瑞萨电子工业以太网单芯片解决方案

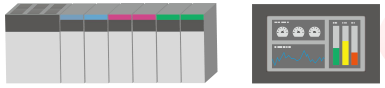
RZ/T& RZ/N

瑞萨电子/工业自动化事业部
2021-11-8
V1.0

面向工业以太网市场的产品路线图

应用控制器

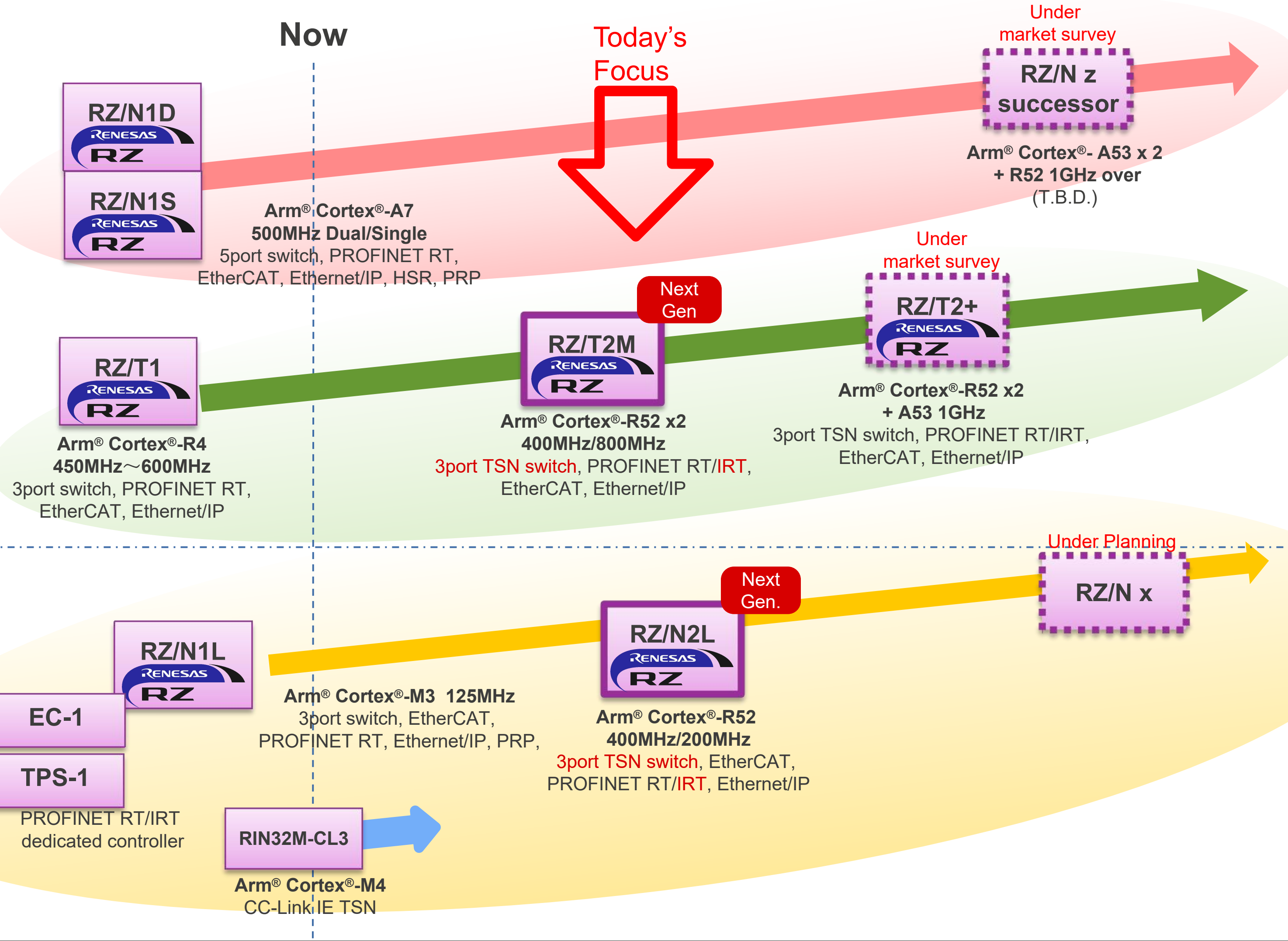
用于PLC/控制器
(Linux, RTOS)



用于伺服/变频器
(实时控制)

网络从站控制器

用于网络从站控制器
(远程I/O, 通信模块)



特点： 基于Cortex-A的高性能CPU 内核，具有多操作系统支持，如 Linux、ThreadX、VxWorks。支持主站和从站的多协议工业以太网通信，最多带5个以太网口。

特点：基于 Cortex-R 的实时控制 CPU 内核和大容量TCM存储器，可实现实时控制应用所需的确定性执行。

特点：网络从站专用控制器可轻松将工业以太网功能应用到现有系统配置中。它支持包括 TSN 在内的多种协议。它使系统中的主控CPU免于网络相关干扰。

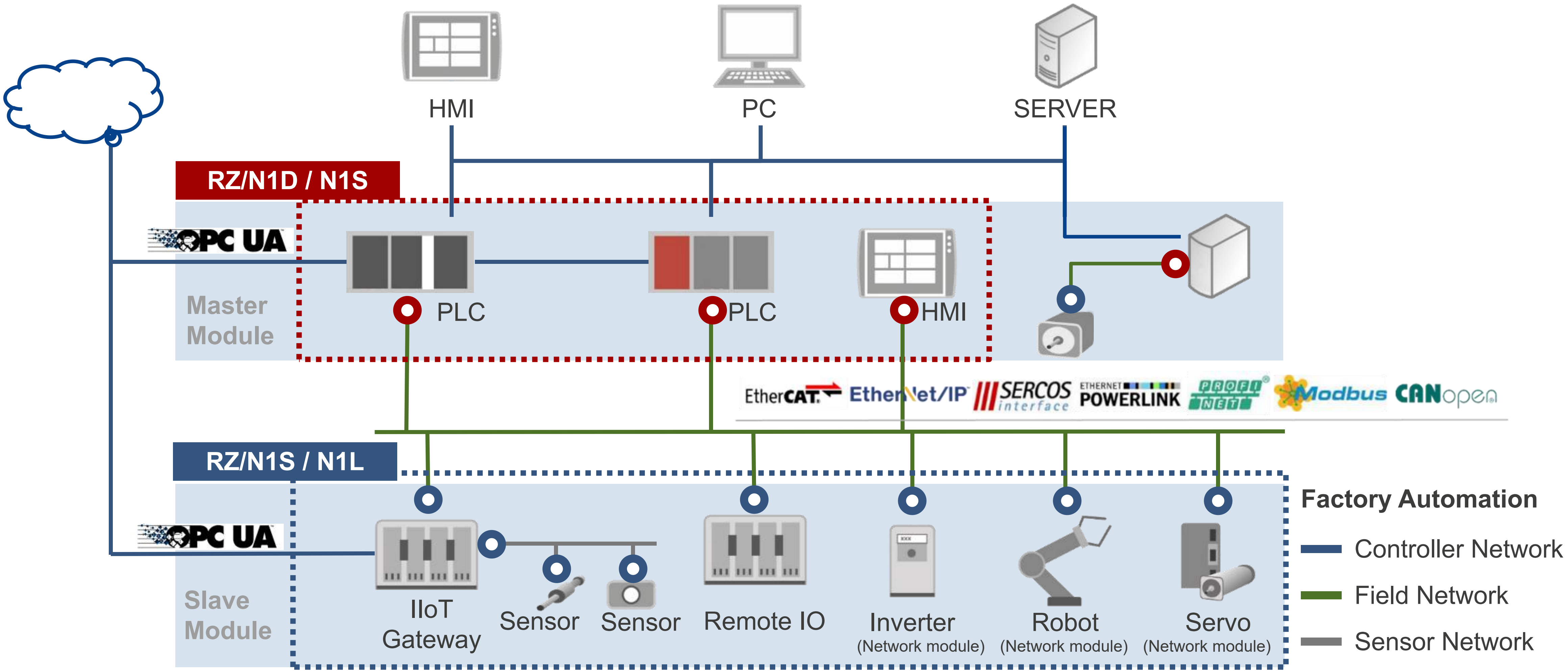
RZ/N1系列产品介绍

工业以太网产品阵容
广泛的产品阵容支持各种协议和应用

Multi Protocol						
Motor Control		PLC, Gateway	Network controller, Remote I/O			
	New		New			New

RZ/T1	RZ/T2	RZ/N1	RZ/N2L	R-IN32M3-EC	R-IN32M3-CL R-IN32M4-CL2	R-IN32M4-CL3
Cortex®-R4 w/ FPU + Cortex®-M3 CPUs* 3+1port Ether Switch EtherCAT Slave Controller	Cortex®-R52 x2 Trigonometric Acc. GMAC w/ 3+1port TSN Ether Switch EtherCAT Slave	Dual Cortex®-A7 + Cortex®-M3 CPU GMAC w/ 4+1port SW True IE multi-protocol PRP/HSR/MRPD	Cortex®-R52 Gigabit EtherMAC w/ 3+1port TSN Switch EtherCAT Slave	Cortex®-M3 CPU 2+1port SW w/ PHY EtherCAT Slave Controller	Cortex®-M3 CPU (CL) Cortex®-M4 CPU (CL2) GMAC w/ 2+1port Switch Gigabit PHY (CL2) CC-Link IE Field Controller	Cortex®-M4 CPU w/ 2+1port Gigabit PHY CC-Link IE Field and CC-Link IE TSN Class B
EtherCAT Technology Group EtherNet/IP PROFINET Modbus	TSN EtherCAT Technology Group EtherNet/IP PROFINET PROFINET IRT Modbus ETHERNET POWERLINK	EtherCAT Technology Group EtherNet/IP PROFINET Modbus ETHERNET POWERLINK SERCOS interface	TSN EtherCAT Technology Group EtherNet/IP PROFINET PROFINET IRT Modbus ETHERNET POWERLINK	EtherCAT Technology Group EtherNet/IP PROFINET Modbus	CC-Link IE EtherNet/IP PROFINET Modbus	CC-Link IE TSN CC-Link IE EtherNet/IP PROFINET Modbus

RZ/N1的目标应用场景

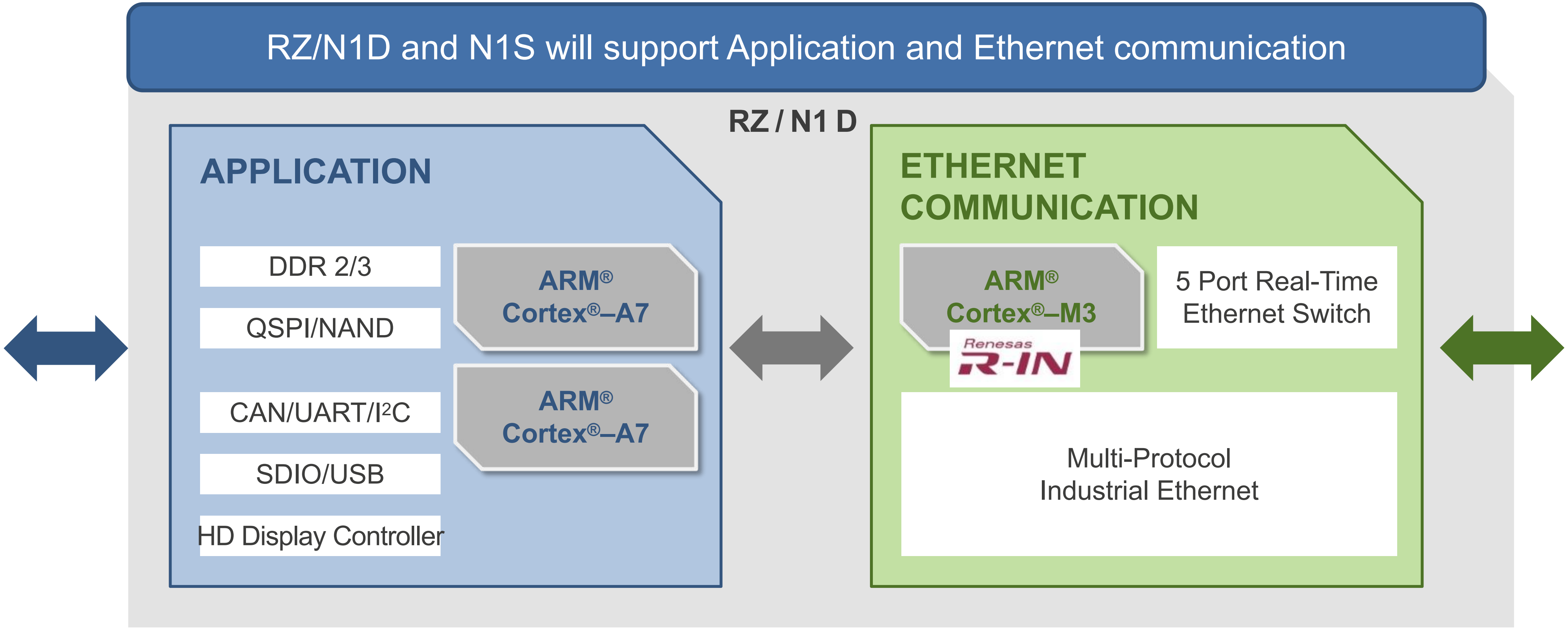


WHAT IS RZ/N1 SERIES?

- **Two in one concept supporting multi-protocol stack**
  - Multicore ARM - Single chip solutions
- **Scalability**
  - 3 groups with 5 packages
- **Wide selection of protocol stack**
- **Redundancy**
  - Support redundancy protocol (PRP and HSR) and make downtime to “0”

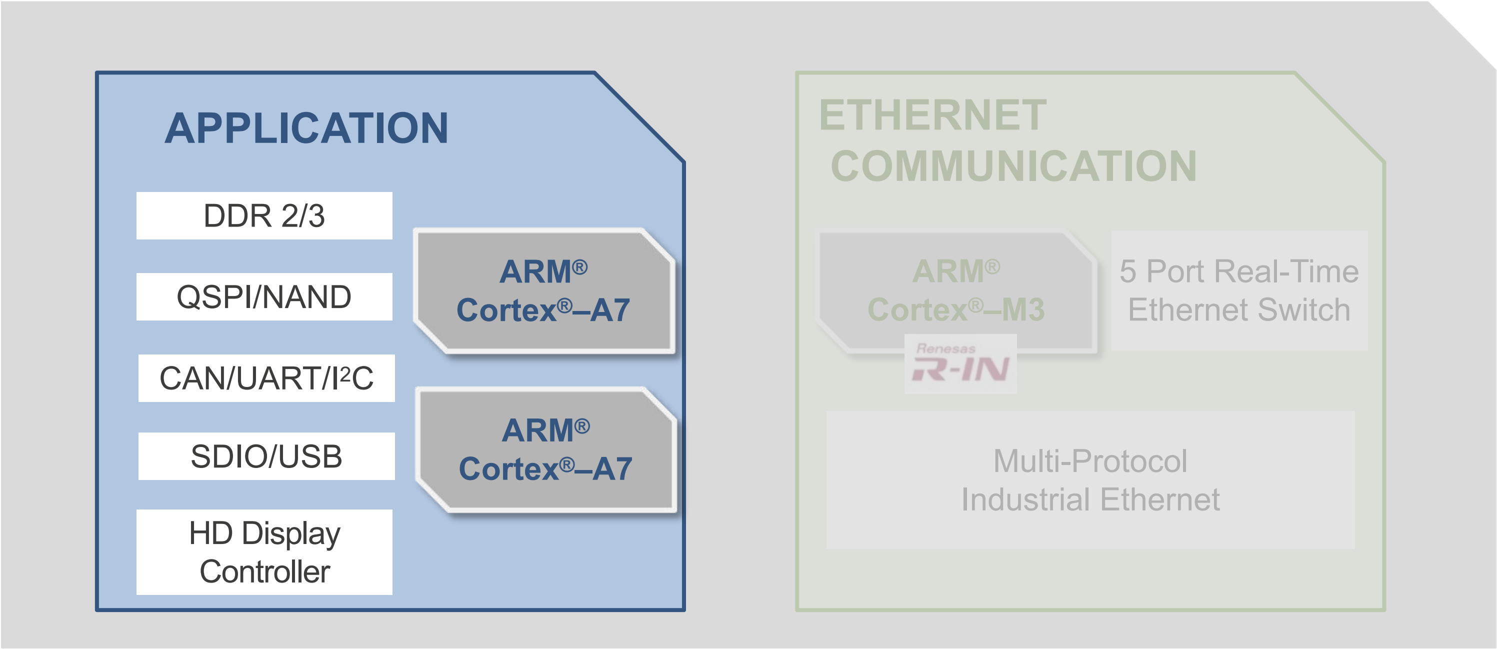
TWO IN ONE CONCEPT

MULTICORE ARM - SINGLE CHIP SOLUTIONS



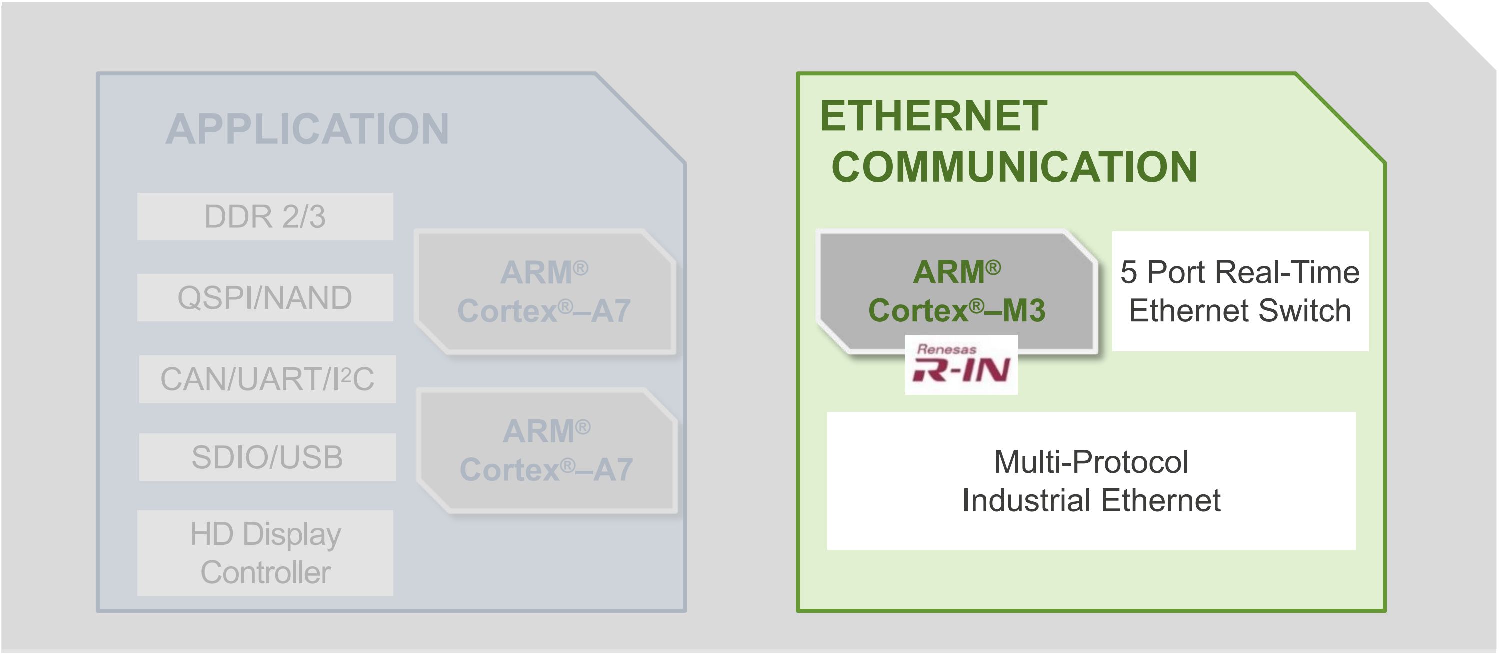
- For more information please check: www.renesas.com/rzn

ARM CORTEX-A7 FOR APPLICATION CONTROL



- **Powerful performance**: N1D/Dual Cortex-A7(500MHz), N1S/Single Cortex-A7(500MHz)
- **Multiple OS environment :** Linux, VxWorks, ThreadX are available

ARM CORTEX-M3 FOR ETHERNET COMMUNICATION



EtherCAT. EtherNet/IP. SERCOS interface. ETHERNET POWERLINK. PROFINET. Modbus. CANopen.

- **Multi-protocol** Industrial Ethernet support
- **Max 5-port** Ethernet with Real time switch

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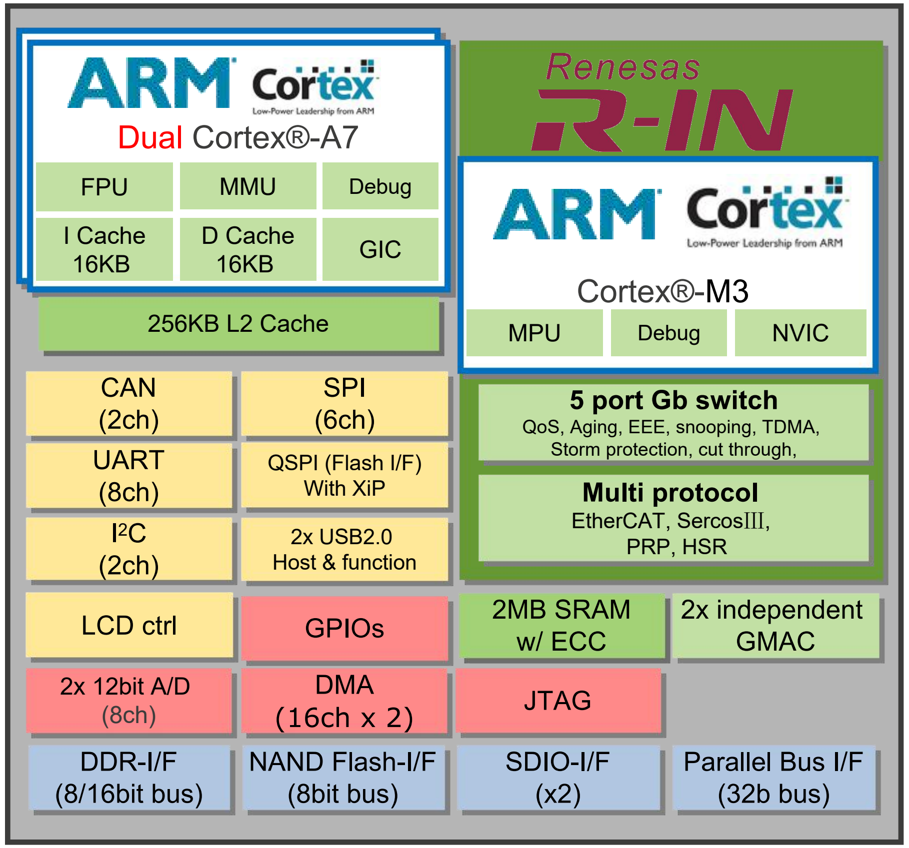
SCALABILITY

3 GROUPS WITH 5 PACKAGES

N for **N**etwork
D for **D**ual/**D**DR
S for **S**ingle/**S**RAM
L for **L**ite

	RZ/N1D	RZ/N1S	RZ/N1L
CPU	Dual Cortex®-A7 (500MHz) + Cortex®-M3 (R-IN Engine)	Single Cortex®-A7 (500MHz) + Cortex®-M3 (R-IN Engine)	Cortex®-M3 (R-IN Engine)
Target Application	PLC, HMI, Switch	PLC, HMI, Switch	Remote IO
Supported Protocol (Ethernet）	PROFINET RT, EtherCAT, EtherNet/IP, Modbus/TCP, SERCOS, POWERLINK		
Internal SRAM	2MB	6MB	6MB
DDR I/F	O	-	-
LCD controller	O	O	-
Ethernet Port	5 port – 400BGA PKG 3 port – 324BGA PKG	5 port – 324BGA PKG 3 port – 196BGA PKG	3 port
Redundancy	HSR, PRP, DLR, MRP	PRP, DLR, MRP	DLR
Package	400BGA(17mm) 324BGA (15mm)	324BGA(15mm) 196BGA (12mm)	196BGA (12mm)
OS (vendor)	CA7: Linux (Renesas)	CA7: VxWorks (Wind river) ThreadX (Express Logic)	NA
	CM3: HW-RTOS		
Sample schedule	2017. Dec (ES)	2017.Dec (ES)	2018.Jan (ES)

RZ/N1D – BLOCK DIAGRAM



400pin : LFBGA 17 x 17 mm, 0.8mm pitch
324pin : LFBGA 15 x 15 mm, 0.8mm pitch

CPU core
- Dual ARM® Cortex®-A7(500MHz)

Cache memory
- L1 I-Cache 16KB×2
  D-Cache 16KB×2
- L2 256KB

R-IN Engine
- ARM® Cortex®-M3 (125MHz)
- HW-RTOS accelerator
- Ethernet accelerator

Internal Memory
- 2MB (with ECC)

External Memory
- DDR2/DDR3 controller
- Quad-I/O SPI
- SDIO-eMMC
- NAND Flash controller

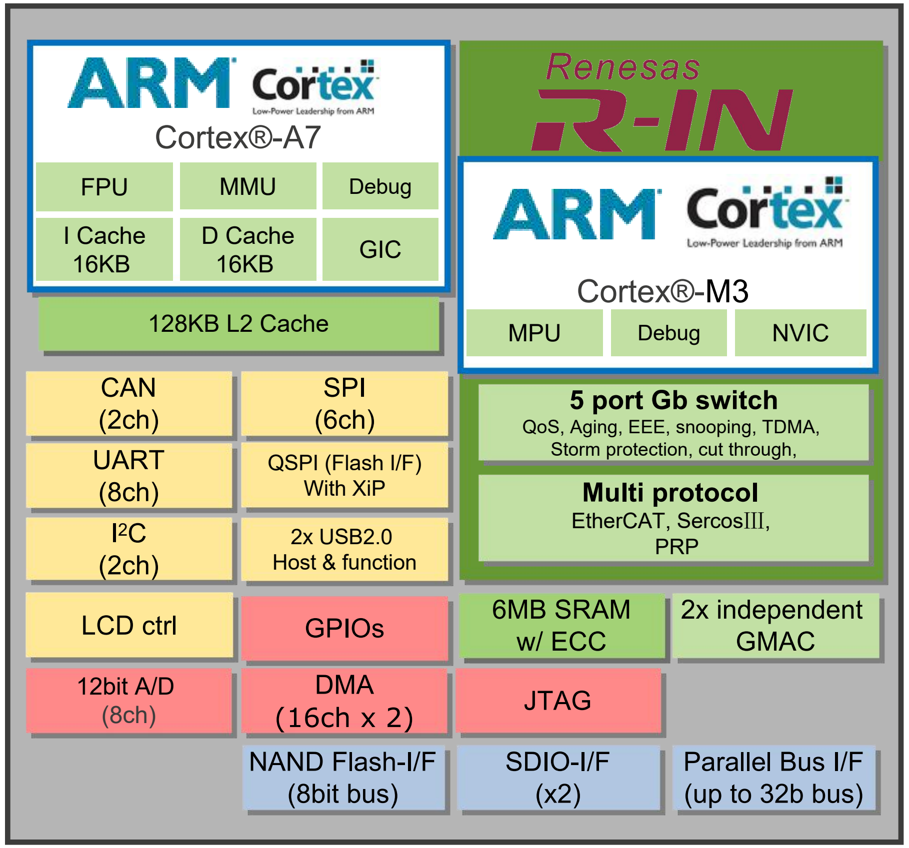
Operation Temperature
- Tj = -40℃ ~ +110℃

Ethernet Communication
- HSR switch
- EtherCAT Slave controller
- SercosIII Slave controller
- Up to 5port Ether switch

Communication features
- UART 8ch
- I2C 2ch
- USB HOST/Function 1ch, HOST 1ch
- SPI 6ch (Master 4ch, Slave 2ch)
- CAN

Others
- LCD controller
- ADC 12bit×8ch×2unit(400pin)
- ADC 12bit×8ch×1unit(324pin)

RZ/N1S – BLOCK DIAGRAM



324pin : LFBGA 15 x 15 mm, 0.8mm pitch
196pin : LFBGA 12 x 12 mm, 0.8mm pitch

CPU core
- Single ARM® Cortex®-A7(500MHz)

Cache memory
- L1 I-Cache 16KB
- D-Cache 16KB
- L2 128KB

R-IN Engine
- ARM® Cortex®-M3 (125MHz)
- HW-RTOS accelerator
- Ethernet accelerator

Internal Memory
- 6MB (with ECC)

External Memory
- Quad-I/O SPI
- SDIO-eMMC
- NAND Flash controller

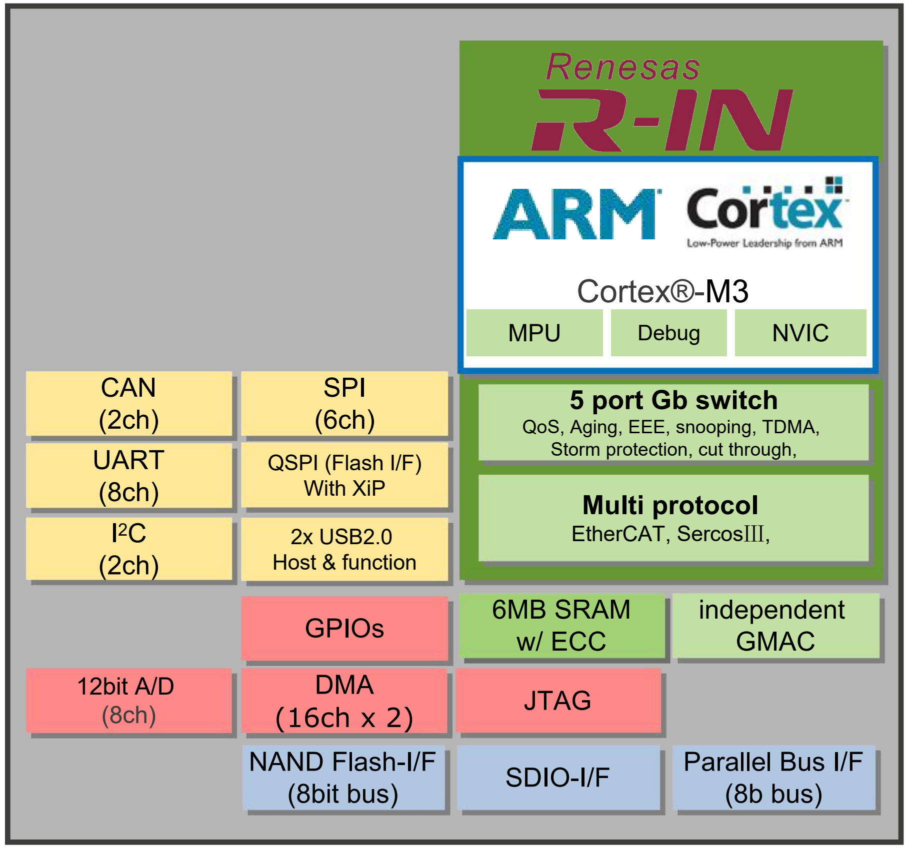
Operation Temperature
- Tj = -40℃ ~ +110℃

Ethernet Communication
- EtherCAT Slave controller
- SercosIII Slave controller
- Up to 5port Ether switch

Communication features
- UART 8ch
- I2C 2ch
- USB HOST/Function 1ch, HOST 1ch
- SPI 6ch (Master 4ch, Slave 2ch)
- CAN

Others
- LCD controller
- ADC 12bit×8ch×1unit

RZ/N1L – BLOCK DIAGRAM



196pin : LFBGA 12 x 12 mm, 0.8mm pitch

R-IN Engine
- ARM® Cortex®-M3 (125MHz)
- HW-RTOS accelerator
- Ethernet accelerator

Internal Memory
- 6MB (with ECC)

External Memory
- DDR2/DDR3 controller
- Quad-I/O SPI
- SDIO-eMMC
- NAND Flash controller

Operation Temperature
- Tj = -40℃ ~ +110℃

Ethernet Communication
- EtherCAT Slave controller
- SercosIII Slave controller
- 3port Ether switch*

Communication features
- UART 8ch
- I2C 2ch
- USB HOST/Function 1ch, HOST 1ch
- SPI 6ch (Master 4ch, Slave 2ch)
- CAN

Others
- ADC 12bit×8ch×1unit

*Switch IP is same as N1D and N1S but only 3 port is available in case N1L

BIG IDEAS FOR EVERY SPACE

WHAT IS RZ/N1 SERIES?

- **Two in one concept supporting multi-protocol stack**
  - Multicore ARM - Single chip solutions
- **Scalability**
  - 3 groups with 5 packages
- **Wide selection of protocol stack**
- **Redundancy**
  - Support redundancy protocol (PRP and HSR) and make downtime to “0”

WIDE SELECTION OF PROTOCOL STACK

Vendor	Protocol	Core	Device	Release schedule JPN
Port.GmbH	PROFINET RT (Slave)	Cortex-M3	RZ/N1D, S, L	Released
	EtherNet/IP (Slave)	Cortex-M3	RZ/N1D, S, L	Released
	Powerlink (Slave)	Cortex-M3	RZ/N1D, S, L	Released
TMG	PROFINET RT (Slave)	Cortex-M3	RZ/N1D, S, L	Released
Renesas	EtherCAT (Slave)	Cortex-M3	RZ/N1D, S, L	Released
	Modbus TCP (Slave)	Cortex-M3	RZ/N1D, S, L	Released
Cannon Automata	SercosIII	Cortex-M3	RZ/N1D, S, L	Released
3S	Software PLC CODESYS (Master)	Cortex-A7	RZ/N1D	Released
NetModule	HSR	Cortex-A7	RZ/N1D	Released
	PRP	Cortex-M3	RZ/N1D (400pin) RZ/N1S (324pin)	Released

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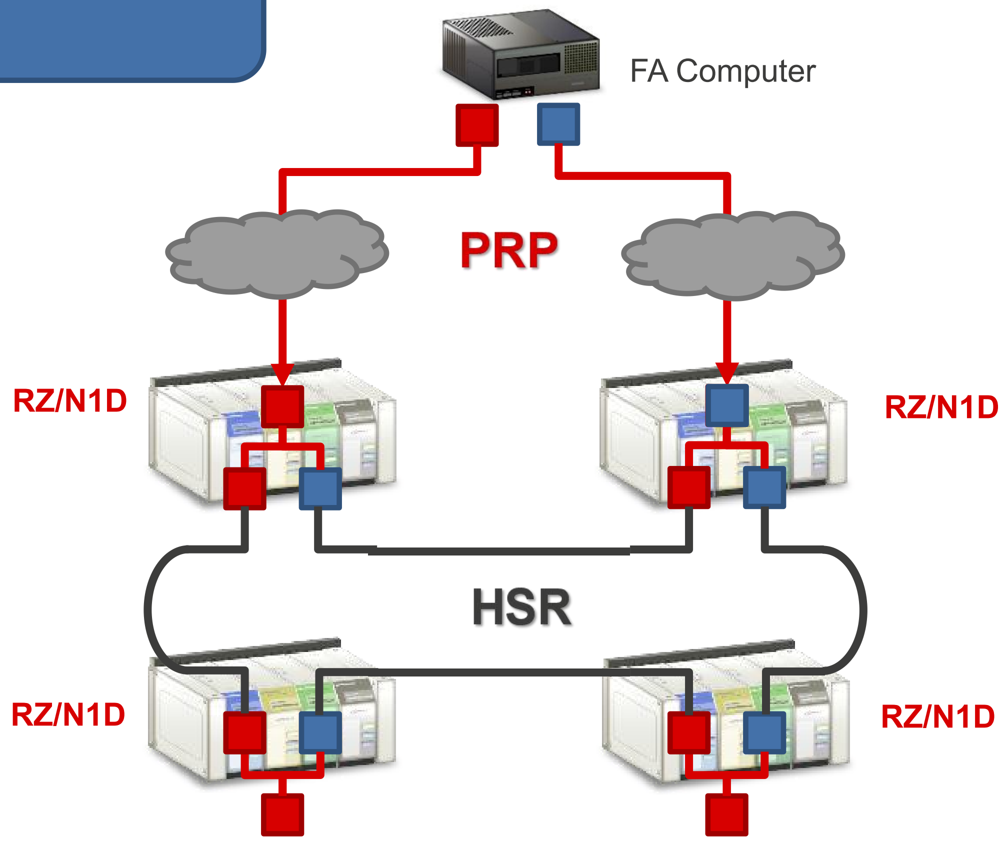
- **Two in one concept supporting multi-protocol stack**
  - Multicore ARM - Single chip solutions
- **Scalability**
  - 3 groups with 5 packages
- **Wide selection of protocol stack**
- **Redundancy**
  - Support redundancy protocol (PRP and HSR) and make downtime to “0”

REDUNDANCY SUPPORT

RZ/N1D and N1S support redundancy protocol
It makes downtime to "0 (zero)"

RZ/N1D(400pin) supports PRP and HSR, and PRP is available on N1S(324pin).

PRP and HSR are standard redundancy protocol for Industrial automation network which realize downtime to "0 (zero)"
RZ/N will be a solution for the application (e.g. Substation Automation) which needs to keep systems working even some network breaking is happened.



PRP : Parallel Redundancy Protocol (IEC 62439-3 Clause 4)
HSR : High-availability Seamless Redundancy (IEC 62439-3 Clause 5)

DEVELOPMENT ENVIROMENT

More flexibility with various operating systems

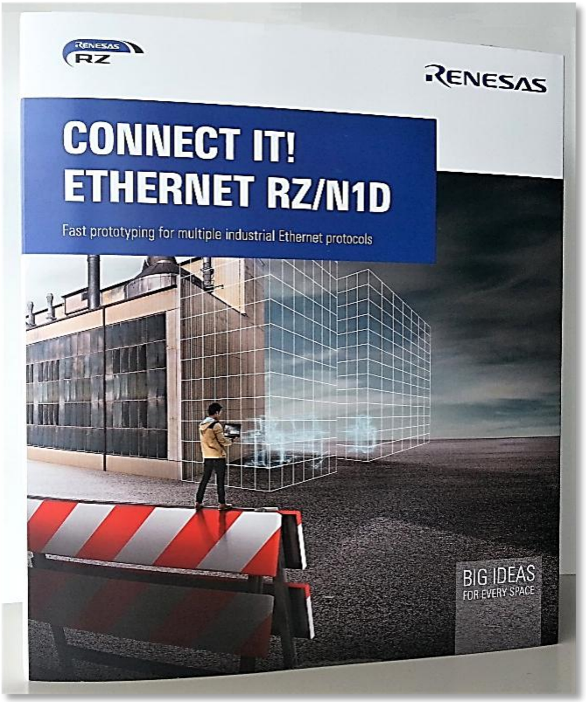
	RZ/N1D, RZ/N1S				RZ/N1L
CPU	Cortex-A7			Cortex-M3 (R-IN engine)	Cortex-M3 (R-IN engine)
OS	Linux (RZ/N1D only)	VxWorks	ThreadX	uITRON (HWRTOS)	uITRON (HWRTOS)
Compiler	GCC	GCC 4.8.1 or DIAB 5.9.6	IAR EWARM	IAR EWARM	IAR EWARM
Debugger	GDB	TCF eclipse			
Debug prove	Segger J-Link 	Lauterbach	I-jet ICE 	I-jet ICE 	I-jet ICE 

* I-jet Trace can support ETM trace. I-jet can support ETB trace only.

RZ/N1D SOLUTION KIT DETAILS

- **CONNECT IT! ETHERNET RZ/N1D**
  - Part No. : YCONNECT-T-RZN1D
  - Board : RZ/N1D CPU board
  - Debug probe : IAR i-Jet lite
  - Cables : Ethernet cable, USB cable
  - S/W : OS (Linux), Uboot, OSAL and Partner's stack binaries (e.g. : PROFINET, EtherNet/IP, EtherCAT,…)
  - Board features :
    - RZ/N1Dx device, Fast Ethernet (MII/RMII) (2 x), NOR flash, DDR3,
    - USB Device/Host, Serial USB debug/power port, LEDs, GPIOs, …

- **CONNECT IT! RZ/N1 Expansion**
  - Part No. : YCONNECT-IT-RZN1-EB
  - Board : RZ/N1-EB expansion board
  - Others : Power supply for RZ/N1-EB and RZ/N1x-DB
  - Features :
    - Gbit Ethernet (RGMII/MII) (3 x), SDIO interface, PMODS (4 x),
    - Parallel Interface, LCD display interface, CAN, RS485, RS232



CONNECT IT! ETHERNET RZ/N1D

RZ/T 系列产品介绍

工业以太网产品阵容
广泛的产品阵容支持各种协议和应用

Multi Protocol

Motor Control		PLC, Gateway	Network controller, Remote I/O			
RZ/T1	New **RZ/T2**	**RZ/N1**	New **RZ/N2L**	**R-IN32M3-EC**	**R-IN32M3-CL** **R-IN32M4-CL2**	New **R-IN32M4-CL3**
Cortex®-R4 w/ FPU + Cortex®-M3 CPUs* 3+1port Ether Switch EtherCAT Slave Controller	Cortex®-R52 x2 Trigonometric Acc. GMAC w/ 3+1port TSN Ether Switch EtherCAT Slave	Dual Cortex®-A7 + Cortex®-M3 CPU GMAC w/ 4+1port SW True IE multi-protocol PRP/HSR/MRPD	Cortex®-R52 Gigabit EtherMAC w/ 3+1port TSN Switch EtherCAT Slave	Cortex®-M3 CPU 2+1port SW w/ PHY EtherCAT Slave Controller	Cortex®-M3 CPU (CL) Cortex®-M4 CPU (CL2) GMAC w/ 2+1port Switch Gigabit PHY (CL2) CC-Link IE Field Controller	Cortex®-M4 CPU w/ 2+1port Gigabit PHY CC-Link IE Field and CC-Link IE TSN Class B
EtherCAT Technology Group, EtherNet/IP, PROFINET, Modbus	TSN, EtherCAT Technology Group, EtherNet/IP, PROFINET, PROFINET IRT, Modbus, ETHERNET POWERLINK	EtherCAT Technology Group, EtherNet/IP, PROFINET, Modbus, ETHERNET POWERLINK, SERCOS interface	TSN, EtherCAT Technology Group, EtherNet/IP, PROFINET, PROFINET IRT, Modbus, ETHERNET POWERLINK	EtherCAT Technology Group, EtherNet/IP, PROFINET, Modbus	CC-Link IE, EtherNet/IP, PROFINET, Modbus	CC-Link IE TSN, CC-Link IE, EtherNet/IP, PROFINET, Modbus

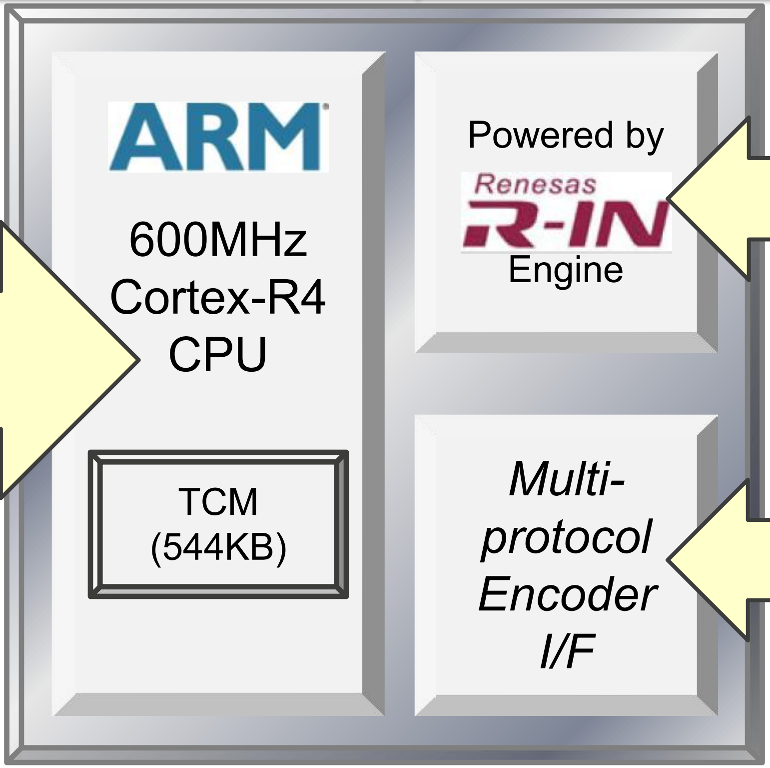
IABZ-AA-20-0037

RZ/T1 three differentiations

High-end realtime MCU with multi-protocol industrial Ethernet and multi-protocol encoder I/F, offers 1 chip AC servo/drive solution.

(1) High performance real-time CPU core with FPU
+
Large size (544KB) TCM
(Tightly Coupled Memory)

600MHz operation frequency and TCM realize high-speed and deterministic execution times for real-time application.



(2) Multi-protocol Industrial Ethernet Accelerator

Embedded “R-IN engine” realizes multiprotocol industrial Ethernet support w/o external ASIC.

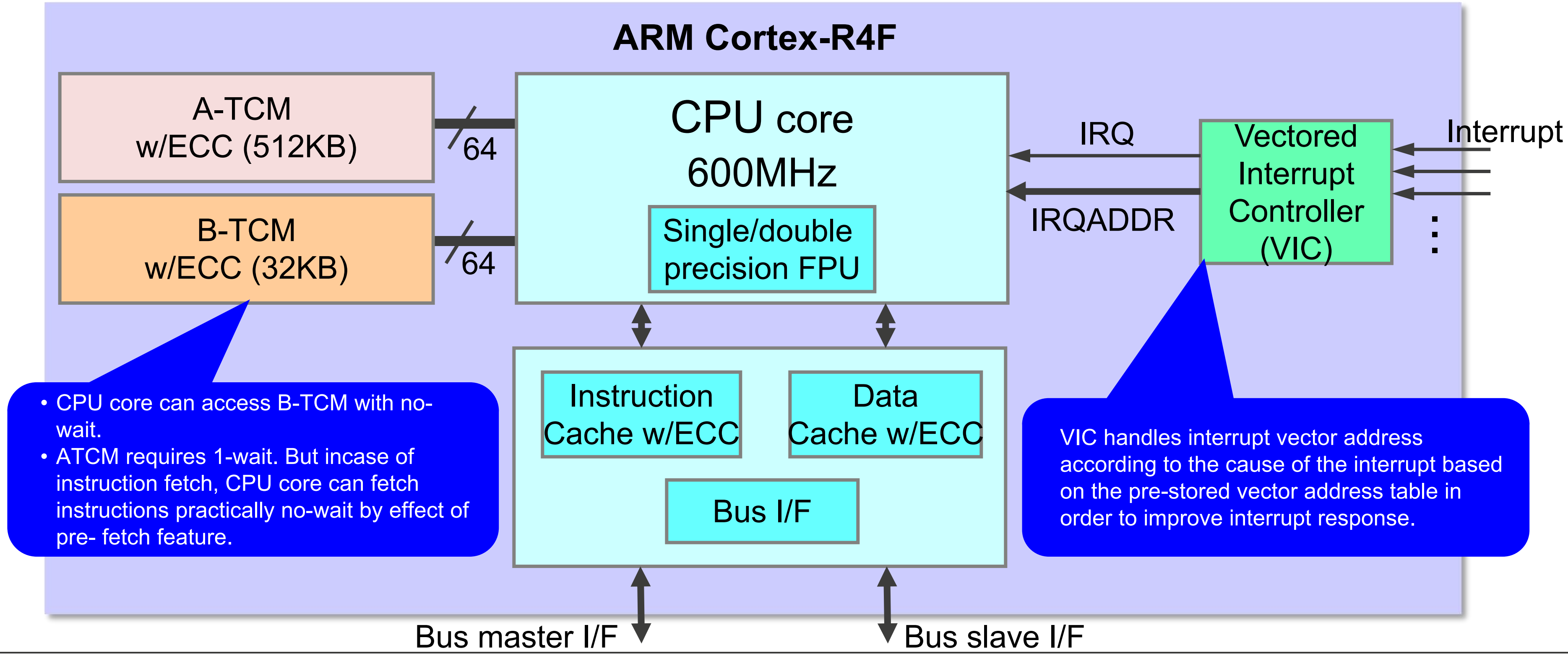
(3) Multi-protocol absolute encoder I/F

Eliminates external FPGA /ASIC for realizing absolute encoder I/F

Integrate over triple value on a chip

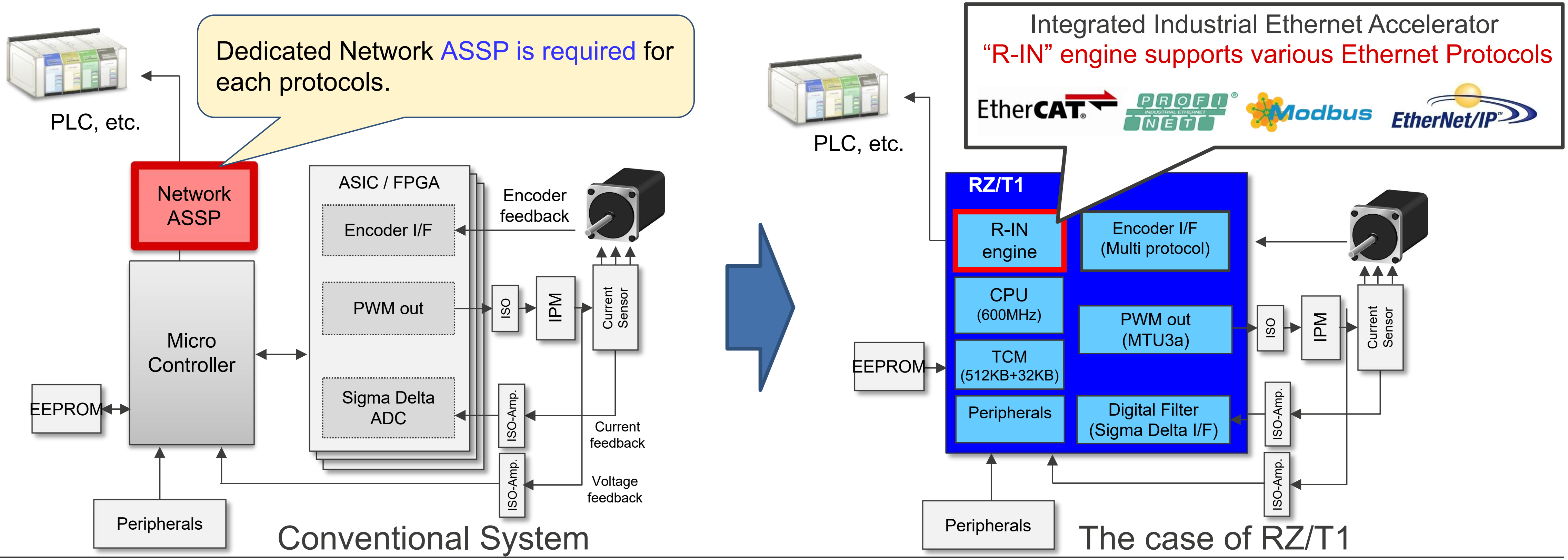
Feature1: Super real-time performance

- **Tightly Coupled Memory(TCM)** provides practical no-wait access for realizing high speed processing and deterministic real-time response without cache.
- **Vectored interrupt controller (VIC)** improves interrupt latency.
- **ECC** is supported for all memory.



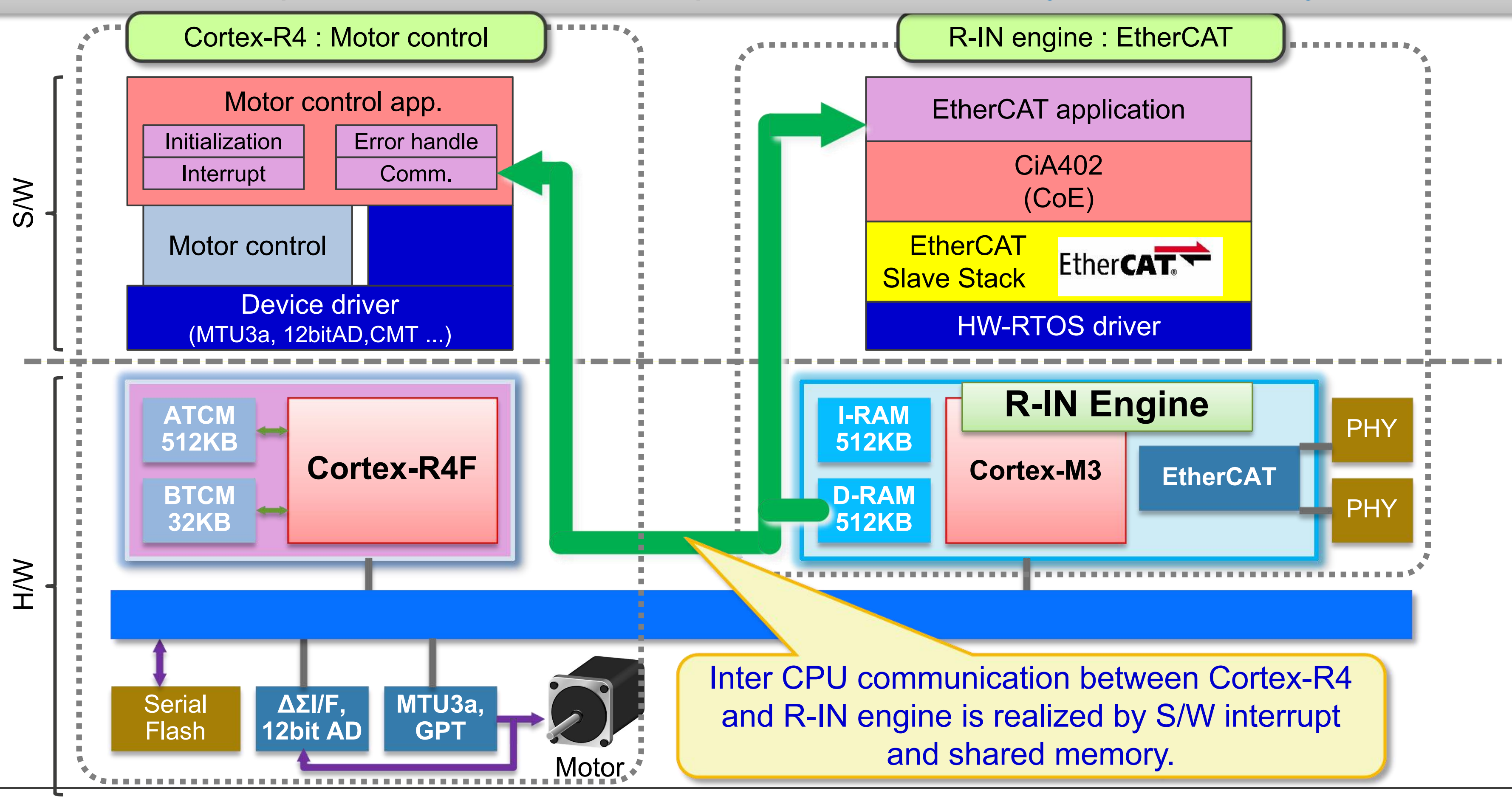
Feature2 : Multi-protocol Industrial Ethernet Accelerator “R-IN”

Integrated Ethernet Accelerator “R-IN” engine eliminate external network ASSP and achieve higher performance.



Separation of real-time and network operation

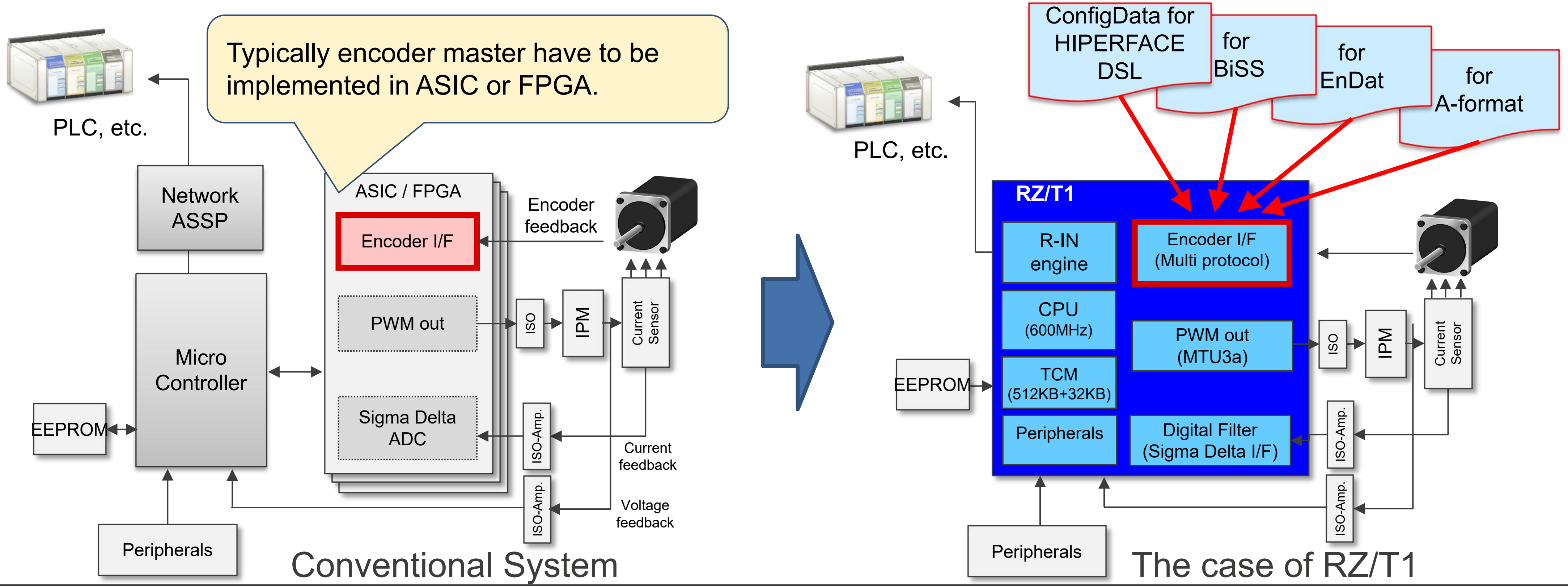
Separation of real-time operation and network operation achieves system reliability and realtimeness



Feature3 : Multi-protocol Encoder Interface

Encoder Interface eliminates external ASIC / FPGA to support various encoder master.

Now, we're ready to support HIPERFACE DSL.



Supported encoder I/F protocols

HIPERFACE DSL® encoder I/F is newly supported.
Now, 5 major encoder protocols in the market are supported.

	EnDat 2.2	BiSS-C	NIKON A-format	Tamagawa Seiki	HIPERFACE DSL
Related specification	Heidenhein Corp http://www.heidenhain.de	iC-Haus GmbH http://www.biss-interface.com	NIKON Corporation http://www.nikon.co.jp	TAMAGAWA SEIKI CO.,LTD. http://www.tamagawa-seiki.co.jp	SICK STEGMANN GmbH http://www.sick.com
Comm. method	Synchronous	Synchronous	Asynchronous	Asynchronous	Asynchronous
Transceiver	RS-485	RS-422	RS-485	RS-485	RS-485
Supported data rate/ frequency	100kHz to 16.7MHz	80.12KHz to10MHz	2.5Mbps/4Mbps/6.67Mbps/8 Mbps	2.5Mbps	9.375MBaud
# of I/F pins / Signal level	4 / 3.3V TTL level	2 / 3.3V TTL level	3 / 3.3V TTL level	3 / 3.3V TTL level	3 / 3.3V TTL level
Other feature	- Support transmission delay - Incremental signals are not supported.	- Support delay compensation - Support C mode (B mode is not supported) - Incremental signals are not supported - 1 to 1 connection is supported (Bus connection is not	- 1 to 1 connection and bus connection are supported - A-Safety is not supported.	- Support baseband NRZ data code - Incremental signals and synchronized Manchester code are not supported.	Newly supported

Firmware and document are available on the Renesas web site: https://www.renesas.com/zh-cn/products/microcontrollers-microprocessors/rz/rzt/rzt1.html#sampleCodes

RZ/T1 product line-up

Wide variety of product line-up, from 300MHz to 600MHz+R-IN engine.

CPU		TCM	exRAM				EtherCAT		Multi Protocol	
R-IN engine integrated	600MHz + R-IN engine (150MHz)	512KB +32KB	- (1MB for R-IN)						R7S910017	R7S910018
	450MHz + R-IN engine (150MHz)	512KB +32KB	- (1MB for R-IN)						R7S910015	R7S910016
Single Core	600MHz	512KB +32KB	1MB		R7S910007	R7S910013	R7S910027	R7S910028		
	450MHz	512KB +32KB	1MB		R7S910006		R7S910025	R7S910026		
			0KB	R7S910001	R7S910002	R7S910011				
	300MHz	512KB +32KB	0KB				R7S910035	R7S910036		
Package				176QFP	320BGA	320BGA	320BGA	320BGA	320BGA	320BGA
Encoder Interface				-		Yes	-	Yes	-	Yes
Industrial Ethernet				-			EtherCAT		Multiprotocol support	

RZ/T1 block diagram (Single Core)

- High Performance CPU (ARM Cortex-R4F)
  - Max. operating freq. : 300MHz/450MHz / 600MHz
  - High-speed real-time response
  - Single/Double precision FPU
- On-chip memory :
  - Tightly Coupled RAM 512KB + 32KB w/ECC
  - Extended RAM 1MB w/ECC (option)
- Features
  - EtherCAT slave controller (option)
  - Ethernet Accelerator
  - 100Mbps EtherMAC w/ switch
  - PWM timer : MTU3a, GPT
  - Encoder I/F (option)
    - Endat2.2, BiSS-C, A-format, Tamagawa, Hiperface DSL
  - High-speed USB
  - Secure boot (option)
  - Safety Feature
    - ECC RAM supported
    - CRC(32bit)
    - Independent WDT with dedicated on-chip oscillator
  - ⊿Σ I/F
- Power supply voltage : 1.2V, 3.3V
- Package
  - FBGA 320pin (17mm□, 0.8mm pitch)
  - QFP 176pin (20mm□, 0.4mm pitch)

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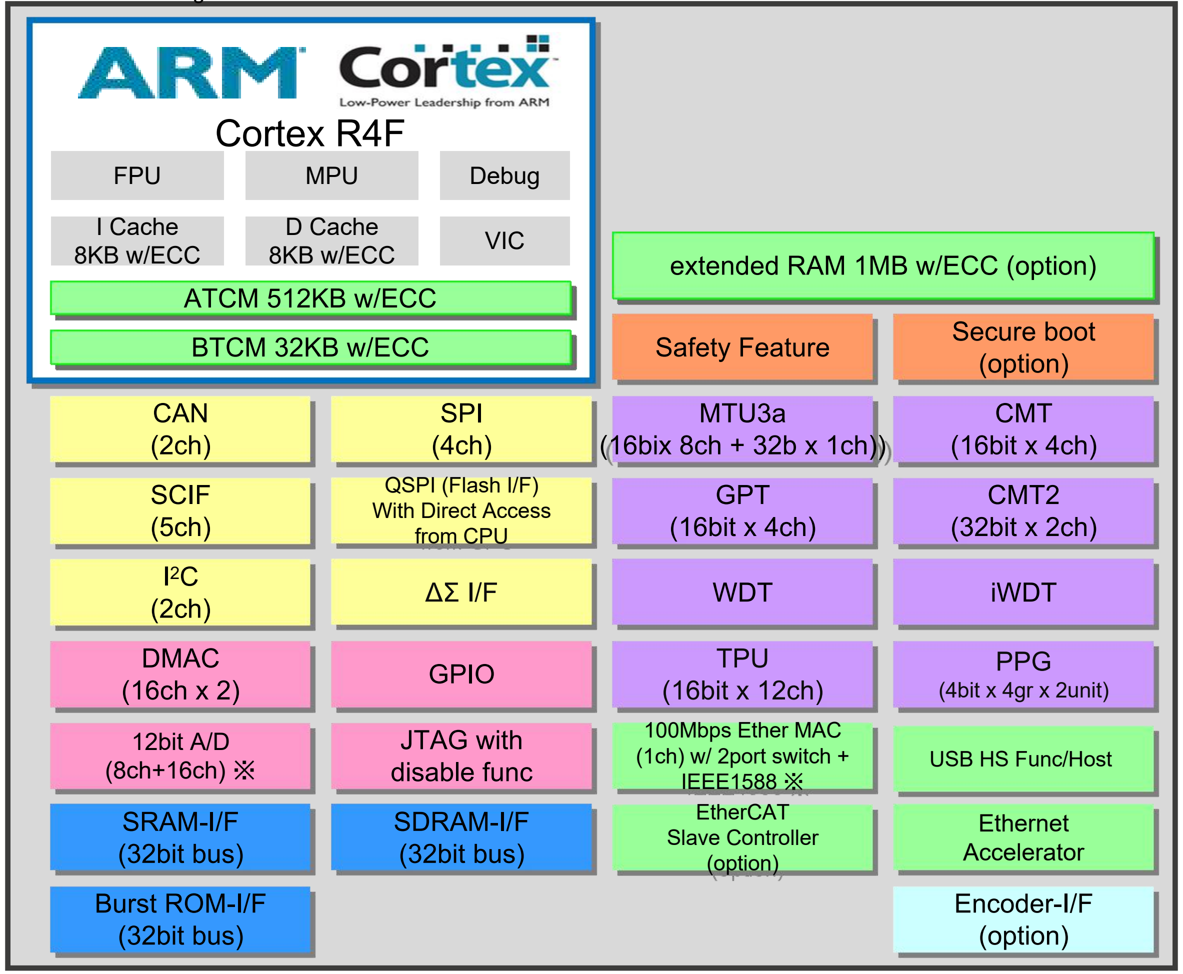
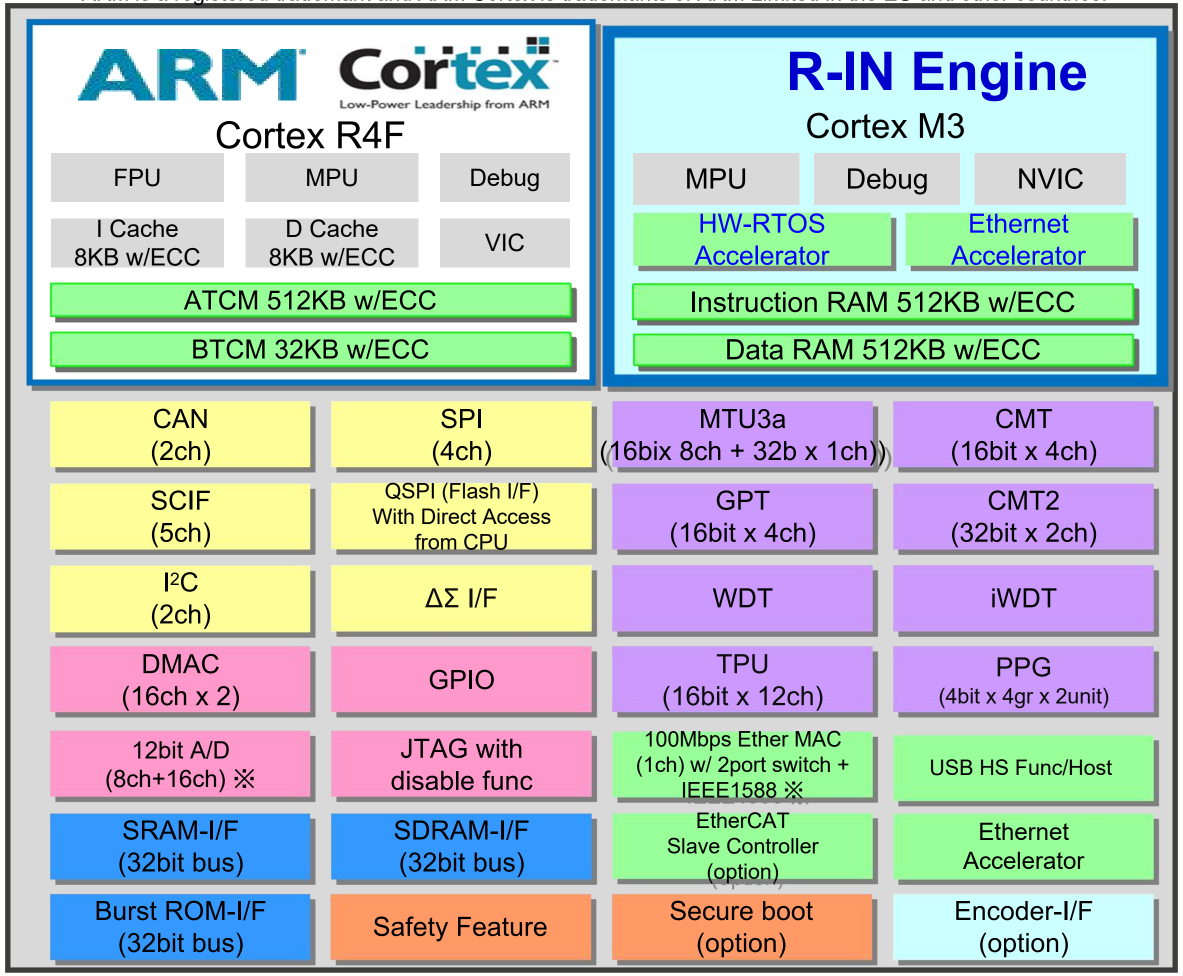


* 176pin QFP product : 12bit A/D x 8ch, TPU x 6ch, PPG x 1unit, Ether port x 1 port.
And Extended RAM 1MB, EtherCAT slave controller, Encoder I/F are not supported.

RZ/T1 block diagram (w/ R-IN engine)

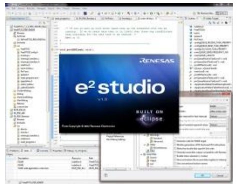
- High Performance CPU (ARM Cortex-R4F)
  - Max. operating freq. : 450MHz / 600MHz
  - High-speed real-time response
  - Single/Double precision FPU
- On-chip memory :
  - Tightly Coupled RAM 512KB + 32KB w/ECC
  - Instruction RAM 512KB + Data RAM 512KB w/ECC for R-IN engine
- Features
  - Multi protocol Industry Network Accelerator(R-IN Engine)
  - EtherCAT slave controller
  - Ethernet Accelerator
  - 100Mbps EtherMAC w/ switch
  - PWM timer : MTU3a, GPT
  - Encoder I/F (option)
    - Endat2.2, BiSS-C, A-format, Tamagawa, Hiperface DSL
  - High-speed USB
  - Secure boot (option)
  - Safety Feature
    - ECC RAM supported
    - CRC(32bit)
    - Independent WDT with dedicated on-chip oscillator
  - ⊿Σ I/F
- Power supply voltage : 1.2V, 3.3V
- Package
  - FBGA 320pin (17mm□, 0.8mm pitch)

ARM is a registered trademark and ARM Cortex is trademarks of ARM Limited in the EU and other countries.



RZ/T1 development tools (IDE)

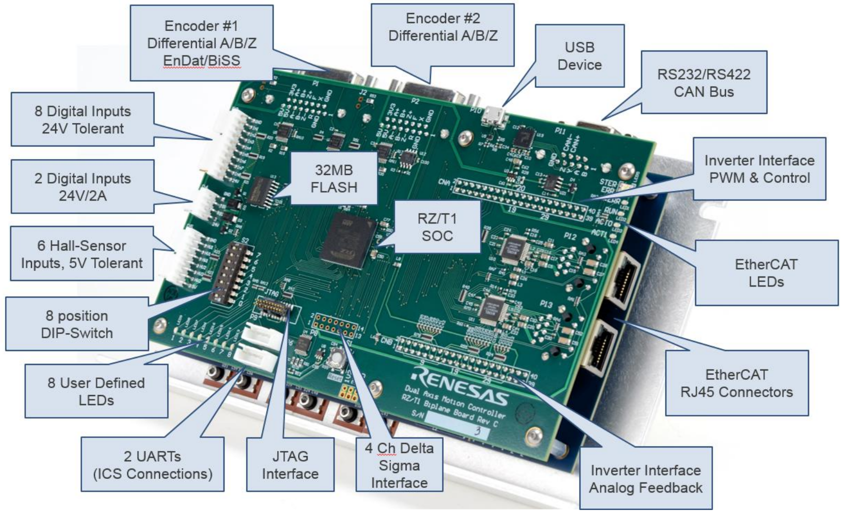
- RZ/T1 is supported by 3rd party's tools chains in addition to Renesas in-house tools.

	IAR SYSTEMS	ARM	RENESAS
IDE	Embedded Workbench for ARM	DS-5 	e2Studio *1 
Compiler	IAR CC	ARM CC	GCC *2
Other tools	Renesas's code generator "AP4" supports IAR CC	Renesas's code generator "AP4" supports ARM CC	Code Generator plugin for e2studio
ICE	I-jet, I-jet Trace, JTAGjet-Trace  	DSTREAM, ULINKpro, ULINKproD, ULINK2 	Segger J-Link LITE, J-Link series ICE 
Multicore support	Yes	Yes	Yes
Secure support	Yes	Yes	Yes

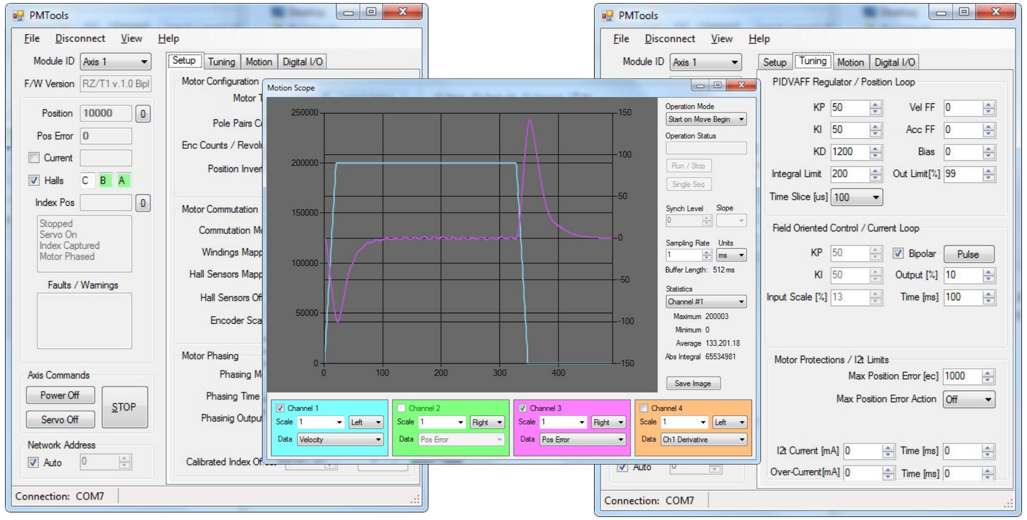
*1 : Eclipse base free IDE by Renesas. (http://www.renesas.com/products/tools/ide/ide_e2studio/index.jsp)
*2 : GNU tools for RZ/T1 and technical support for it is provided by CyberThor Studios, Ltd.(https://gcc-renesas.com/)

RZ/T1 Solution Kit "Drive It!"

- Dual Servo Motor Control
  - Incremental Encoder Interface – A/B/Index – RS422
  - 5V Tolerant Hall Sensor Inputs
- Industrial Connectivity
  - EtherCAT, PROFINET, EtherNet/IP, CAN Bus
- Single Absolute Encoders Interface
  - EnDat / BiSS / Tamagawa Seiki / A-format interface buffers
- Single Motor Inverter with Complimentary PWM Signals or Dual Motor Inverter with Single Ended PWM Signals
- Motion Control Software
  - Algorithms in source code and Library
    - Current control loop algorithms, Position loop and feedback
    - Position Capture, SVM, Velocity Profile Generator
- Motion Control tool (library)
  - Multi-axis support
  - Position/rev setting
  - Windings mapping
  - Phase modes
  - Kp, Ki, Kd tuning
  - FF velocity/acceleration
  - Motor commutation profile
  - Motion scope in realtime
  - Channel selectable, zoom in



Motion Control Solution Board



Motion Control Tool

https://www.renesas.com/en-eu/products/software-tools/boards-and-kits/evaluation-demo-solution-boards/ydrive-it-rzt1.html

Renesas.com