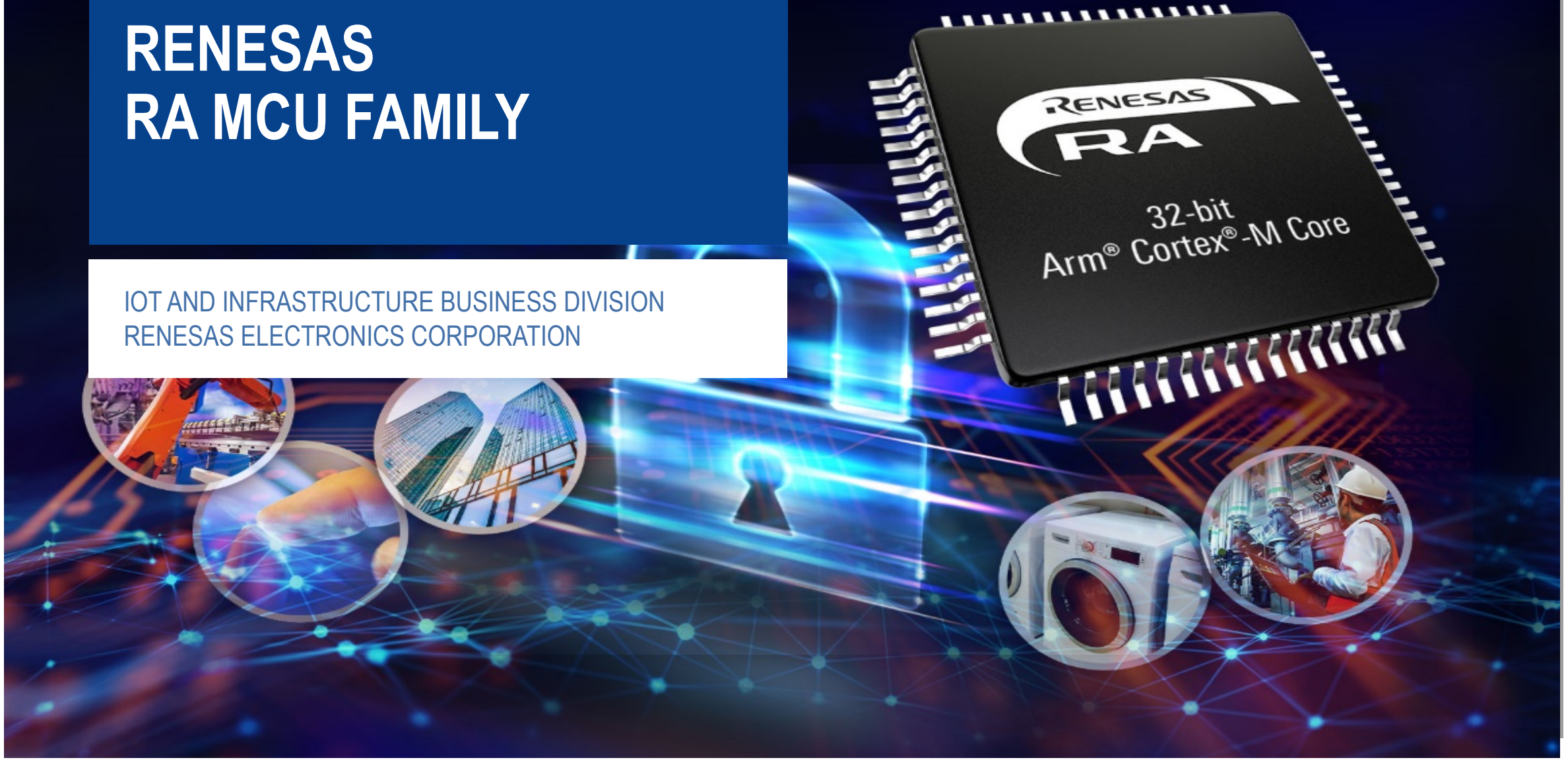
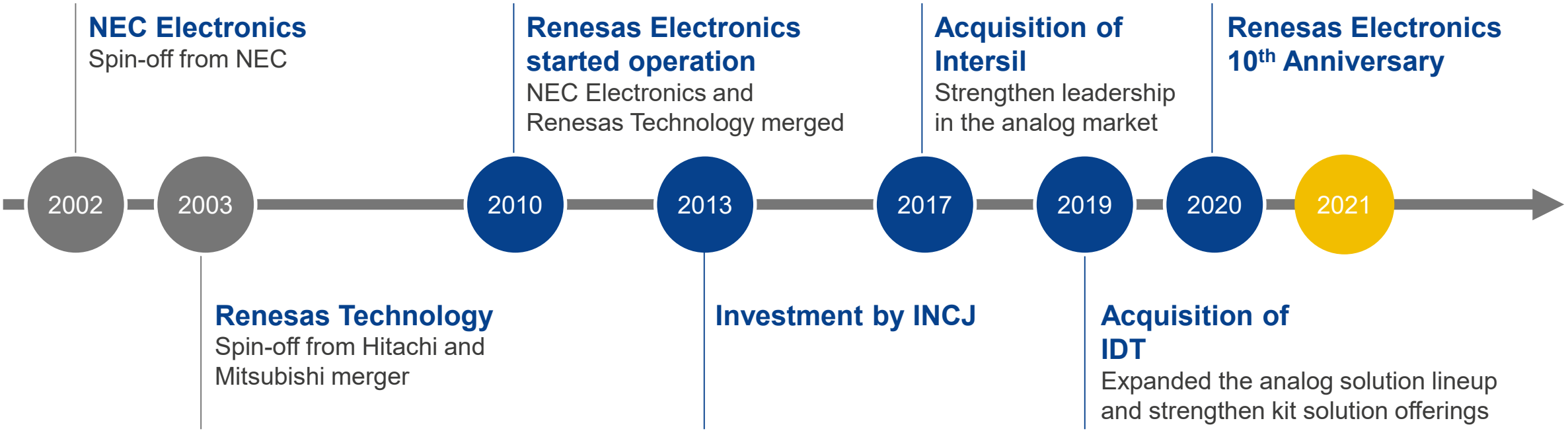
RENESAS
RA MCU FAMILY

IOT AND INFRASTRUCTURE BUSINESS DIVISION
RENESAS ELECTRONICS CORPORATION



OUR HISTORY

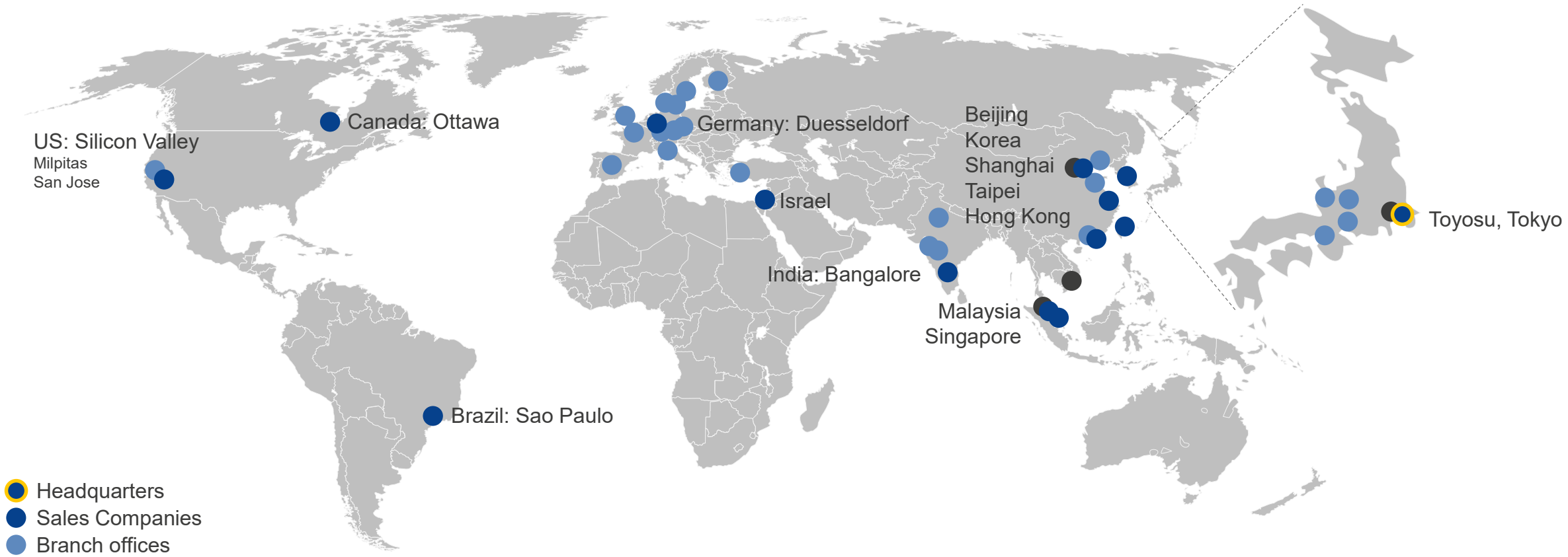
Renesas is built on a strong historical foundation of technological innovation originating from Hitachi, Mitsubishi and NEC. Fueled by the Intersil and IDT integrations, Renesas is now poised to extend its share in fast-growing data economy-related markets such as infrastructure and data center, and strengthen its presence in the industrial and automotive segments.



IDT: Integrated Device Technology

GLOBAL SALES NETWORK

- Global sales network operating across more than 20 countries
- Comprehensive R&D capabilities and support through a global network



As of January 1, 2021

BIG IDEAS FOR EVERY SPACE RENESAS

GLOBAL MANUFACTURING NETWORK

- 14 manufacturing facilities in Japan, China, Southeast Asia, and the US
- Global partners such as TSMC and GLOBALFOUNDRIES

As of January 1, 2021

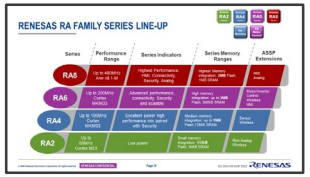
RA MCU INTRODUCTION

INTRODUCING 32-BIT RENESAS RA FAMILY

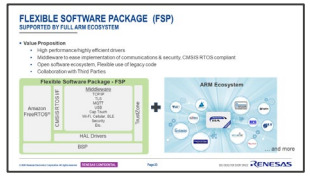
HIGH PERFORMANCE, HIGH SECURITY, BROAD CONNECTIVITY AND WIDE LINE-UP

RENESAS RA

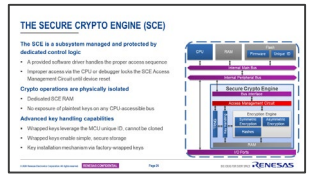
- **Up to 200MHZ** — High performance Using ARM Cortex Cores
- **Up to 2MB** — High Flash memory integration
- **Security** — Renesas' leading security IP with options based on TrustZone
- **USB CAN-FD Ethernet** — Broad connectivity
- **Scalable** — 32pin-176pin packages 48MHz-200MHz performance Feature and pin compatible



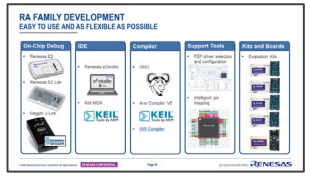
RA Family Lineup



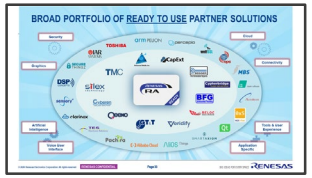
Flexible Software Package



RA Family Security



Tools & Kits



Ecosystem

TARGET MARKETS AND APPLICATIONS

Industrial Automation

- Long product life
- 105°C support
- Industrial quality grade
- Strongest robustness

Security

- TrustZone support
- Integrated Crypto Module
- Key isolation and management
- True Random Number Generator (TRNG)

Connectivity

- Large On-chip RAM suitable for stacks
- CAN/USB/Ethernet
- Large amount on serial Interfaces
- QSPI and OCTA SPI Interfaces
- HW Crypto Module on-chip

Building Automation

- High On-Chip Flash/RAM memory ratio
- Wide range of connectivity: CAN/USB/Ethernet
- Rich analog features
- Small packages

Metering

- Scalable lineup
- Industrial quality grade
- Long product life
- Encryption On-Chip

Home Appliance

- Temp up to 105°C
- Extensive family lineup
- Motor control solutions
- Capacitive Touch Interface

RENESAS RA FAMILY: KEY VALUES

ARM Core

- Next generation CM23/CM33 ARM cores, but also CM4 core
- Including TrustZone for advanced security

Security for IoT

- Strong security solutions targeting IoT use cases, with excellent ease-of-use tools and offering end-to-end lifetime security solutions

Leading Technology

- Best in class peripheral IP's, built on strong MCU heritage.
- Excellence in embedded FLASH, performance & field upgrade.
- Class leading Capacitive Touch technology

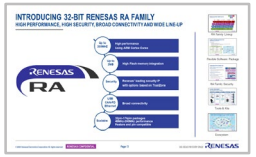
Connectivity Solutions

- Excellent solutions for wired applications
- BLE, 15.4, LORA, LP-WAN eg NB-IoT, Wi-Fi, etc.
- Supporting 3rd party RF solutions
- Integrated RF solutions planned

Software Solutions

- New Flexible Software Package.
- Fast-start software for Security & Connectivity
- Flexible open architecture supporting customers legacy code and environment
- Collaboration with 3rd parties for strong ecosystem support

RENESAS RA FAMILY SERIES LINE-UP

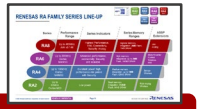


RA Introduction

Series	Performance Range	Series Indicators	Series Memory Ranges	ASSP Extensions
RA8	Up to 480MHz Arm v8.1-M	Highest Performance, HMI, Connectivity, Security, Analog	Highest Memory integration: **2MB** Flash, 1MB SRAM	HMI Analog
RA6	Up to 200MHz Cortex M4/M33	Advanced performance, connectivity, Security and scalable	High memory integration: up to **2MB** Flash, 640kB SRAM	Motor/Inverter Control Wireless HMI
RA4	Up to 100MHz Cortex M4/M33	Excellent power high performance mix paired with Security	Medium memory integration: up to **1MB** Flash,128kB SRAM	Sensor Wireless
RA2	Up to 60MHz Cortex M23	Low power	Small memory integration: **512kB** Flash, 64kB SRAM	Rich Analog Wireless

RENESAS RA FAMILY COMPLETE LINE UP

RA Family Lineup



RA8 200MHz~

- **RA8xx** — UNDER PLANNING
- **RA8xx** — UNDER DEVELOPMENT

RA6 ~200MHz

- **RA6M5** — CM33, 200MHz; 1.5B-2MB (512kB), 100-176pin, Ether, USB HS, CAN-FD , Full Security with TrustZone
- **RA6M4** — CM33, 200MHz; 512kB-1MB (256kB), 64-144pin, Ether, USB FS, CAN, Full Security with TrustZone
- **RA6M3** — CM4, 120MHz; 1MB-2MB (640kB), 100-176pin, TFT, Ether, USB FS+HS, CAN, Security
- **RA6M2** — CM4, 120MHz; 512kB-1MB (384kB), 100-145pin, Ether, USB FS, CAN, Security
- **RA6M1** — CM4, 120MHz; 512kB (256kB), 64-100pin, USB FS, CAN, Security
- **RA6T1** — CM4, 120MHz for Motor Control; 256KB-512KB(64KB), 64-100pin high resolution PWM
- **RA6xx** — UNDER PLANNING

RA4 ~100MHz

- **RA4M3** — CM33 100MHz; 768kB-1MB (128kB), 64-144pin, USB FS, Touch, Full Security with TrustZone
- **RA4M2** — CM33 100MHz; 256kB-512kB (128kB), 48-100pin, USB FS, CAN Touch, Full Security with TrustZone
- **RA4W1** — CM4 48MHz + BLE; 512KB(96KB), 56pin
- **RA4M1** — CM4, 48MHz; 256kB (32kB), 48-100pin, USB-FS, CAN, Touch, Basic Security
- **RA4xx** — UNDER PLANNING

RA2 ~60MHz

- **RA2A1** — CM23, 48MHz; 256kB (32kB), 32-64pin, 24bit ADC, 5V, CAN, Touch
- **RA2L1** — CM23, 48MHz; 128kB-256kB (32kB), 64-100pin, 5V, DAC, CAN, Touch
- **RA2E1** — CM23, 48MHz, ; 32kB-128kB (16kB), 25-64pin, 5V, Touch
- **RA2xx** — UNDER PLANNING

Legend

Not recommended for new design	MP Product recommended for new design
Products Under Development	Products Under Planning

Note: Code Flash listed first, (SRAM) listed second

A – Rich Analog
E – Entry level
M – Mainstream
L – Low Power
T – Motor Control
W - Wireless

2018 2019 2020 2021

RENESAS RA FAMILY COMPLETE LINE UP

RA Family Lineup

RA8 — 360MHz Arm v8.1-M

RA6 — Up to 200MHz

RA4 — Up to 100MHz

RA2 — Up to 60 MHz

- **RA8Xx** — Arm M7, 480MHz – 1Ghz — UNDER DEVELOPMENT
- **RA6Mx** — CM33, 200MHZ — UNDER DEVELOPMENT
- **RA6M4** — CM33, 200MHz — 512kB-1MB (256kB), 64-144pin, Ether, USB FS, CAN, Full Security with TrustZone
- **RA6M3** — CM4, 120MHz — 1MB-2MB (640kB), 100-176pin, TFT, Ether, USB FS+HS, CAN, Security
- **RA6M2** — CM4, 120MHz — 512kB-1MB (384kB), 100-145pin, Ether, USB FS, CAN, Security
- **RA6M1** — CM4, 120MHz — 512kB (256kB), 64-100pin, USB FS, CAN, Security
- **RA6Tx** — CM4, 120MHz for Motor Control — UNDER DEVELOPMENT
- **RA6Mx** — UNDER PLANNING
- **RA6Wx** — UNDER PLANNING
- **RA6Tx** — CM33, 200MHzfor Motor Control — UNDER PLANNING
- **RA4Mx** — CM33 100MHz — UNDER DEVELOPMENT
- **RA4W1** — CM4 48MHz + BLE — 512KB(96KB), 56pin
- **RA4M1** — CM4, 48MHz — 256kB (32kB), 48-100pin, USB-FS, CAN, Touch, Basic Security
- **RA4Wx** — UNDER PLANNING
- **RA2Ex** — CM23, 48MHz, — UNDER DEVELOPMENT
- **RA2Lx** — CM23, 48MHz — UNDER DEVELOPMENT
- **RA2A1** — CM23, 48MHz — 256kB (32kB), 32-64pin, 24bit ADC, 5V, CAN, Touch
- **RA2Wx** — UNDER PLANNING
- **RA2Ax** — UNDER PLANNING

Legend

Not recommended for new design	MP Product recommended for new design
Products Under Development	Products Under Planning

Note: Code Flash listed first, (SRAM) listed second

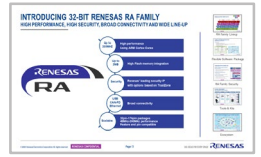
A – Rich Analog
C – Metering
E – Entry level
M – Mainstream
L – Low Power
T – Motor Control
W - Wireless

2018 2019 2020 2021 2022 2023

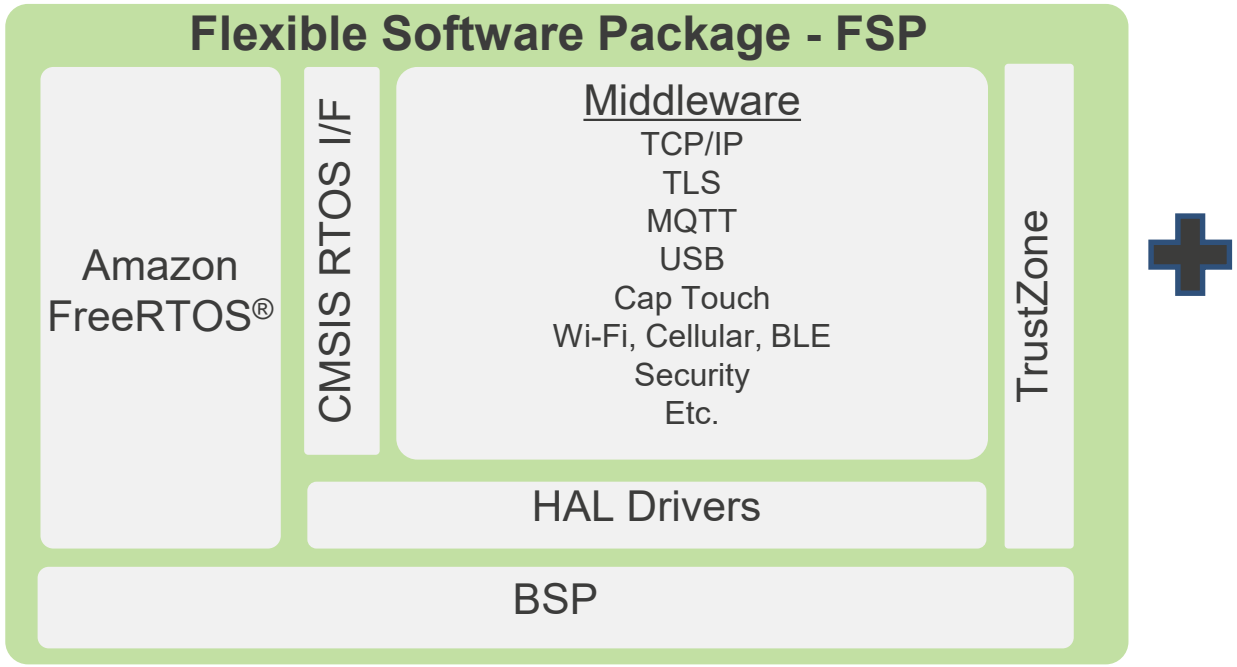
FLEXIBLE SOFTWARE PACKAGE (FSP)

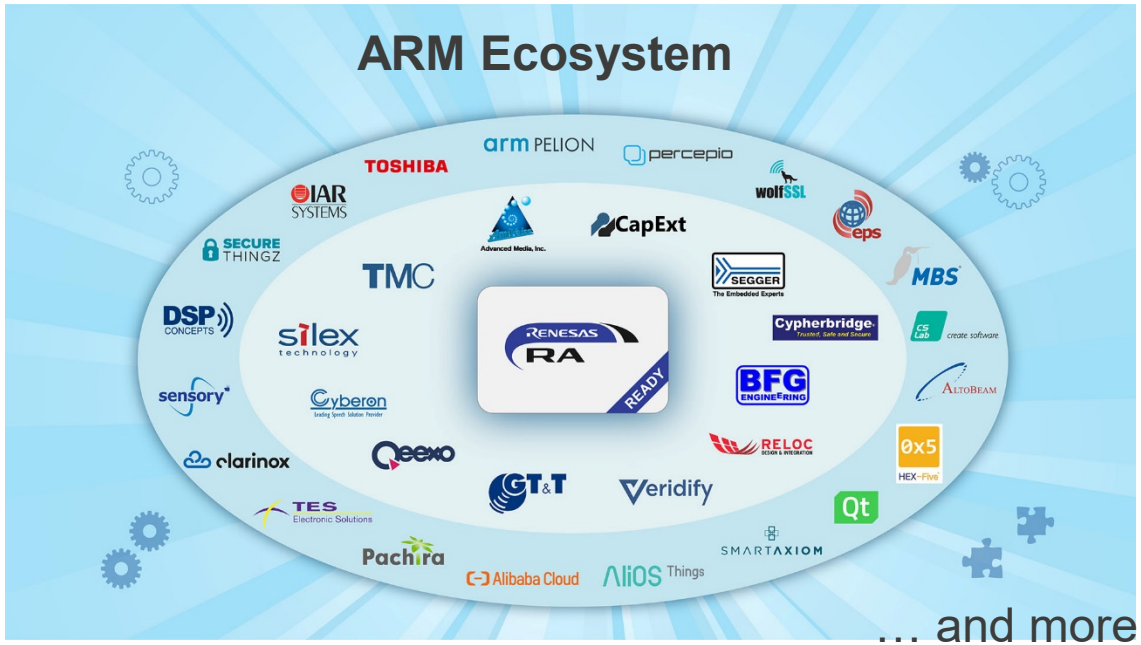
FLEXIBLE SOFTWARE PACKAGE (FSP)

SUPPORTED BY FULL ARM ECOSYSTEM

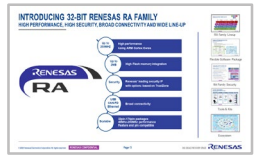

RA Introduction

- **Value Proposition**
  - High performance/highly efficient drivers
  - Middleware to ease implementation of communications & security, CMSIS RTOS compliant
  - Open software ecosystem, Flexible use of legacy code
  - Collaboration with Third Parties

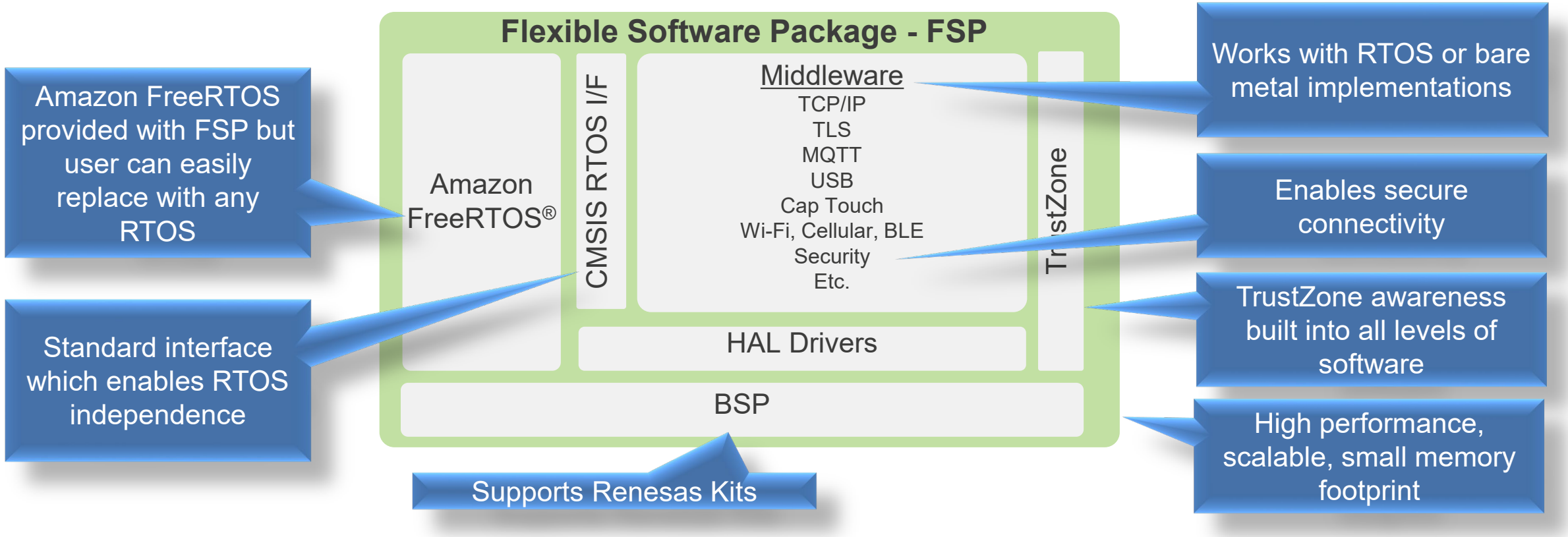




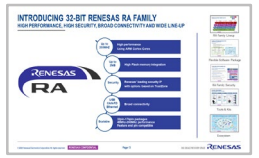
FSP OVERVIEW


RA Introduction

- Start your Applications development right away, based on FSP API
  - Licensing
  - Full source code, Limited to Renesas hardware only



FLEXIBLE SOFTWARE PACKAGE
ECOSYSTEM SUPPORTS


RA Introduction

Licensing

- Full source code.
- For use on Renesas hardware

Compilers

- GCC
- ARM Compiler V6 [New]
- IAR [New]

Documentations

- FSP User manuals (HTML & PDF)
- API documentation, Sample code, Application notes
- GitHub Pages

Support System

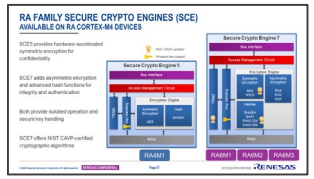
- RA Support Ticket system (Teams support)
- Forum (Renesas Rulz)
- GitHub Issues (Additional forum)
- RA and FSP Knowledge Base
- Example Projects (EP) and Application Notes

Software Distribution

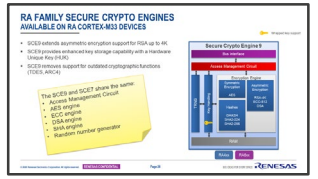
- Source code distribution through GitHub
- Platform and CMSIS pack installers
- “GitHub releases” for software release
- FSP web page in renesas.com

RA MCU SECURITY

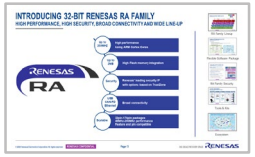
THE SECURE CRYPTO ENGINE (SCE)



SCE7 CM4



SCE9 CM4



RA Introduction

The SCE is a subsystem managed and protected by dedicated control logic

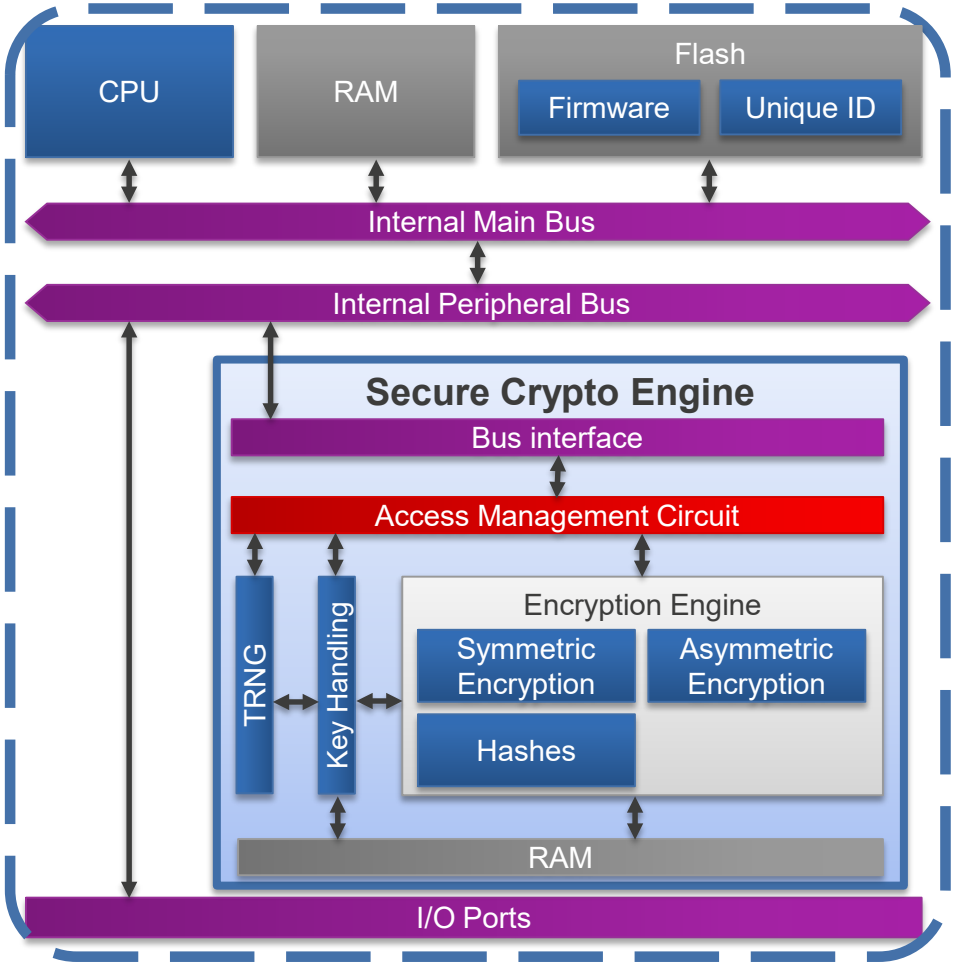
- A provided software driver handles the proper access sequence
- Improper access via the CPU or debugger locks the SCE Access Management Circuit until device reset

Crypto operations are physically isolated

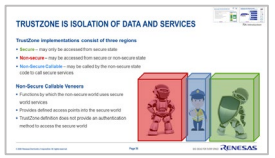
- Dedicated SCE RAM
- No exposure of plaintext keys on any CPU-accessible bus

Advanced key handling capabilities

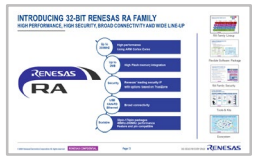
- Wrapped keys leverage the MCU unique ID, cannot be cloned
- Wrapped keys enable simple, secure storage
- Key installation mechanism via factory-wrapped keys



BEST IN CLASS TRUSTZONE IMPLEMENTATION

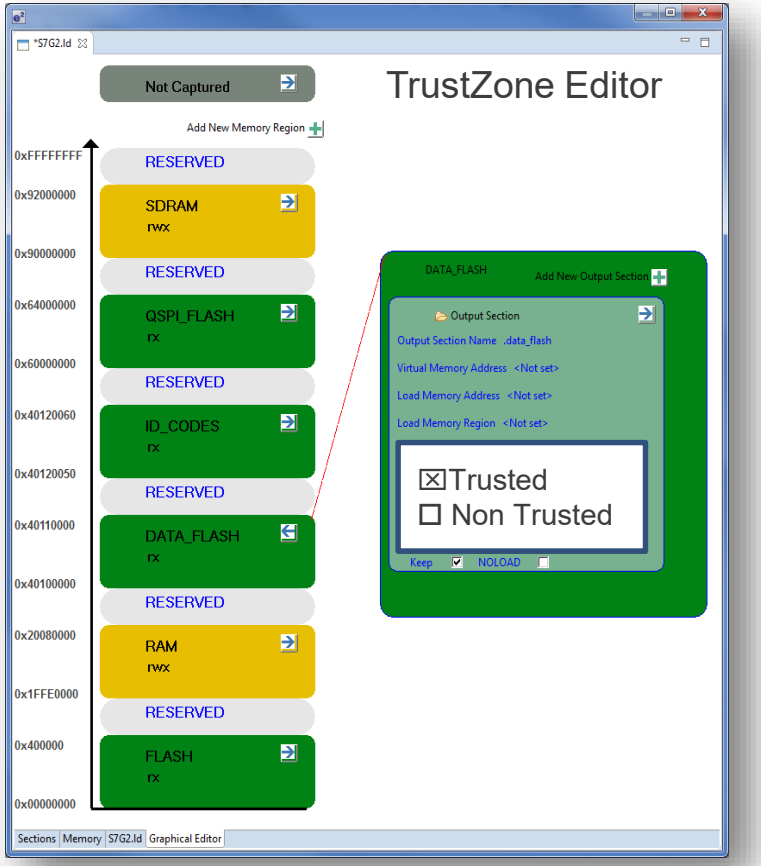


ARM TrustZone



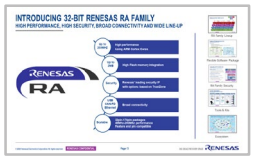
RA Introduction

- Additional e^2 studio & standalone configurator to graphically configure ARM Cortex M33 TrustZone
- Secure and Non-Secure Callable memory regions are dynamically configured after project build to ensure best memory usage and alignment to flash bocks
- New linker memory / Peripheral regions added and configured as secure or non secure
- Syntax checker will capture / eliminate errors
- Includes support for CortexM secure MPU
- TrustZone configuration carried forward into debugger session
- Controlled access to secure zone during debug
- Authenticated debugger connection



BIG IDEAS FOR EVERY SPACE RENESAS

RA FAMILY DEVELOPMENT
EASY TO USE AND AS FLEXIBLE AS POSSIBLE


RA Introduction

On-Chip Debug

- Renesas E2

- Renesas E2 Lite

- Segger J-Link

IDE

- Renesas e2studio

- Keil MDK

KEIL™ Tools by ARM

Compiler

- GNU

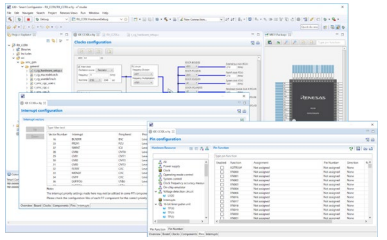
- Arm Compiler V6

KEIL™ Tools by ARM

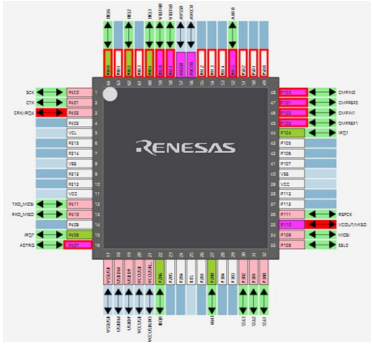
- IAR Compiler

Support Tools

- FSP driver selection and configuration



- Intelligent pin mapping



Kits and Boards

- Evaluation Kits

BROAD PORTFOLIO OF READY TO USE PARTNER SOLUTIONS

RA Introduction

Security

Graphics

Artificial Intelligence

Voice User Interface

Cloud

Connectivity

Tools & User Experience

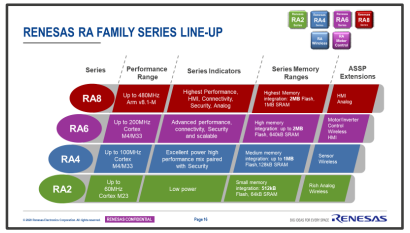
Application Specific

arm PELION
percepio
TOSHIBA
wolfSSL
IAR SYSTEMS
Advanced Media, Inc.
CapExt
eps
SECURE THINGZ
TMC
SEGGER The Embedded Experts
MBS
DSP CONCEPTS
silex technology
Cypherbridge Trusted, Safe and Secure
CS Lab create software
RENESAS RA READY
BFG ENGINEERING
AltoBeam
sensory
Cyberon Leading Speech Solution Provider
RELOC DESIGN & INTEGRATION
0x5 HEX-Five
clarinox
Qeexo
GT&T
Veridify
Qt
TES Electronic Solutions
SMARTAXIOM
Pachira
Alibaba Cloud
AliOS Things

RA MCU DEVICES

RA2 , RA4 , RA6 SERIES

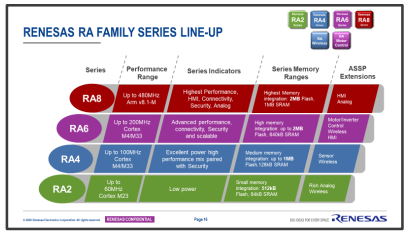
RENESAS RA2 SERIES - GROUP OVERVIEW

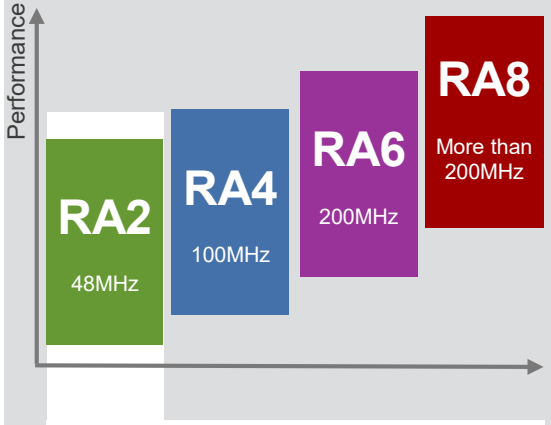


Series	Group	Feature
Renesas RA2 Series	RA2L1	48MHz, Cortex M23, 256kB Flash, 32kB RAM, 48-100pin, CAN, 32ch Cap Touch, Security
	RA2E1	48MHz, Cortex M23, 128kB Flash, 16kB RAM, 25-64pin, 30ch Cap Touch, Security
	RA2A1	48MHz, Cortex M23, 256kB Flash, 32kB RAM, 32-64pin, USB, CAN, 24bit Sigma Delta ADC, 16bit ADC, Security

RA2A1 GROUP – ANALOG PERFORMANCE

ARM CORTEX M23 – 256KB FLASH WITH 32KB RAM





- 130-nm low power process
- 32-bit Cortex M23 Core
- Operating temperature range: Ta = -40°C to 105°C
- Operating Voltage: 1.6V-5.5V

RA2A1 — 48MHz 32-Bit Arm® Cortex®-M23 Core — NVIC | SWD | ETB

Memory

- Code Flash (256kB)
- SRAM (16kB) Parity
- SRAM (16kB) ECC
- Data Flash (8kB)

Analogue

- 16-bit A/D (17ch)
- 24-bit Sigma Delta A/D(10ch)
- 12-bit DAC (1ch)
- 8-bit DAC (2ch)
- OPAMP (3ch)
- ACMPHS
- ACMPLP(2ch)
- Temperature Sensor

Timers

- GPT 32-bit (1ch)
- GPT 16-bit (6ch)
- Low Power GPT (2ch)
- WDT

HMI

- Capacitive Touch Sensing Unit (26ch)

Communication

- USB2.0 FS x1
- CAN x1
- I2C x2
- SCI x3
- SPI x2

System

- Sys Tick
- DTC
- Multiple Clocks
- On-Chip Oscillator HOCO (24,32,48,64MHz), LOCO(32kHz), ILOCO (15kHz)
- Low Power Modes
- ELC
- Port Function Select
- RTC

Safety

- Memory Protection Unit
- SRAM Parity Check
- ECC in SRAM
- Clock Frequency Accuracy Measurement
- CRC Calculator
- IWDT
- Data Operation Circuit
- Flash Area Protection
- ADC Self Test

Security

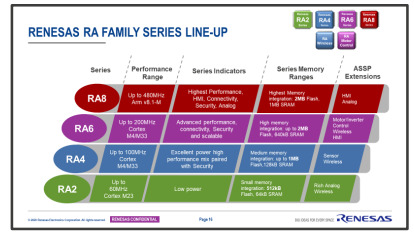
- AES (128/256)
- TRNG
- 128 bit Unique ID

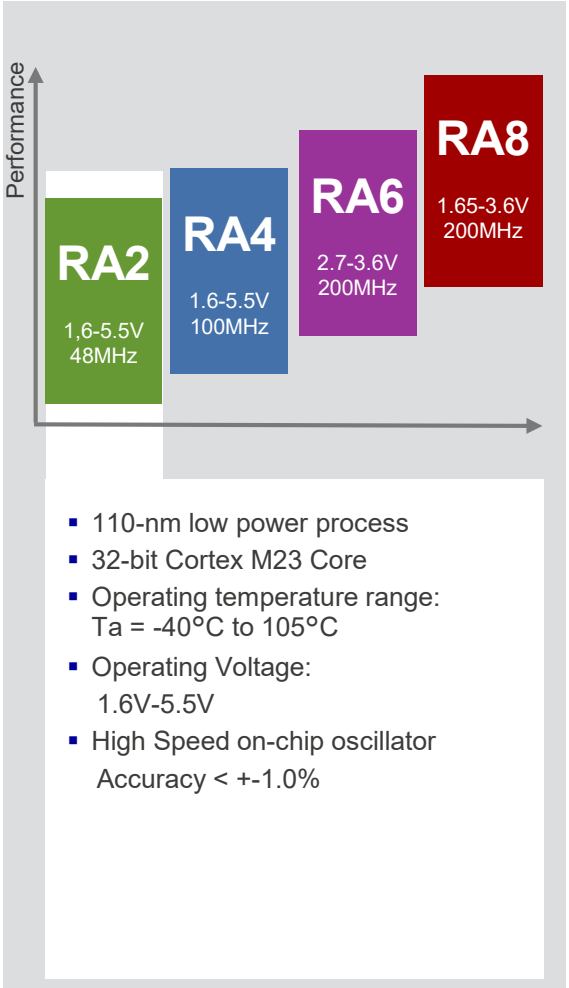
Package

- LQFP 32, 64
- QFN 40, 48; BGA 36

RA2E1 GROUP – ENTRY LEVEL

ARM CORTEX M23 - 128KB - 32KB FLASH WITH 16KB RAM





- 110-nm low power process
- 32-bit Cortex M23 Core
- Operating temperature range:
  Ta = -40°C to 105°C
- Operating Voltage:
  1.6V-5.5V
- High Speed on-chip oscillator
  Accuracy < +-1.0%

RA2E1 — 48MHz 32-Bit Arm® Cortex®-M23 Core — NVIC | SWD | ETB

Memory

- Code Flash (128kB, 96kB, 64kB, 32kB)
- SRAM (16kB) Parity
- Data Flash (4kB)

Analogue

- 12-bit ADC (13ch)
- Low Power Analog Comparator (2ch)
- Temperature Sensor

Timers

- GPT 32-bit (1ch)
- GPT 16-bit (6ch)
- AGT 16-bit (2ch)
- WDT

HMI

- Capacitive Touch Sensing Unit (30ch)

Communication

- I2C x1
- SCI x4
- SPI x1

System

- Sys Tick
- DTC
- Multiple Clocks
- On-Chip Oscillator HOCO (24,32,48,64MHz), LOCO (32kHz), ILOCO (15kHz)
- Low Power Modes
- ELC
- Port Function Select
- RTC

Safety

- Memory Protection Unit
- SRAM Parity Check
- POE
- Clock Frequency Accuracy Measurement
- CRC Calculator
- IWDT
- Data Operation Circuit
- Flash Area Protection
- ADC Self Test

Security

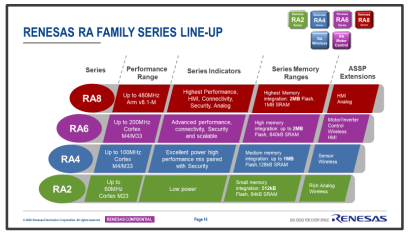
- AES (128/256)
- TRNG
- 128 bit Unique ID

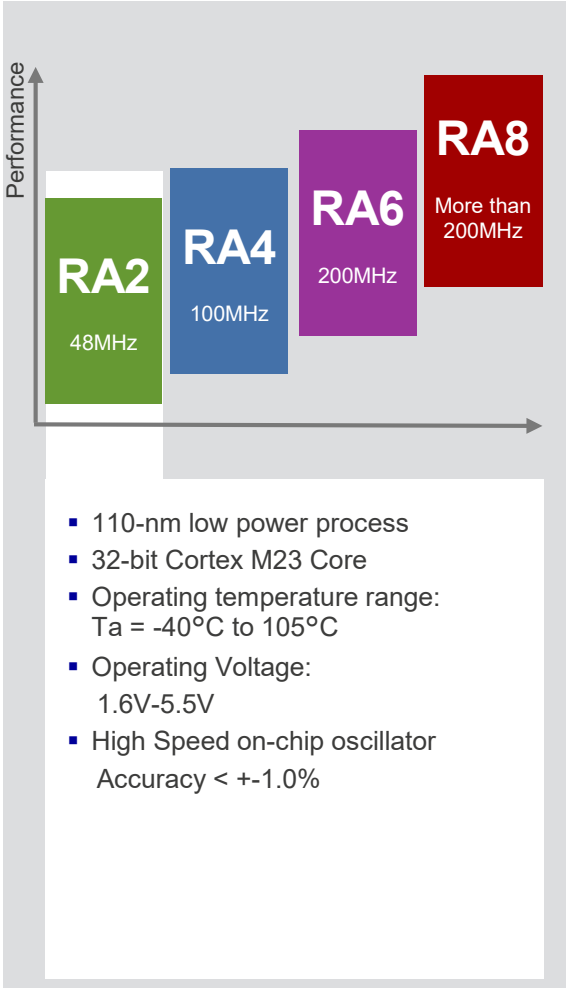
Package

- LQFP 32, 48, 64; LGA 36
- BGA 64; QFN 32, 48; WLCSP 25

RA2L1 GROUP – LOW POWER

ARM CORTEX M23 - 256KB, 128KB FLASH WITH 32KB RAM





- 110-nm low power process
- 32-bit Cortex M23 Core
- Operating temperature range: Ta = -40°C to 105°C
- Operating Voltage: 1.6V-5.5V
- High Speed on-chip oscillator Accuracy < +-1.0%

RA2L1 — 48MHz 32-Bit Arm® Cortex®-M23 Core — NVIC | SWD | ETB

Memory
- Code Flash (256kB, 128kB)
- SRAM (16kB) Parity
- SRAM (16kB) ECC
- Data Flash (8kB)

Analogue
- 12-bit ADC (19ch)
- 12-bit DAC (1ch)
- Low Power Analog Comparator (2ch)
- Temperature Sensor

Timers
- GPT 32-bit (4ch)
- GPT 16-bit (6ch)
- AGT 16-bit (2ch)
- WDT

HMI
- Capacitive Touch Sensing Unit (32ch)
- High Current IO (-20mA)

Communication
- CAN x1
- I2C x2
- SCI x5
- SPI x2

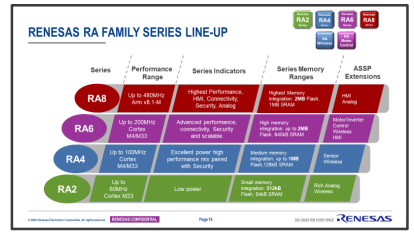
System
- Sys Tick
- DTC
- Multiple Clocks
- On-Chip Oscillator HOCO (24,32,48,64MHz), LOCO (32kHz), ILOCO (15kHz)
- Low Power Modes
- ELC
- Port Function Select
- RTC

Safety
- Memory Protection Unit
- SRAM Parity Check
- ECC in SRAM
- POE
- Clock Frequency Accuracy Measurement
- CRC Calculator
- IWDT
- Data Operation Circuit
- Flash Area Protection
- ADC Self Test

Security
- AES (128/256)
- TRNG
- 128 bit Unique ID

Package
- LQFP 48, 64, 80, 100
- QFN 48

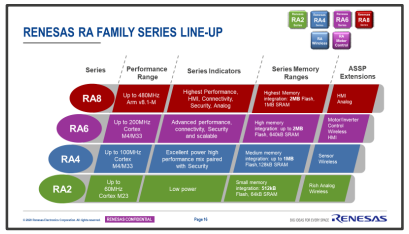
RENESAS RA4 SERIES - GROUP OVERVIEW

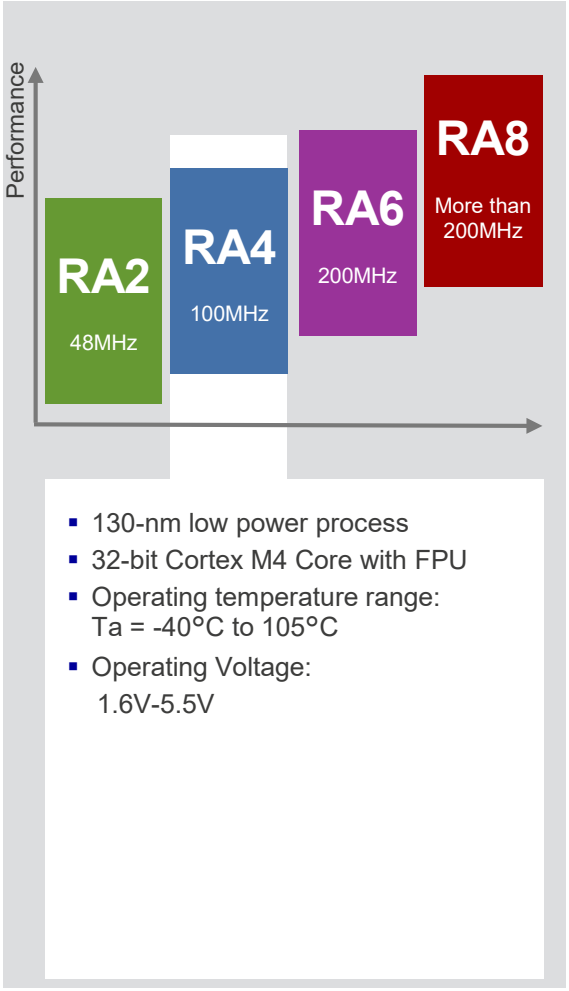


Series	Group	Feature
Renesas RA4 Series	RA4M1	48MHz, Cortex M4, 256kB Flash, 32kB RAM, 40-100pin, USB, CAN, Security
	RA4M2	100MHz, Cortex M33, 512kB Flash, 128kB RAM, 48-100pin, USB, CAN, Advanced Security with Trust Zone
	RA4M3	100MHz, Cortex M33, 1MB Flash, 128kB RAM, 64-144pin, USB, CAN, Advanced Security with Trust Zone
	RA4W1	48MHz, Cortex M4, 512kB Flash, 96kB RAM, QFN56, Bluetooth 5.0, USB, CAN, Security

RENESAS RA4M1 GROUP

ARM CORTEX M4 – 256KB FLASH WITH 32KB RAM





- 130-nm low power process
- 32-bit Cortex M4 Core with FPU
- Operating temperature range:
  Ta = -40°C to 105°C
- Operating Voltage:
  1.6V-5.5V

RA4M1 — 48MHz 32-Bit Arm® Cortex®-M4 Core

FPU | ARM MPU | NVIC | JTAG | SWD | ETB | Boundary Scan

Memory

- Code Flash (256kB)
- SRAM (16kB) Parity
- SRAM (16kB) ECC
- Data Flash (8kB)

Analogue

- 14-bit A/D (25ch) 1S/H
- 12-bit DAC (1ch)
- OPAMP (4ch)
- Low Power Comparator (2ch)
- Temperature Sensor

Timers

- GPT 32-bit (2ch)
- GPT 16-bit (6ch)
- Low Power GPT (2ch)
- WDT
- RTC, Calendar, Vbat

HMI

- Capacitive Touch Sensing Unit (27ch)
- Segment LCD Controller 38 Seg/8 Com

Communication

- USB2.0 FS x1
- CAN x1
- I2C x2
- SCI x4
- SPI x2
- SSI x1

System

- DMA (4ch)
- DTC
- Clock Generation
- On-Chip Oscillator HOCO (24,32,48,64MHz), MOCO (8MHZ), LOCO(32kHz), ILOCO (15kHz)
- Low Power Modes
- ELC
- Interrupt Controller

Safety

- Memory Protection Unit
- SRAM Parity Check
- ECC in SRAM
- POE
- Clock Frequency Accuracy Measurement
- CRC Calculator
- IWDT
- Data Operation Circuit
- Flash Area Protection
- ADC Self Test

Security

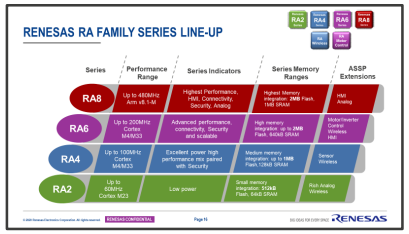
- AES (128/256)
- TRNG
- Key Management
- GHASH

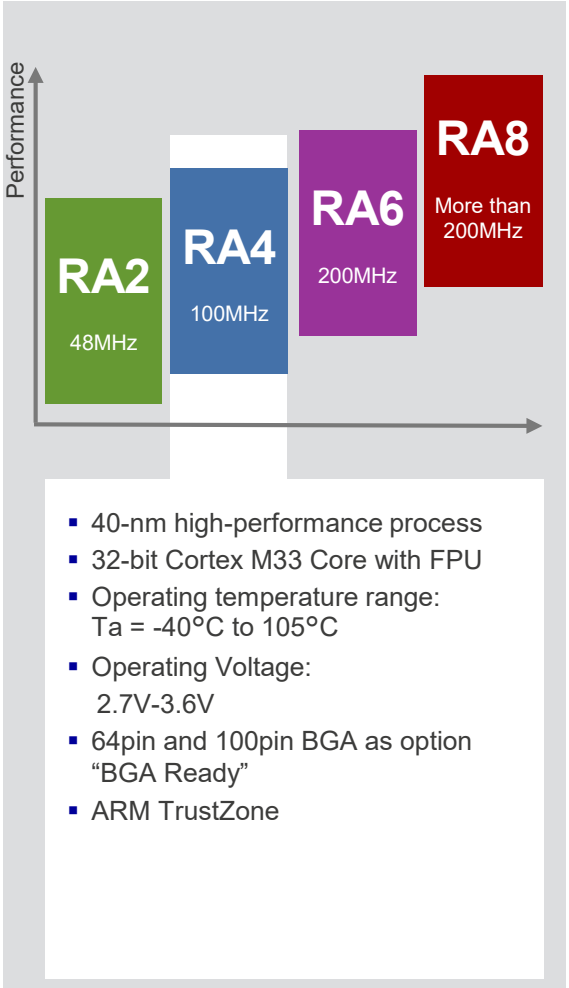
Package

- LQFP 48, 64, 100
- QFN 48, 64, 40, LGA 100

RENESAS RA4M2 GROUP

ARM CORTEX M33 - 256KB TO 512KB FLASH WITH 128KB RAM





- 40-nm high-performance process
- 32-bit Cortex M33 Core with FPU
- Operating temperature range:
  Ta = -40°C to 105°C
- Operating Voltage:
  2.7V-3.6V
- 64pin and 100pin BGA as option
  “BGA Ready”
- ARM TrustZone

RA4M2 — 100MHz 32-Bit Arm® Cortex®-M33 Core — NVIC | JTAG | SWD | ETB

Memory

- Code Flash (256kB, 384kB, 512kB)
- SRAM (64kB) Parity
- SRAM (64kB) ECC
- Data Flash (8kB)
- Standby SRAM (1kB)

Analogue

- 12-bit A/D (13ch) 1S/H
- 12-bit DAC (2ch)
- Temperature Sensor

Timers

- GPT 32-bit (4ch)
- GPT 16-bit (4ch)
- Low Power GPT (6ch)
- WDT
- RTC, Calendar, Vbat, 128Byte SRAM

HMI

- Capacitive Touch Sensing Unit (12ch)

Communication

- USB2.0 FS x1
- CAN x1
- I2C x2
- SCI x6
- SPI x1
- QSPI x1
- SDHI / MMC
- SSI x1

System

- DMA (8ch)
- DTC
- Clock Generation
- On-Chip Oscillator HOCO (16,18,20MHz), LOCO (32kHz), ILOCO (15kHz)
- Low Power Modes
- ELC
- Interrupt Controller
- TrustZone

Safety

- Memory Protection Unit
- SRAM Parity Check
- ECC in SRAM
- Clock Frequency Accuracy Measurement
- CRC Calculator
- IWDT
- Data Operation Circuit
- Flash Area Protection
- ADC Self Test

Security

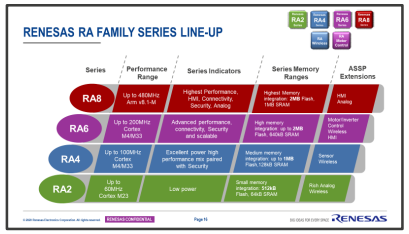
- Unique ID
- AES (128/192/256)
- TRNG
- Key Management
- RSA / ECC / DSA
- SHA256 / SHA224
- Tamper Resistance
- SPA/DPA Enhanced Resistance

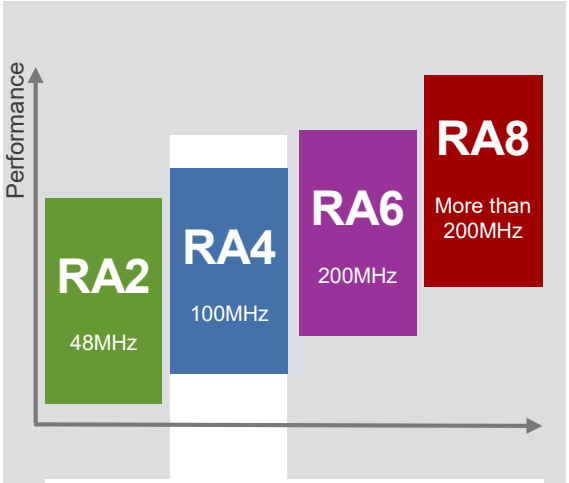
Package

- LQFP 48, 64, 100
- QFN 48

RENESAS RA4M3 GROUP

ARM CORTEX M33 - 768KB TO 1MB FLASH WITH 128KB RAM





- 40-nm high-performance process
- 32-bit Cortex M33 Core with FPU
- Operating temperature range:
  Ta = -40°C to 105°C
- Operating Voltage:
  2.7V-3.6V
- 64pin and 144pin BGA as option
  “BGA Ready”
- ARM TrustZone

RA4M3 — 100MHz 32-Bit Arm® Cortex®-M33 Core — NVIC | JTAG | SWD | ETB

Memory

- Code Flash (512kB, 768kB, 1MB)
- Block SWAP Function
- SRAM (64kB) Parity
- SRAM (64kB) ECC
- Data Flash (8kB)
- Standby SRAM (1kB)

Analogue

- 12-bit A/D (9ch) 1S/H
- 12-bit A/D (10ch) 1S/H
- 12-bit DAC (2ch)
- Temperature Sensor

Timers

- GPT 32-bit (2ch)
- GPT 16-bit (6ch)
- Low Power GPT (6ch)
- WDT
- RTC, Calendar, Vbat, 128Byte SRAM

HMI

- Capacitive Touch Sensing Unit (20ch)

Communication

- USB2.0 FS x1
- CAN x1
- I2C x2
- SCI x6
- SPI x1
- QSPI x1
- SDHI / MMC
- SSI x1

System

- DMA (8ch)
- DTC
- Clock Generation
- On-Chip Oscillator HOCO (16,18,20MHz), LOCO (32kHz), ILOCO (15kHz)
- Low Power Modes
- ELC
- Interrupt Controller
- TrustZone

Safety

- Memory Protection Unit
- SRAM Parity Check
- ECC in SRAM
- Clock Frequency Accuracy Measurement
- CRC Calculator
- IWDT
- Data Operation Circuit
- Flash Area Protection
- ADC Self Test

Security

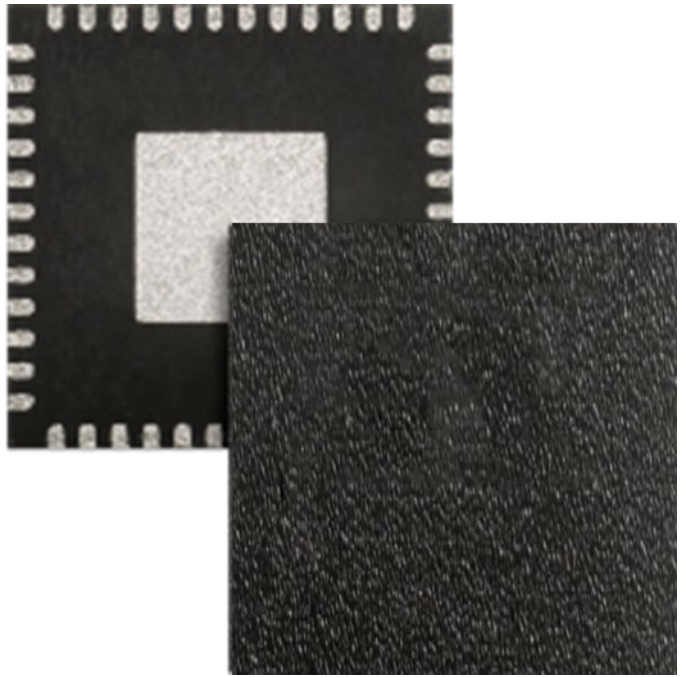
- Unique ID
- AES (128/192/256)
- TRNG
- Key Management
- RSA / ECC / DSA
- SHA256 / SHA224
- Tamper Resistance
- SPA/DPA Enhanced Resistance

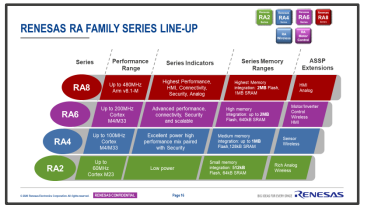
Package

- LQFP 64,100, 144

RA4W1 WITH BT5.0

KEY FEATURES



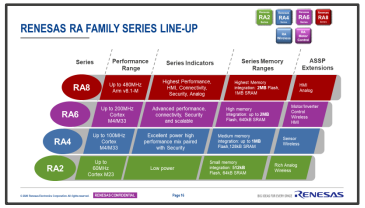


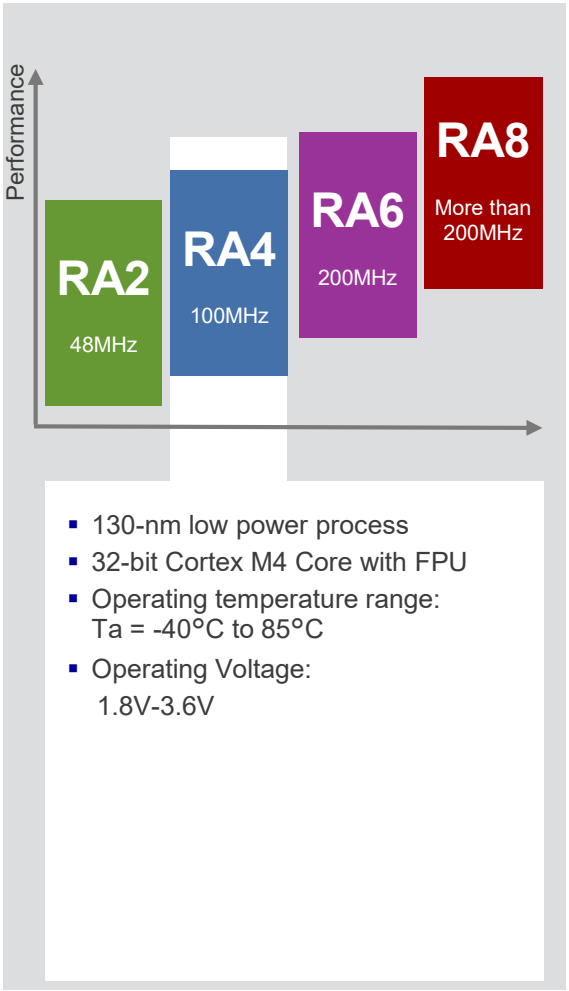
Key Features

MCU	MCU	ARM Cortex-M4 @48MHz, Flash: 512KB, SRAM: 96KB
	Peripheral Interface	FS USB 2.0, SCI(4), SPI(2), I2C(2), CAN
	Analog	14-bit ADC14, 12-bit DAC, 8-bit DAC(2), LP Comparator(2), Amplifier, Temp Sensor
	Timers	32-bit PWM Timer(4), 16-bit PWM Timer(3), Async Timer(2), Watchdog Timer
	Security	AES128/256, GHASH, True Random Number Generator (TRNG)
	HMI	Segment LCD Controller (SLCDC), Capacitive Touch Sensing Unit (CTSU)
	GPIO	Up to 35 input/output pins
	Operating Voltage	1.8V ~ 3.6 V
	Operating Temp	–40°C ~ +85°C (Ambient)
BLE	Standards	Bluetooth 5.0 (Bluetooth Low Energy)
	Frequency	2.4GHz ISM band (2402mHz ~ 2480MHz)
	Data Rates	2Mbps, 1Mbps, 500kbps, 125kbps
	Transmit Power	0dBm or 4dBm
	Receive Sensitivity	-92dBm @2Mbps, -95dBm @1Mbps, -100dBm @500Kbps, -105dBm @125Kbps
	Power Consumption	DC to DC Converter in use: - Transmit: 4.0~8.3mA - Receive: 2.8~3.2mA @1/2Mbps, 2.9~3.3mA @500Kbps, 3.0~3.3 @125Kbps - Idle: 0.54mA - Sleep: 1.5uA - Down: 0.1uA DC to DC Converter not in use: - Transmit: 9.5~17.5mA - Receive: 6.3mA @1/2Mbps, 6.5mA @500Kbps, 6.6mA @125Kbps - Idle: 0.75mA - Sleep: 1.5uA - Down: 0.1uA
	Regulatory Compliance	US: FCC CFR Title 47 parts 15.247 and 15.249 EU: EN 300 440 and EN 300 328 JP: ARIB STD-T66

RENESAS RA4W1 GROUP

ARM CORTEX M4 – 512KB FLASH WITH 96KB RAM AND BLUETOOTH LOW ENERGY 5.0





- 130-nm low power process
- 32-bit Cortex M4 Core with FPU
- Operating temperature range: Ta = -40°C to 85°C
- Operating Voltage: 1.8V-3.6V

RA4W1 — 48MHz 32-Bit Arm® Cortex®-M4 Core

FPU | ARM MPU | NVIC | JTAG | SWD | ETB | Boundary Scan

Memory
- Code Flash (512 KB)
- Data Flash (8 KB)
- SRAM (96 KB)
- Flash Cache
- Memory Mirror Function

Analogue
- 14-Bit A/D Converter (8 ch.)
- 12-Bit D/A Converter x1
- Low-Power Analog Comparator x2
- OPAMP x1
- Temperature Sensor

Timers
- General PWM Timer 32-Bit x4
- General PWM Timer 16-Bit x3
- Asynchronous General Purpose Timer x2
- WDT
- RTC

HMI
- Capacitive Touch Sensing Unit (11 ch.)
- Segment LCD Controller 4com x 9seg

Communication
- USBFS x1
- CAN x1
- Serial Communications Interface x4
- SPI x2
- I2C x2 | SCI x4
- 2.4 GHz RF (Bluetooth 5, Master/Slave AES Engine for BT5)

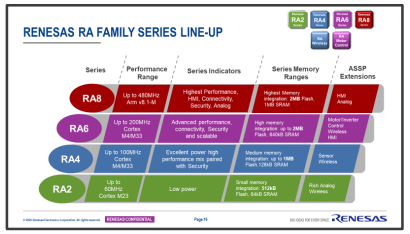
System
- DMA (4ch)
- DTC
- Clock Generation
- On-Chip Oscillator HOCO (24,32,48,64MHz), MOCO (8MHZ), LOCO (32kHz), ILOCO (15kHz)
- Low Power Modes
- ELC
- Interrupt Controller

Safety
- Memory Protection Unit
- SRAM Parity Check
- ECC in SRAM
- POE
- Clock Frequency Accuracy Measurement
- CRC Calculator
- IWDT
- Data Operation Circuit
- Flash Area Protection
- ADC Self Test

Security
- 128-Bit Unique ID
- TRNG
- Key Management
- AES (128/256)
- GHASH

Package
- QFN 56

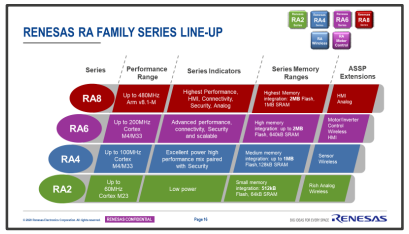
RENESAS RA6 SERIES - GROUP OVERVIEW

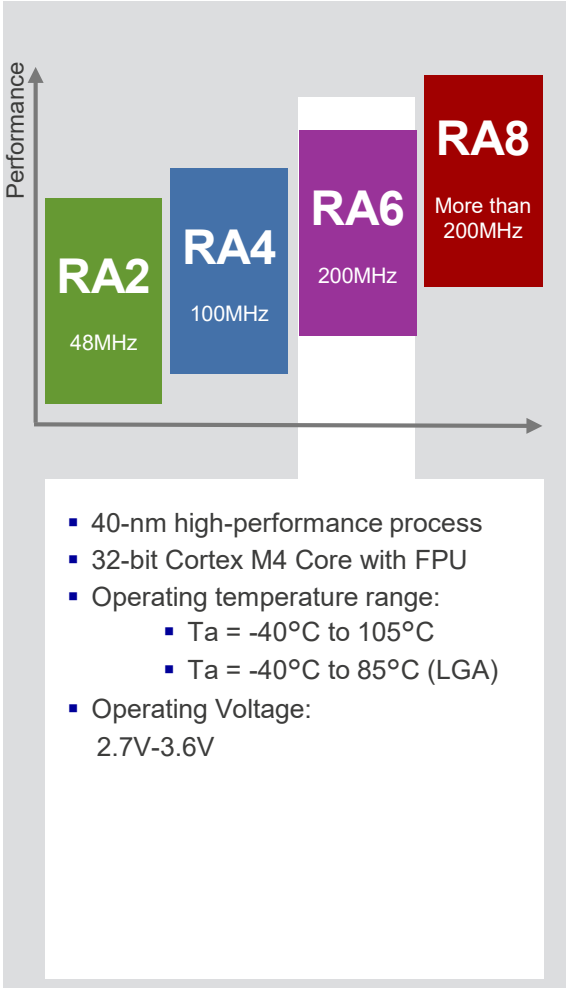


Series	Group	Feature
Renesas RA6 Series	RA6M1	120MHz, Cortex M4, 512kB Flash, 256kB RAM, 64-100pin, USB, CAN, Security
	RA6M2	120MHz, Cortex M4, 1MB Flash, 384kB RAM, 100-145pin, USB, CAN, Ethernet, Security
	RA6M3	120MHz, Cortex M4, 2MB Flash, 640kB RAM100-176pin, USB, CAN, Ethernet, TFT, Security
	RA6T1	120MHz, Cortex M4, 512kB Flash, 64kB RAM, 64-100pin, USB, CAN, ADC with S/H, Timer, PGA, High Speed Comparators
	RA6M4	200MHz, Cortex M33, 1MB Flash, 256kB RAM, 64-144pin, USB, CAN, Ethernet, Advanced Security with Trust Zone

RENESAS RA6M1 GROUP

ARM CORTEX M4 – 512KB FLASH WITH 256KB RAM





- 40-nm high-performance process
- 32-bit Cortex M4 Core with FPU
- Operating temperature range:
  - Ta = -40°C to 105°C
  - Ta = -40°C to 85°C (LGA)
- Operating Voltage:
  2.7V-3.6V

RA6M1 — 120MHz 32-Bit Arm® Cortex®-M4 Core — NVIC | JTAG | SWD | ETM

Memory

- Code Flash (512kB)
- SRAM (96kB) Parity
- SRAMHS (128kB) Parity
- SRAM (32kB) ECC
- Data Flash (8kB)
- Standby SRAM (8kB)

Analogue

- 12-bit A/D (11ch) 3S/H
- 12-bit A/D (8ch) 3S/H
- 12-bit DAC (2ch)
- 3ch PGA for each ADC
- High Speed Comparator (6ch)
- Temperature Sensor

Timers

- GPT HighRes 32-bit (4ch)
- GPT Enh. 32-bit (4ch)
- GPT 32-bit (5ch)
- Low Power GPT (2ch)
- WDT
- RTC, Calendar, Vbat

HMI

- Capacitive Touch Sensing Unit (12ch)

Communication

- USB2.0 FS x1
- CAN x2
- I2C x2
- SCI x7
- SPI x2
- QSPI x1
- SDHI x2
- SSI x1 and SRC
- External Memory Bus

System

- DMA (8ch)
- DTC
- Clock Generation
- On-Chip Oscillator
  HOCO (16,18,20MHz),
  MOCO (8MHZ),
  LOCO(32kHz),
  ILOCO (15kHz)
- Low Power Modes
- ELC
- Interrupt Controller

Safety

- Memory Protection Unit
- SRAM Parity Check
- ECC in SRAM
- POE
- Clock Frequency Accuracy Measurement
- CRC Calculator
- IWDT
- Data Operation Circuit
- Flash Area Protection
- ADC Self Test

Security

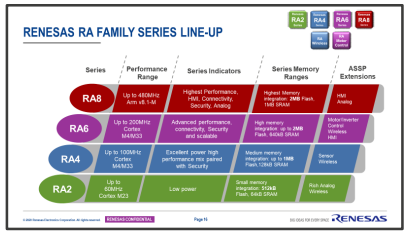
- AES (128/192/256)
- TRNG
- Key Management
- GHASH
- SHA1/SHA224/SHA256
- ECC/RSA/DSA
- 3DES/ARC4

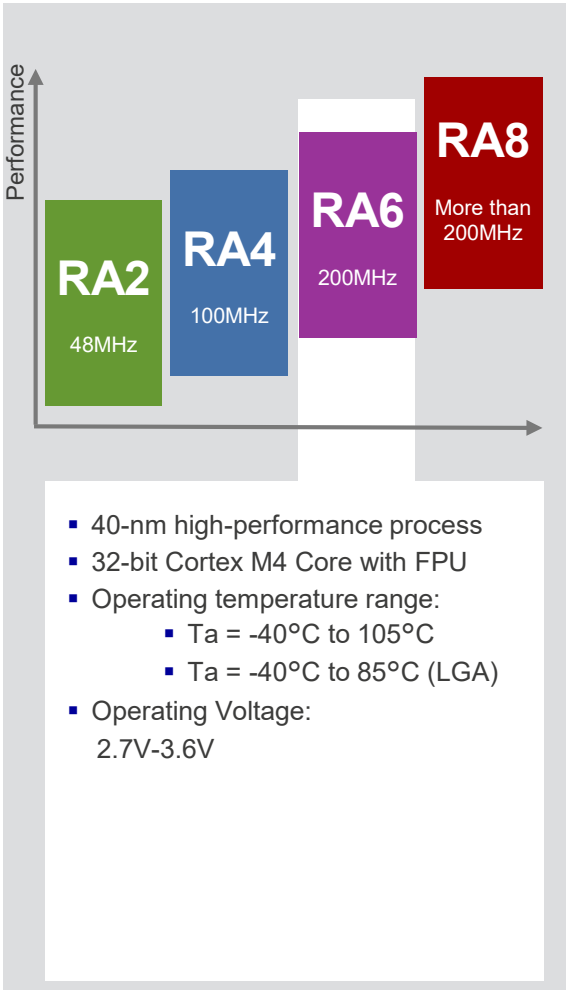
Package

- LQFP 64, 100
- LGA 100, QFN 64

RENESAS RA6M2 GROUP

ARM CORTEX M4 – 512KB TO 1MB FLASH WITH 384KB RAM





- 40-nm high-performance process
- 32-bit Cortex M4 Core with FPU
- Operating temperature range:
  - Ta = -40°C to 105°C
  - Ta = -40°C to 85°C (LGA)
- Operating Voltage:
  2.7V-3.6V

RA6M2 — 120MHz 32-Bit Arm® Cortex®-M4 Core — NVIC | JTAG | SWD | ETM

Memory

- Code Flash (512kB, 1MB)
- SRAM (224kB) Parity
- SRAMHS(128kB) Parity
- SRAM (32kB) ECC
- Data Flash (32kB)
- Standby SRAM (8kB)

Analogue

- 12-bit A/D (13ch) 3S/H
- 12-bit A/D (9ch) 3S/H
- 12-bit DAC (2ch)
- High Speed Comparator (6ch)
- Temperature Sensor

Timers

- GPT HighRes 32-bit (4ch)
- GPT Enh. 32-bit (4ch)
- GPT 32-bit (6ch)
- Low Power GPT (2ch)
- WDT
- RTC, Calendar, Vbat

HMI

- Capacitive Touch Sensing Unit (18ch)
- Parallel Capture Unit

Communication

- Ethernet MAC with DMA
- USB2.0 FS x1
- CAN x2
- I2C x3
- SCI x10
- SPI x2
- QSPI x1
- SDHI x2
- SSI x1 and SRC
- External Memory Bus

System

- DMA (8ch)
- DTC
- Clock Generation
- On-Chip Oscillator
  HOCO (16,18,20MHz),
  MOCO (8MHZ),
  LOCO(32kHz),
  ILOCO (15kHz)
- Low Power Modes
- ELC
- Interrupt Controller

Safety

- Memory Protection Unit
- SRAM Parity Check
- ECC in SRAM
- POE
- Clock Frequency Accuracy Measurement
- CRC Calculator
- IWDT
- Data Operation Circuit
- Flash Area Protection
- ADC Self Test

Security

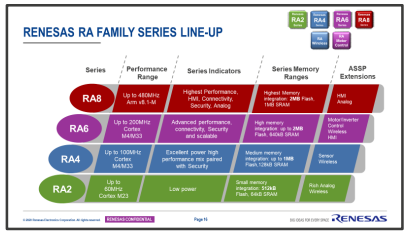
- AES (128/192/256)
- TRNG
- Key Management
- GHASH
- SHA1/SHA224/SHA256
- ECC/RSA/DSA
- 3DES/ARC4

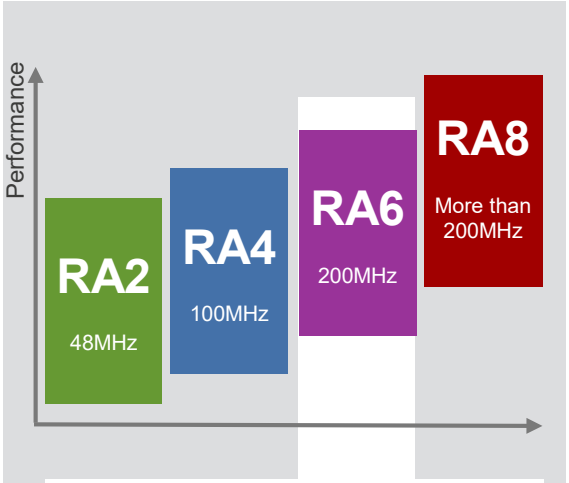
Package

- LQFP 100, 144
- LGA 145

RENESAS RA6M3 GROUP

ARM CORTEX M4 – 1MB TO 2MB FLASH WITH 640KB RAM





- 40-nm high-performance process
- 32-bit Cortex M4 Core with FPU
- Operating temperature range:
  - Ta = -40°C to 105°C
  - Ta = -40°C to 85°C (LGA, BGA)
- Operating Voltage:
  2.7V-3.6V

RA6M3 — 120MHz 32-Bit Arm® Cortex®-M4 Core — NVIC | JTAG | SWD | ETM

Memory

- Code Flash (1MB, 2MB)
- SRAM (480kB) Parity
- SRAMHS(128kB) Parity
- SRAM (32kB) ECC
- Data Flash (64kB)
- Standby SRAM (8kB)

Analogue

- 12-bit A/D (13ch) 3S/H
- 12-bit A/D (11ch) 3S/H
- 12-bit DAC (2ch)
- 3ch PGA for each ADC
- High Speed Comparator (6ch)
- Temperature Sensor

Timers

- GPT HighRes 32-bit (4ch)
- GPT Enh. 32-bit (4ch)
- GPT 32-bit (6ch)
- Low Power GPT (2ch)
- WDT
- RTC, Calendar, Vbat

HMI

- Graphic LCD Controller for TFT
- 2D Drawing Engine
- JPEG Codec
- Capacitive Touch Sensing Unit (18ch)
- Parallel Capture Unit

Communication

- Ethernet MAC with DMA
- USB2.0 FS x1
- USB2.0 HS x1
- CAN x2
- I2C x3
- SCI x10
- SPI x2
- QSPI x1
- SDHI x2
- SSI x2 and SRC
- External Memory Bus

System

- DMA (8ch)
- DTC
- Clock Generation
- On-Chip Oscillator HOCO (16,18,20MHz), MOCO (8MHZ), LOCO(32kHz), ILOCO (15kHz)
- Low Power Modes
- ELC
- Interrupt Controller

Safety

- Memory Protection Unit
- SRAM Parity Check
- ECC in SRAM
- POE
- Clock Frequency Accuracy Measurement
- CRC Calculator
- IWDT
- Data Operation Circuit
- Flash Area Protection
- ADC Self Test

Security

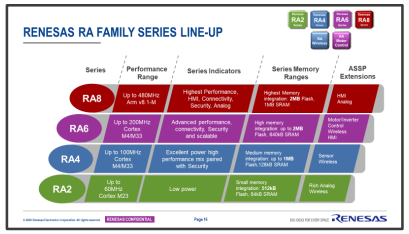
- AES (128/192/256)
- TRNG
- Key Management
- GHASH
- SHA1/SHA224/SHA256
- ECC/RSA/DSA
- 3DES/ARC4

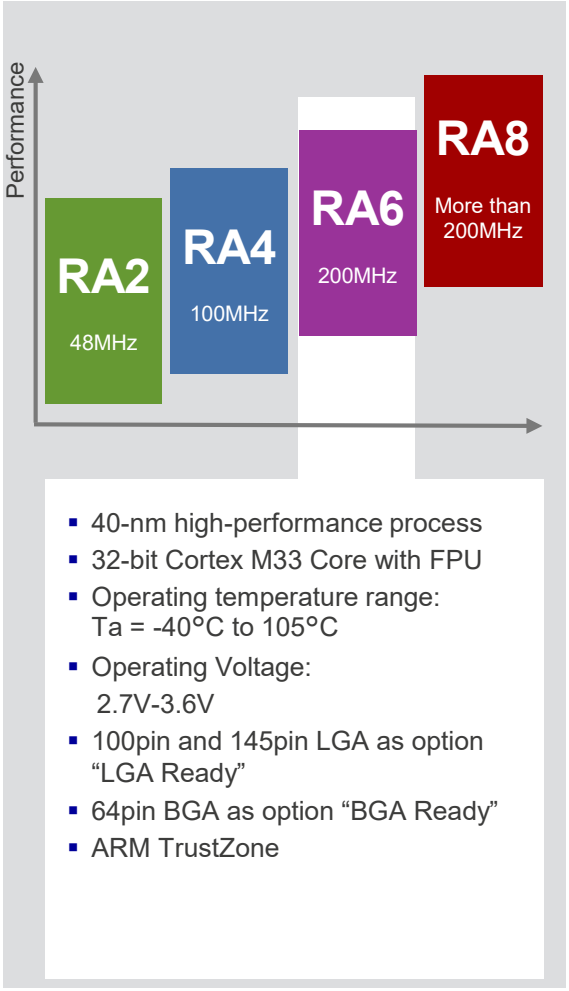
Package

- LQFP 100, 144, 176
- LGA 145, BGA 176

RENESAS RA6M4 GROUP

ARM CORTEX M33 – 512KB TO 1MB FLASH WITH 256KB RAM





- 40-nm high-performance process
- 32-bit Cortex M33 Core with FPU
- Operating temperature range:
  Ta = -40°C to 105°C
- Operating Voltage:
  2.7V-3.6V
- 100pin and 145pin LGA as option "LGA Ready"
- 64pin BGA as option "BGA Ready"
- ARM TrustZone

RA6M4 — 200MHz 32-Bit Arm® Cortex®-M33 Core — NVIC | JTAG | SWD | ETB

Memory

- Code Flash (512kB, 768kB, 1MB)
- BGO/SWAP Function
- SRAM (192kB) Parity
- SRAM (64kB) ECC
- Data Flash (8kB)
- Standby SRAM (1kB)

Analogue

- 12-bit A/D (9ch) 2S/H
- 12-bit A/D (8ch) 1S/H
- 12-bit DAC (2ch)
- Temperature Sensor

Timers

- GPT 32-bit (4ch)
- GPT 16-bit (6ch)
- Low Power GPT (6ch)
- WDT
- RTC, Calendar, Vbat, 128Byte SRAM

HMI

- Capacitive Touch Sensing Unit (20ch)

Communication

- Ethernet MAC with DMA
- USB2.0 FS x1
- CAN x2
- I2C x2
- SCI x10
- SPI x2
- QSPI x1 - OctaMemory
- SDHI x1
- SSI x1
- External Memory Bus

System

- DMA (8ch)
- DTC
- Clock Generation
- On-Chip Oscillator HOCO (16,18,20MHz), LOCO (32kHz), ILOCO (15kHz)
- Low Power Modes
- ELC
- Interrupt Controller
- Trust Zone

Safety

- Memory Protection Unit
- SRAM Parity Check
- ECC in SRAM
- Clock Frequency Accuracy Measurement
- CRC Calculator
- IWDT
- Data Operation Circuit
- Flash Area Protection
- ADC Self Test

Security

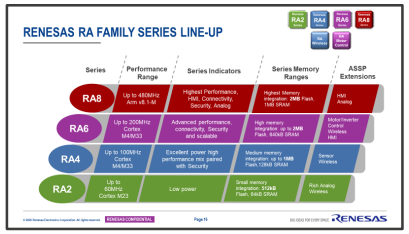
- AES (128/192/256)
- TRNG
- Key Management
- RSA (incl.3K/4K)
- SHA256
- ECC
- Tamper Detection
- SPA/DPA Enhanced Resistance

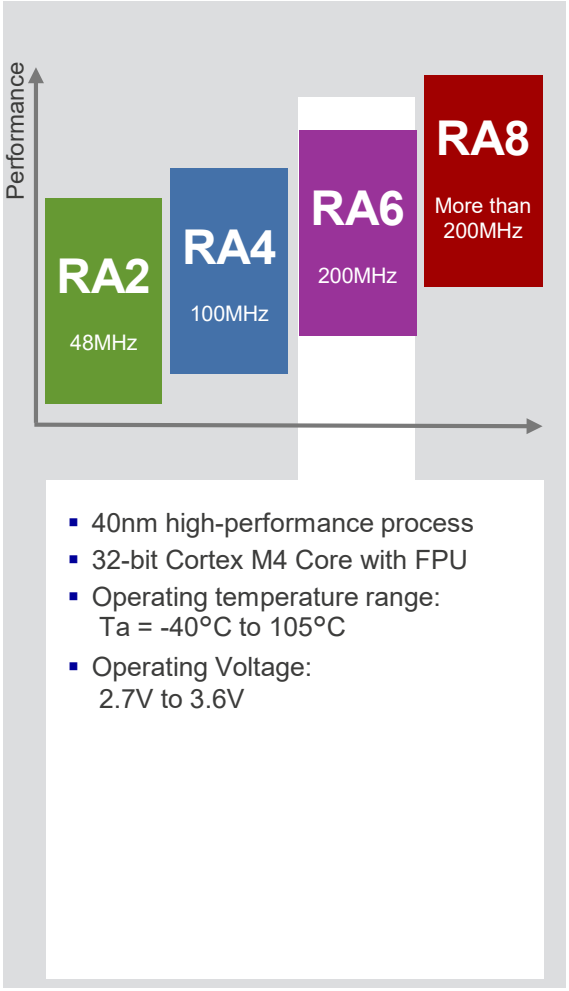
Package

- LQFP 64, 100, 144

RENESAS RA6T1 GROUP

ARM CORTEX-M4 - 512KB FLASH WITH 64KB RAM FOR MOTOR CONTROL





- 40nm high-performance process
- 32-bit Cortex M4 Core with FPU
- Operating temperature range:
  Ta = -40°C to 105°C
- Operating Voltage:
  2.7V to 3.6V

RA6T1 — 120MHz 32-Bit Arm® Cortex®-M4 Core — NVIC | JTAG | SWD | ETM

Memory

- Code Flash (256kB, 512kB)
- SRAMHS (64kB) Parity
- Data Flash (8kB)

Analogue

- 12-bit A/D (11ch) 3S/H
- 12-bit A/D (8ch) 3S/H
- 12-bit DAC (2ch)
- 3ch PGA for each ADC
- High Speed Comparator (6ch)
- Temperature Sensor

Timers

- GPT HighRes 32-bit (4ch)
- GPT Enh. 32-bit (4ch)
- GPT 32-bit (5ch)
- Low Power GPT (2ch)
- WDT

Communication

- CAN x1
- I2C x2
- SCI x7
- SPI x2

System

- DMA (8ch)
- DTC
- Clock Generation
- On-Chip Oscillator
  HOCO (16,18,20MHz),
  MOCO (8MHZ),
  LOCO (32kHz),
  ILOCO (15kHz)
- Low Power Modes
- ELC
- Interrupt Controller

Safety

- Memory Protection Unit
- SRAM Parity Check
- POE
- Clock Frequency Accuracy Measurement
- CRC Calculator
- IWDT
- Data Operation Circuit
- Flash Area Protection
- ADC Self Test

Security

- AES (128/192/256)
- TRNG
- GHASH
- SHA1/SHA224/SHA256
- ECC/RSA/DSA
- 3DES/ARC4

Package

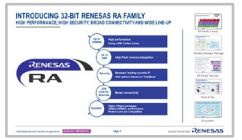
LQFP 64, 100

RA SECURITY

Page 38

RA FAMILY SECURE CRYPTO ENGINES (SCE)
AVAILABLE ON RA CORTEX-M4 DEVICES


SCE Intro

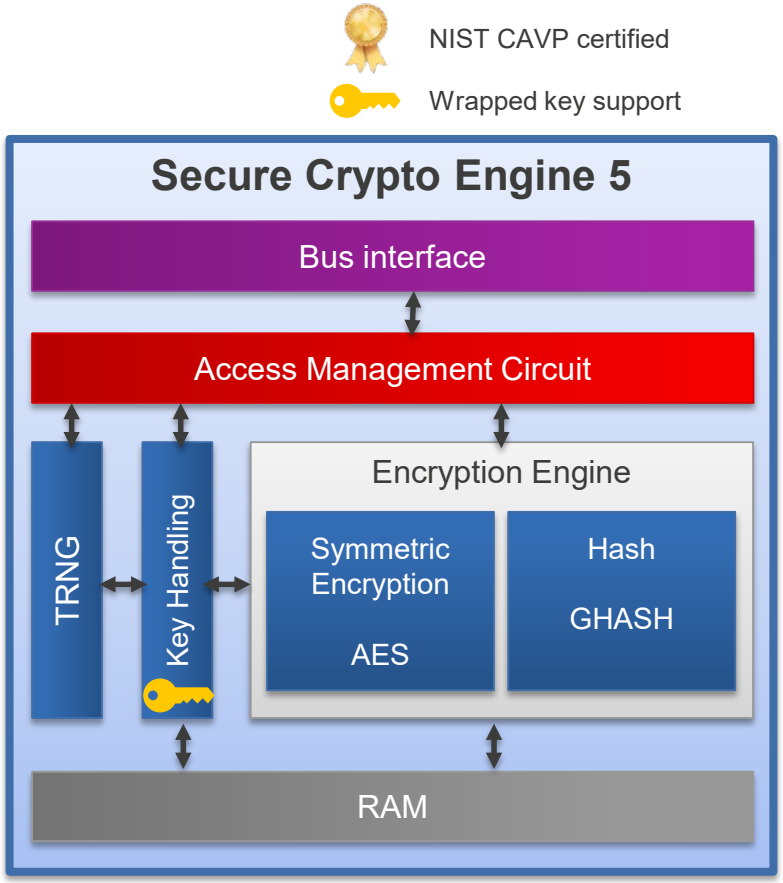

RA Introduction

SCE5 provides hardware-accelerated symmetric encryption for confidentiality

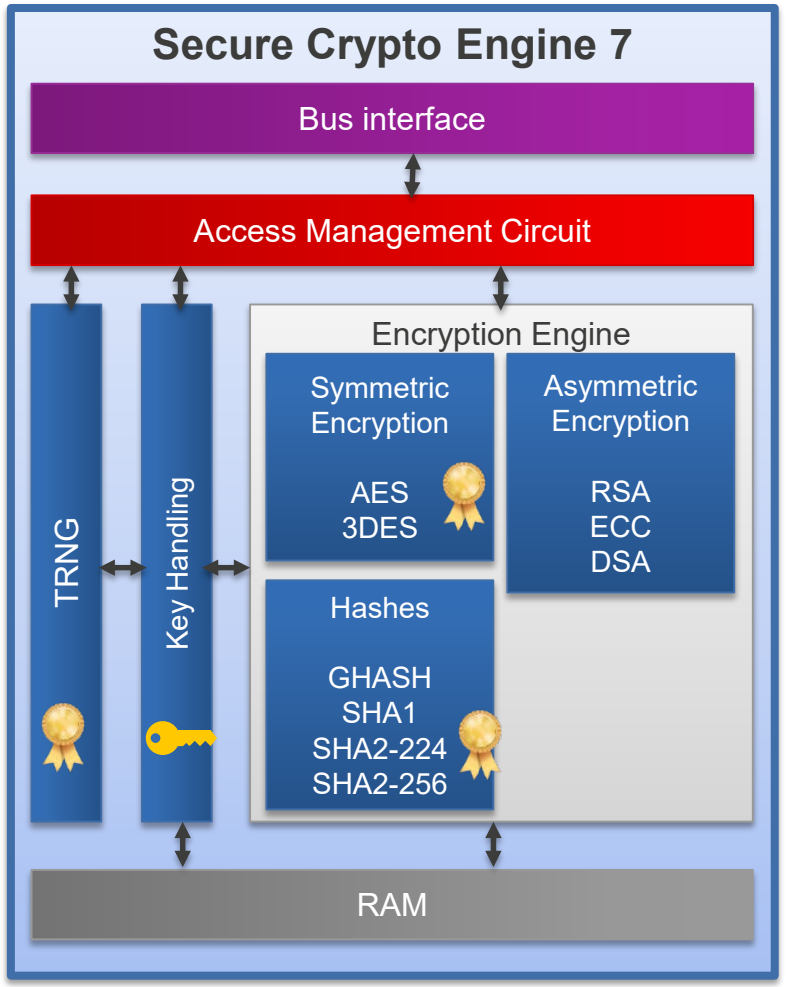
SCE7 adds asymmetric encryption and advanced hash functions for integrity and authentication

Both provide isolated operation and secure key handling

SCE7 offers NIST CAVP-certified cryptographic algorithms

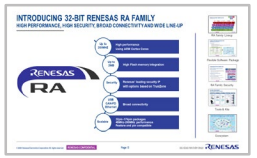


RA4M1



RA6M1 RA6M2 RA6M3

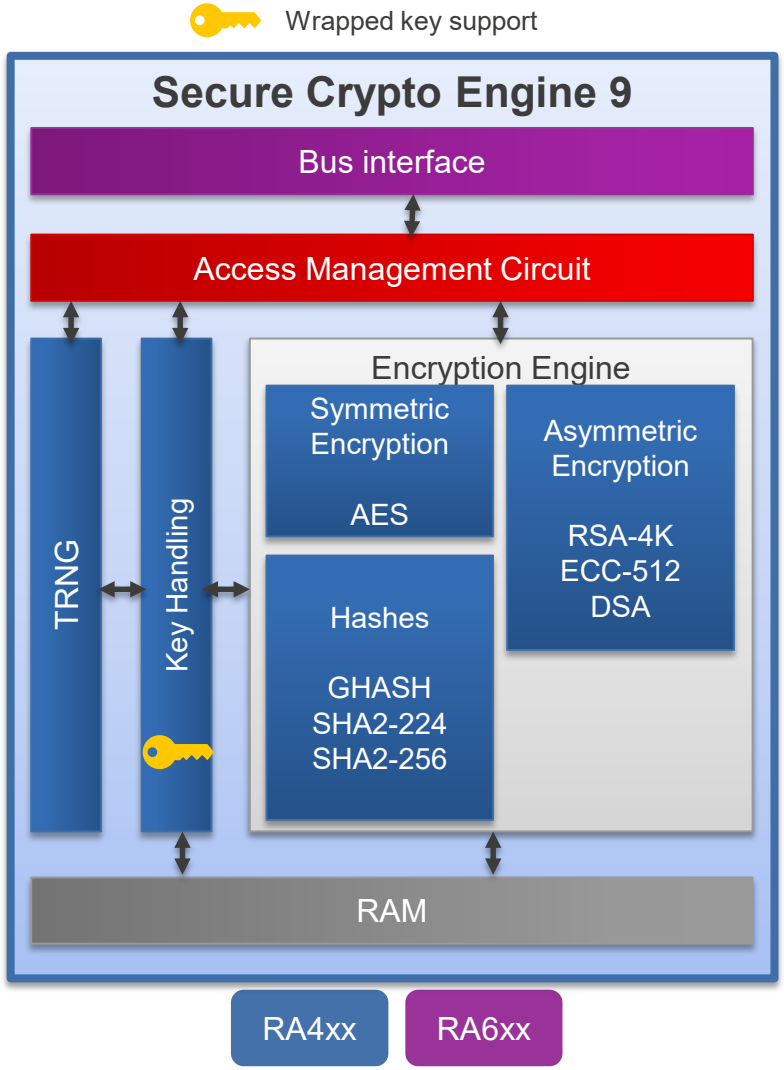
RA FAMILY SECURE CRYPTO ENGINES
AVAILABLE ON RA CORTEX-M33 DEVICES


RA Introduction

TrustZone

- SCE9 extends asymmetric encryption support for RSA up to 4K
- SCE9 provides enhanced key storage capability with a Hardware Unique Key (HUK)
- SCE9 removes support for outdated cryptographic functions (TDES, ARC4)

The SCE9 and SCE7 share the same:
- Access Management Circuit
- AES engine
- ECC engine
- DSA engine
- SHA engine
- Random number generator



RA Introduction

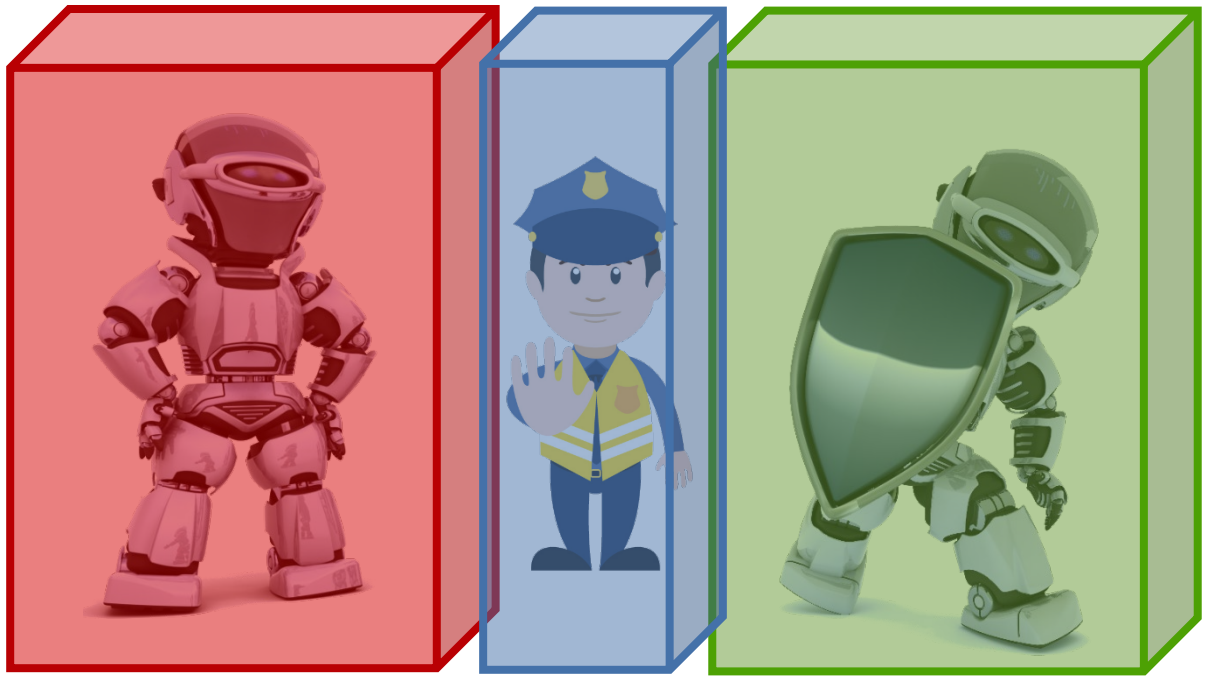
TRUSTZONE IS ISOLATION OF DATA AND SERVICES

TrustZone implementations consist of three regions

- **Secure** – may only be accessed from secure state
- **Non-secure** – may be accessed from secure or non-secure state
- **Non-Secure Callable** – may be called by the non-secure state code to call secure services

Non-Secure Callable Veneers

- Functions by which the non-secure world uses secure world services
- Provides defined access points into the secure world
- TrustZone definition does not provide an authentication method to access the secure world



RA Introduction

RA FAMILY TRUSTZONE IMPLEMENTATION

Renesas applied TrustZone filters to other busses

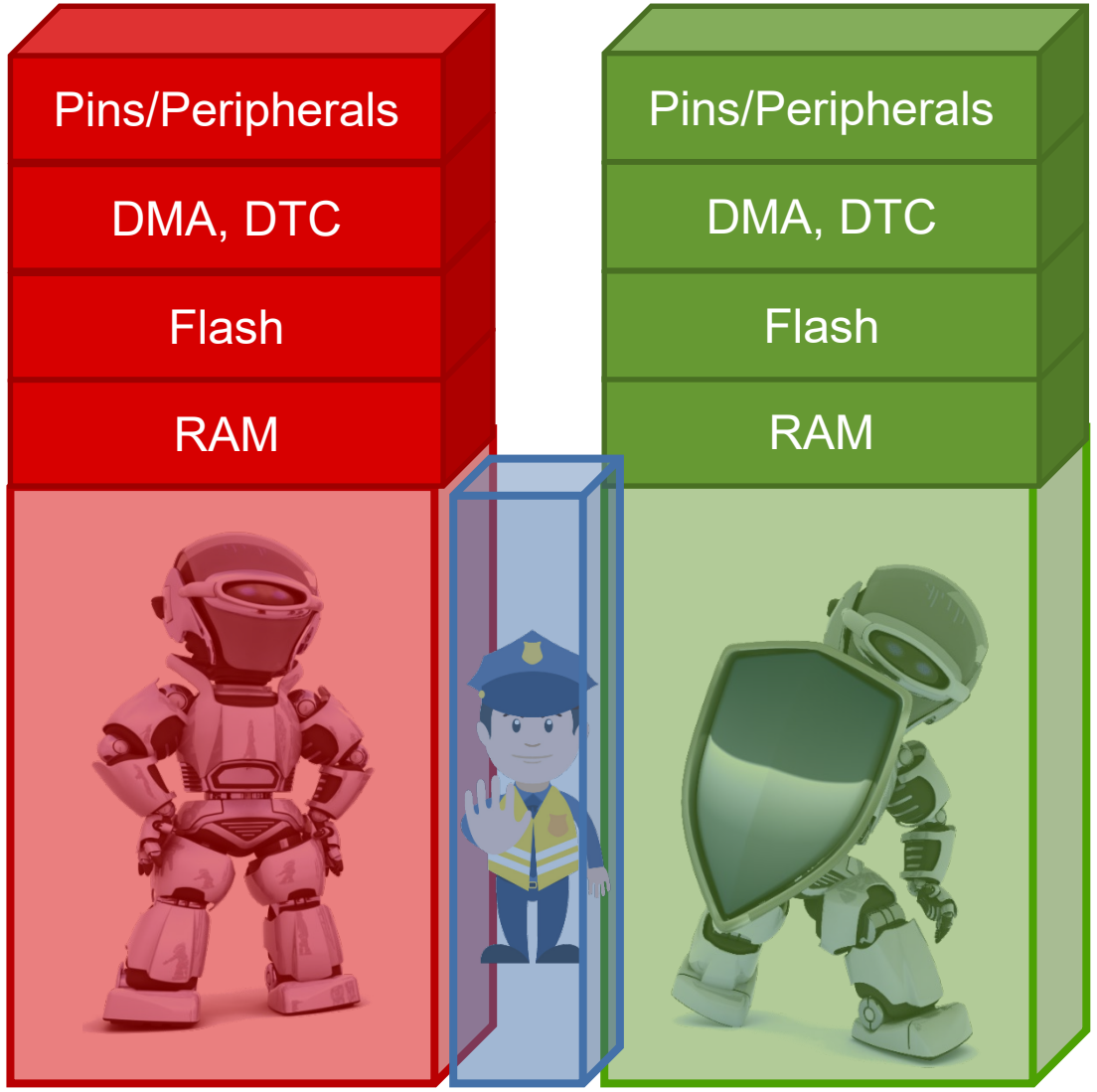
- Prevents non-secure code from extracting secure code and data via DMA, DTC, and other similar mechanisms

Renesas applied TrustZone filters to pins and peripherals

- Protects external interfaces
- Prevents non-secure code from eavesdropping on inputs
- Prevents non-secure code from overriding outputs

TrustZone is optional

- Applications do not have to use it



Renesas.com