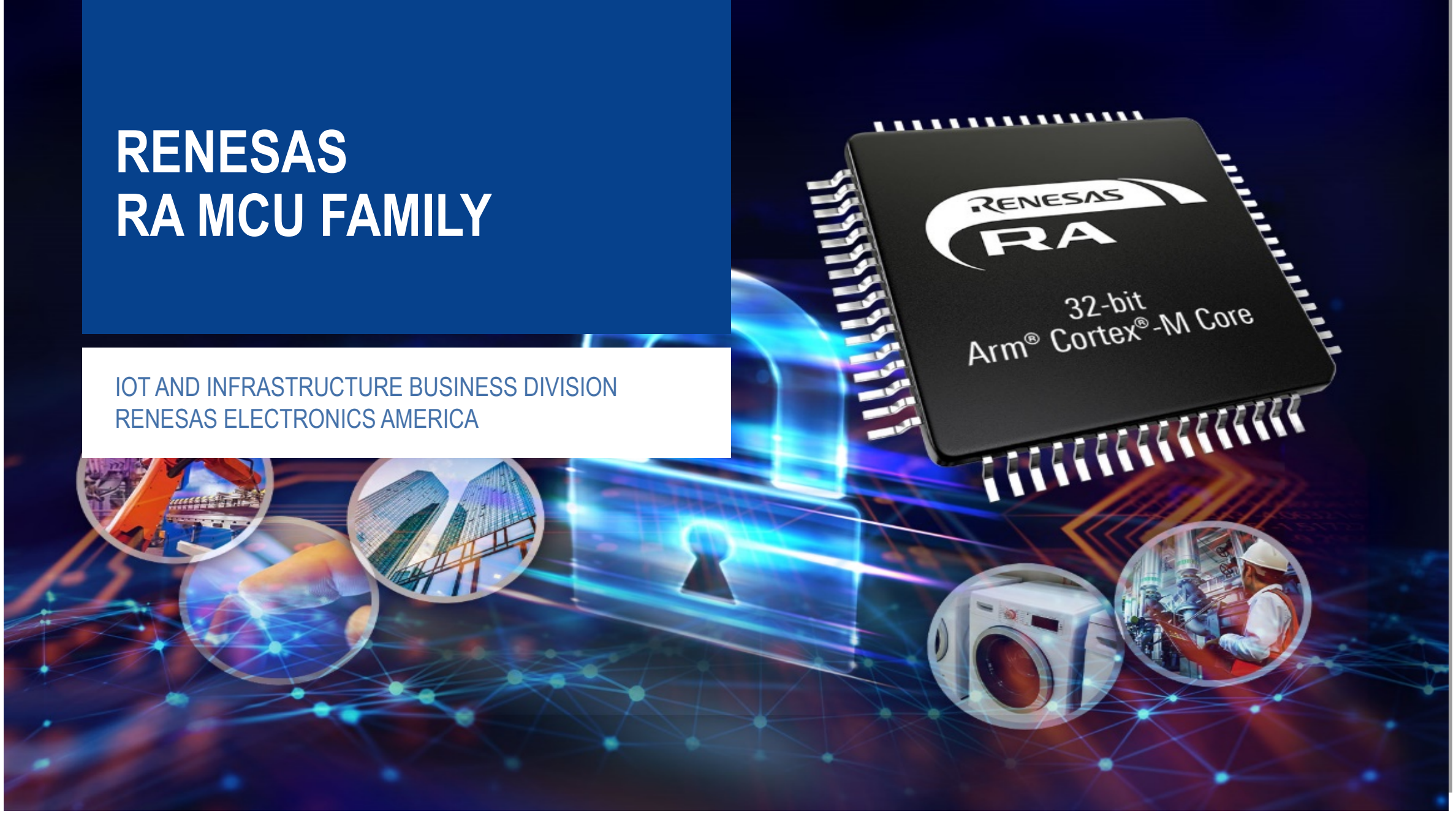
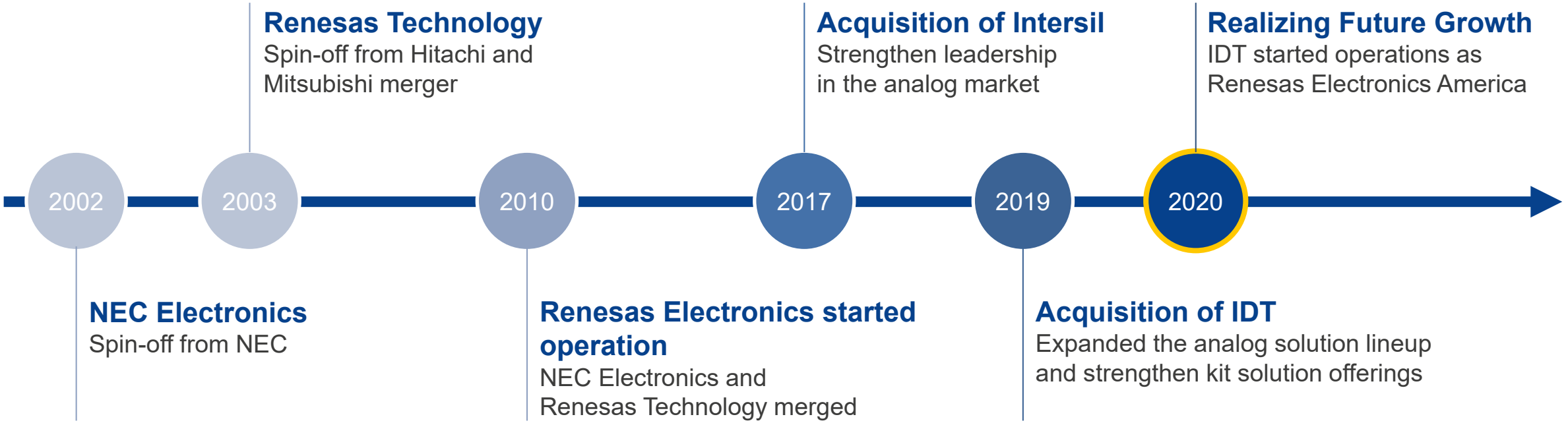
RENESAS
RA MCU FAMILY

IOT AND INFRASTRUCTURE BUSINESS DIVISION
RENESAS ELECTRONICS AMERICA



OUR HISTORY

Renesas is built on a strong historical foundation of technological innovation originating from Hitachi, Mitsubishi, 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
AS OF JANUARY 1, 2020

- Global sales network operates in more than 20 countries
- Comprehensive R&D capabilities and support through the global network

GLOBAL MANUFACTURING NETWORK
AS OF JANUARY 1, 2020

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

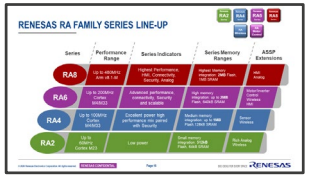
RA MCU INTRODUCTION

INTRODUCING 32-BIT RENESAS RA FAMILY

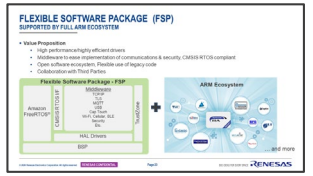
HIGH PERFORMANCE, HIGH SECURITY, BROAD CONNECTIVITY AND WIDE LINE-UP

RENESAS RA

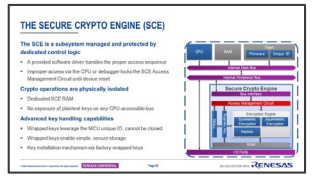
- **Up to 200MHZ** — High performance Using ARM Cortex Cores
- **Up to 2MB** — High Flash memory integration
- **Security** — Renesas' leading security IP with options based on TrustZone
- **USB CAN-FD Ethernet** — Broad connectivity
- **Scalable** — 32pin-176pin packages 48MHz-200MHz performance Feature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



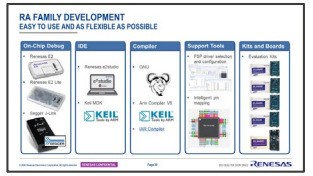
RA Family Lineup



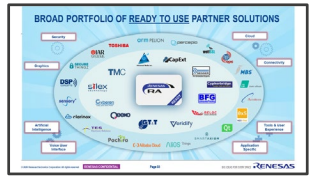
Flexible Software Package



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.

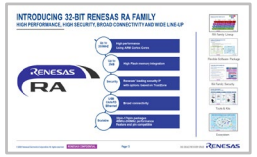
Connectivity Solutions

- 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 — 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

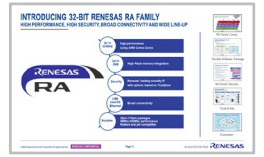
A – Rich Analog
C – Metering
E – Entry level
M – Mainstream
L – Low Power
T – Motor Control
W - Wireless

2018 2019 2020 2021 2022 2023

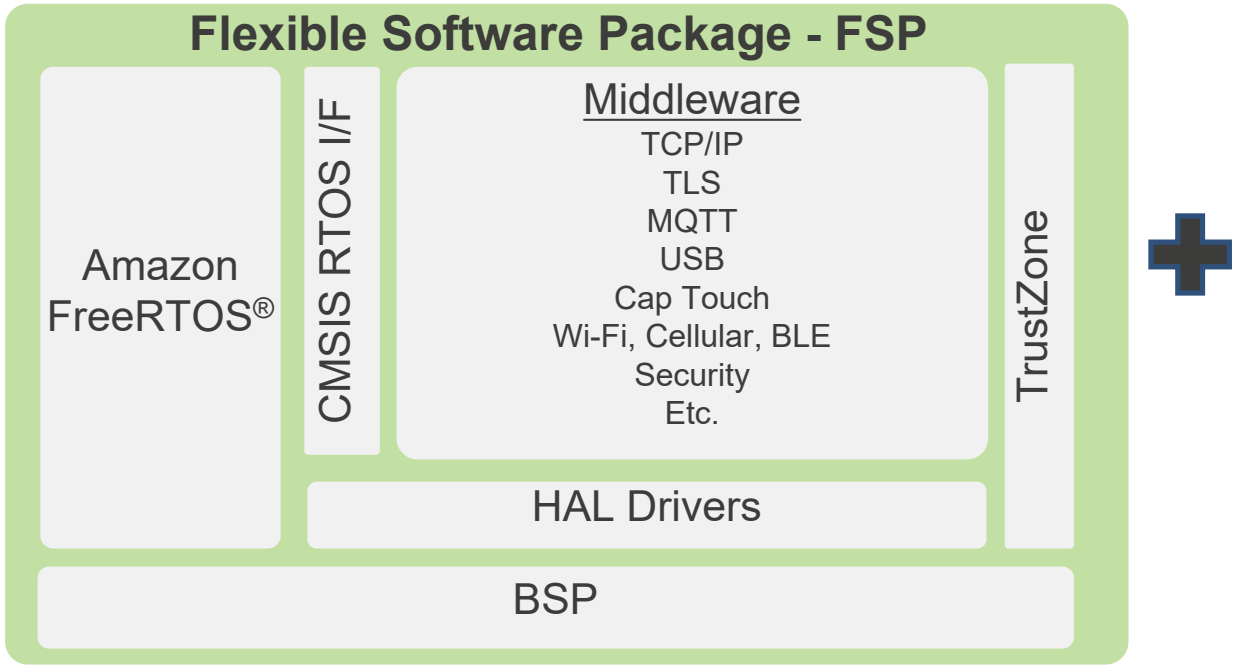
FLEXIBLE SOFTWARE PACKAGE (FSP)

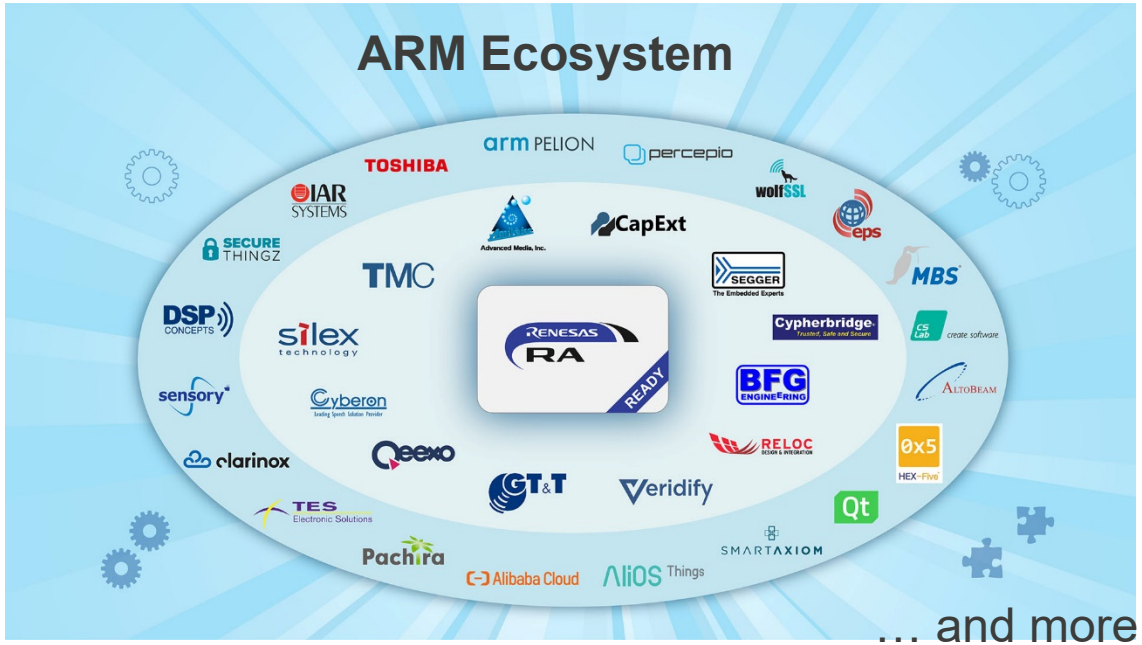
FLEXIBLE SOFTWARE PACKAGE (FSP)

SUPPORTED BY FULL ARM ECOSYSTEM

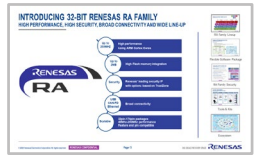

RA Introduction

- **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

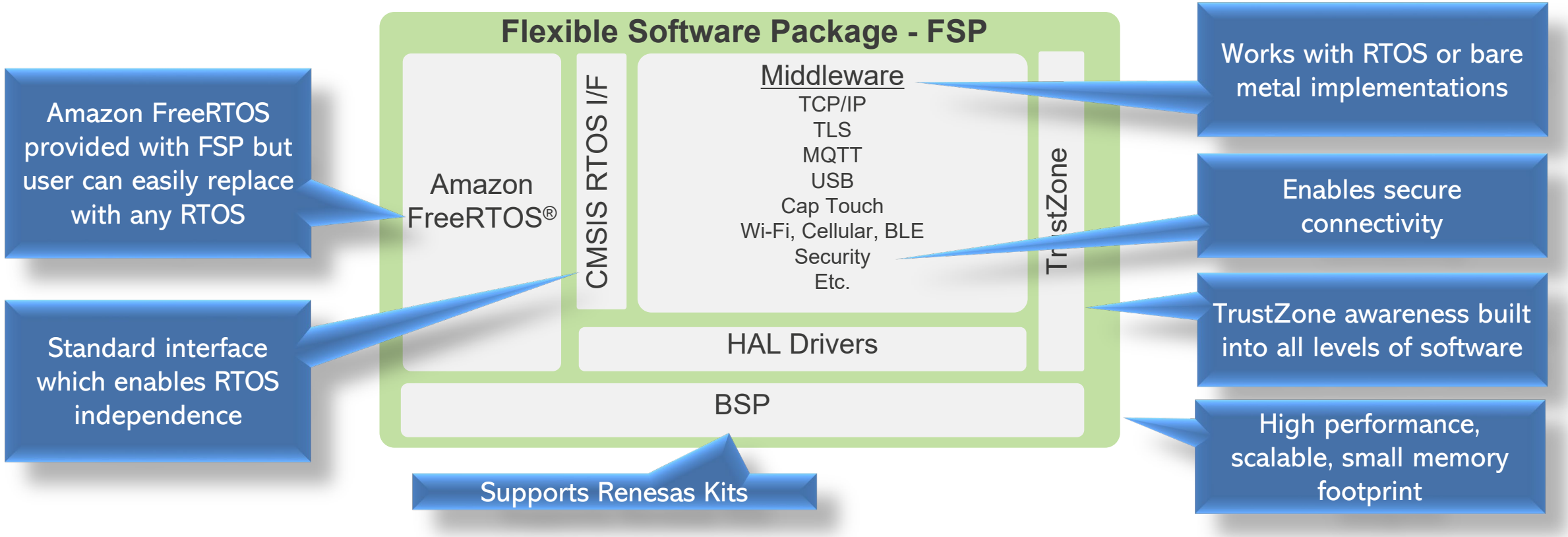




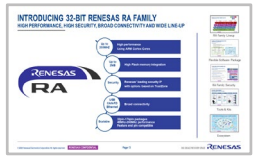
FSP OVERVIEW


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

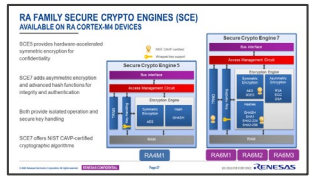
- RA Support Ticket system (Teams support)
- Forum (Renesas Rulz)
- GitHub Issues (Additional forum)
- RA and FSP Knowledge Base
- Example Projects (EP) and Application Notes

Software Distribution

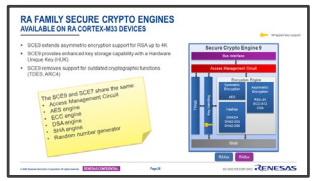
- Source code distribution through GitHub
- Platform and CMSIS pack installers
- “GitHub releases” for software release
- FSP web page in renesas.com

RA MCU SECURITY

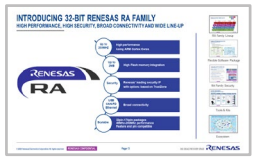
THE SECURE CRYPTO ENGINE (SCE)



SCE7 CM4



SCE9 CM4



RA Introduction

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

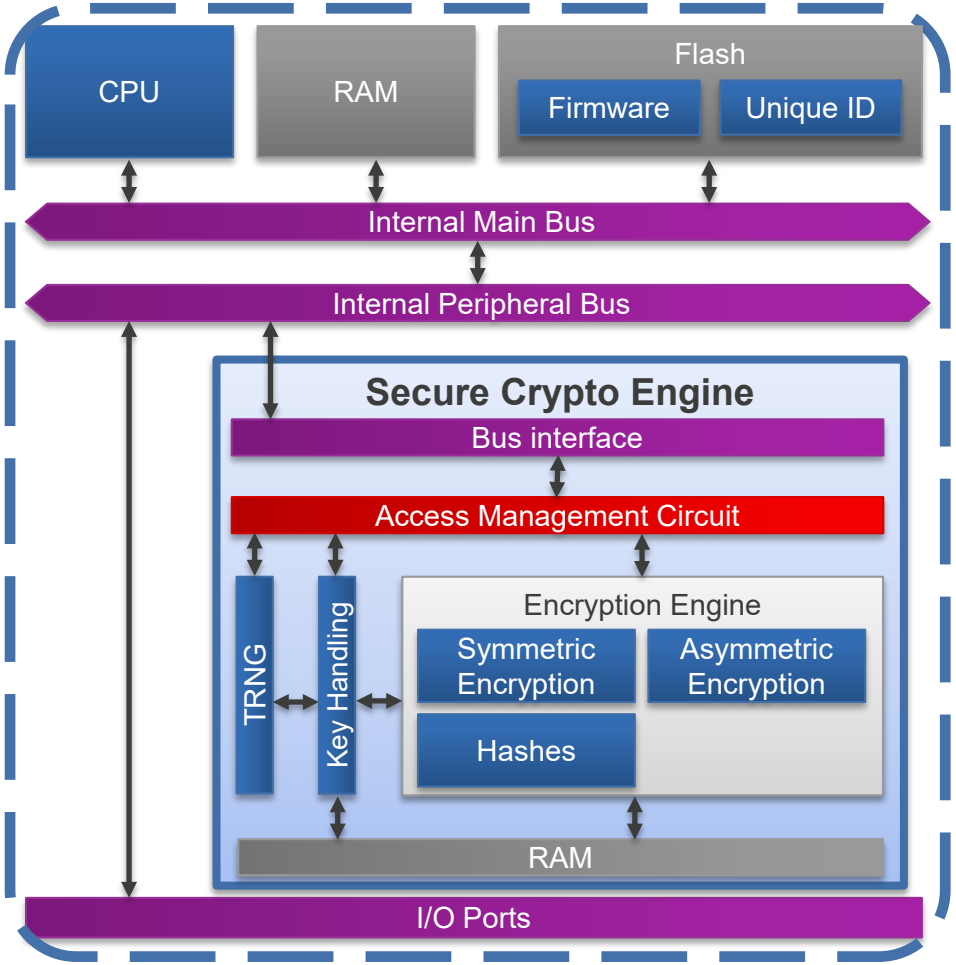
- A provided software driver handles the proper access sequence
- Improper access via the CPU or debugger locks the SCE Access Management Circuit until device reset

Crypto operations are physically isolated

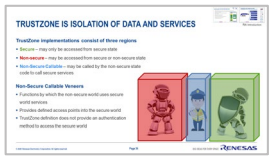
- Dedicated SCE RAM
- No exposure of plaintext keys on any CPU-accessible bus

Advanced key handling capabilities

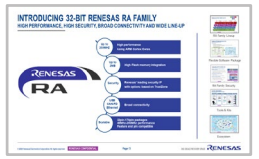
- Wrapped keys leverage the MCU unique ID, cannot be cloned
- Wrapped keys enable simple, secure storage
- Key installation mechanism via factory-wrapped keys



BEST IN CLASS TRUSTZONE IMPLEMENTATION

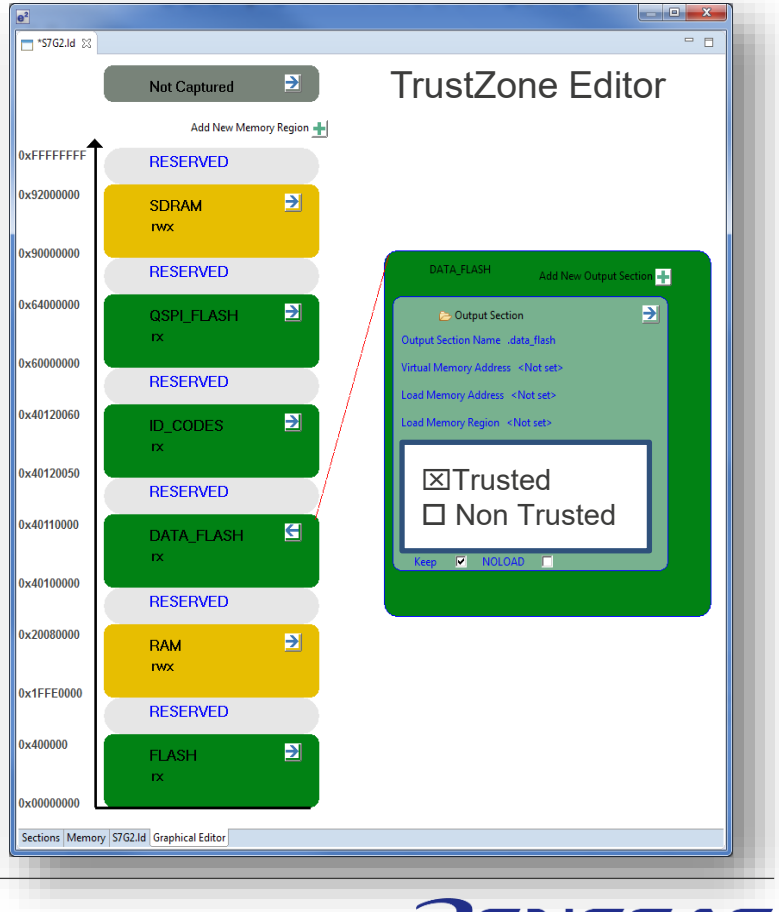


ARM TrustZone



RA Introduction

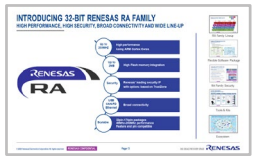
- Additional e^2 studio & standalone configurator to graphically configure ARM Cortex M33 TrustZone
- Secure and Non-Secure Callable memory regions are dynamically configured after project build to ensure best memory usage and alignment to flash bocks
- New linker memory / Peripheral regions added and 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

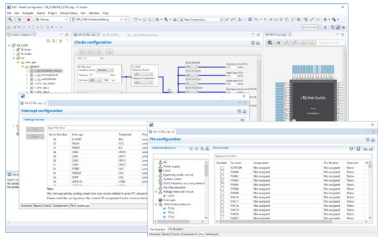
- Arm Compiler V6

KEIL™ Tools by ARM

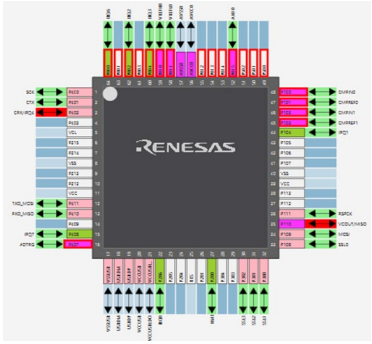
- IAR Compiler

Support Tools

- FSP driver selection and configuration



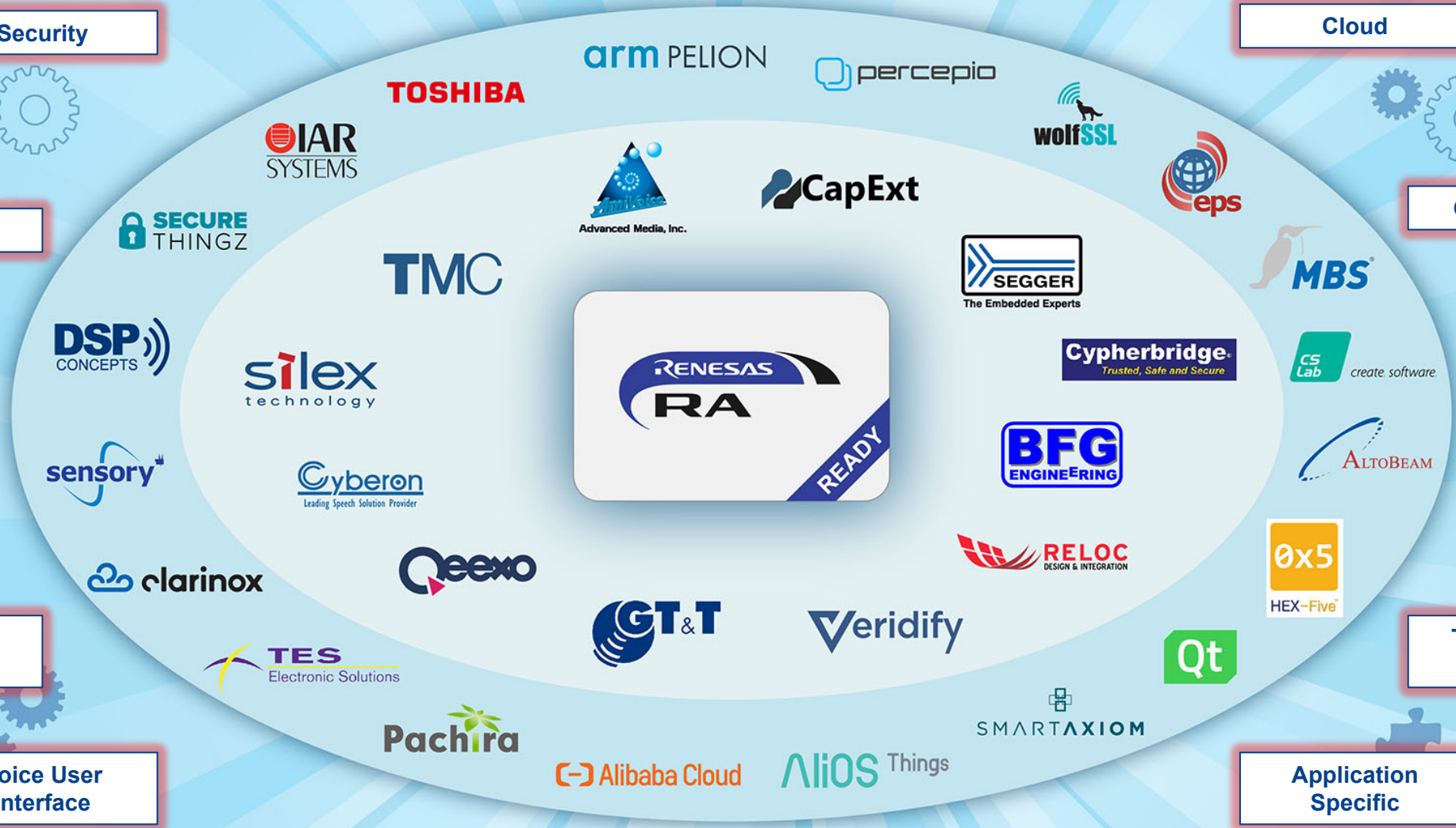
- Intelligent pin mapping



Kits and Boards

- Evaluation Kits

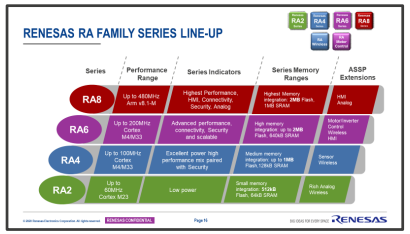
BROAD PORTFOLIO OF READY TO USE PARTNER SOLUTIONS



RA MCU DEVICES

RA2 , RA4 , RA6 SERIES

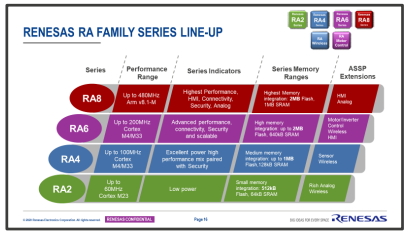
RENESAS RA2 SERIES - GROUP OVERVIEW

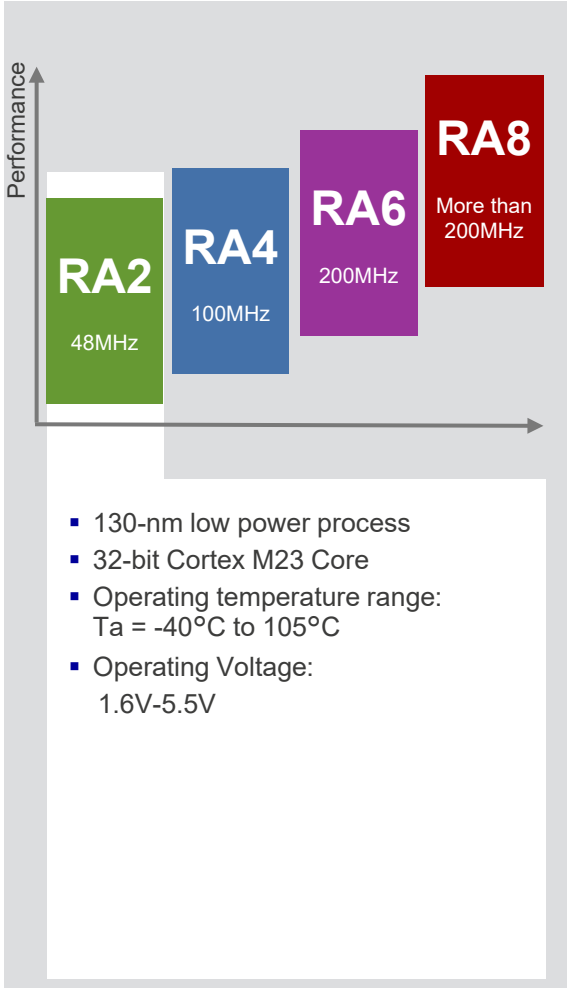


Series	Group	Feature
Renesas RA2 Series	RA2A1	48MHz, Cortex M23, 256kB Flash, 32kB RAM, 32-64pin, USB, CAN, 24bit Sigma Delta ADC, 16bit ADC, Security

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

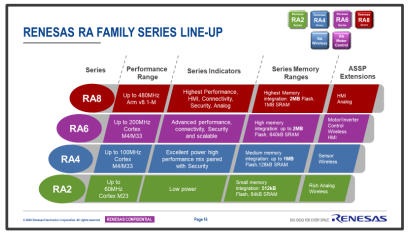
- AES (128/256)
- TRNG
- 128 bit Unique ID

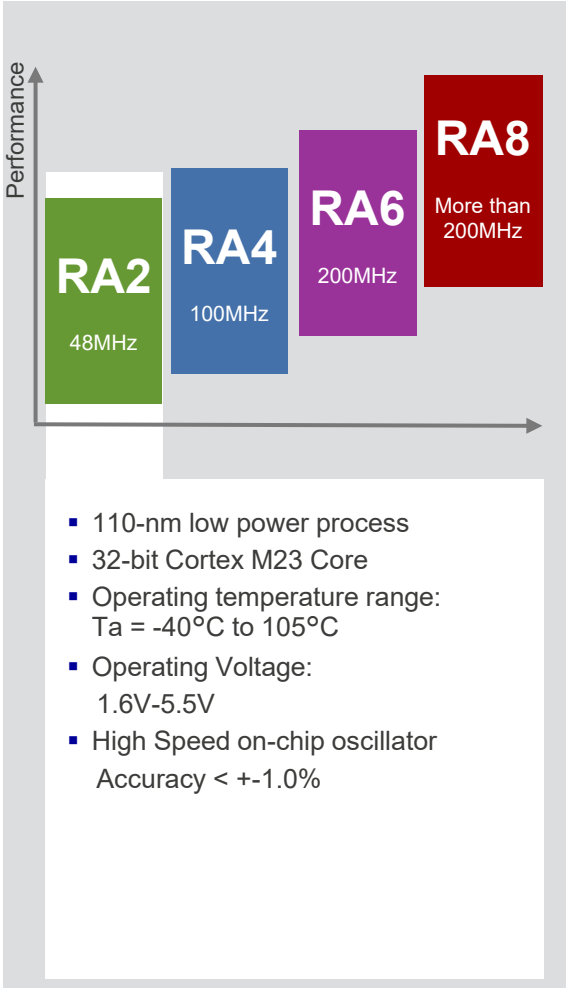
Package

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

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

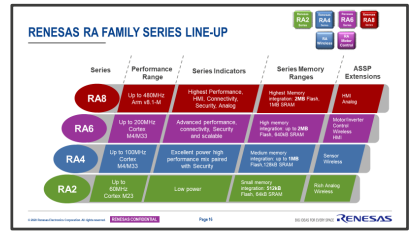
Security

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

Package

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

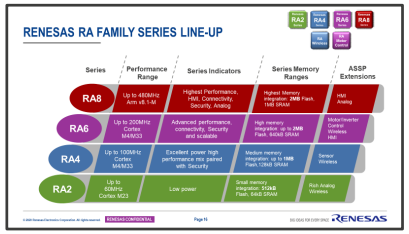
RENESAS RA4 SERIES - GROUP OVERVIEW

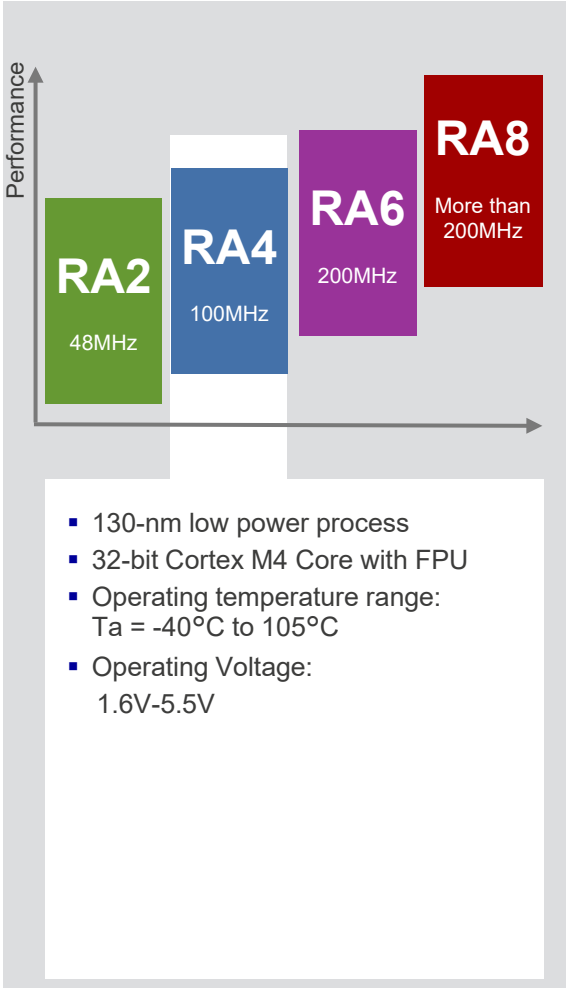


Series	Group	Feature
Renesas RA4 Series	RA4M1	48MHz, Cortex M4, 256kB Flash, 32kB RAM, 40-100pin, USB, CAN, Security
	RA4W1	48MHz, Cortex M4, 512kB Flash, 96kB RAM, QFN56, Bluetooth 5.0, USB, CAN, Security

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

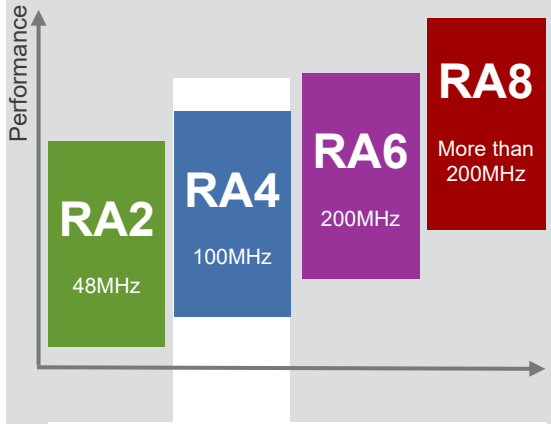
- AES (128/256)
- TRNG
- Key Management
- GHASH

Package

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

RENESAS 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

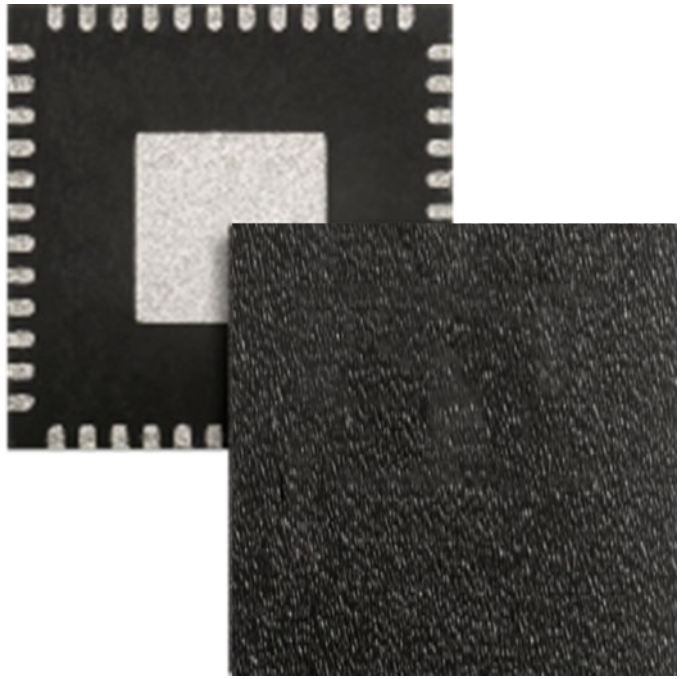
- Unique ID
- AES (128/192/256)
- TRNG
- Key Management
- RSA / ECC / DSA
- SHA256 / SHA224
- Tamper Resistance
- SPA/DPA Enhanced Resistance

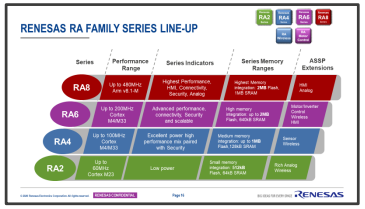
Package

- LQFP 64,100, 144

RA4W1 WITH BT5.0

KEY FEATURES



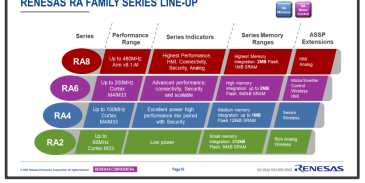


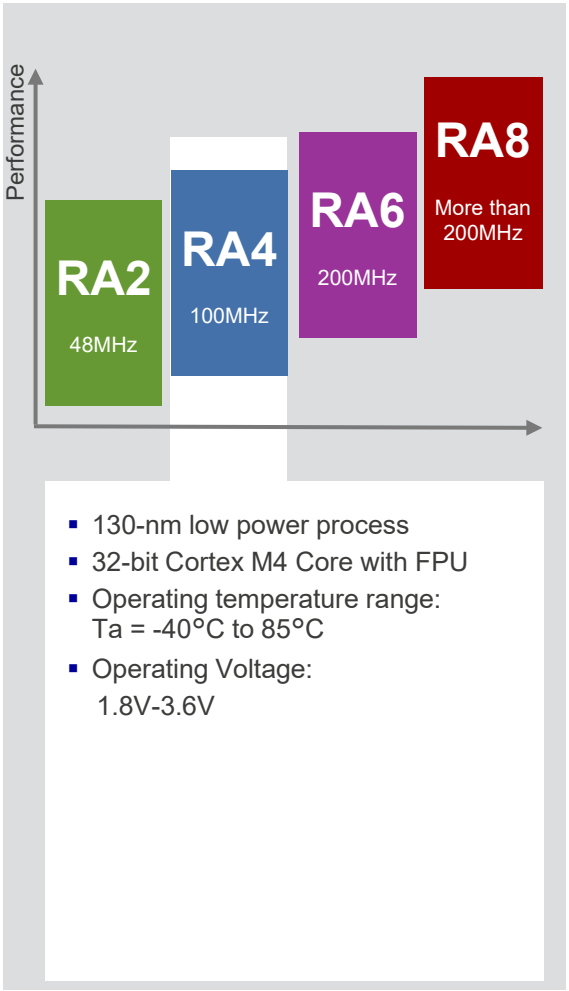
Key Features

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)

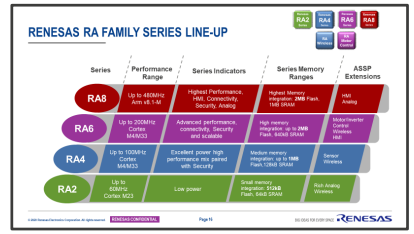
System
- DMA (4ch)
- DTC
- Clock Generation
- On-Chip Oscillator HOCO (24,32,48,64MHz), MOCO (8MHZ), LOCO (32kHz), ILOCO (15kHz)
- Low Power Modes
- ELC
- Interrupt Controller

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

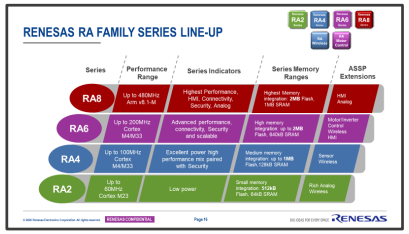
RENESAS RA6 SERIES - GROUP OVERVIEW

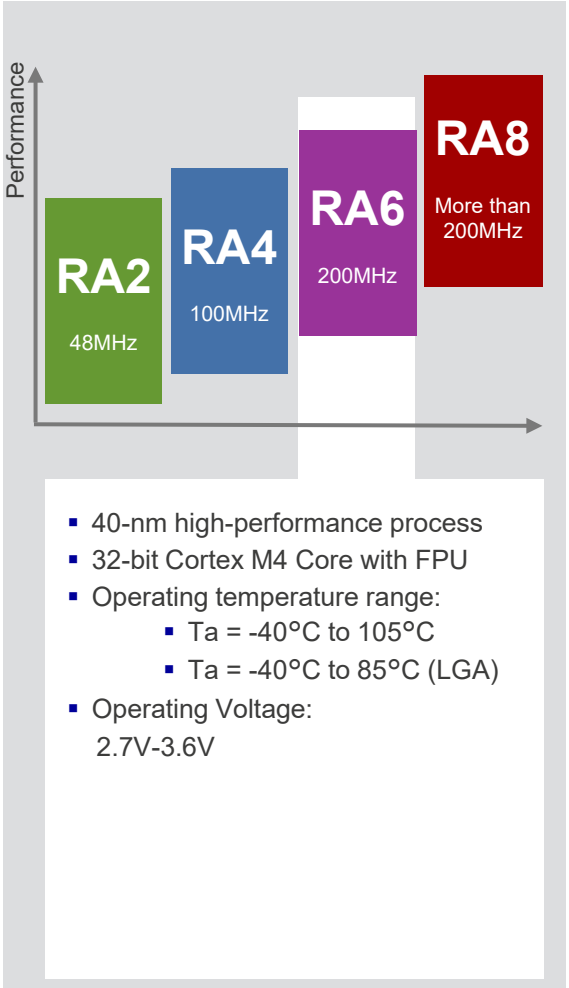


Series	Group	Feature
Renesas RA6 Series	RA6M1	120MHz, Cortex M4, 512kB Flash, 256kB RAM, 64-100pin, USB, CAN, Security
	RA6M2	120MHz, Cortex M4, 1MB Flash, 384kB RAM, 100-145pin, USB, CAN, Ethernet, Security
	RA6M3	120MHz, Cortex M4, 2MB Flash, 640kB RAM100-176pin, USB, CAN, Ethernet, TFT, Security
	RA6M4	200MHz, Cortex M33, 1MB Flash, 256kB RAM, 64-144pin, USB, CAN, Ethernet, Advanced Security with TrustZone

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

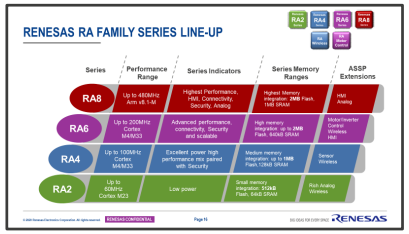
- AES (128/192/256)
- TRNG
- Key Management
- GHASH
- SHA1/SHA224/SHA256
- ECC/RSA/DSA
- 3DES/ARC4

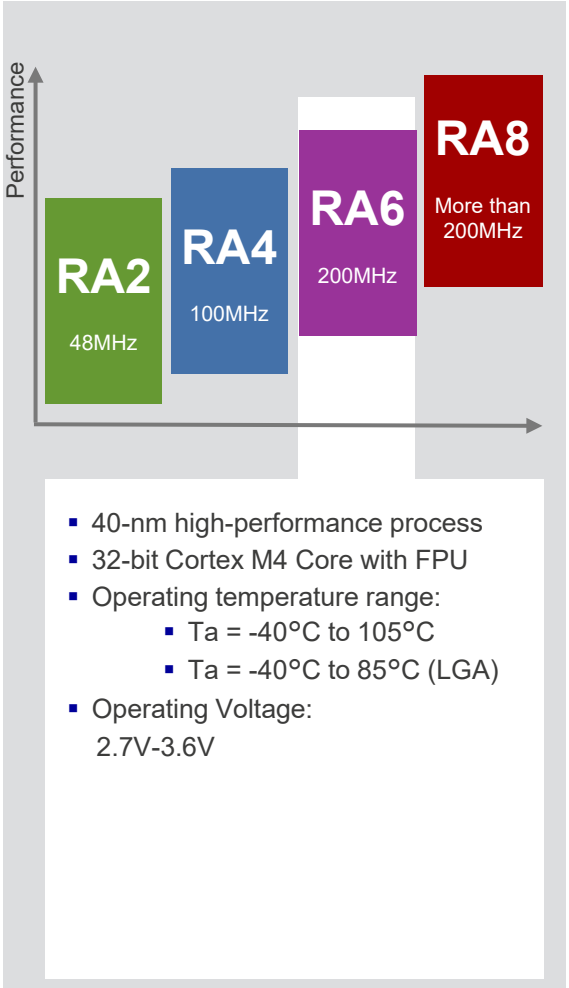
Package

- 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

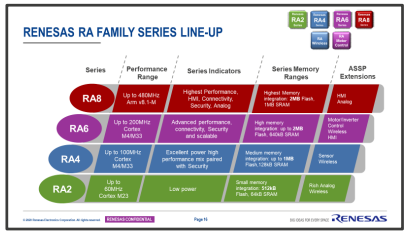
- AES (128/192/256)
- TRNG
- Key Management
- GHASH
- SHA1/SHA224/SHA256
- ECC/RSA/DSA
- 3DES/ARC4

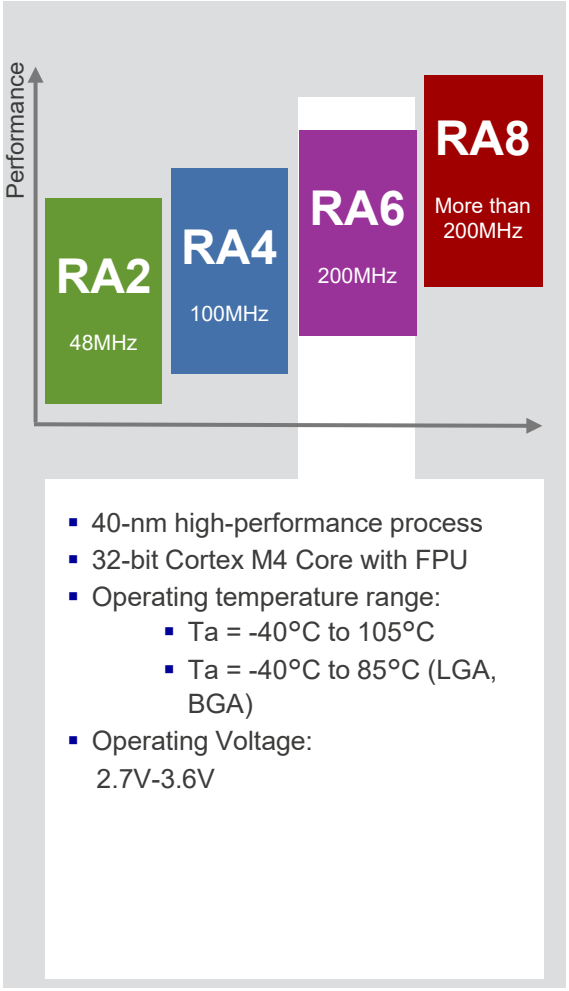
Package

- 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

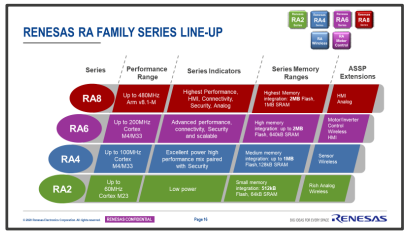
- AES (128/192/256)
- TRNG
- Key Management
- GHASH
- SHA1/SHA224/SHA256
- ECC/RSA/DSA
- 3DES/ARC4

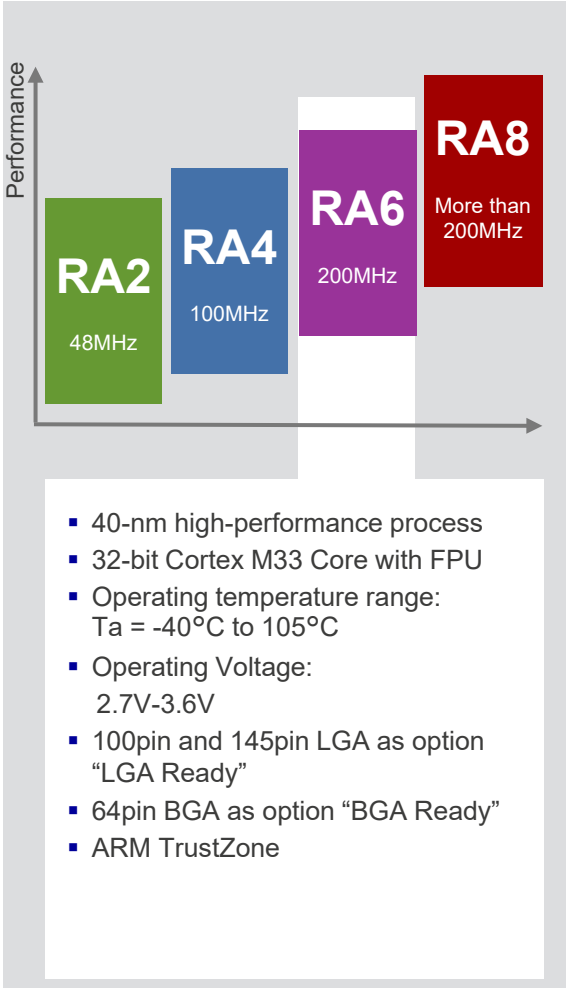
Package

- 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

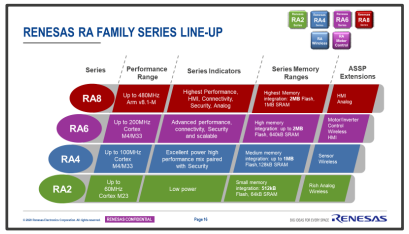
Safety
- Memory Protection Unit
- SRAM Parity Check
- ECC in SRAM
- Clock Frequency Accuracy Measurement
- CRC Calculator
- IWDT
- Data Operation Circuit
- Flash Area Protection
- ADC Self Test

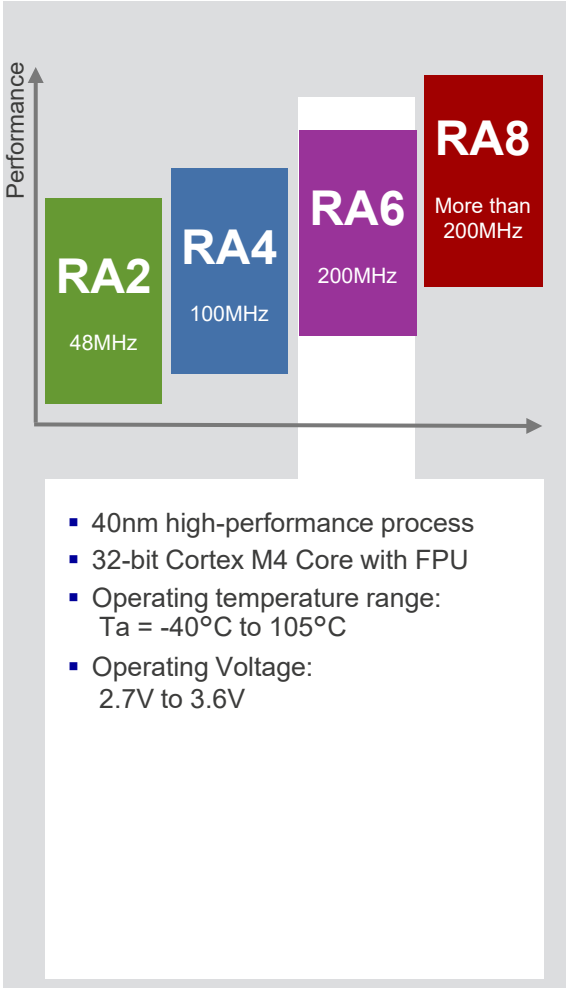
Security
- AES (128/192/256)
- TRNG
- Key Management
- RSA (incl.3K/4K)
- SHA256
- ECC
- Tamper Detection
- SPA/DPA Enhanced Resistance

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

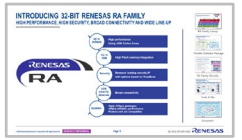
LQFP 64, 100

RA SECURITY

Page 35

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


SCE Intro

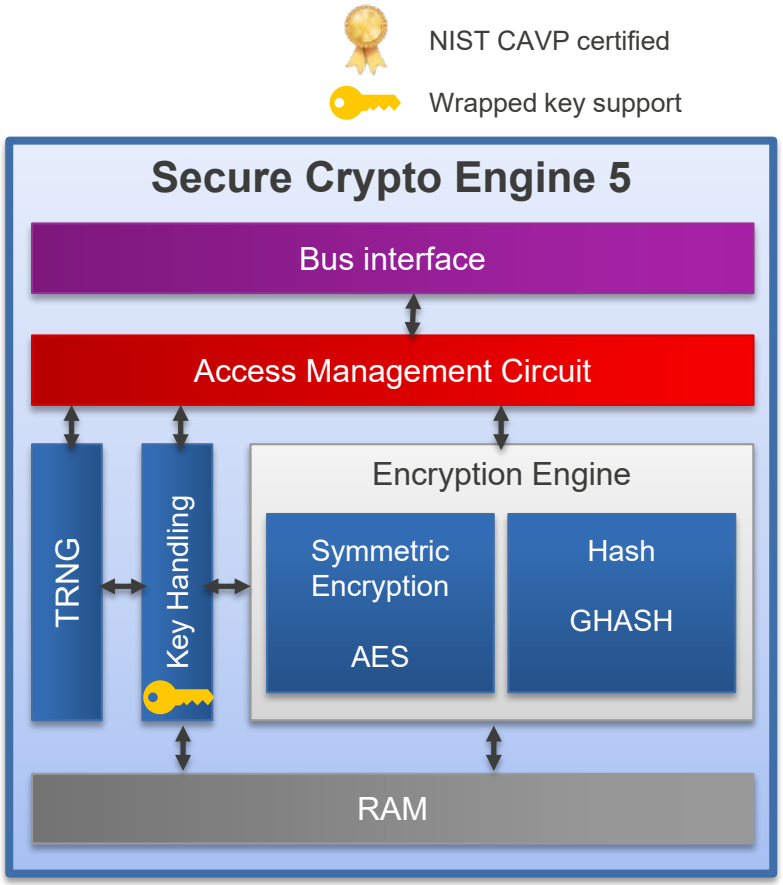

RA Introduction

SCE5 provides hardware-accelerated symmetric encryption for confidentiality

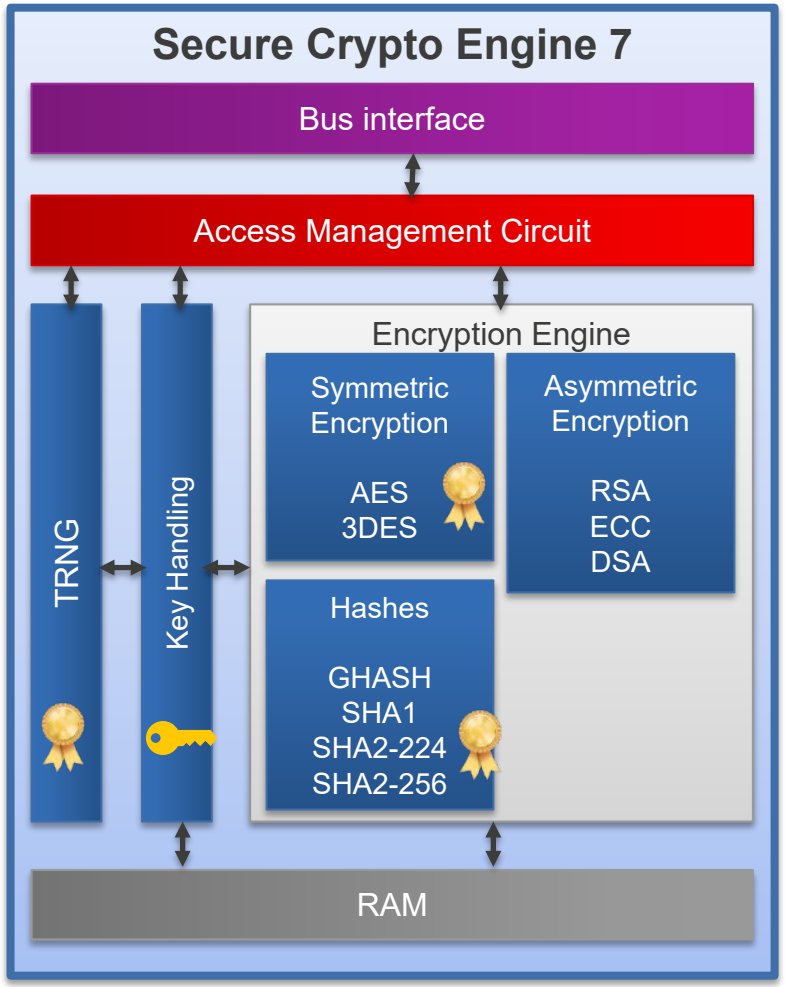
SCE7 adds asymmetric encryption and advanced hash functions for integrity and authentication

Both provide isolated operation and secure key handling

SCE7 offers NIST CAVP-certified cryptographic algorithms

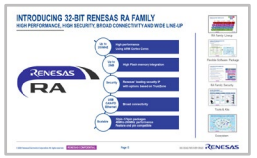


RA4M1



RA6M1 RA6M2 RA6M3

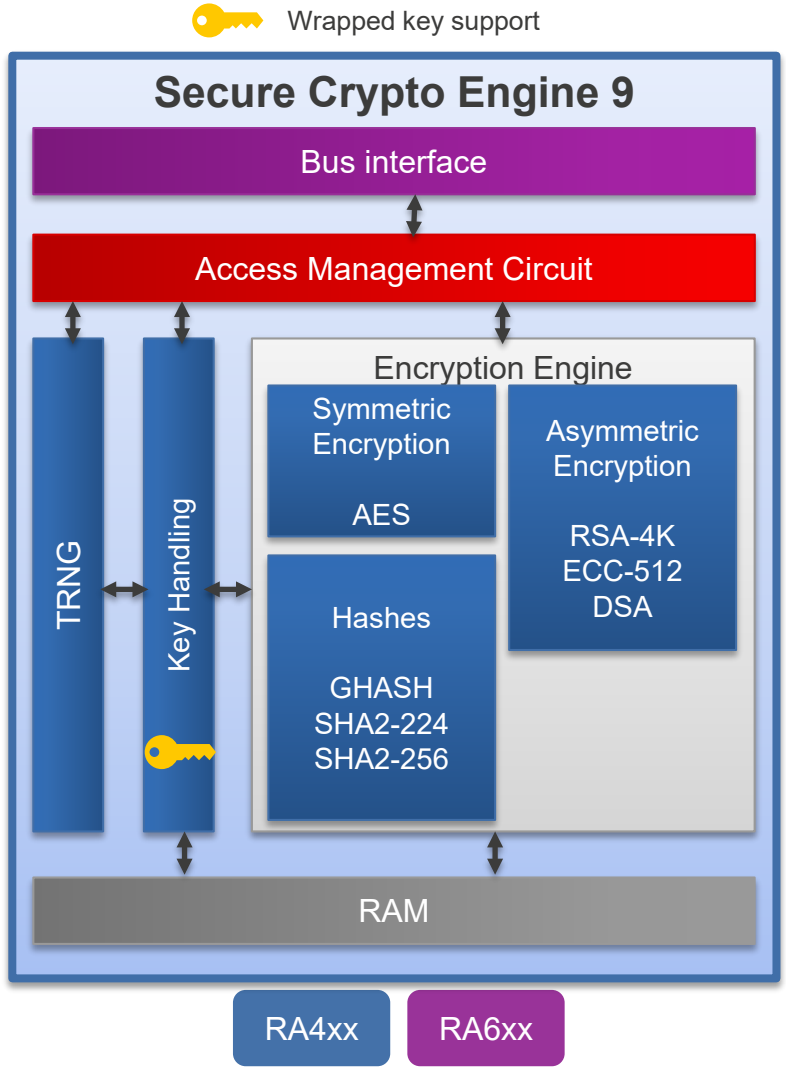
RA FAMILY SECURE CRYPTO ENGINES
AVAILABLE ON RA CORTEX-M33 DEVICES


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

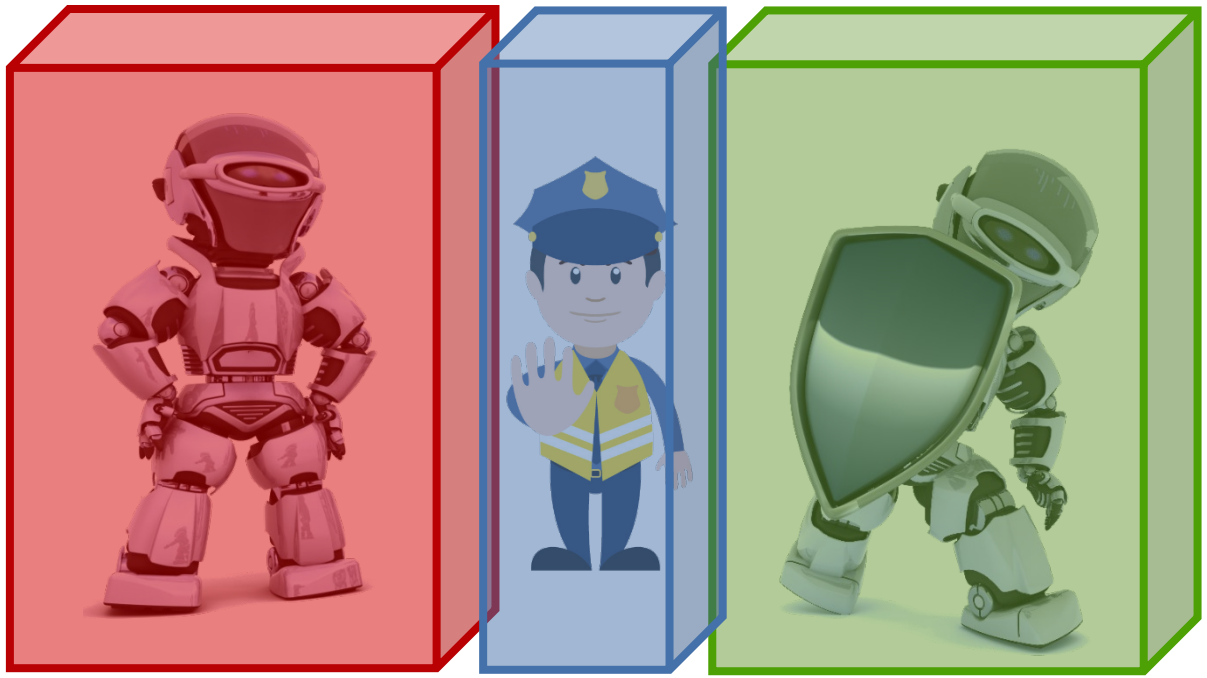
TRUSTZONE IS ISOLATION OF DATA AND SERVICES

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 FAMILY TRUSTZONE IMPLEMENTATION

RA Introduction

Renesas applied TrustZone filters to other busses

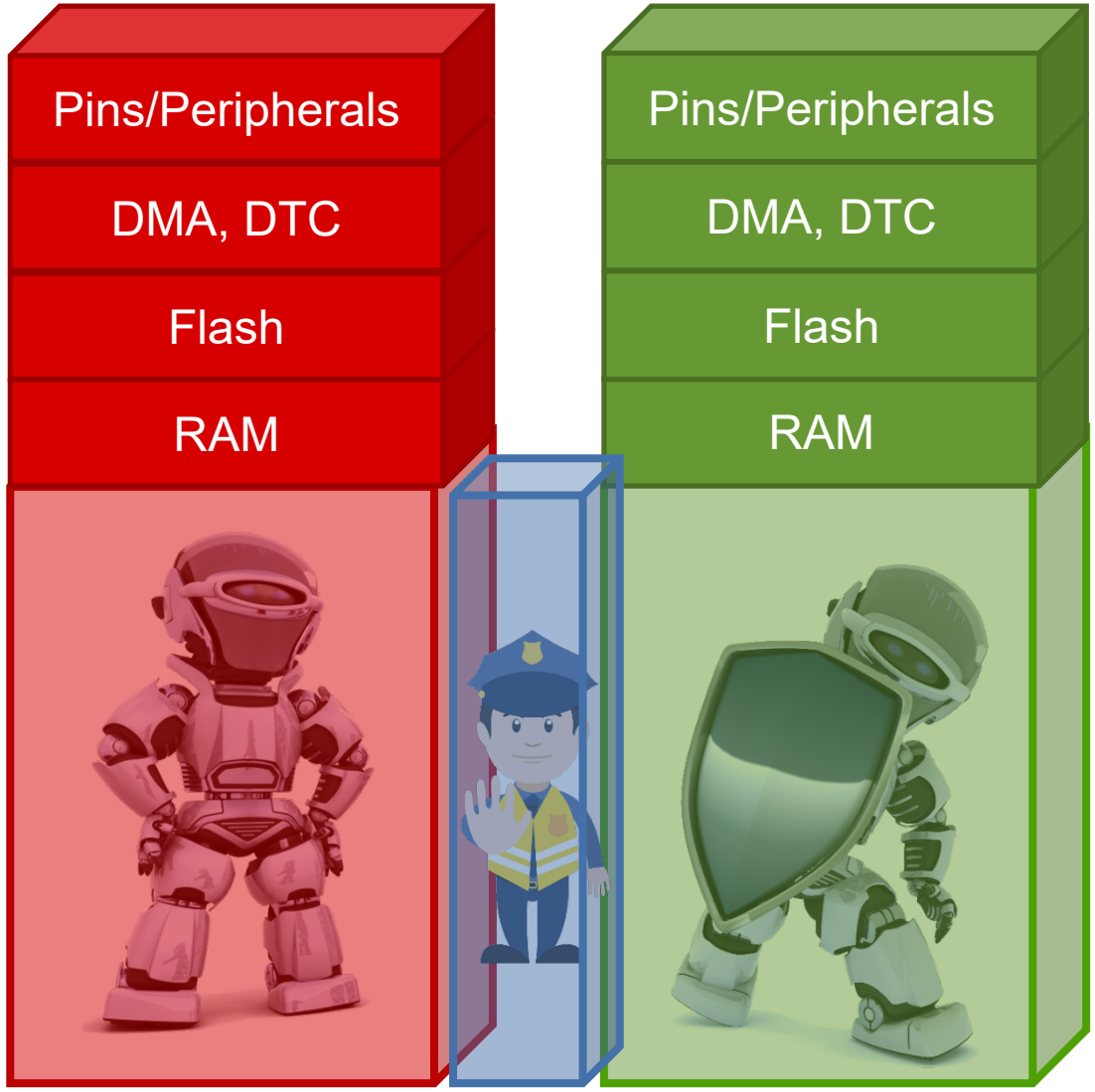
- Prevents non-secure code from extracting secure code and data via DMA, DTC, and other similar mechanisms

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