
Zone-ECU Virtualization Solution Platform

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Overview

The high complexity of future vehicle systems will need to move away from today's distributed automotive E/E architecture towards a more centralized E/E structure based on less but much more powerful ECUs, instead of many individual control entities.

A Zone-oriented architecture moves the integration of numerous functions and services into one ECU. The resulting network concept must deal with the associated higher demands for bandwidth, determinism, and maximum latency, whereas the Zone-related ECUs, depending on their role as Zone-aggregator, Zone-controller, or Zone-processor, have an obvious need for much higher computing performance to run multiple functions. On the other hand, the Zone-related ECUs must also ensure freedom from interference between concurrent applications for safety and security, preserve real-time behavior and support internal network routing acceleration.

A solution to these challenges is to use a hypervisor to turn one physical ECU into multiple virtual ECUs. The RH850/U2x Zone-ECU Virtualization Solution Platform is a development platform that provides a pre-integrated solution including relevant SW-products and tools to allow automotive customers to take a ready-to-use approach for their individual Zone-ECU project.

Based on a collaboration between ETAS and Renesas, the Zone-ECU Virtualization Solution Platform combines the MCU hardware (HW) key-features for Zone, like hypervisor-support, safety, security, QoS and more with the outstanding software (SW)-product portfolio and SW-competence of ETAS.

Introduction

Renesas' RH850/U2x hardware together with ETAS' RTA-HVR software, a hypervisor designed for microcontrollers with hardware virtualization support, provide a SW-first solution to enable the integration of multiple applications into a single ECU that are safely and securely separated from each other to ensure the highest degree of freedom from interference. This Winning Combination allows customers to benefit from reduced development effort, resulting in significantly lower cost and design risk.

Zonal Architecture Featuring HW Solutions – RH850/U2A, RH850/U2B

The RH850/U2x high performance Microcontroller product lines for next generation Zone/Integration-ECUs support a rich set of embedded HW key-features which are specific for Zone-applications, such as Hypervisor HW-support, Quality-of-Service (U2B only), Safety & Security functions to enable freedom from interference. On top, a high-performance NoC (Network on Chip) structure can ensure real-time behavior of each individually integrated application concerning peripheral and memory access.

Renesas' [RH850/U2A](#) MCU (Micro Controller Unit) is designed as cross-domain platform for high-end body and chassis applications to cover the growing need to integrate multiple applications into a single chip. Based on 28 nm process technology, the 32-bit RH850/U2A MCU builds on key functions from Renesas' RH850/Px Series for chassis control and RH850/Fx Series for body control to deliver improved performance.

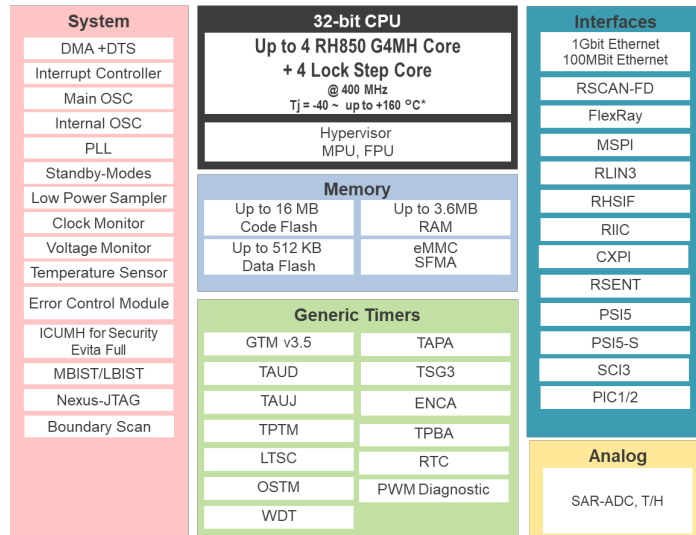


Figure 1: RH850/U2A Block Diagram

[RH850/U2B](#) family builds on the strengths of the RH850/U2A and is tailored to solve the challenges of innovative E/E architectures for the upcoming vehicle generations. With its new levels of performance and memory integration of up to 32MB the RH850/U2B is positioned above the RH850/U2A Series to cover the increased requirements of future automotive integration platform concepts while still providing a cost sensitive monolithic MCU solution in comparison to a System-on Chip (SoC).

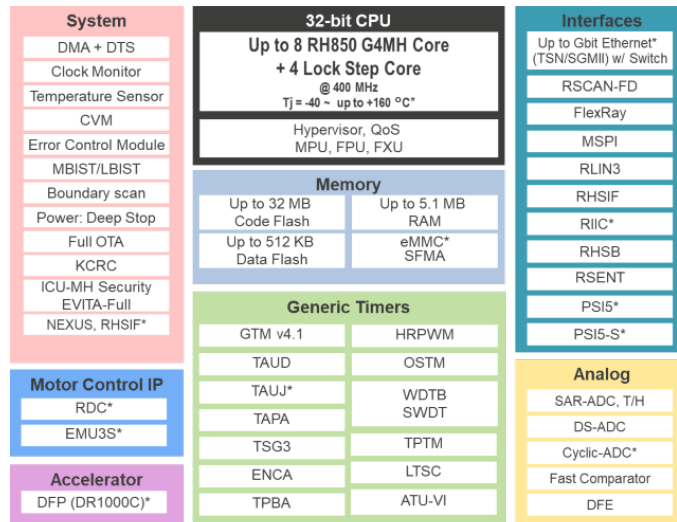


Figure 2: RH850/U2B Block Diagram

The RH850/U2x MCUs are equipped with the latest HW-support technologies to realize the integration of multiple ASIL-D SW-partitions:

- Hypervisor HW-assist function to enable a Hypervisor-OS in a high-performance manner (fast context switching, HV interrupt concept)
- Quality of Service (QoS): Latency monitoring and active regulation functions for all bus masters to ensure minimum bandwidth is available by preventing a bus master from consuming all the bandwidth (RH850/U2B only).
- Memory Protection Unit (MPU): Fine granular separation of bus master access to memory and other resources
- Guard concept: Highly flexible slave protection system for peripheral memory and peripheral modules

- Safety: Multiple individual Error output signals to ensure individual treatment on a SW-partition level
- Security: Multiple instances of AES128 lockstep modules for conflict-free and deterministic secure and safe communication
- No-wait OTA: Background operation on flash banks to ensure independent update of individual SW-partitions

Zonal Architecture Featuring SW Solutions – RTA-HVR

The ETAS hypervisor, RTA-HVR, provides the complimentary SW to the Renesas RH850/U2x HW to meet strict automotive safety and security requirements. RTA-HVR uses the hardware virtualization features of the Renesas RH850/U2x family to create multiple VMs. Each VM has one or more virtual CPU cores, a section of memory space and a set of peripherals.

Each VM “guest” is an independently compliable and flash-able ECU image that can be built and shipped by a 3rd party. RTA-HVR supports “bare metal” and AUTOSAR Classic platform guests.

RTA-HVR supports flexible VM to physical CPU core allocation. When a VM has unique access to one (or more) CPU cores then there is zero VM scheduling overhead. When multiple VMs share a CPU core, a choice of either:

- A statically configured round-robin scheduler; or
- A dynamic reservation-based scheduler driven by RH850U2x background interrupts.

RTA-HVR uses the MPU and guard concept to provide spatial isolation between VMs, partitioning the memory and peripheral space for each VM.

In addition, RTA-HVR provides a mechanism called “Virtual Device Extension” (VDE) allowing ECU integrators to customize the binding between virtual and physical peripherals for a specific Zone ECU. VDEs provide a safe way to share peripherals between VMs (e.g. when the number of VMs needing a peripheral exceeds the number of physical peripherals in the HW). Typical examples here are ethernet controller, HW security modules and watchdogs or to add additional CAN channels as shown in the figure below:

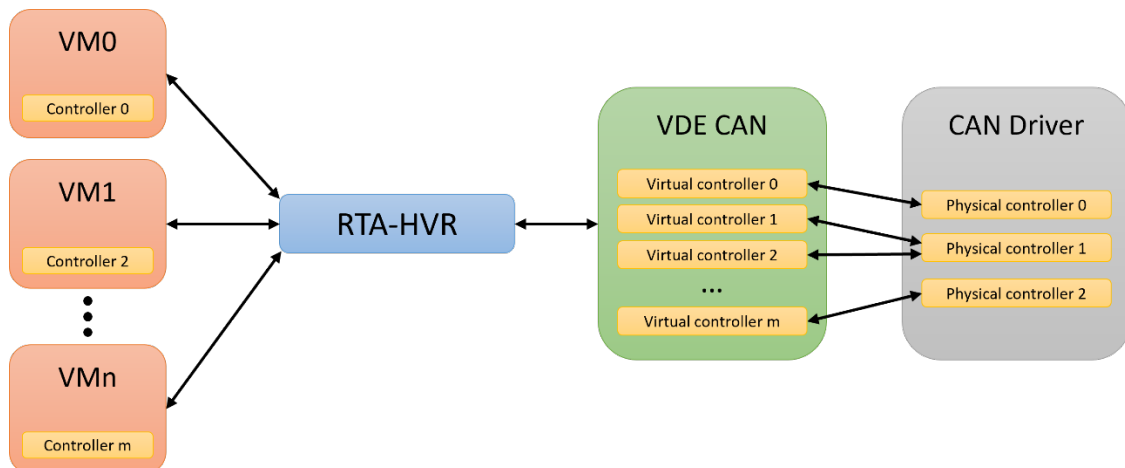


Figure 3: Create Fully Virtual Peripherals Devices for Optimized Inter-VM Communication Channels through VDEs

Zone-ECU Virtualization Solution Platform Overview

To support automotive customers for the conceptual Zone-ECU development with focus of integrating multiple applications, ETAS and Renesas have realized the *Zone-ECU Virtualization Solution Platform*.

This platform combines Renesas’ RH850/U2x HW capabilities with ETAS’ RTA-HVR, a set of VMs each of which host an ECU image using ETAS’ RTA-CAR AUTOSAR Classic Platform and a PC-hosted interaction tool.

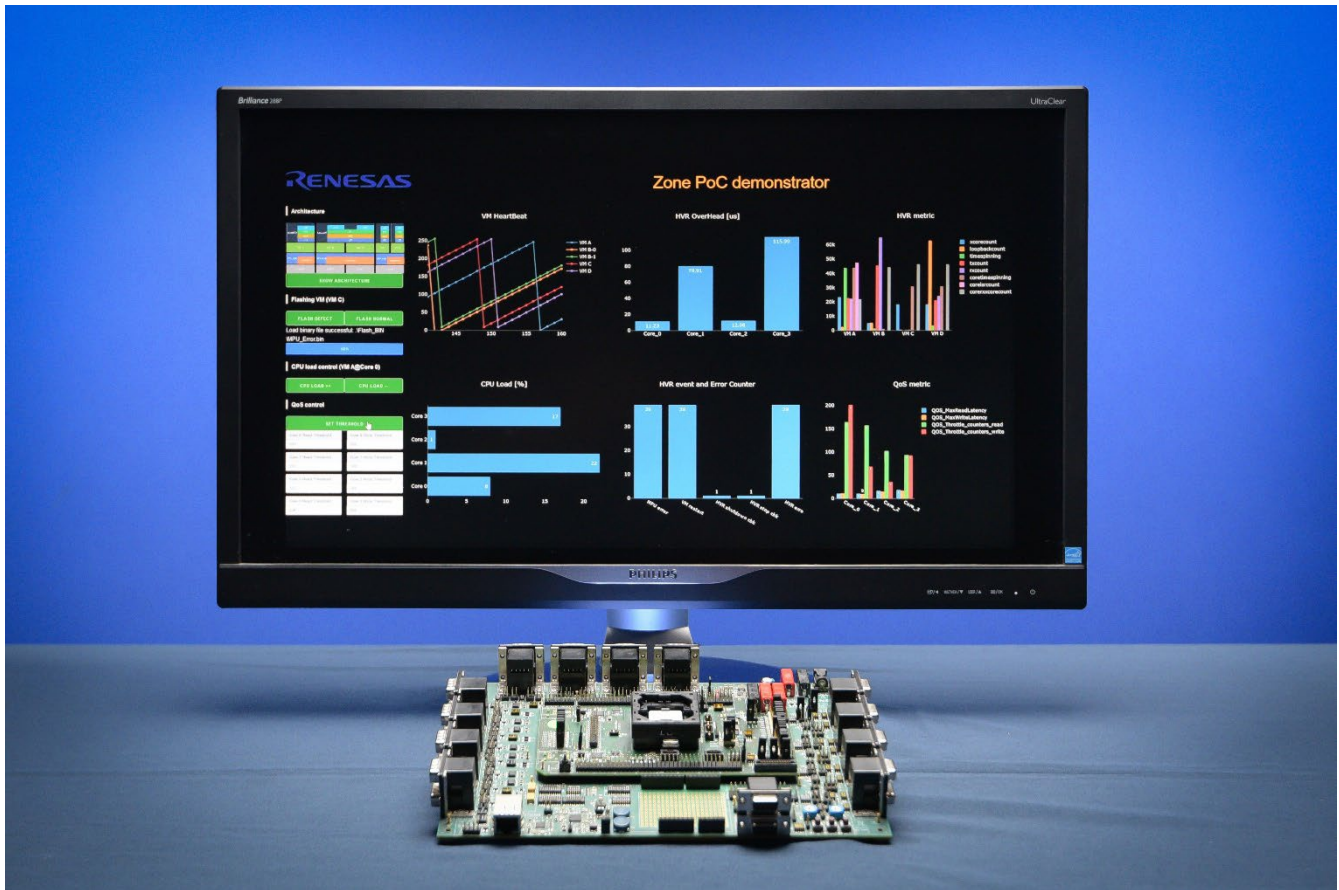


Figure 4: Zone-ECU Virtualization Solution Platform Laboratory Setup

The Zone-ECU Virtualization Solution Platform provides a pre-configured and pre-built SW for RH850/U2x MCUs as an easy-to-start development platform, containing a demonstrator SW as well as a benchmark environment that enables automotive customers to quickly start with design exploration for their individual Zone-ECU projects. The Zone-ECU Virtualization Solution Platform allows customers to benefit from reduced development effort, cost, and risk.

Zone-ECU Virtualization Solution Platform HW

There are two HW options available as shown below:

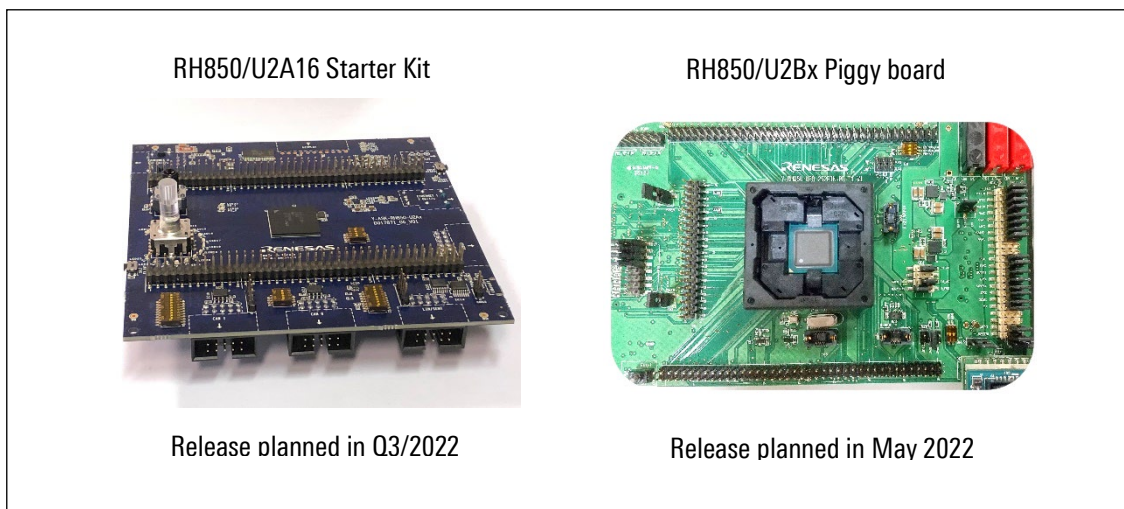


Figure 5: Zone-PoC HW Evaluation Board Options

Zone-ECU Virtualization Solution Platform SW

The Zone-PoC SW-stack comprises an RTA-HVR configuration and 4 VMs. Each VM has been configured to run a simple set of AUTOSAR SWCs on full ETAS RTA-CAR AUTOSAR Classic SW stack. Inter-VM communication uses RTA-HVR VDEs for:

- Virtual CAN
- Virtual Ethernet
- Virtual Watchdog
- Access to the RH850/U2x

RTA-HVR is configured to map the VMs in 3 different representative configurations:

- Partition A: 1x Single core VM allocated to 1x CPU core
- Partition B: 1x Multi-core VM allocated to 2x CPU cores
- Partition C: 1x Single-core VM allocated to 1x CPU core shared with Partition D
- Partition D: 1x Single-core VM allocated to 1x CPU core shared with Partition C

There are 2 alternative RTA-HVR configurations provided that allow the difference in VM scheduling policies to be explored.

Zone-ECU Virtualization Solution Platform - Design Exploration Tooling

The Zone-ECU Virtualization Solution Platform provides a PC-hosted application that captures and displays real-time VM status data.

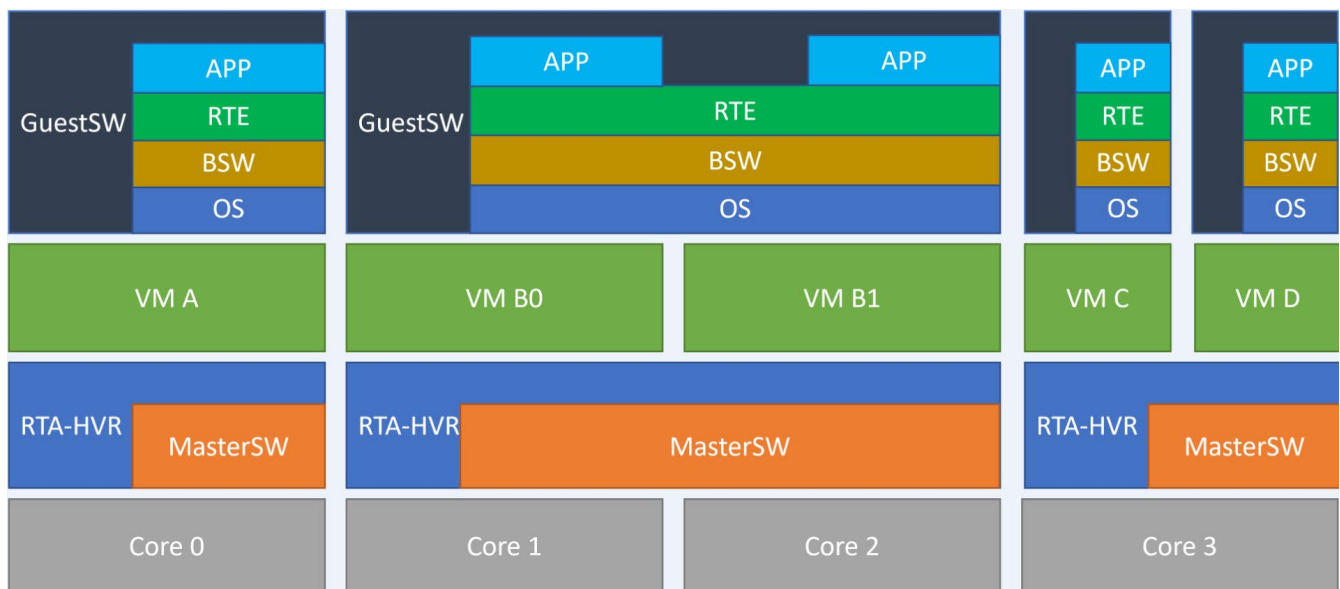


Figure 6: Zone-ECU Virtualization Solution Platform Demonstration Kit VM Structure in the Design Exploration Tool

By running different RTA-HVR scheduling policies provided that allows easy developer integration with the embedded HW & SW allow exploration of:

- Fault injection to VMs (e.g. trigger memory access violation)
- Performance and timing using in Zone-ECU Virtualization Solution Platform instrumentation
- Exploration of U2x HW features (OTA, QoS etc.)

Zone-ECU Virtualization Solution Platform Deliverables & Prerequisites

The Zone-ECU Virtualization Solution Platform necessary hardware components:

- RH850U2x HW of choice: either RH850/U2A Starter kit (from Q3/2022) or
- RH850/U2Bx Piggy board incl. Standard Main Board for CAN communication
- USB CAN FD Bus Interface, required for PC-hosted design exploration tool, e.g., ETAS (ES582)
- Binary flash-able images for images for RTA-HVR and each VM, including alternative VMs and builds to explore scheduling and on-chip flashing
- PC-hosted design exploration tool

Users wanting to find out more can request a 3-month evaluation license:

- Renesas RH850 MCAL & configuration tooling
- ETAS: RTA-CAR configuration tools, RTA-HVR Beta Software; configuration files; source code; debugger scripts

What else is needed:

- GreenHills RH850/U2x compiler (2019.1.5)
- Lauterbach Trace32 Debugger for RH850/U2x

Summary

The Zone-ECU Virtualization Solution Platform is a comprehensive package to support customers to develop, showcase and benchmark ECUs targeting new E/E architecture development or investigation.

Related Information

- [Zone ECU Virtualization Solution Platform Winning Combination](#)
- [RH850/U2A - Zone/Domain Microcontroller Series](#) – Zone /Domain Microcontroller Series
- [RH850/U2B - Zone/Domain and Vehicle Motion Microcontroller](#) – Zone/Domain and Vehicle Motion Microcontroller

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