

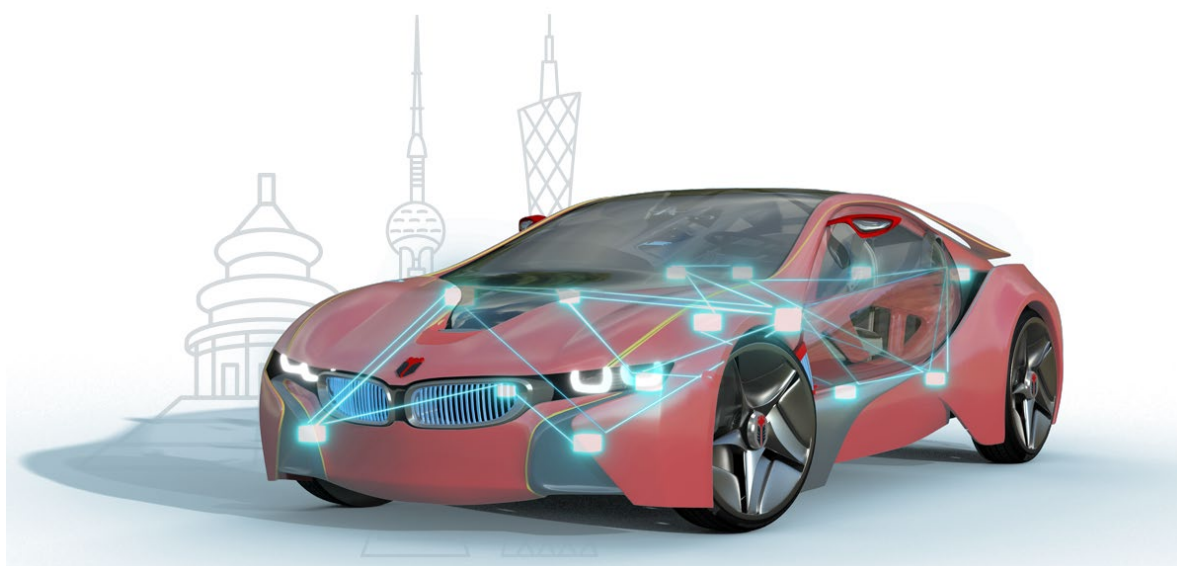


# 知从青龙 FOTA 产品手册

## ZQ.QINGLONG FOTA PRODUCT MANUAL

知从青龙 BootLoader

ZC.QINGLONG BootLoader



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### 1 功能概述 FUNCTION OVERVIEW

知从青龙 FOTA 是由知从科技自主研发的程序刷新软件(BootLoader)。使用知从青龙 FOTA 的控制器，可以通过 TCP/IP 的方式实现应用程序和操作系统的更新功能。目前，知从青龙 FOTA 已支持 LINUX, RTOS, QNX 等多款操作系统，并且支持多家整车厂程序刷新规范，可提供定制开发服务。

ZC.QingLong FOTA is a flash programming software (BootLoader) independently developed by ZC. Using the controller of ZC.Qinglong FOTA, the update function of applications and operating systems can be achieved through TCP/IP. Currently, ZC.Qinglong FOTA supports multiple operating systems such as LINUX, RTOS, QNX, and complies with the program update specifications of many vehicle manufacturers, offering customized development services.

目前知从青龙 FOTA 已经支持多家主流整车厂的程序刷新规范。

ZC.Qinglong FOTA has already supported the program update specifications of many mainstream vehicle manufacturers.

知从青龙 FOTA 可应用于整车多个域中的控制器程序刷新功能。支持的控制器包括：

ZC.Qinglong FOTA can be applied to the controller program update function in multiple domains of a vehicle. The supported controllers include::

➤ 车身系统 Body System

车身控制器、空调控制器、车门控制器、网关等

Body controller, air conditioning controller, door controller, gateway, etc.

➤ 动力系统 Power System

发动机控制器、电池管理系统、电机控制器、整车控制器等

Power System Engine controller, battery management system, motor controller, vehicle controller, etc.

➤ 底盘系统 Chassis System

电动助力转向系统、制动防抱死系统、电气稳定系统等

Electric power steering system, anti-lock braking system, electronic stability system, etc.

➤ ADAS 系统 ADAS System

雷达、摄像头系统等  
Radar, camera systems, etc.

## 2 平台支持 PLATFORM SUPPORT

支持平台 Supported Platforms	
操作系统 Operating Systems	Linux、RTOS、QNX 等
芯片 Chips	Qualcomm、MTK、TI、RDA、NXP、Infineon、Renesas、ST 等
编译器 Compilers	arm-linux-gxx, arm-unknown-nto-qnx-xx-gxx

## 3 开发背景 DEVELOPMENT BACKGROUND

智能化和网联化是未来汽车的发展方向。智能汽车快速发展，改变了汽车的价值，伴随着用户体验需求攀升，系统软件愈发重要，软件定义汽车成为不可逆转的趋势。

Intelligentization and connectivity are the future development directions of the automotive industry. The rapid development of smart cars has changed the value of the car. With the rising demand for user experience, system software has become increasingly important, and the trend of software-defined vehicles has become irreversible.

软件定义汽车 (SoftwareDefinedVehicles, 简称 SDV) 核心思想是: 决定未来汽车的是以人工智能为核心的软件技术, 而不再是汽车的马力大小、是否真皮座椅、机械性能好坏, 而这也将成为汽车行业普遍的发展趋势。汽车行业的产业结构构建正重走电脑和手机行业的发展路径, 将来衡量汽车优劣的标准将从“硬件”水平转化为智能化水平高低和软件服务的好坏。

The core idea of Software Defined Vehicles (SDV) is that the future of cars will be determined by software technology centered on artificial intelligence, rather than the size of the car's horsepower, whether it has genuine leather seats, or the quality of its mechanical performance. This will also become a common development trend in the automotive industry. The industrial structure of the automotive industry is re-following the development path of the computer and mobile phone industries. In the future, the standard for measuring the quality of cars will shift from "hardware" level to the level of intelligence and the quality of software services.

在汽车智能化发展过程中, 尽管软件的重要性及占比不断提升, 但整车研发周期却在无形中缩短, 因此由于软件漏洞引发汽车召回的风险持续攀升。目前高端汽车的整车代码量已经突破 1 亿行, 即使按照 CMMI (CapabilityMaturityModelIntegration, 能力成熟度集成模型) 5 级的最高软件标准进行控制, 代码缺陷率仍为 0.32‰, 潜在问题的规模不容小觑。而召回事件, 需要整车厂付出巨大的直接和间接成本。

In the process of automotive intelligence development, although the importance and proportion of software continue to increase, the R&D cycle of the whole vehicle is invisibly shortened, so the risk of car recalls caused by software vulnerabilities continues to rise. At present, the code volume of high-end cars has already broken through 100 million lines. Even if controlled according to the highest software standard of CMMI (Capability Maturity Model Integration) Level 5, the code defect rate is still 0.32 ‰, and the scale of potential problems is not to be underestimated. Recall events require car manufacturers to pay huge direct and indirect costs.

对于处在发展中的行业而言, 面对智能汽车行业发展大趋势, 类似于特斯拉一样的系统更新功能必将成为行业可持续发展的前提和基础, FOTA (FirmwareOver-The-Air, 移动终端空中下载软件升级) 也就成为解决软件漏洞、进行智能汽车配件升级的最佳解决方案之一。

For the industry in development, facing the big trend of the development of smart cars, system update functions like Tesla will inevitably become the premise and foundation for the sustainable development of the industry, and FOTA (Firmware Over-The-Air) has become one of the best solutions for solving software vulnerabilities and upgrading smart car accessories.

FOTA 无线升级，是指通过云端为具有连网功能的终端设备提供固件升级服务，用户使用网络以按需、易扩展的方式获取智能终端系统升级包，并通过 FOTA 进行云端升级，完成系统修复和优化。汽车制造商和供应商通过 FOTA 专业的升级方案，能方便快捷地实现汽车 ECU、系统版本等迭代，保证系统安全、快速升级，让用户在不更换硬件设备的前提下，体验新功能。

FOTA wireless upgrade refers to providing firmware upgrade services for terminal devices with networking capabilities through the cloud. Users use the network to obtain smart terminal system upgrade packages on demand and in an easy-to-expand manner, and upgrade through FOTA to complete system repair and optimization. Car manufacturers and suppliers can quickly and conveniently realize the iteration of car ECU, system version, etc., through professional FOTA upgrade solutions, ensuring system security and rapid upgrade, allowing users to experience new functions without replacing hardware equipment.

目前，FOTA 已逐渐被认可，并发展成为影响 OEM（Original Equipment Manufacturer，原始设备制造商）和 TSP（Telematics Service Provider，汽车远程服务提供商）决策的车联网新趋势，也是汽车厂商提升用户体验的创新尝试和趋势之一。

At present, FOTA has gradually been recognized and has developed into a new trend of the car networking that affects the decision-making of OEM (Original Equipment Manufacturer) and TSP (Telematics Service Provider), and it is also one of the innovative attempts and trends for car manufacturers to improve user experience.

## 4 功能描述 FEATURE DESCRIPTION

### 5.1 产品特点 Product Features

- 使用 DoIP 协议传输数据，符合 ISO13400 规范；  
Utilizes the DoIP protocol for data transmission, compliant with the ISO13400 standard;
- 适用于多家整车厂的程序更新规范  
Suitable for the program update specifications of multiple vehicle manufacturers;
- 支持多家芯片厂商的芯片  
Supports chips from multiple chip manufacturers.
- 支持多重加密机制，保证数据的安全可靠  
Supports multiple encryption mechanisms to ensure the security and reliability of data;
- 支持应用程序和数据的更新功能  
Supports the update functionality for applications and data;
- 支持断点续传、智能还原、可回溯的安全机制，保证升级过程安全稳定  
Supports resumable transfers, intelligent rollback, and traceable security mechanisms to ensure a safe and stable upgrade process.
- 支持差分还原技术，比普通升级时间提速 90%  
Supports differential rollback technology, which speeds up the upgrade time by 90% compared to conventional upgrades;
- 支持整包升级，提供更多的安全保障  
Supports full package upgrades, providing more security assurance;
- 适配知从玄武程序更新工具，提供完整的程序更新解决方案  
Compatible with ZC.Xuanwu program update tools, offering a complete program update solution.

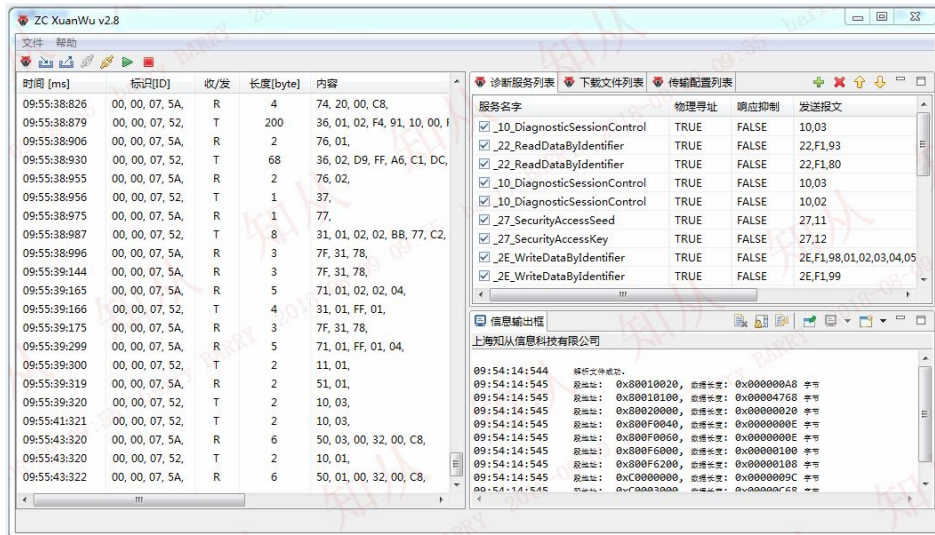
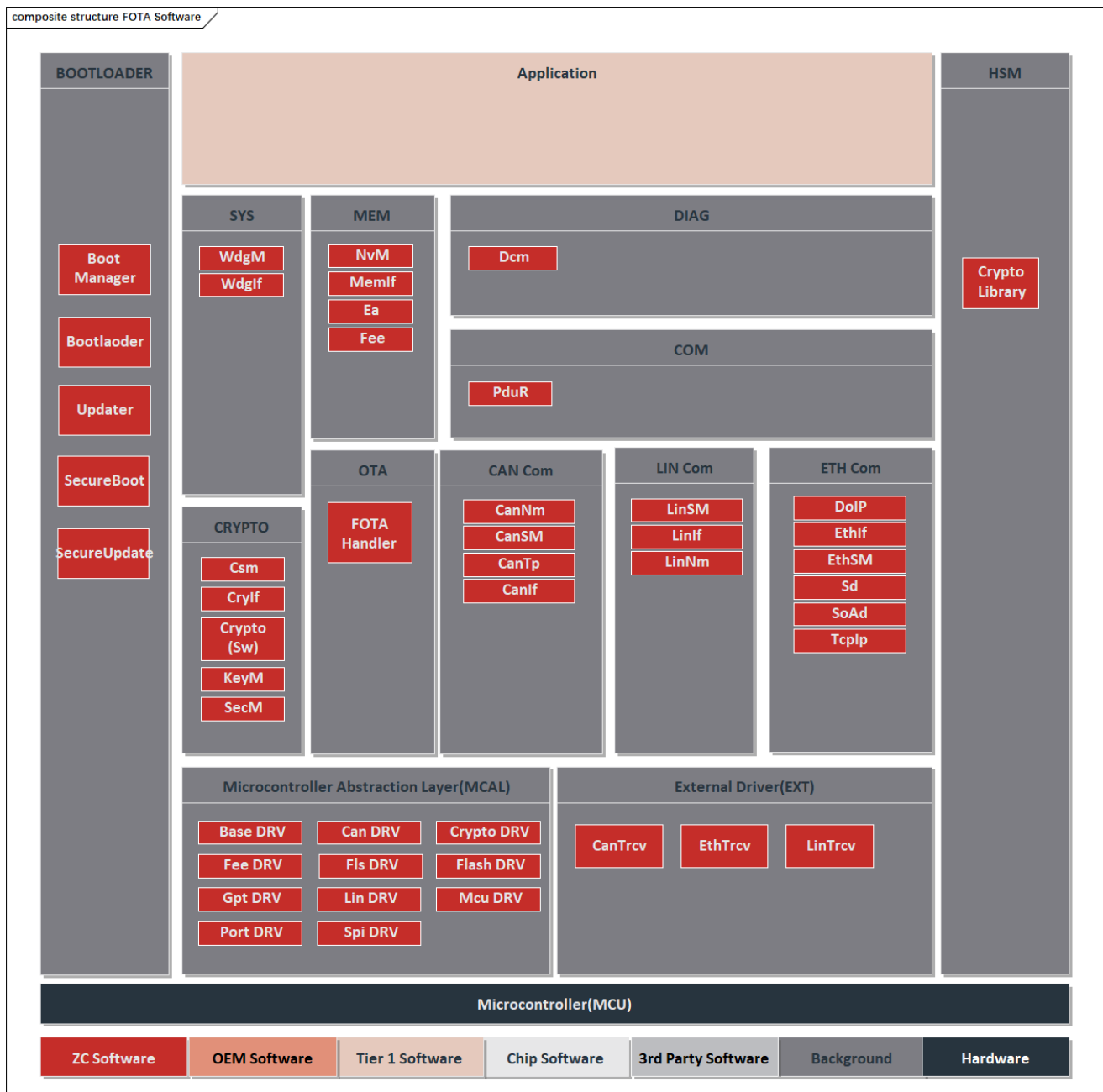


图 5 - 1 知从玄武--程序更新工具

图 5 - 2 ZC. XUANWU - PROGRAM UPDATE TOOL



## 5.2 系统架构 System Architecture



FOTA 系统架构  
 FOTA SYSTEM ARCHITECTURE

知从青龙 FOTA 系统架构支持 CAN、LIN、SPI、Ethernet 通信场景下的 FOTA 功能，通过 Dcm 模块实现 UDS 报文解析和诊断刷写，并通过适配 Crypto Library 实现各 OEM 规范的信息安全需求。以下为各模块的功能描述：

### ➤ Bootloader

BootManager 模块提供 FOTA 启动管理功能，支持适配软硬件 SecureBoot 功能，通过烧录和刷写存储 Bootloader 和 Application 的期望 MAC 值，启动阶段 SecureBoot 通过计算比较 Bootloader 和 Application 的 MAC 执行软件完整性校验，保证软件安全需求。



- Can Com  
Can 模块支持 CAN、CANFD 通信功能。
- Spi Com  
Spi 模块支持主从刷写功能，通过适配 5、6、7 线硬件配置，可支持多种 SPI 通信刷写模式。
- Ethernet Com  
DoIP 模块基于 TCP/IP 协议实现 Ethernet 通信收发功能，满足 ISO 13400 标准定义。通过车辆识别、路由激活、诊断消息功能实现 UDS 刷写流程，实现 Ethernet OTA 功能。
- Dcm  
Dcm 模块基于通信模块支持实现诊断功能，满足 ISO 14229 以及 ISO 15765 标准定义。
- Crypto、HSM  
Ethernet OTA 支持适配木牛加密库功能，支持非对称加密算法和加密算法结合实现安全刷写功能，适配证书认证功能满足安全诊断功能，适配 HSM 提高信息安全功能的稳定性和校验速度。

The Qinglong Ethernet FOTA system architecture supports the FOTA function in communication scenarios such as CAN, LIN, SPI, and Ethernet. It realizes the parsing of UDS messages and diagnostic programming through the Dcm module, and meets the information security requirements of various OEM specifications by adapting to the Crypto Library. The following are the functional descriptions of each module:

- Bootloader  
  
The BootManager module provides FOTA startup management functions and supports the adaptation of hardware and software SecureBoot functions. It stores the expected MAC values of the Bootloader and Application through programming and flashing. During the startup phase, SecureBoot performs software integrity verification by calculating and comparing the MACs of the Bootloader and Application to ensure software security requirements.
- Can Com  
  
The Can module supports CAN and CANFD communication functions.
- Spi Com

The Spi module supports the master-slave programming function. By adapting to the hardware configurations of 5, 6, and 7 wires, it can support multiple SPI communication programming modes.

➤ Ethernet Com

The DoIP module realizes the Ethernet communication sending and receiving functions based on the TCP/IP protocol, meeting the definition of the ISO 13400 standard. It implements the UDS flashing process through vehicle identification, routing activation, and diagnostic message functions, thereby achieving the Ethernet OTA function.

➤ Dcm

The Dcm module realizes the diagnostic function based on the support of the communication module, meeting the definitions of ISO 14229 and ISO 15765 standards.

➤ Crypto, HSM

The Ethernet OTA supports the adaptation of the Muniu Crypto Library functions. It combines asymmetric encryption algorithms with other encryption algorithms to achieve the secure flashing function. It adapts to the certificate authentication function to meet the security diagnostic requirements and adapts to the HSM to improve the stability and verification speed of the Cybersecurity function.

### 5.3 部署模式 Deployment Modes

知从青龙 FOTA 支持三种方式部署，可以为用户提供不同的实施方案。

ZC.Qinglong FOTA supports three deployment methods, which can provide users with different implementation schemes.

➤ 硬件 AB 分区方案：

Hardware AB Partition Scheme:

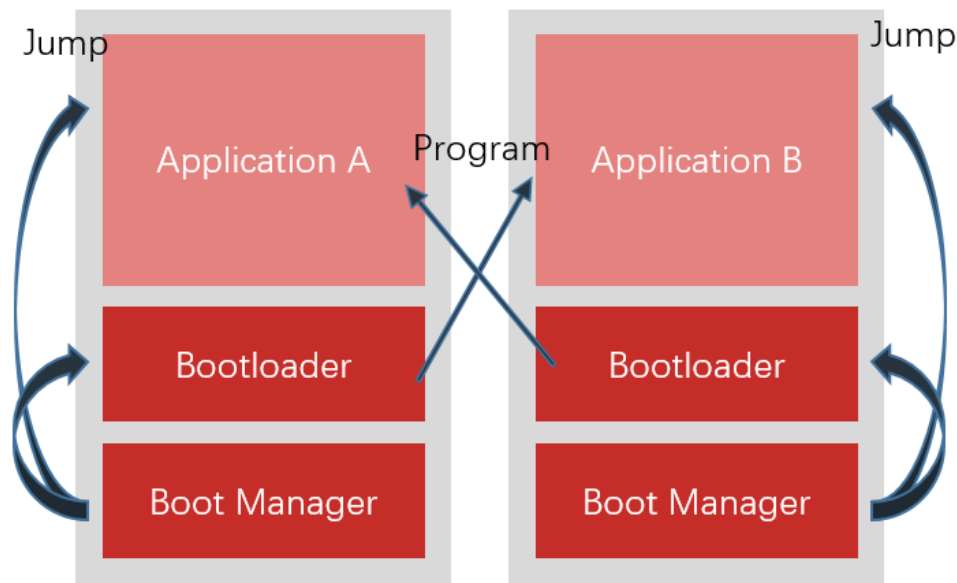


图 5 - 3 硬件 AB 分区方案  
FIGURE 5-3 HARDWARE AB PARTITION SCHEME

如图 5-3 所示，将 Flash 区域分为 A 区和 B 区，A 区和 B 区仅有一个激活区，一个非激活区。激活区用于运行 App 软件，非激活区用于供 Bootloader 下载新版本的 App 软件，通过硬件功能自由切换激活区和非激活区并运行对应区域软件。

As shown in Figure 5-3, the Flash area is divided into Area A and Area B, with only one active area and one inactive area. The active area is used to run the App software, while the inactive area is used for the Bootloader to download new versions of the App software, and the active and inactive areas can be freely switched through hardware functionality to run the corresponding area software.

方案优点：

Advantages of the scheme:

- Application A 和 Application B 互不干扰，能够独立运行  
Application A and Application B do not interfere with each other and can run independently.
- 回滚方便，切换激活区并复位即可完成回滚  
Rolling back is convenient; simply switch the active area and reset to complete the rollback.

方案缺点：

Disadvantages of the scheme:

- 需要芯片支持地址映射功能

Requires the chip to support address mapping functionality.

- 地址分配受限于地址映射功能

Address allocation is limited by the address mapping functionality.

➤ 软件 AB 分区方案：

Software AB Partition Scheme:

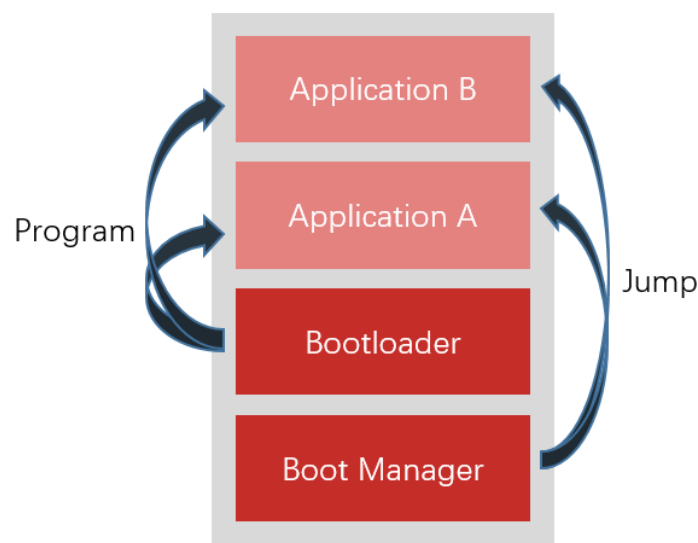


图 5-4 软件 AB 分区方案  
FIGURE 5-4 SOFTWARE AB PARTITION SCHEME

如图 5-4 所示，将 Application 区域分为 A 区和 B 区，A 区和 B 区仅有一个激活区，一个非激活区。激活区用于运行 App 软件，非激活区用于供 Bootloader 下载新版本的 App 软件，激活区和非激活区可以自由切换。Boot Manager 会在启动时判断跳转激活区。

As shown in Figure 5-4, the Application area is divided into Area A and Area B, with only one active area and one inactive area. The active area is used to run the App software, while the inactive area is used for the Bootloader to download new versions of the App software, and the active and inactive areas can be freely switched. The Boot Manager will determine which active area to jump to at startup

方案优点：

Advantages of the scheme:

- Application A 和 Application B 互不干扰，能够独立运行  
Application A and Application B do not interfere with each other and can run independently.
- 回滚方便，切换激活区并复位即可完成回滚  
Rolling back is convenient; simply switch the active area and reset to complete the rollback.
- 不需要硬件支持地址映射功能  
No hardware support for address mapping functionality is required.

方案缺点：

Disadvantages of the scheme:

- A、B 分区的地址分配不一致，需要使用两套地址分配生成 Application 软件。  
The address allocation for partitions A and B is inconsistent, requiring the use of two sets of address allocations to generate Application software.

➤ 软件备份分区方案：

Software Backup Partition Scheme:

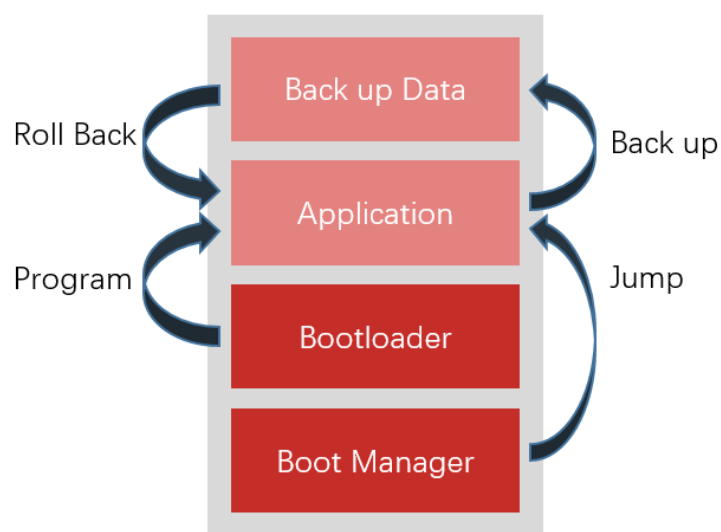


图 5-5 软件备份分区方案  
FIGURE 5-5 SOFTWARE BACKUP PARTITION SCHEME

如图 5-5 所示，将 Application 区域分为运行区和备份区，运行区用于存放运行的 Application，备份区用于存储更新前运行的 Application。当 App 软件需要回滚时，Bootloader 通过将 Back up Data 区域的数据下载回 Application 完成回滚。

As shown in Figure 5-5, the Application area is divided into a running area and a backup area. The running area is used to store the running Application, and the backup area is used to store the Application that was running before the update. When the App software needs to be rolled back, the Bootloader completes the rollback by downloading the data from the Back up Data area back into the Application.

#### 方案优点：

Advantages of the scheme:

- Application 运行地址固定  
The Application running address is fixed.
- Back up Data 区域大小可以通过压缩算法进行压缩  
The size of the Back up Data area can be reduced through compression algorithms.

#### 方案缺点：

Disadvantages of the scheme:

- 回滚需要一定时间  
Rolling back requires a certain amount of time.
- 仅能将 Application 回滚为旧版本，无法将旧版本切换回新版本  
Only the Application can be rolled back to an older version; it is not possible to switch an old version back to a new version.

## 5 过程文档 PROCESS DOCUMENTATION

开发流程 Development Process	文档描述 Document Description
需求收集 Development Process	顾客的需求文档 Document Description
软件需求分析 Requirement Collection	ZC 对软件的需求分析 ZC's Software Requirement Analysis 需求分析规格书 Requirement Analysis Specification 软件需求追踪表 Software Requirement Traceability Matrix 客户的问题沟通表 Customer Issue Communication Form
软件架构设计 Software Architecture Design	软件架构说明书 Software Architecture Manual 软件架构的追踪表 Software Architecture Traceability Table
软件详细设计和单元设计 Software Detailed Design and Unit Design	FOTA 详细设计说明书 FOTA Detailed Design Manual 配置工具设计 Configuration Tool Design 软件详细设计追踪表 Software Detailed Design Traceability Table FOTA 详细设计评审 FOTA Detailed Design Review
软件单元测试 Software Unit Testing	QAC 分析报告 QAC Analysis Report Tessy 测试报告 Tessy Test Report 软件单元验证策略 Software Unit Verification Strategy
软件集成和集成测试	集成策略 Integration Strategy 集成手册 Integration Manual



开发流程 Development Process	文档描述 Document Description
Software Integration and Integration Testing	集成测试策略 Integration Test Strategy
	集成测试报告 Integration Test Report
	资源分析报告 Resource Analysis Report
软件认可测试 Software System Testing	FOTA 软件测试报告 FOTA Software Test Report
	FOTA 软件测试报告评审 FOTA Software Test Report Review
发布 Release	发布文档 Release



公众号



业务联系

成为全球领先的**汽车基础软件**公司

To Be the Global Leading **Automotive Basic Software** Company

