知从木牛操作系统 OS NG HYPERVISOR 产品手册
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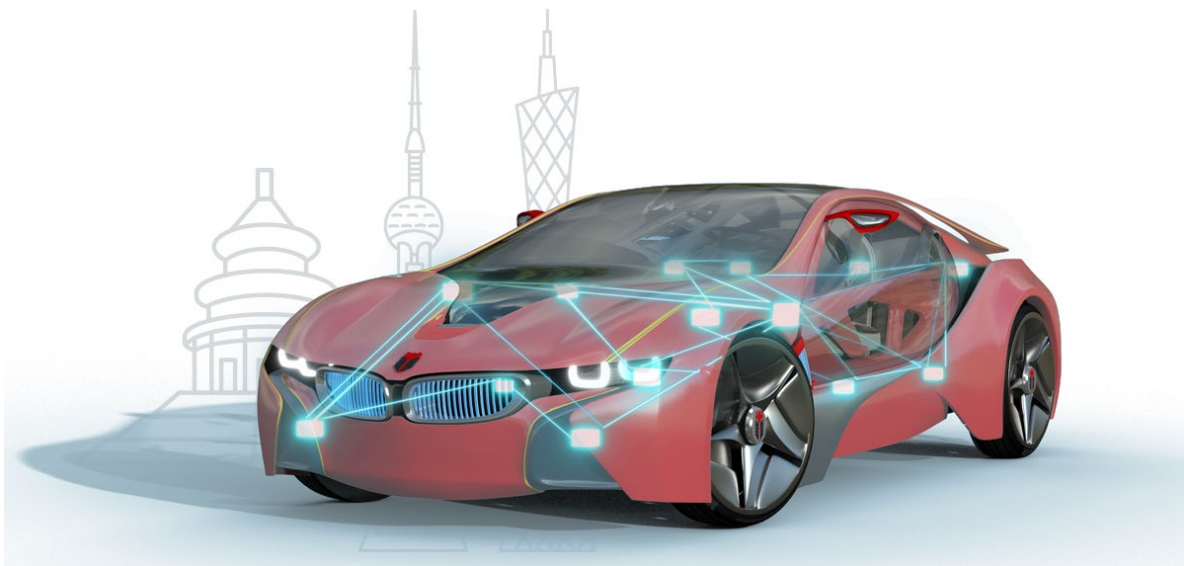
知从木牛操作系统 OS NG HYPERVISOR 产品手册
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知从木牛操作系统 OS NG HYPERVISOR

ZC.MuNiu OS NG HYPERVISOR

1 功能概述 FUNCTIONAL OVERVIEW

知从.木牛（ZC.MuNiu）为汽车电子控制器产品开发，提供完整的基础软件平台解决方案。该产品参考 AUTOSAR、OSEK 等国际规范，有基于 AUTOSAR ARTOP 架构的上位机配置工具。木牛操作系统 OS NG HYPERVISOR 产品是下一代（NG：Next Generation）的，面向虚拟机环境（HYPERVISOR）的嵌入式实时操作系统（RTOS）。木牛操作系统 OS NG HYPERVISOR 产品面向 ARM CORTEX R52+等高性能多核微控制器，支持虚拟化，可大大提高系统整合能力，并有利于功能安全和信息安全的灵活部署。

ZC.MuNiu provides a comprehensive basic software platform solution for the development of automotive electronic control unit products. The product is based on international standards such as AUTOSAR and OSEK, and it features an upper - level configuration tool based on the AUTOSAR ARTO P architecture. The MuNiu Operating System (OS NG HYPERVISOR) is a next - generation (NG: Next Generation) embedded real - time operating system (RTOS) designed for virtual machine environments (HYPERVISOR). The OS NG HYPERVISOR is targeted at high - performance multicore microcontrollers such as ARM CORTEX R52 +, supports virtualization, and can significantly enhance system integration capabilities. It also facilitates flexible deployment of functional safety and information security.
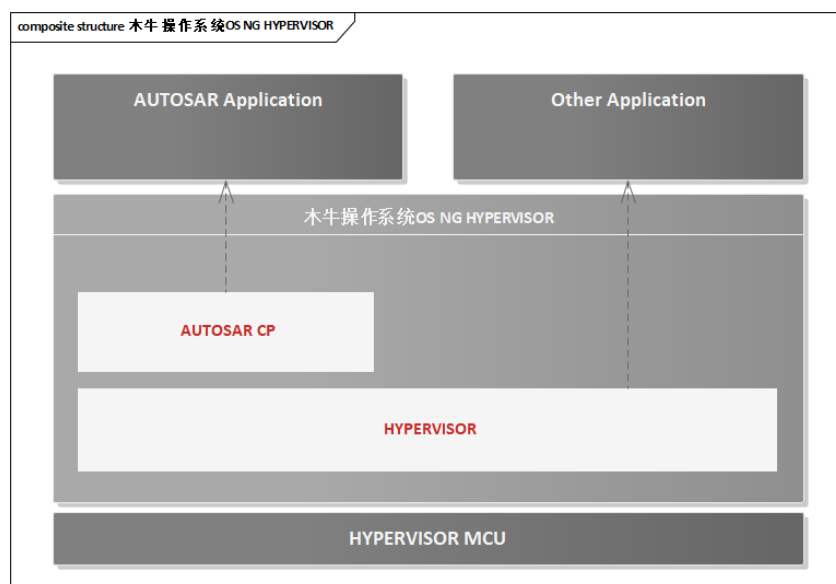
木牛操作系统 OS NG HYPERVISOR 产品主要面向新一代汽车电子控制器。从系统架构来看看，整车电子架构正在经历从传统的分布式系统向集中式架构转变。引入虚拟化技术之后，可以将原分布式系统中的 ECU 整合至统一 MCU 中，最大化地使用 MCU 的硬件资源，从而减少 ECU 的数量。木牛操作系统 OS NG HYPERVISOR 产品实现了虚拟机-AUTOSAR 两级任务调度，高效的多级中断处理框架，从而为多种类型应用的整合奠定了良好基础。

The MuNiu Operating System (OS NG HYPERVISOR) is primarily designed for the next - generation automotive electronic control units.From a system architecture perspective, the vehicle's electronic architecture is undergoing a transition from traditional distributed systems to a centralized architecture. With the introduction of virtualization technology, ECUs from the original distributed systems can be integrated into a unified MCU, maximizing the utilization of the MCU's hardware resources and thereby reducing the number of ECUs. The MuNiu Operating System (OS NG HYPERVISOR) has implemented a two - level task scheduling between virtual machines and AUTOSAR, as well as an efficient multi - level interrupt - handling framework, which lays a solid foundation for the integration of various types of applications.

虚拟化技术的另一个显著特点是隔离。木牛操作系统 OS NG HYPERVISOR 产品控制不同虚拟机的硬件资源分配，如内存，外设以及中断。用户可以为每个虚拟机分配特定的内存，外设以及中断，独立配置访问权限。同时，木牛操作系 OS NG HYPERVISOR 产品支持多级 MPU 权限控制，可实现虚拟机之间的内存隔离，以及同一虚拟机内部的内存隔离，有效支撑不同 ECU 层面的功能安全和信息安全目标整合，大大提高了系统集成的灵活性。

Another significant feature of virtualization technology is isolation. The MuNiu Operating System (OS NG HYPERVISOR) controls the allocation of hardware resources such as memory, peripherals, and interrupts for different virtual machines. Users can assign specific memory, peripherals, and interrupts to each virtual machine and configure access permissions independently. Moreover, the MuNiu Operating System (OS NG HYPERVISOR) supports multi - level MPU permission control, enabling memory isolation between virtual machines and within the same virtual machine. This effectively supports the integration of functional safety and information security objectives at different ECU levels, significantly enhancing the flexibility of system integration.
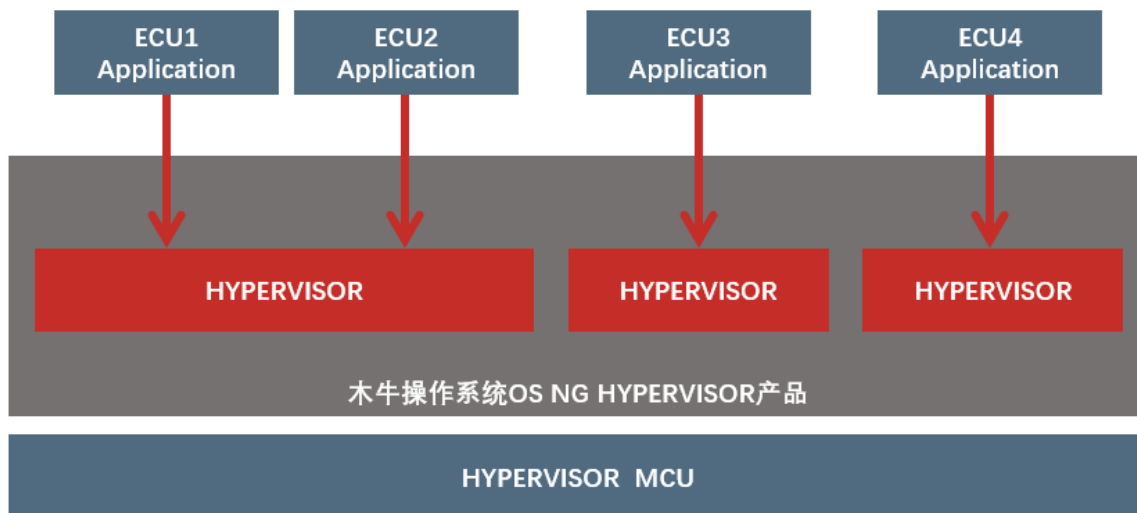
3 配置环境 CONFIGURATION ENVIRONMENT

i. 木牛操作系统 OS NG HYPERVISOR 产品的 ARM CORTEX R52+系列芯片软件配置:
The software configuration for the ARM Cortex-R52+ series chips in the ZC.MuNiu Operating System (OS NG HYPERVISOR) product is as follows:

配置环境 Configuration Environment	
Hardware (Chip)	ARM Cortex-R52+
Compilers Supported	Arm C Compiler 6
Evaluation Hardware	Based on ARM Cortex-R52+ EVB
Debugger	Arm DS IDE 2023.1
Configuration Tools	Muniu_v5.1.0
Configuration Environment	Win7/Win10 64bit

4 开发背景 DEVELOPMENT BACKGROUND

木牛操作系统 OS NG HYPERVISOR 产品支持虚拟化，实现了基于调度表的虚拟机调度算法。通过上位机工具，用户可配置虚拟机调度表，为各个虚拟机的任务包（HYPERVISOR TASK PACKAGE: HTP）设置调度次序以及相应的运行时间窗口。通过虚拟机中运行的 AUTOSAR OS 组件，可实现虚拟机-AUTOSAR 两级任务调度，整个调度框架具备高实时性特征。

The MuNiu Operating System (OS NG HYPERVISOR) supports virtualization and implements a virtual machine scheduling algorithm based on scheduling tables. Through the upper-level configuration tool, users can configure the virtual machine scheduling table, setting the scheduling order and corresponding runtime windows for each virtual machine's task package (HYPERVISOR TASK PACKAGE: HTP). The AUTOSAR OS component running within the virtual machine enables a two-level task scheduling between the virtual machine and AUTOSAR, with the entire scheduling framework characterized by high real-time performance.

木牛操作系统 OS NG HYPERVISOR 产品支持高效的多级中断处理框架，虚拟机完成一级中断调度，并实现向上层 OS 的中断路由，可灵活满足不同种类 OS 的中断处理需求。

The MuNiu Operating System (OS NG HYPERVISOR) supports an efficient multi-level interrupt handling framework. The virtual machine completes the first-level interrupt scheduling and routes interrupts to the upper-layer OS, flexibly meeting the interrupt handling requirements of different types of operating systems.

木牛操作系统 OS NG HYPERVISOR 产品提供了符合 AUTOSAR CP 标准的协议栈，包含 BSW 和 MCAL 等标准模块和组件。其中，BSW 中的 AUTOSAR OS 组件支持任务抢占式调度和高效的中断处理框架，为系统实时性提供了良好保障。包含上位机配置工具，可实现灵活的配置和裁剪，自动化生成配置源代码和应用参考框架，大大降低汽车电子控制器开发成本。

The MuNiu Operating System (OS NG HYPERVISOR) provides a protocol stack compliant with the AUTOSAR CP standard, including standard modules and components such as BSW and MCAL. The AUTOSAR OS component within BSW supports preemptive task scheduling and an efficient interrupt handling framework, ensuring the system's real-time performance. It includes an upper-level configuration tool that enables flexible configuration and customization, automatically generating configuration source code and application reference frameworks, significantly reducing the development cost of automotive electronic control units.

木牛操作系统 OS NG HYPERVISOR 产品支持多级 MPU，支持多级故障隔离。通过虚拟机管理一级 MPU，实现虚拟机之间的内存隔离，有效避免不同虚拟机之间应用相互影响，满足系统功能安全要求。木牛操作系统 OS NG HYPERVISOR 产品所提供的 AUTOSAR OS 具备自主

研发的轻量化内存保护和时间保护框架，可在同一虚拟机内有效防止低安全等级应用访问非法内存区域，阻止低安全等级应用出现非预期时间行为，从而实现同一虚拟机内的故障隔离。

The MuNiu Operating System (OS NG HYPERVISOR) supports multi-level MPU and multi-level fault isolation. Through virtual machine management of the first-level MPU, it achieves memory isolation between virtual machines, effectively preventing applications in different virtual machines from interfering with each other, meeting the system's functional safety requirements. The AUTOSAR OS provided by the MuNiu Operating System (OS NG HYPERVISOR) features an independently developed lightweight memory protection and time protection framework, which effectively prevents low-safety-level applications within the same virtual machine from accessing unauthorized memory areas and prevents low-safety-level applications from exhibiting unintended time behaviors, thus achieving fault isolation within the same virtual machine.

木牛操作系统 OS NG HYPERVISOR 产品可针对汽车领域微控制器（MCU）以及智能座舱、智能驾驶控制器进行深度定制和优化，具有执行效率高和应用代码部署灵活的特点。

The MuNiu Operating System (OS NG HYPERVISOR) can be deeply customized and optimized for automotive microcontrollers (MCUs) as well as intelligent cockpit and intelligent driving controllers, characterized by high execution efficiency and flexible application code deployment.

木牛操作系统 OS NG HYPERVISOR 产品由知从科技自主研发，打破了车规级 MCU 虚拟化嵌入式实时操作系统软件长期以来依赖国外厂商的现状，率先实现基础软件产品自主可控。同时，知从科技积极投入对国产芯片的适配工作，率先基于旗芯微、杰发科技、兆易创新、复旦微等国产芯片厂商的核心产品进行适配，不断完善木牛基础软件对国产芯片的兼容和支持。

The MuNiu Operating System (OS NG HYPERVISOR) is independently developed by ZC, breaking the long-standing reliance on foreign vendors for automotive-grade MCU virtualized embedded real-time operating system software, and achieving independent control of basic software products. ZC actively engages in the adaptation of domestic chips, being the first to adapt to core products from domestic chip manufacturers such as Flagchip, AutoChips, GigaDevice, and Fudan Micro, continuously improving the compatibility and support of MuNiu basic software for domestic chips.

知从科技掌握 AUTOSAR 平台软件的开发和应用核心技术，提供本地现场支持，质量好，速度快，成本低。

ZC masters the core technologies for the development and application of AUTOSAR platform software, providing local on-site support with high quality, fast response, and low cost.

5 功能描述 FUNCTIONAL DESCRIPTION

5.1 产品特点 Product Features

➤ 支持虚拟化，具备基于调度表的虚拟机调度机制，可运行不同种类的 RTOS
Supports virtualization with a virtual machine scheduling mechanism based on scheduling tables, capable of running different types of RTOS.

➤ 支持多级任务调度机制，提供 AUTOSAR OS 实现，支持虚拟机内的任务调度
Supports multi-level task scheduling mechanisms, providing an AUTOSAR OS implementation for task scheduling within virtual machines.

➤ 支持虚拟机-OS 多级中断路由机制
Supports multi-level interrupt routing mechanisms between virtual machines and the OS.

➤ 支持多级 MPU 管理，支持虚拟机间的内存隔离以及虚拟机内的内存隔离
Supports multi-level MPU management, enabling memory isolation between virtual machines and within virtual machines.

➤ 提供符合 AUTOSAR CP 标准的协议栈，包括 BSW 和 MCAL 等标准模块和组件
Provides a protocol stack compliant with the AUTOSAR CP standard, including standard modules and components such as BSW and MCAL.

➤ ARTOP 架构上位机配置工具，符合 AUTOSAR 4.2.2/4.3.1/4.4.0 版本
Upper-level configuration tool based on the ARTO P architecture, compliant with AUTOSAR versions 4.2.2/4.3.1/4.4.0.

➤ AUTOSAR OS 支持 AUTOSAR SC1、SC2、SC3 和 SC4
AUTOSAR OS supports AUTOSAR SC1, SC2, SC3, and SC4.

➤ AUTOSAR OS 具备轻量化内存保护和时间保护框架
AUTOSAR OS features a lightweight memory protection and time protection framework.

➤ 定制化服务
Customization services.

5.2　软件架构 Software Architecture
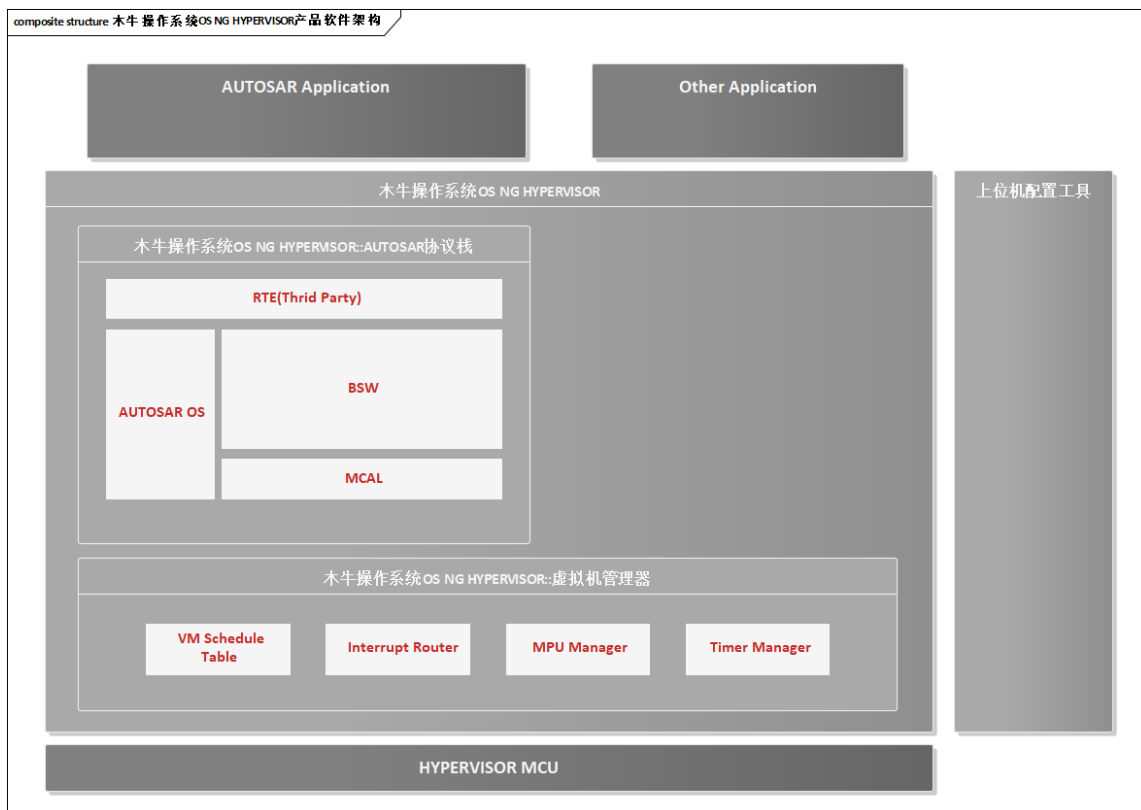
木牛操作系统 OS NG HYPERVISOR 产品软件架构

The software architecture of the MuNiu OS NG HYPERVISOR product

模块	子模块	描述
虚拟机管理器 **Virtual Machine Manager**	VM Schedule Table	虚拟机调度表管理器 Virtual Machine Scheduling Table Manager	虚拟机调度管理 Virtual Machine Scheduling Management
	Interrupt Router	虚拟机中断路由 Virtual Machine Interrupt Routing	面向虚拟机的中断一级调度功能 First-Level Interrupt Scheduling for Virtual Machine
	MPU Manager	MPU管理器 MPU Manager	MPU管理 MPU Management
	Timer Manager	时钟管理器 Clock Manager	时钟管理 Clock Management
AUTOSAR CP协议栈 **AUTOSAR CP Protocol Stack**	BSW	基础软件协议栈 Basic Software Protocol Stack	符合AUTOSAR CP标准的协议栈 Protocol Stack Compliant with AUTOSAR CP Standard
	MCAL	微控制器抽象层 Microcontroller Abstraction Layer	
	AUTOSAR OS	AUTOSAR OS组件 AUTOSAR OS Component	

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开发流程 Development Process	文档描述 Document Description
需求收集 Requirement Collection	需求文档 Requirement Document
软件需求分析 Software Requirement Analysis	软件需求追踪表 Software Requirement Traceability Matrix
	问题沟通表 Issue Communication Form
软件架构设计 Software Architecture Design	软件架构说明书 Software Architecture Specification
	软件架构的追踪表 Software Architecture Traceability Matrix
软件详细设计和单元设计 Software Detailed Design and Unit Design	软件详细设计说明书 Software Detailed Design Specification
	配置工具设计文档 Configuration Tool Design Document
	软件详细设计追踪表 Software Detailed Design Traceability Matrix
	软件详细设计评审表 Software Detailed Design Review Form
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 Software Integration and Integration Testing	集成策略 Integration Strategy
	集成手册 Integration Manual
	集成测试策略 Integration Test Strategy

开发流程 Development Process	文档描述 Document Description
	集成测试报告 Integration Test Report
	资源分析报告 Resource Analysis Report
软件系统测试 Software System Testing	符合性测试报告 Compliance Test Report
	系统测试报告 System Test Report
	性能测试报告 Performance Test Report
	系统测试报告评审 System Test Report Review
发布 Release	发布文档 Release Documentation

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[简称：知从木牛]
V4.4

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No. 07262640

2021年01月19日

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To Be the Global Leading Automotive Basic Software Company

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