW transfer to Secondary is supported.