RENESAS EMBEDDED PROCESSING OFFERINGS W/ ZEPHYR

LUCA BARTOLOMEO, PHD
VICE PRESIDENT EMBEDDED PROCESSING
RENESAS ELECTRONICS CORPORATION

RENESAS: WHO WE ARE

Renesas empowers a safer, smarter and more sustainable future where technology helps make our lives easier.

A leading global provider of microcontrollers, Renesas combines our expertise in **embedded processing, analog, power and connectivity** to deliver **complete semiconductor solutions**. These Winning Combinations accelerate time to market for automotive, industrial, infrastructure and IoT applications, enabling billions of connected, intelligent devices that enhance the way people work and live.

Headquarters
Tokyo, Japan

Approx. 22,000
employees *

Operating in
30+ countries

1,348.5 billion yen
revenue in 2024

Approx. 20,000
patents & pending applications

* Consolidated, as of December 31, 2024

OUR PURPOSE

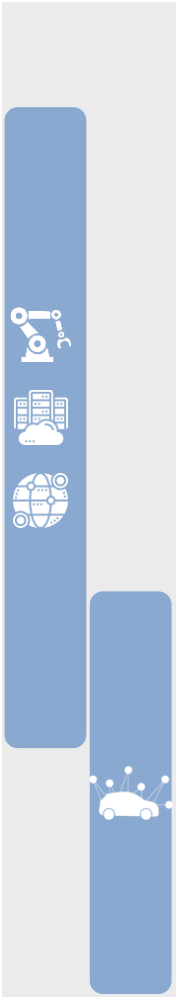
To Make Our Lives Easier

by complementing human capabilities

…and with Zephyr®

BROAD AND SCALABLE PRODUCT PORTFOLIO

Semiconductor World is complex



Microcontrollers & Microprocessors, System-on-Chips (SoCs)

RENESAS RZ — High-end 32/64-bit MPUs
High-resolution HMI, Industrial network & real-time control

RENESAS RA — Advanced 32-bit MCUs
Arm ecosystem, Advanced security, Intelligent IoT

RENESAS RX — High Power Efficiently 32-bit MCUs
Motor control, Capacitive touch, Functional safety, GUI

RISC-V products — General-purpose 64-bit MPUs (RZ/Five Group)
Application-specific 32-bit MCUs

RENESAS RL78 — Ultra-low Energy 8/16-bit MCUs
Bluetooth® Low Energy, SubGHz, LoRa®-based Solutions
Automotive actuators & sensors, Low-end ECUs

RENESAS RH850 — Automotive 32-bit MCUs
Rich functional safety and embedded security features

RENESAS R-Car — Automotive SoCs
Next generation of automotive computing

Analog and Power Devices

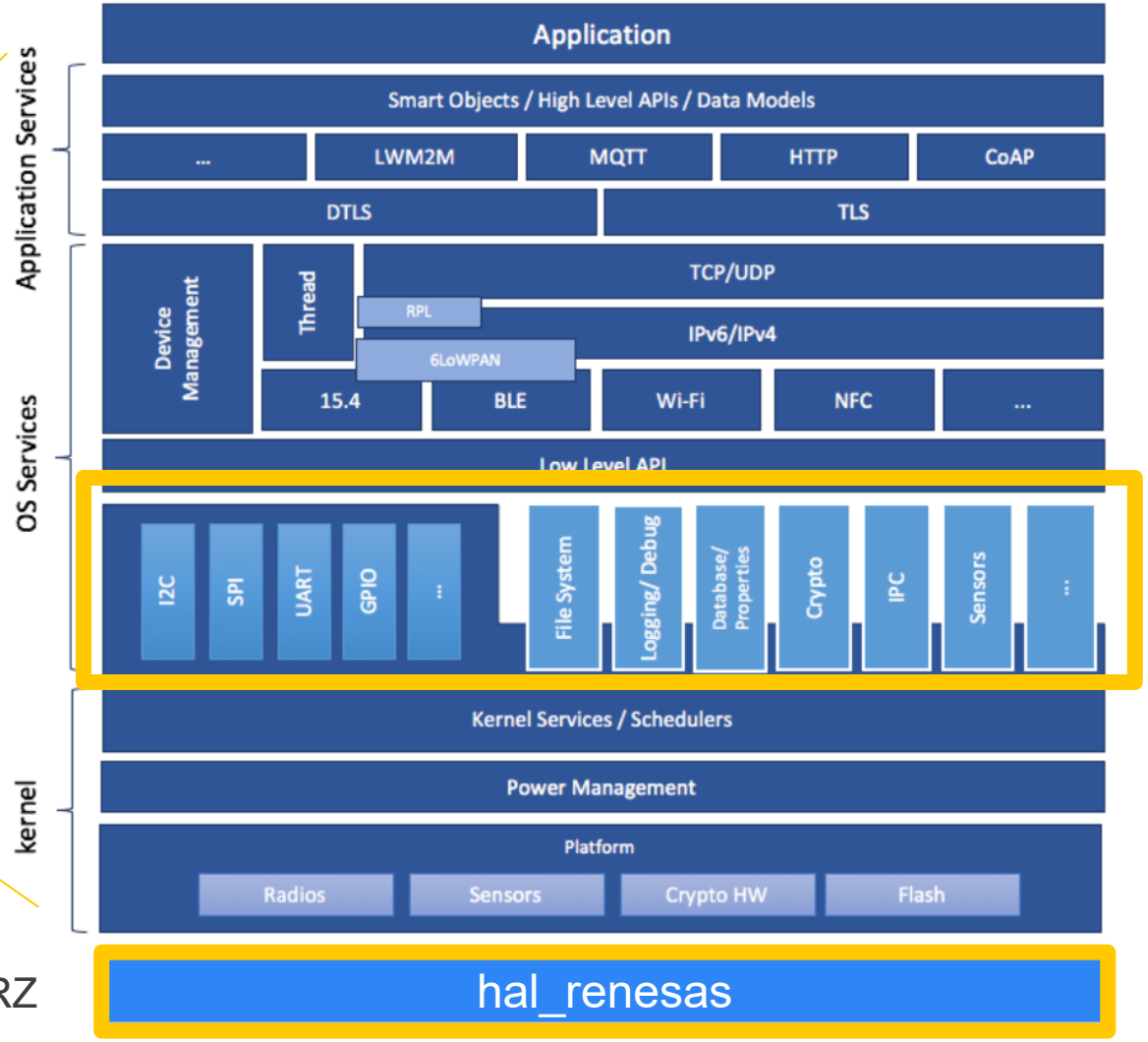
- Analog products
- Clocks & Timing
- Interface & Connectivity
- Memory & Logic
- Power & Power management
- Programmable Mixed-signal, ASIC, & IP products
- RF products
- Sensor products
- Space & Harsh environment

- Wireless Power
- Battery Management
- Power Devices
- Power Management
- Sensors
- Video & Display

SOFTWARE ARCHITECTURE

Zephyr OS

System Architecture



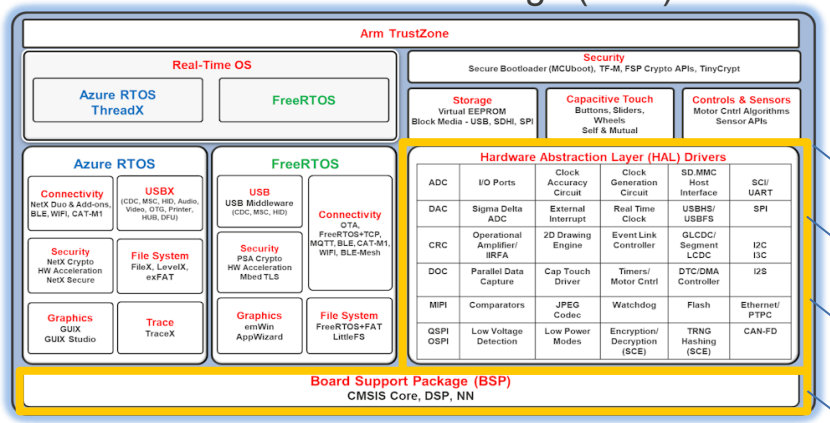
Main target area for development

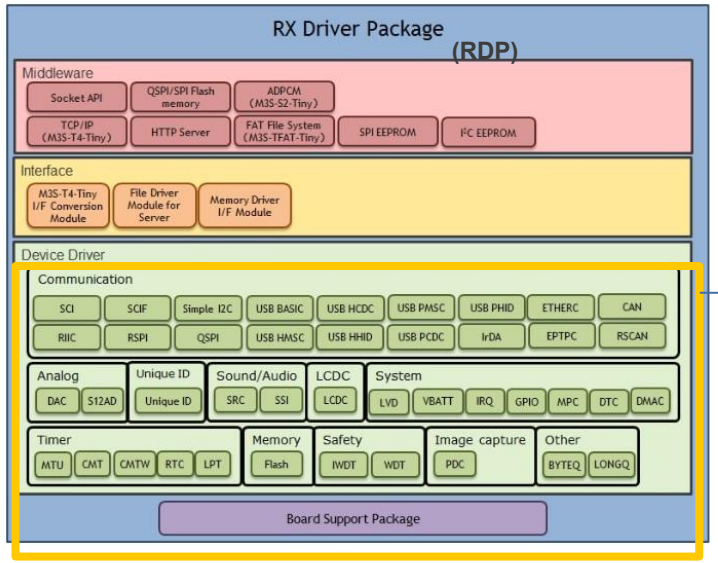
hal_renesas for Renesas devices: RA, RX, RZ

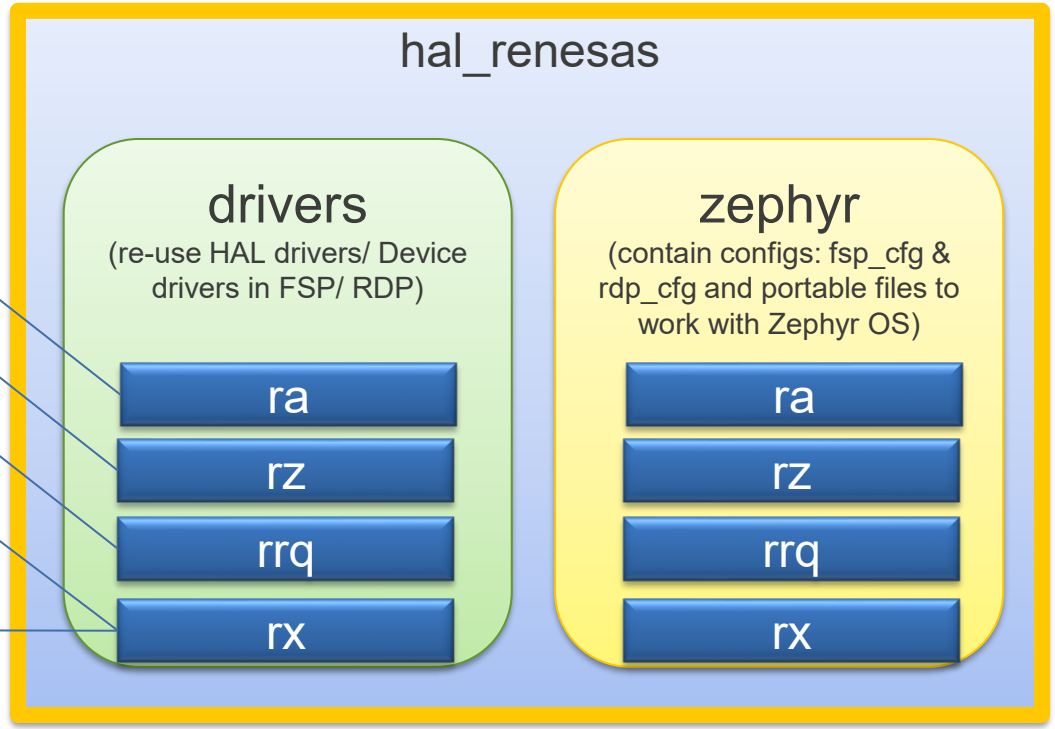
Resource: Zephyr Security Overview — Zephyr Project Documentation

SOFTWARE ARCHITECTURE (HAL_RENESAS)

Flexible Software Package (**FSP**)







Re-useable area in FSP/RDP

SOME EXAMPLES

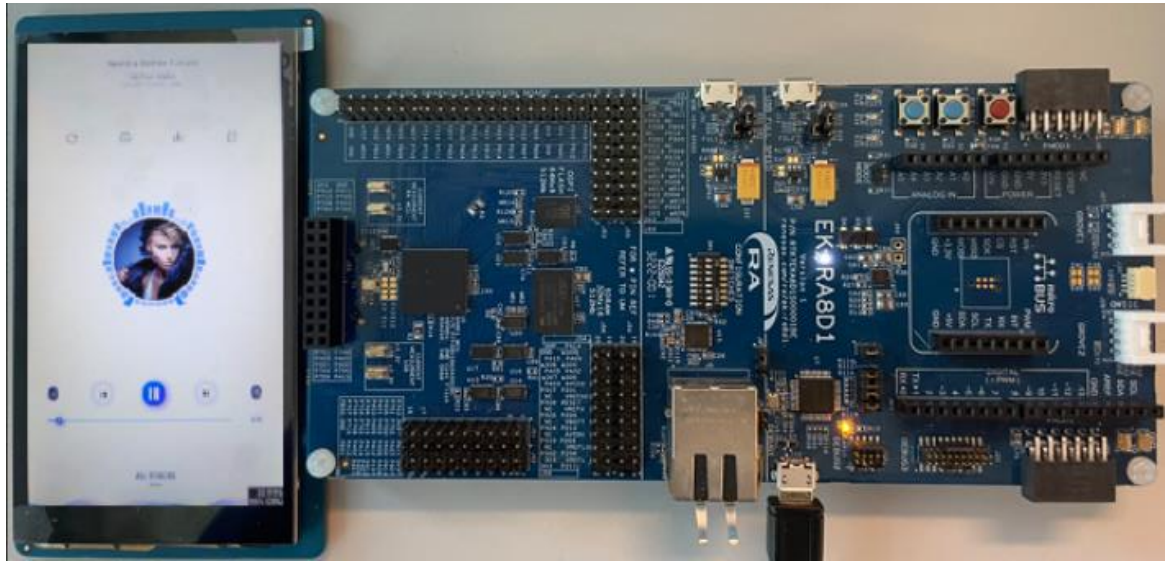
ZEPHYR RTOS
GRAPHICS

Includes LVGL graphics libraries for a high-quality GUI

Embedded device **library LVGL**

GUI example sample projects with required device drivers (drw, glcdc, mipi_dsi, lcdc etc..)

Supported first by **MCU/RA8D1**, then by **RZ/A3x** series



EK-RA8D1 Graphics Demo
- 4.5 Inch backlit TFT display
- 480x854 pixels x 30fsp
- DRW GPU available

LVGL demos — Zephyr Project Documentation

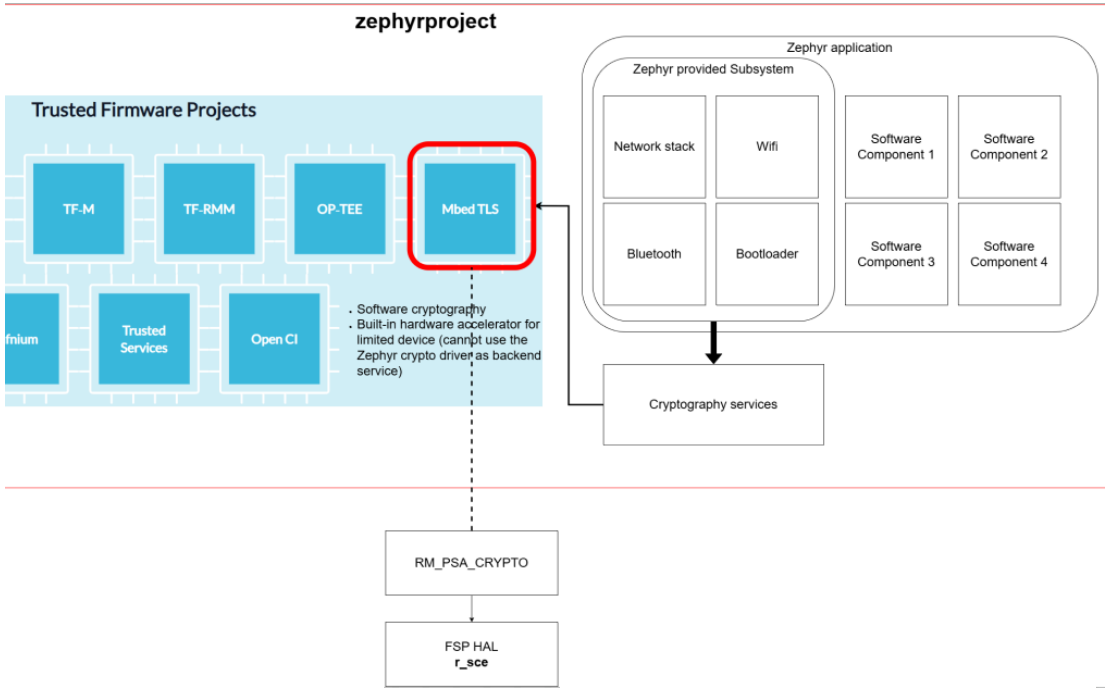
ZEPHYR RTOS
SECURITY

Includes MbedTLS Hardware Accelerator support

Software and **Hardware crypto**

Hardware accelerator for Renesas RA8 devices (**RSIP-E51A**) with MbedTLS library

MQTT connections



ZEPHYR RTOS
MULTI-OS

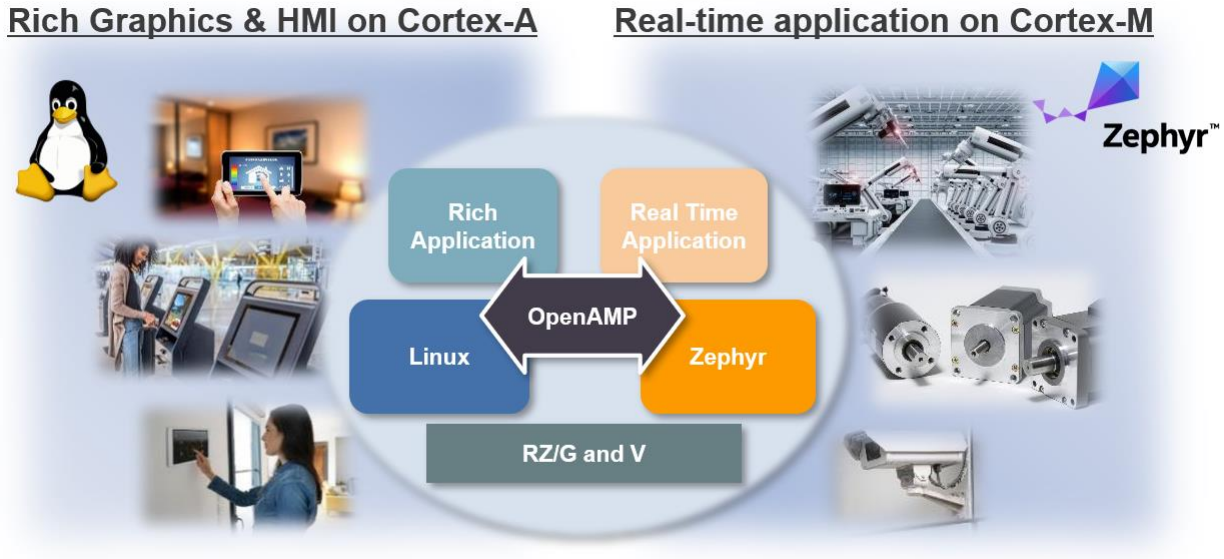
Enables Inter-core Communication with OpenAMP

Integration on **Cortex-A with real-time control** on Cortex-M (Linux ↔ Zephyr)

OpenAMP Library Support Available

Inter-core communication hardware feature support on Renesas RZ (mailbox)

Supported first by **RZ/G3S**, then by **RZ/G2xx and RZ/V2x** series



OpenAMP Linux Zephyr RPMsg — Zephyr Project Documentation

ZEPHYR RTOS
FILE SYSTEMS

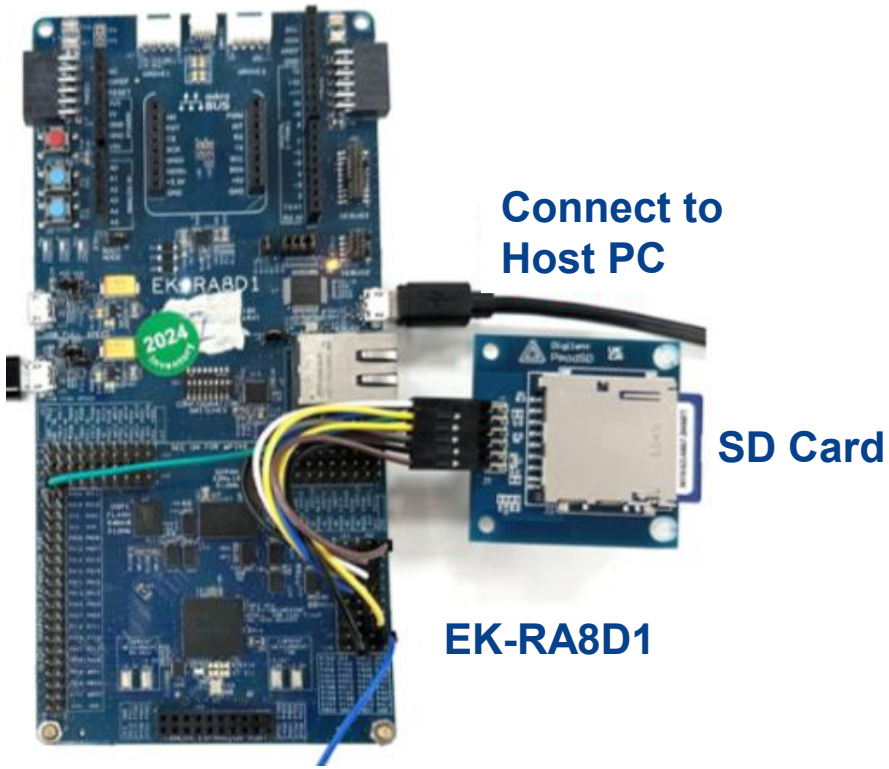
Includes multiple file systems at different mount points

FAT FS, LittleFS and EXT2 FS

Support **SDHC card**, **SoC Flash** or **external flash** chip

Support **USB Mass Storage** with FAT FS on RAM or FLASH disk

Supported for **MCU/RA8x1** (RA8M1, RA8D1 and RA8T1)



File system manipulation — Zephyr Project Documentation
USB Mass Storage — Zephyr Project Documentation

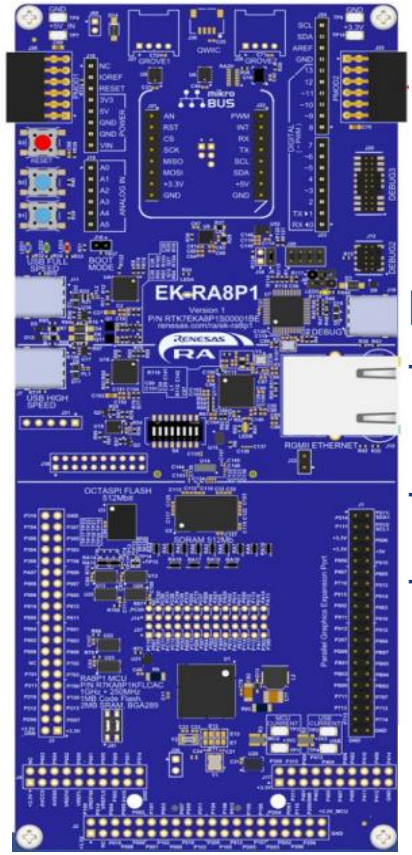
ZEPHYR RTOS
MACHINE LEARNING

Includes Arm Ethos-U NPU (Neural processing unit) support

Enable **neural networks** to be hardware accelerated on embedded devices.

Tensorflow Lite Micro framework (TFLM) using Arm model zoo model (a collection of machine learning models optimized for Arm IP) and

1st support will be cloned on **RA8P1**



EK-RA8P1 with Ethos NPU

- Arm® Cortex®-M85 core (up to 1GHz) and Arm® Cortex®-M33 core (up to 250MHz)
- Neural processing support: **Arm® EthosTM-U55 NPU**
- Human machine interfaces: Graphic LCD Controller, 2D Drawing Engine, Capture Engine Unit, MIPI DSI and CSI interfaces

Ethosu (NPU) enable support - Zephyr BSP - confluence.eng.renesas.com
TensorFlow Lite for Microcontrollers on Arm Ethos-U — Zephyr Project Documentation

ZEPHYR RTOS
NETWORK STACKS

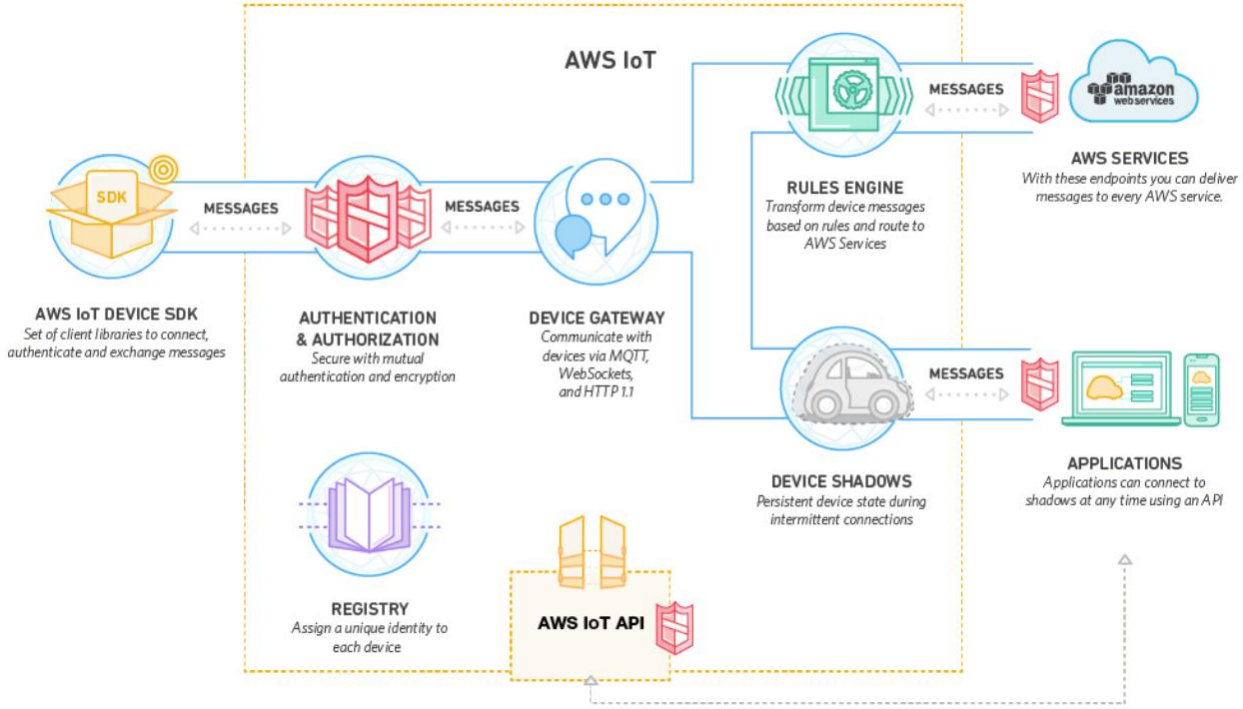
Enables Cloud Connectivity with AWS IoT Core (MQTT)

Lightweight and secure connectivity using **MQTT protocol**

Device identity secured using **X.509 certificates** stored in flash

TLS encryption ensuring end-to-end secure communication with AWS IoT Core

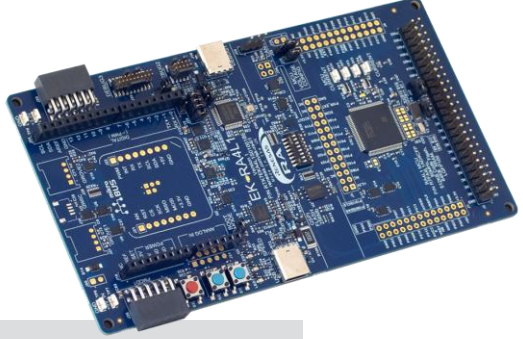
Supported by **EK-RA8x1, EK-RA6M3**

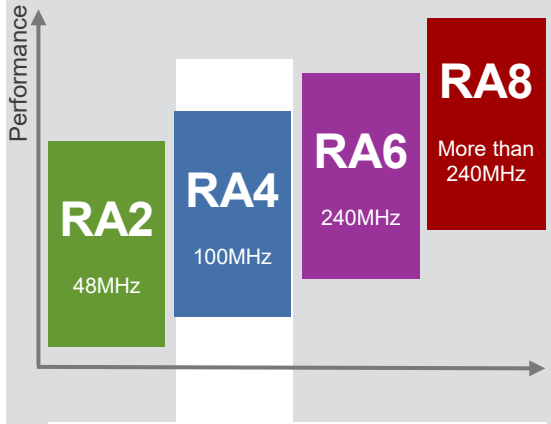


Run AWS IOT core MQTT sample on EK-RA8M1 · renesas/zephyr Wiki

RA4L1 – LOW POWER WITH LCD

ARM CORTEX M33@80MHZ - 512KB FLASH WITH 64KB RAM





- 110-nm low power process
- 32-bit Cortex M33 Core with FPU
- Operating temperature range: Ta = -40°C to 125°C
- Operating Voltage: 1.6V-3.6V
- High-Speed on-chip oscillator +-1% w/o any external crystal
- ARM TrustZone
- RSIP-E04A security engine

RA4L1 — 80MHz 32-bit Arm® Cortex®-M33 — NVIC | SWD | ETB

Memory

Code Flash
256KB x 2Banks
SRAM 32KB Parity
SRAM 32KB ECC
DataFlash 8KB

Analogue

12-bit A/D
12-bit D/A
Temperature Sensor
Comparator x 2

Timers

GPT 32-bit (2ch)
GPT 16-bit (4ch)
Low-power AGT 32-bit (2ch)
WDT
RTC, Calendar

HMI

Segment LCD Controller
8 com x 48 seg w charge pump
Cap Touch (12 ch)

Communication

I3C x 1
I2C x 1
SCI x 6
LPUART x 2
SPI x 1
QSPI x 1
CANFD x 1
USBFS w/o crystal
SSI x 1

System

TrustZone
DMA (8ch), DTC, ELC
Interrupt Controller
Clock Generation
On-Chip Oscillator
HOCO (24/32/40/48/64/80MHz)
LOCO (32KHz)
ILOCO (15KHz)
Low-power Modes

Safety

Memory Protection Unit
SRAM Parity Check
ECC SRAM
Clock Frequency Accuracy Measurement
CRC calculation
IWDT
Data Operation Circuit
Flash Area Protection
ADC self test
LVDs for 3V to 1.6V

Security

Unique ID
TRNG
AES 128//256
Key Management
ECC (256)
SHA-2 (256)
Enhanced Tamper Detection
SPA/DPA
Resistance

Package

LQFP 48, 64, 100
BGA 64, 100
QFN 48, CSP72

ZEPHYR RTOS
SUPPORTED MCU/MPU PRODUCTS

Supported MCU/MPU

- DA14695
- DA1469x
- RA2A1
- ek_ra2l1
- RA4E2
- RA4L1
- RA4M1
- RA4M2
- RA4M3
- RA4W1
- RA6E2
- RA6M1
- RA6M2
- RA6M3
- RA6M4
- RA6M5
- RA8D1
- RA8M1
- RA4E1
- RA6E1
- RA6E2
- RA8T1
- R-Car H3ULCB
- R-Car Salvator-X
- R-Car Salvator-XS
- R-Car Spider
- RX130
- RZ/A2M
- RZ/A3UL
- RZ/G2L
- RZ/G2L
- RZ/G3S
- RZ/N2L
- RZ/T2L
- RZ/T2M
- RZ/V2L
- RA4E1

Zephyr source code

- Kernel
- Drivers
- Architecture-specific code
- Board configurations
- Subsystems
- Build system
- Sample applications


RENESAS