RZ MPU PRODUCTS INTRODUCTION

VERSION 1.11

RENESAS ELECTRONICS

INTELLIGENCE MOVING FROM THE CLOUD TO "THE IOT EDGE" AND "THE ENDPOINT"

DX AND AI/ML ACCELERATE INVESTMENT TO INNOVATE

Cloud Data Center, Server

Edge

Enterprise Edge On-premise server

IoT Edge

Real-time Analytics Accelerator

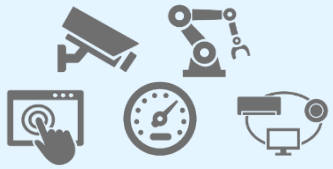
Intelligent IoT Gateway

Endpoint

Intelligent Devices

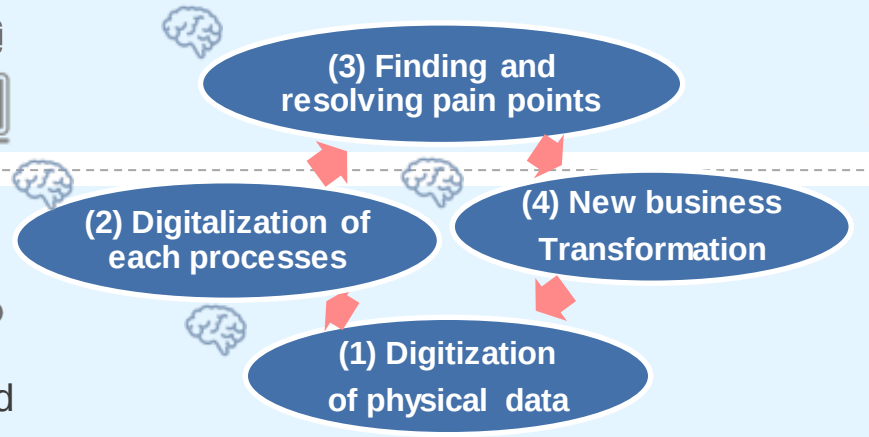
Massive Sensors

AI/ML and Robotics adoption further expanded



Investment in Embedded Computing is Growing

New DX Job for Innovation



CAGR 21%
@2021-2025

THE BEST IOT EDGE/ENDPOINT SOLUTION

RENESAS EMBEDDED PROCESSING PLATFORM PROVIDES LOW LATENCY/REAL-TIME, BANDWIDTH, SECURITY/ROBUSTNESS, AND AUTONOMOUS

Renesas' Embedded Processing Platform

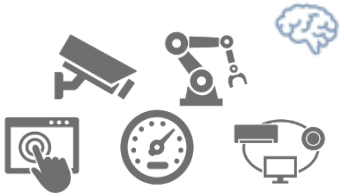
IoT Edge

- Many cores @GHz operation
- AI acceleration with multitasking
- Cyber security compliant
- OSS (Open Source Software) availability

RZ G, N, and V Series

CIP Linux

Endpoint



- Scalable MCU/MPU lineups
- Real-time control & networking
- AI acceleration with real-time and low-power
- Security and safety compliant
- Combination with sensors & analogs
- OSS availability

MCUs

RA, RX, RE, RL78

MPUs

RZ A, G, N, T, and V Series

ONNX, TensorFlow Lite, PyTorch, FreeRTOS, Qt, CIP Linux

RZ FAMILY

DEMONSTRATE MAXIMUM PERFORMANCE FOR HMI, INDUSTRIAL NETWORK & VISION AI

Human machine interface

RZ/A Series

2D Graphics + RTOS

RZ/G Series

Multimedia /3D Graphics + Linux

Industrial Network

RZ/N Series

Multi-protocol Industrial Ethernet +
5ports GMAC with Switch & Redundancy

Vision AI

RZ/V Series

AI accelerator + Linux

RENESAS RZ

Industrial real-time control

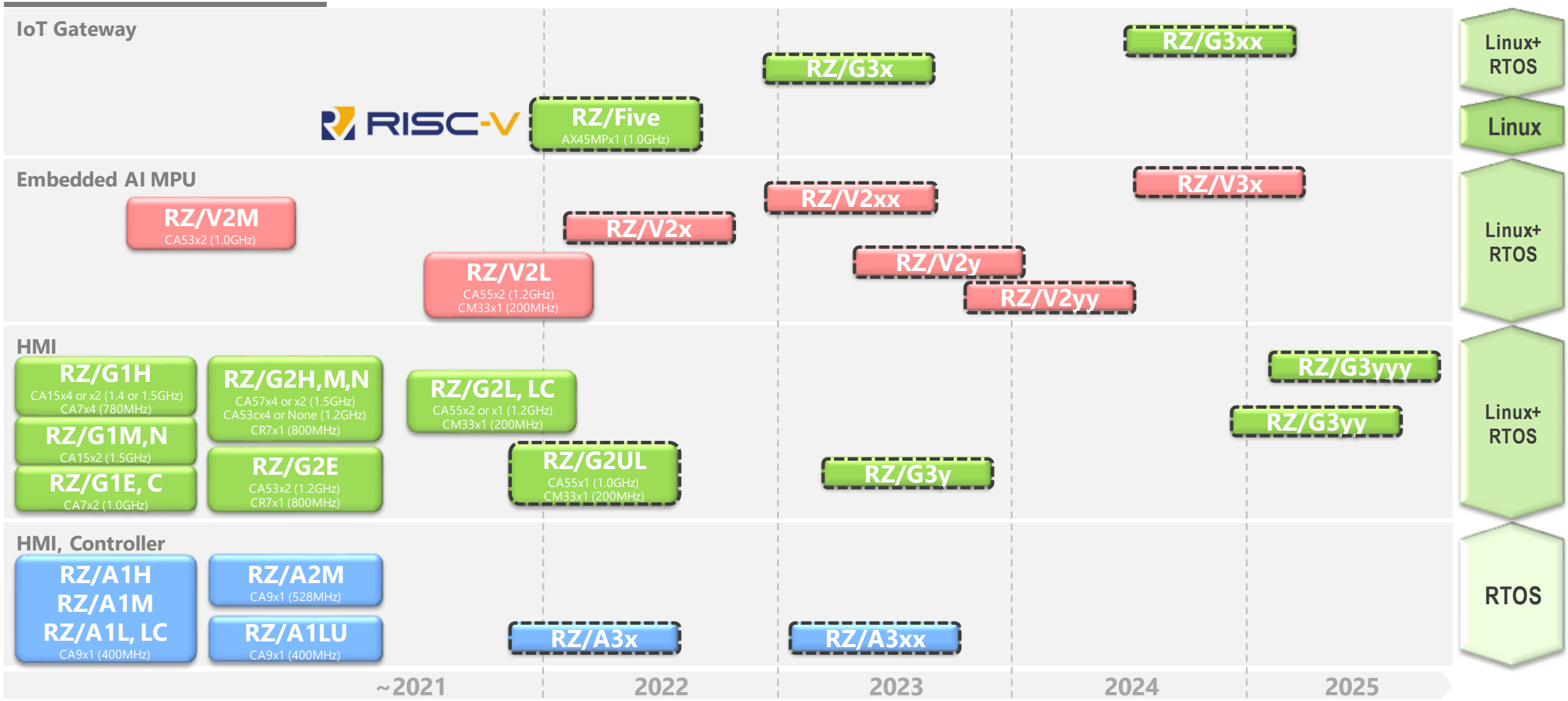
RZ/T Series

Real-time control+
Multi-protocol Industrial Ethernet

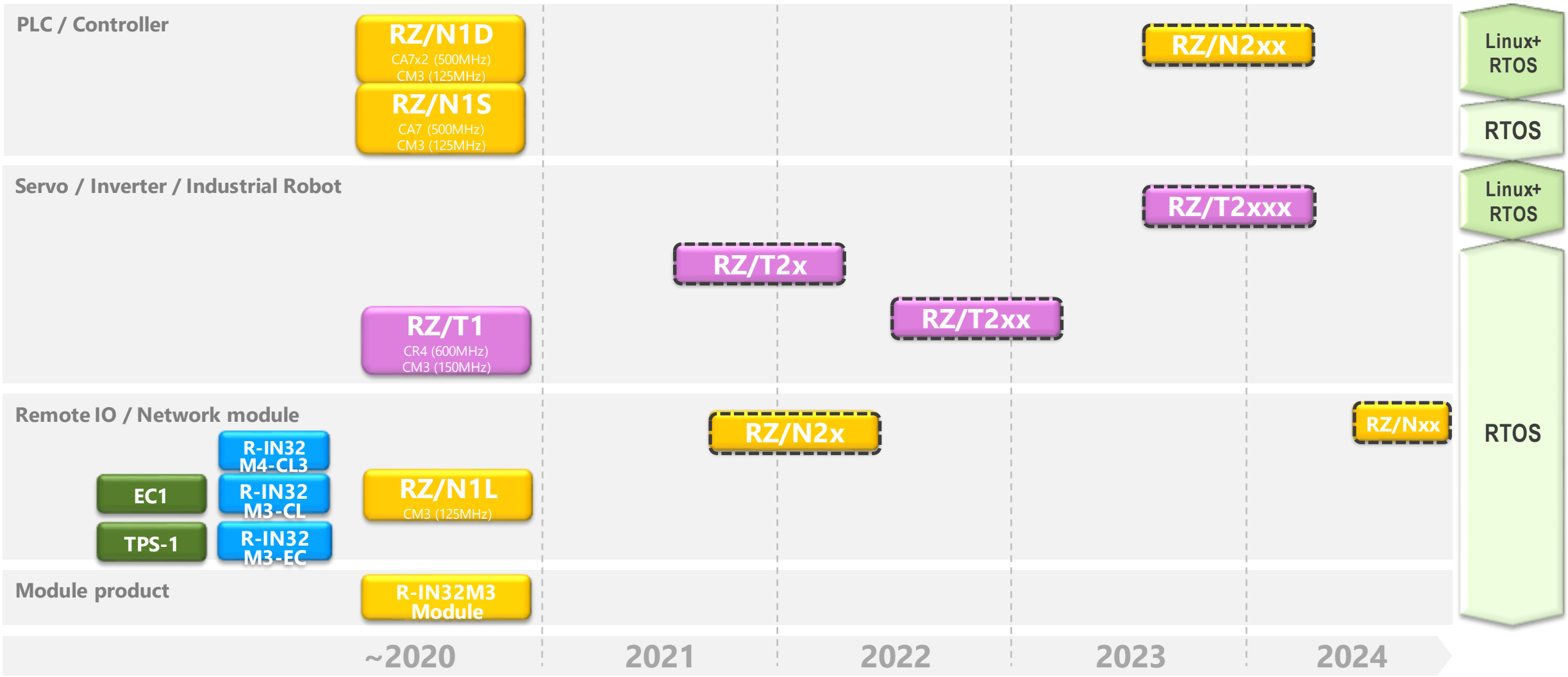
RENESAS' RZ MPU FAMILY

	HMI		Networking	Control	AI
	RZ/A	RZ/G	RZ/N	RZ/T	RZ/V
	2D Graphics + RTOS	Multimedia /3D Graphics + Linux	Multi-protocol Industrial Ethernet + 5ports switch w/ GMAC & redundancy	Real-time control+ Multi-protocol Industrial Ethernet, FuSa	AI accelerator + Linux
IoT Edge		✔ Linux + RTOS • Wider portfolio from High to Entry class • Super long-term support Linux(CIP)	✔ Linux + RTOS • Up to 5 ports TSN switch with GMAC • Redundancy network support		✔ Linux + RTOS • DRP enabling good power efficiency (performance / watt) • CIP Linux & Flexible AI Tool support
Endpoint	✔ RTOS • Integrated Large RAM (w/o DRAM) • Easy to use GHz CPU like MCU	✔ Linux + RTOS • Wider portfolio from High to Entry class • CIP Linux & GUI Framework support	✔ Linux + RTOS • Up to 5 ports TSN switch w/ GMAC • Multi-protocol IA network support	✔ RTOS • Realtime CPU & large size TCM • Multi-protocol IA network & FuSa	✔ Linux + RTOS • DRP enabling good power efficiency (performance / watt) • CIP Linux & Flexible AI Tool support

RZ MPU FOR HMI, AI AND IOT GATEWAY



RZ MPU AND ASSP FOR INDUSTRIAL AUTOMATION



RZ FAMILY TARGET APPLICATION

RZ Family can realize wide range applications

Vision AI

Linux

- RZ/V2M (DRP-AI)
- NEW RZ/V2L (DRP-AI)
- NEW RZ/G2L, RZ/G2LC, RZ/G2UL

HMI (w/ Display)

Linux

- RZ/G2H, RZ/G2M, RZ/G2N, RZ/G2E
- NEW RZ/G2L, RZ/G2LC, RZ/G2UL

RTOS

- NEW RZ/A3x
- RZ/A2M
- RZ/A1H, RZ/A1M, RZ/A1LU, RZ/A1LC

IoT (w/o Display)

Linux+ RTOS

- NEW RZ/G2L, RZ/G2LC, RZ/G2UL
- NEW RZ/Five
- RZ/N1D
- RZ/N2xx

RTOS

- NEW RZ/A3x
- RZ/A2M
- RZ/A1H, RZ/A1M, RZ/A1LU, RZ/A1LC
- RZ/N1S
- RZ/N1L
- RZ/N2x

Under development/planning

RZ FAMILY TARGET APPLICATION

RZ Family can realize wide range applications

PLC/ Controller

Linux /
Linux+RTOS

RZ/G2H
RZ/G2M

RZ/N1D

RZ/N2xx

RTOS

RZ/N1S

RZ/T2x

Remote IO/ NetworkModule

RTOS

R-IN32M3-EC

R-IN32M4-CL3

R-IN32M4-CL2

EC-1

TPS-1

RZ/N1S

RZ/N1L

RZ/N2x

Motor control

Linux
+RTOS

RZ/T2xxx

RTOS /
Baremetal

RZ/T1

RZ/T2x

RZ/T2xx

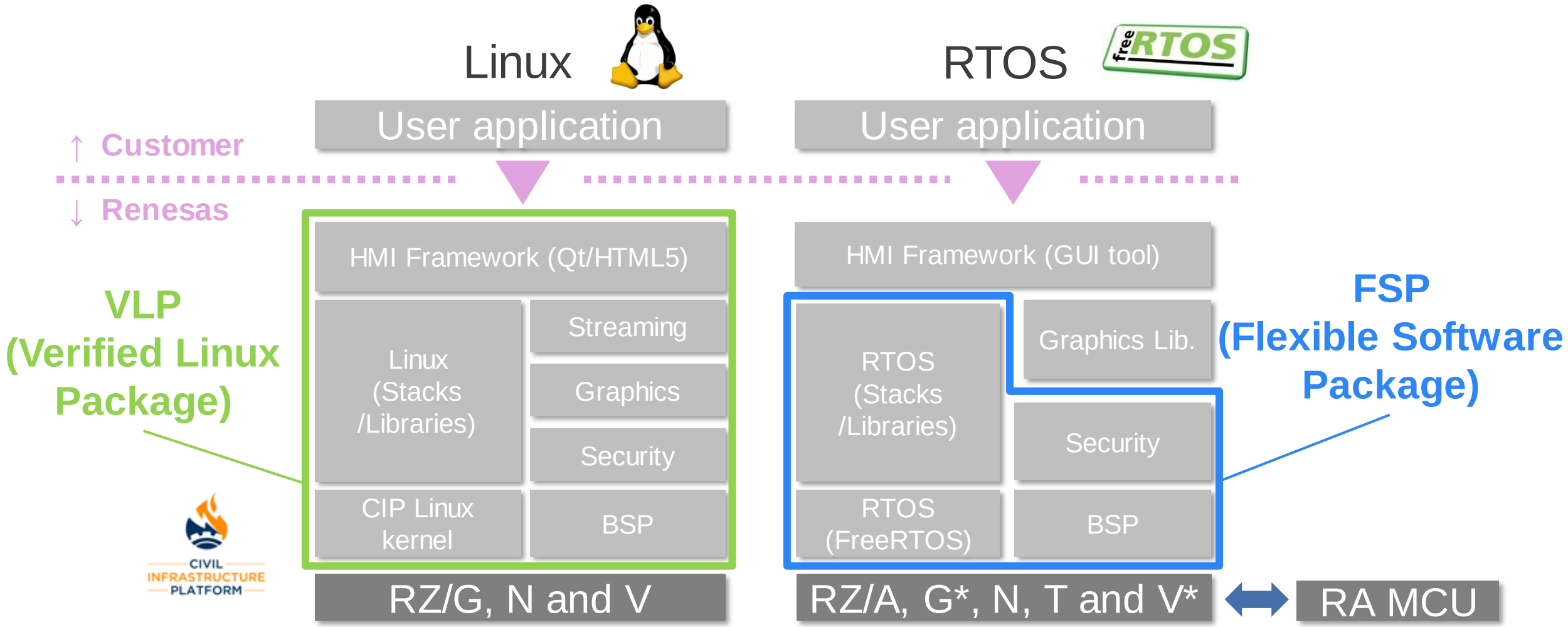
RZ/N2x

Under development/planning

BIG IDEAS FOR EVERY SPACE

RZ FAMILY SOFTWARE SCALABILITY FOR LINUX & RTOS

”VLP” FOR LINUX & “FSP” FOR RTOS SUSTAIN SW SCALABILITY ACROSS MCU AND MPU

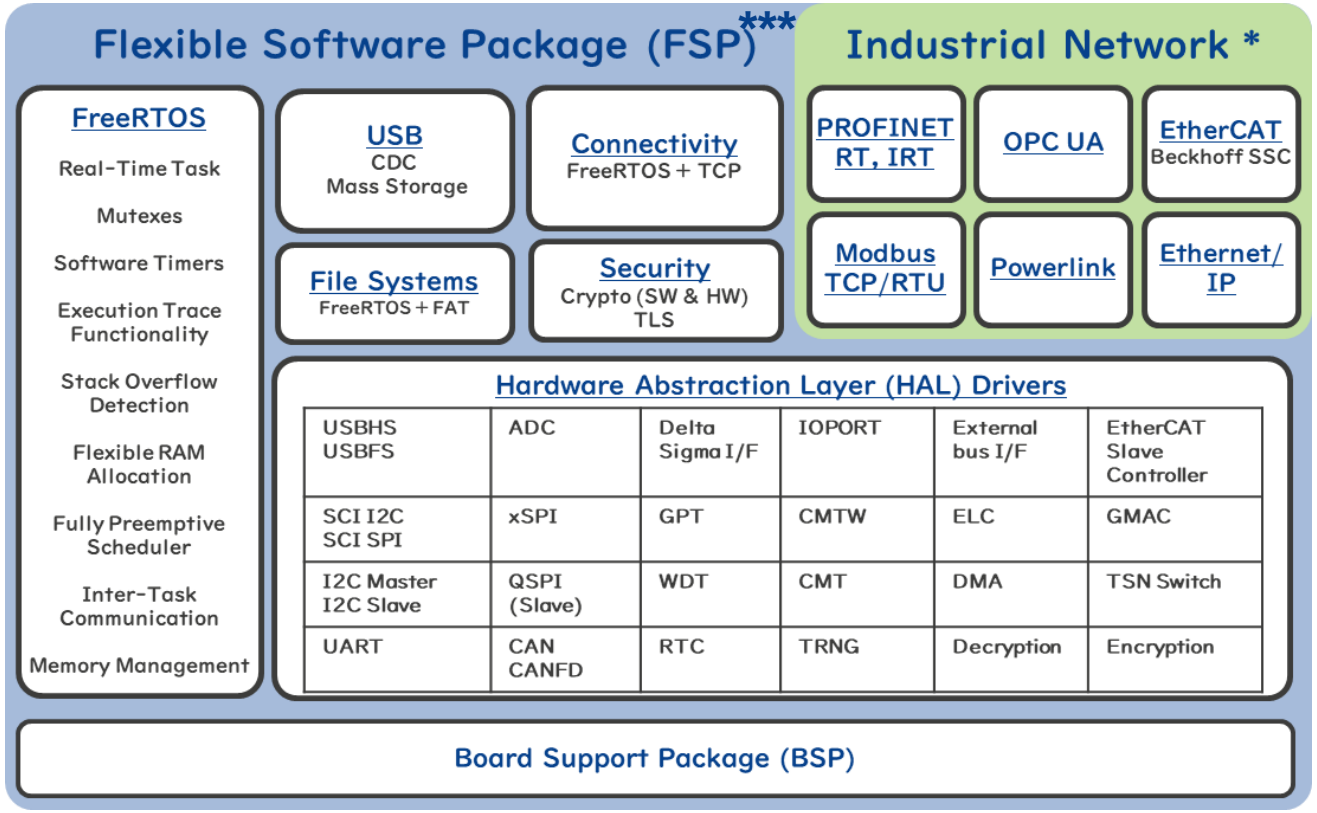


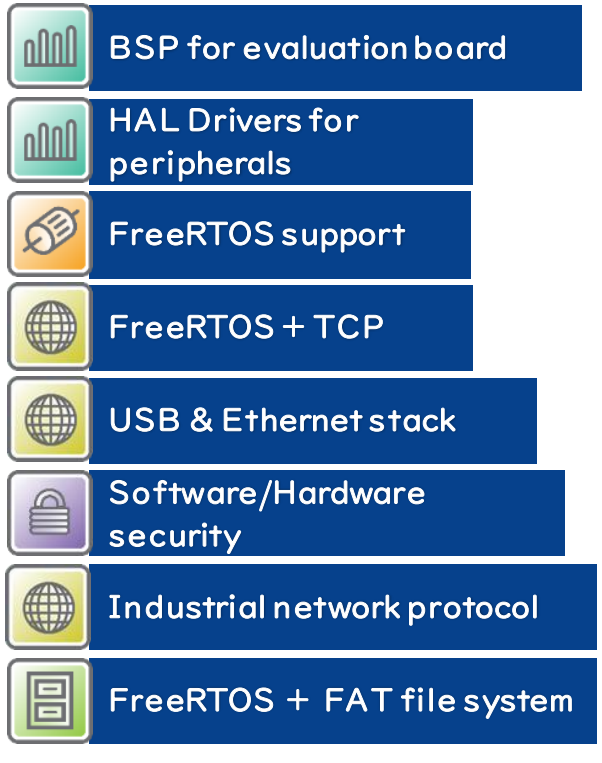
CIP: Civil Infrastructure Platform, BSP: Board Support Package

* : Multi OS solution which Cortex-M core operates with RTOS

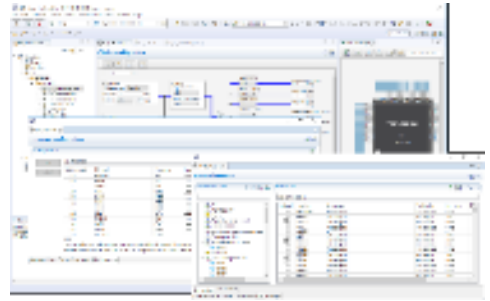
FLEXIBLE SOFTWARE PACKAGE (FSP)

RZ/A, RZ/G**, RZ/N, RZ/T and RZ/V** supports Flexible Software Package (FSP) and Smart Configurator, which has compatibility with RA MCU family. Additionally, industrial network protocols are supported.





Configurators for drivers and OS



Pin configurators

* : RZ/N and RZ/T only. Supported functions or specifications will be extended in phase. Industrial network protocol stacks are provided by Renesas or our partners
** : Multi OS solution which Cortex-M core operates with FSP (RTOS). Please see next page for more information.
*** : Supported device drivers and middleware differ depending on each product

VERIFIED LINUX PACKAGE (VLP)

For more details: Verified Linux Package | Renesas

Customers can use verified S/W including middleware necessary for various applications. Application development can be started from a stable operating environment

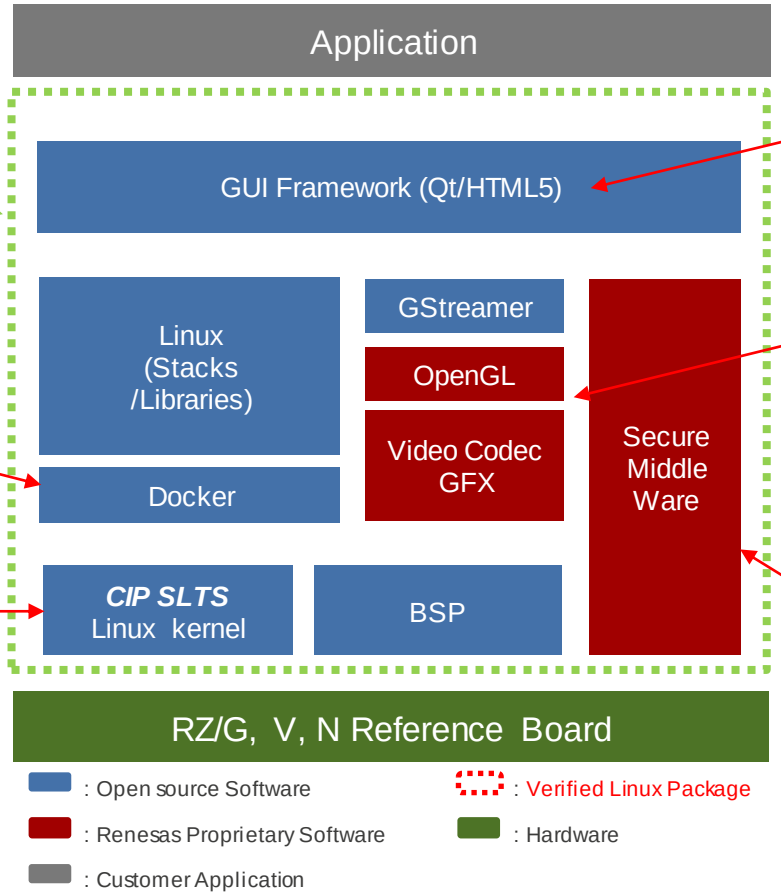
Verified Linux Package
- Renesas carries out verification

Docker
- Easily turn on the container type virtualization

CIVIL INFRASTRUCTURE PLATFORM

CIP SLTS Kernel
- Civil Infrastructure Platform project
- 10+ years super long term support
  Reliability/Security/Real-time

(cf. LTS kernel: 2-6years support)



GUI Framework (for RZ/G, N)
- Qt application framework(Qt5.6.3)
- HTML5 application framework

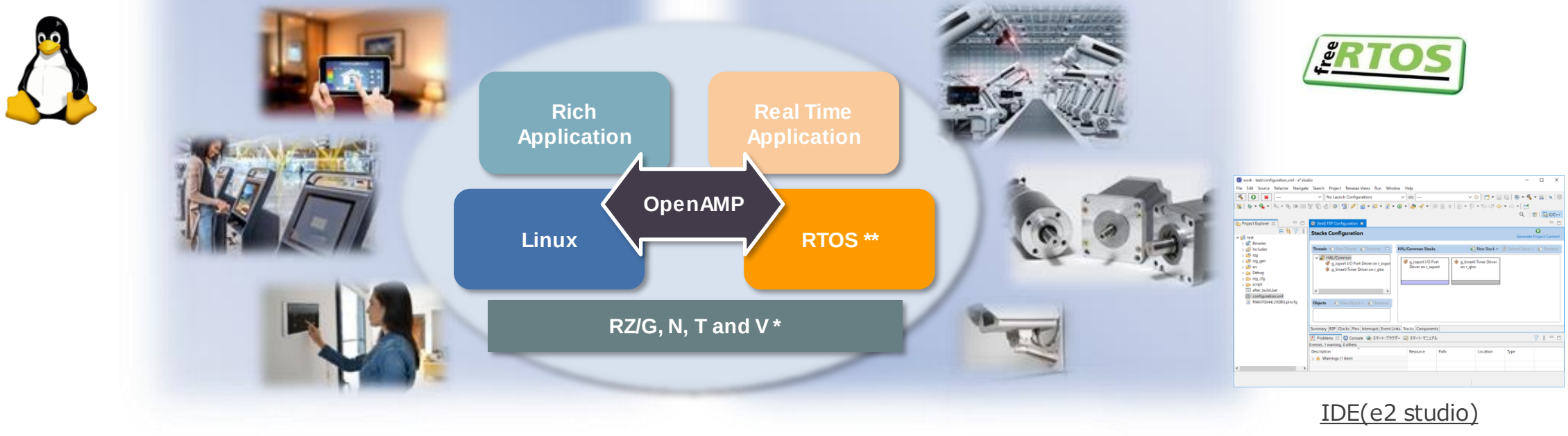
Multimedia (for RZ/G, V)
- H.264 Codec
- H.265 Codec
- 2D/3D graphics

Security Software (for RZ/G, N)
- Secure boot
- Security communication
- Secure storage

MULTI OS SOLUTION

”LINUX + RTOS” SOLUTION REALIZES BOTH RICH HMI AND REAL-TIME OPERATION IN THE ONE SYSTEM

- Rich Graphics & HMI on Cortex-A
- Real-time application on Cortex-M/Cortex-R



IDE(e2 studio)

Providing OpenAMP for Inter-Processor communication

- Provides OpenAMP environment and sample software for Linux and FreeRTOS

* Supported devices : RZ/G2L, G2LC, G2UL, V2L, N1D, N2xx, T2xxx

** Supported device drivers and middleware differ depending on each product

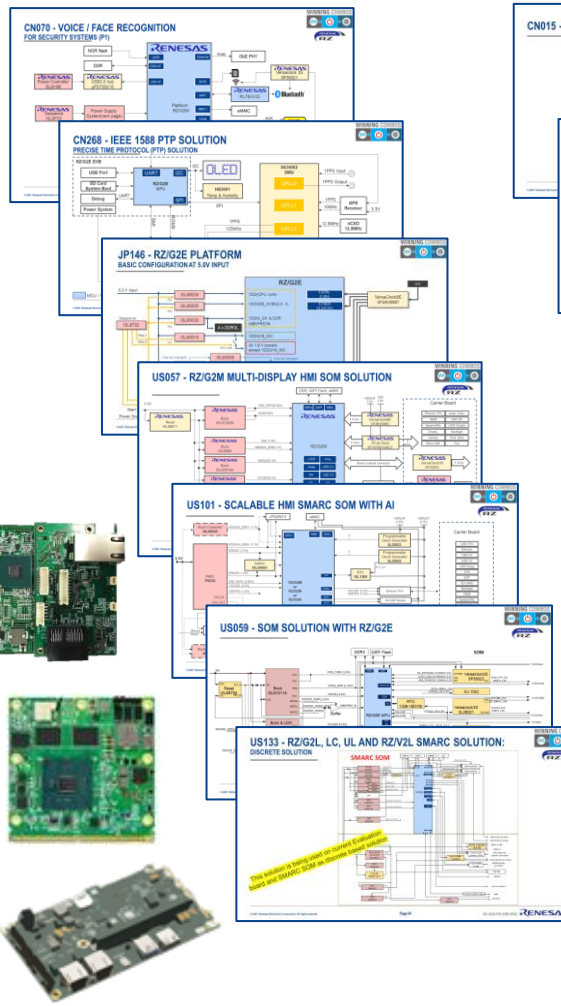
Providing IDE (e2 studio) for Cortex-M/Cortex-R

- e2 studio(IDE) enables efficient software development.
- Providing software that complies with the Flexible Software Package (FSP) Drivers and middleware can be added and set using the e2 studio GUI.

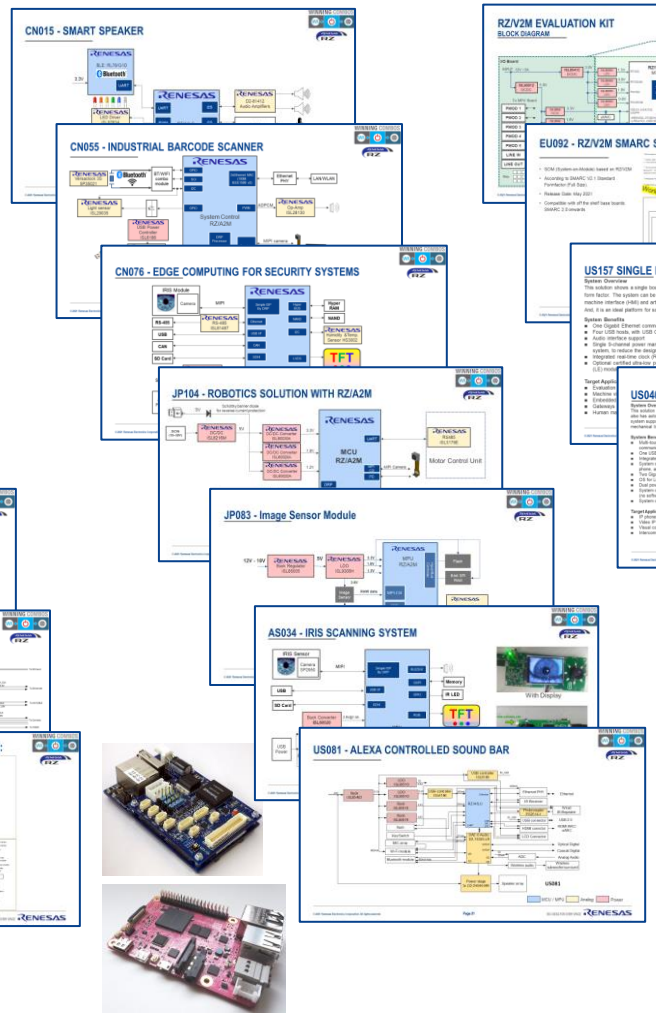
MANY EXAMPLES OF SOLUTIONS USING RENESAS PRODUCTS

WINNING COMBINATION : WE ARE POSTING, BUT NOT ALL, SOLUTIONS FOR EACH FAMILY AND SERIES, AND WE WILL GRADUALLY INCREASE SOLUTIONS.

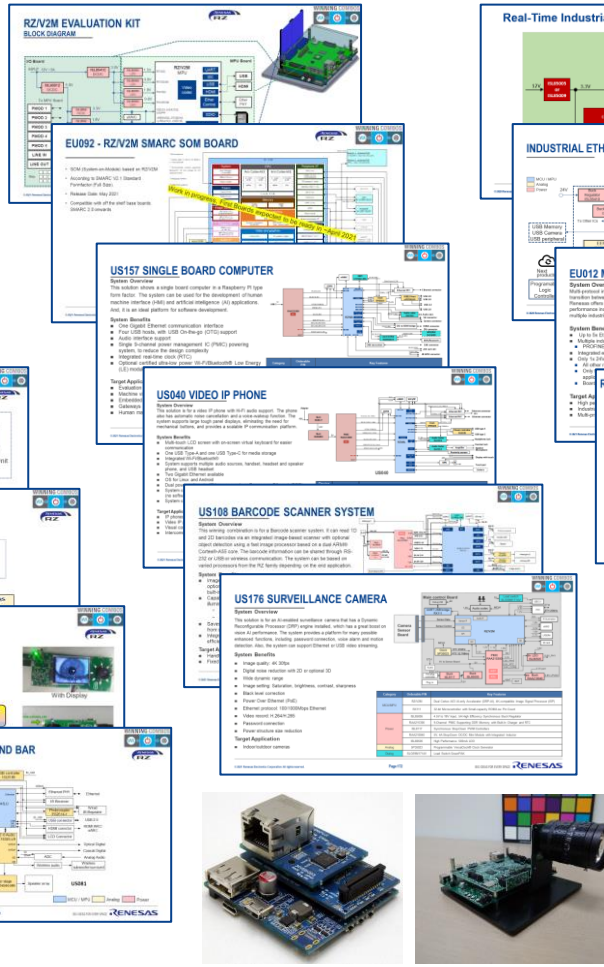
RZ/G Series



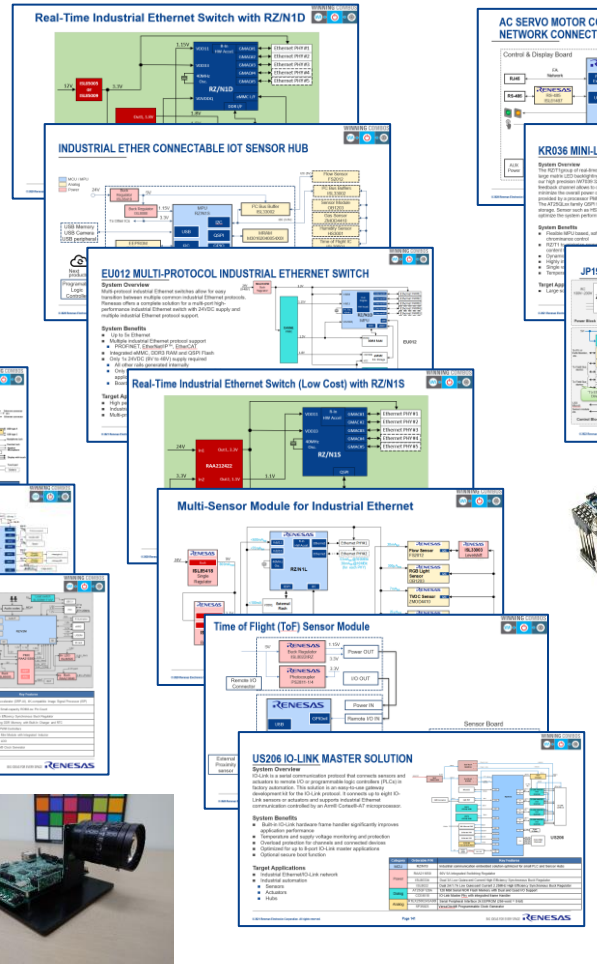
RZ/A Series



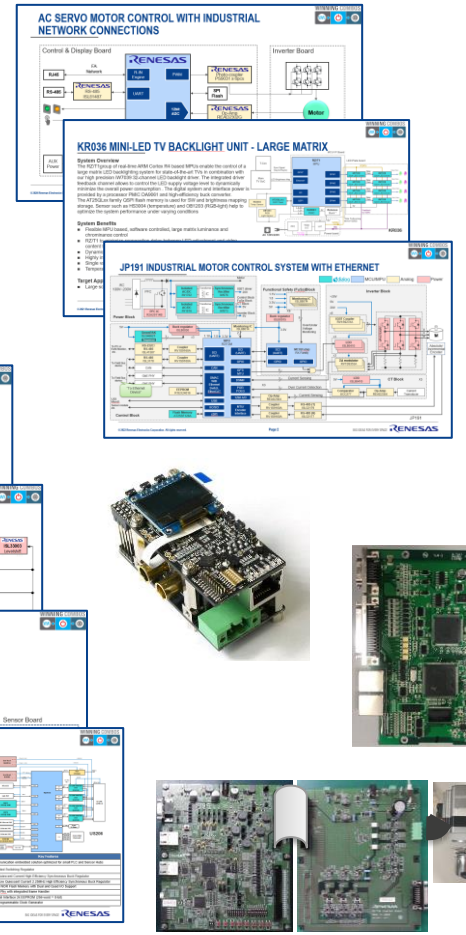
RZ/V Series



RZ/N Series



RZ/T Series



https://www.renesas.com/us/en/application/winning-combinations

APPENDIX (PRODUCT COMPARISON)

RZ FAMILY FEATURES FOR VISION AI

High Performance

Entry Class

Pin Compatible

Pin Compatible

V2M	V2L	G2L	G2LC	G2UL
HW Accelerator	HW Accelerator	CPU (x2)	CPU (x2)	CPU (x1)
42fps (TinyYOLOv2, FP*) 55fps (Mobilenetv2,FP*)	28fps (TinyYOLOv2,FP*) 39fps (Mobilenetv2, FP*)	- 18fps (Mobilenetv2, INT8*)	- 18fps (Mobilenetv2, INT8*)	- 10fps (Mobilenetv2, INT8*)
DRP-AI Translator (Converted from ONNX)	DRP-AI Translator (Converted from ONNX)	ONNX, Tensorflow Lite, Tensorflow, ArmNN	ONNX, Tensorflow Lite, Tensorflow, ArmNN	ONNX, Tensorflow Lite, Tensorflow, ArmNN
MIPI CSI-2 x2	MIPI CSI-2 x1	MIPI CSI-2 x1	MIPI CSI-2 x1	MIPI CSI-2 x1
ISP (30fps/4K)	ISP (15fps/FHD)	-	-	-
H.265 Enc/Dec H.264 Enc/Dec	- H.264 Enc/Dec	- H.264 Enc/Dec	- -	- -
Linux	Linux+RTOS			

MIPI is a registered trademark of MIPI Alliance, Inc.

*FP: Floating Point, INT8: 8bit Integer

RZ FAMILY FEATURES FOR HMI

4K		FHD			WXGA	
Pin Compatible			Pin Compatible	Pin Compatible		
G2H / G2M / G2N		G2E	V2L / G2L	G2LC	G2UL / A3x	A1 / A2M
Cortex-A57&53* LPDDR4	* RZ/G2N has Cortex-A57 only (No Cortex-A53)	Cortex-A53 DDR3L	Cortex-A55 DDR3L/4	Cortex-A55 DDR3L/4	Cortex-A55 DDR3L/4 / DDR3L/4 Octa	Cortex-A9 Int. RAM
H.265dec H.264enc/dec		H.265dec H.264enc/dec	- H264enc/dec	- -	- -	- -
3DGfx		3DGfx	3DGfx	3DGfx	-	2DGfx
HDMI/LVDS MIPI CSI-2		LVDS MIPI CSI-2	MIPI DSI MIPI CSI-2	MIPI DSI MIPI CSI-2	Parallel MIPI CSI-2	LVDS MIPI CSI-2*
Linux			Linux+RTOS			RTOS

HDMI is a registered trademark of HDMI Licensing LLC.

*: RZ/A2M only

RZ FAMILY FEATURES FOR IOT EDGE

8 to 2 cores			2 cores		1 core					
Pin Compatible				Pin Compatible						
G2H	G2M	G2N	G2E	G2L	G2LC	G2UL	Five	A3x	A1 A2M	N2x
4xCortex-A57 4xCortex-A53	2xCortex-A57 4xCortex-A53	2xCortex-A57 -	- 2xCortex-A53	- 2xCortex-A55	1xCortex-A55	- 1xAX45MP	1xCortex-A55	- 1xCortex-A9	- -	
1xCortex-R7	1xCortex-R7	1xCortex-R7	1xCortex-R7	1xCortex-M33	1xCortex-M33	-	-	-	1xCortex-R52	
LPDDR4x64	LPDDR4x64	LPDDR4x32	DDR3Lx32	DDR3L/4x16	DDR3L/4x16		DDR3L/4x16 Octa x8	Int. RAM	Int. RAM	
PCIe Gbit Ether USB3, USB2 CAN	PCIe Gbit Ether USB3, USB2 CAN	PCIe Gbit Ether USB3, USB2 CAN	PCIe Gbit Ether USB3, USB2 CAN	- Gbit Ether USB2 CAN	- Gbit Ether USB2 CAN			- Ether USB2 CAN	Gbit Ether 3port Switch & TSN** USB2, CANFD	
Security	Security	Security	Security	Security	Security		-	Security*	Security	
Linux			Linux+RTOS		Linux		RTOS			

*: RZ/A2M only **TSN : Time Sensitive Networking Under development/planning

RZ FAMILY FEATURES FOR IOT EDGE (INDUSTRIAL AUTOMATION)

for High-ed controller (PLC/ motion controller)			for network controller (Gateway, remote I/O..)		for Realtime controller (Robot, servo, inverter)				
N2xx	N1D	N1S	N2x	N1L	T2xxx	T2x	T2xx	T1	N2x
4xCortex-A55 2xCortex-R52	2xCortex-A7 1xCortex-M3	1xCortex-A7 1xCortex-M3	1xCortex-R52 -	1xCortex-M3 -	4xCortex-A55 2xCortex-R52	2xCortex-R52 -	1xCortex-R52 -	1xCortex-R4 1xCortex-M3	1xCortex-R52 -
LPDDR4x32	DDR3x16	Int. RAM	Int. RAM	Int. RAM	LPDDR4x32	Int. RAM	Int. RAM	Int. RAM	Int. RAM
3xGMAC, 4port Switch TSN & IE*	2xGMAC 5port Switch IE*	2xGMAC 5port Switch TSN & IE*	Gbit Ether 3port Switch TSN & IE*	2xGMAC 3port Switch TSN & IE*	3xGMAC, 3port Switch TSN & IE*	Gbit Ether 3port Switch TSN & IE*	Gbit Ether EtherCAT	Gbit Ether 3port Switch IE*	Gbit Ether 3port Switch TSN & IE*
Display out PCIe, USB3, USB2, CANFD	Display out USB2 CAN	- USB2 CAN	- USB2 CANFD	- USB2 CAN	- PCIe, USB3, USB2, CANFD, Encoder I/F	- USB2 CANFD, Encoder I/F	- USB2 CANFD, Encoder I/F	- USB2 CAN, Encoder I/F	- USB2 CANFD,
-	-	-	-	-					-
Security	Security	Security	Security	Security	Security	Security	Security	Security	Security
Linux+RTOS		RTOS / Baremetal			Linux+RTOS	RTOS / Baremetal			

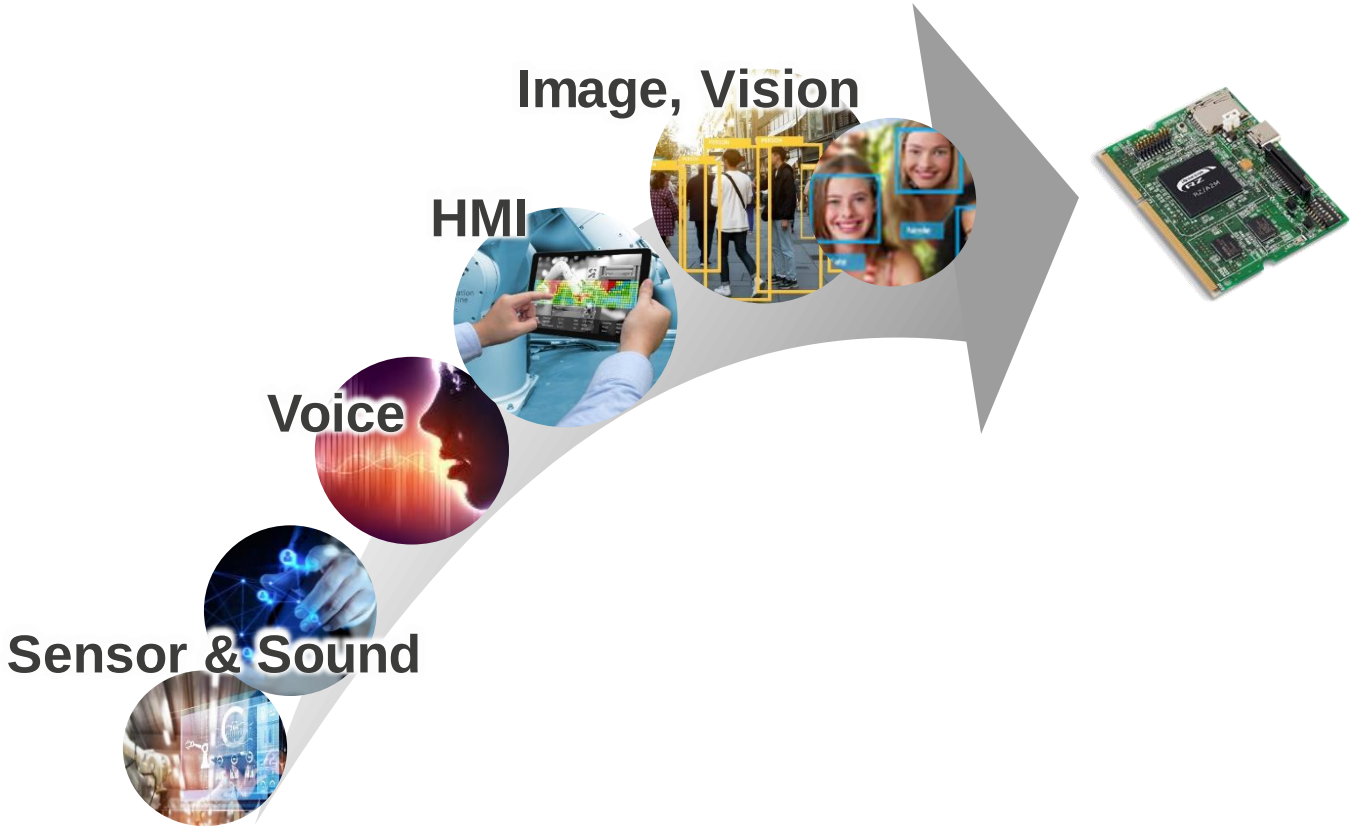
*IE : Multi-protocol Industrial Ethernet

Under development/planning

APPENDIX (AI PART)

EVOLUTION OF AI APPLICATIONS

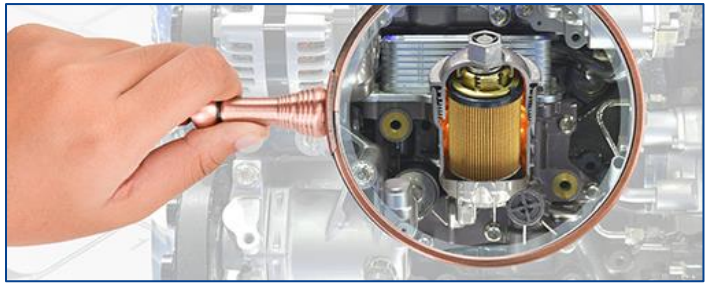
Deployable on Embedded MPU/MCU



Common use cases

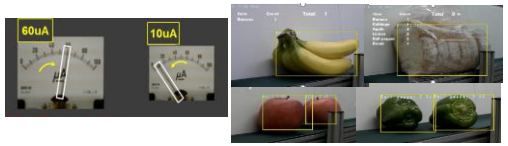
Failure prediction

Reduce maintenance cost
Improve service quality



Recognition

Objects,
industrial automation, retails



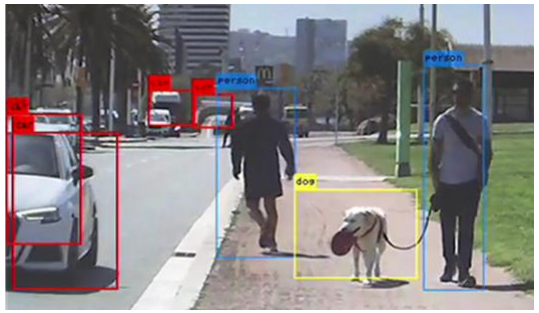
Surveillance,
smart society

Biometrics,
entrance security, payment

AI EVOLUTION ACCELERATES FURTHER
EXPANSION OF AI APPLICATION SCENES

Until Now

Object / Machine Centric



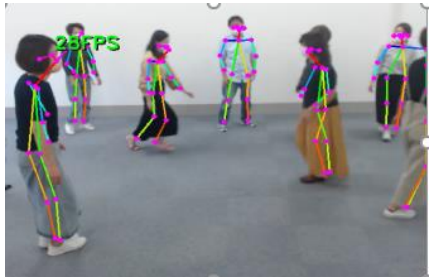
From Now

READY TO USE

Human Behavior Centric

Worker's pose estimation

Multiple people



Abnormal/dangerous behavior detection as safety function

AI will sustain growing needs in diversified services involving human behavior

FULFILLING DEVELOPMENT SUPPORT ENVIRONMENT

■ Renesas prepare tools, document for easy evaluation, design, and development.

DRP-AI Translator

AI development support

- Convert AI model from ONNX to object code for DRP-AI

Evaluation Board

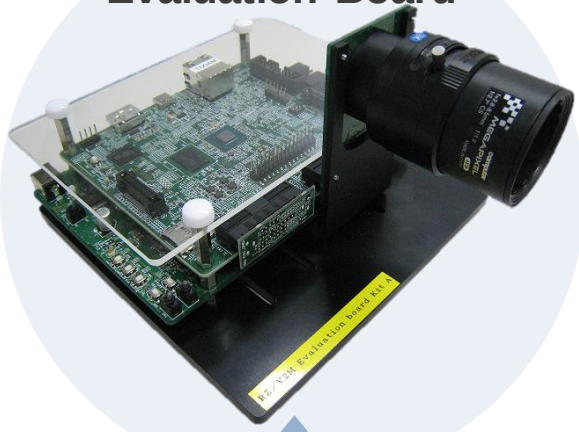


Image Quality Adjustment Tool

ISP adjustment support

- Initial settings for ISP parameter
- Adjustment to install product on field

Solution

System and software development support

- CIP Linux BSP
- ISP Support Package(multimedia software)
- DRP-AI Support Package

Design materials

Design Support

- Design guide for circuit
- Schematics of board
- Pattern information
- Parts list

Document

Development support

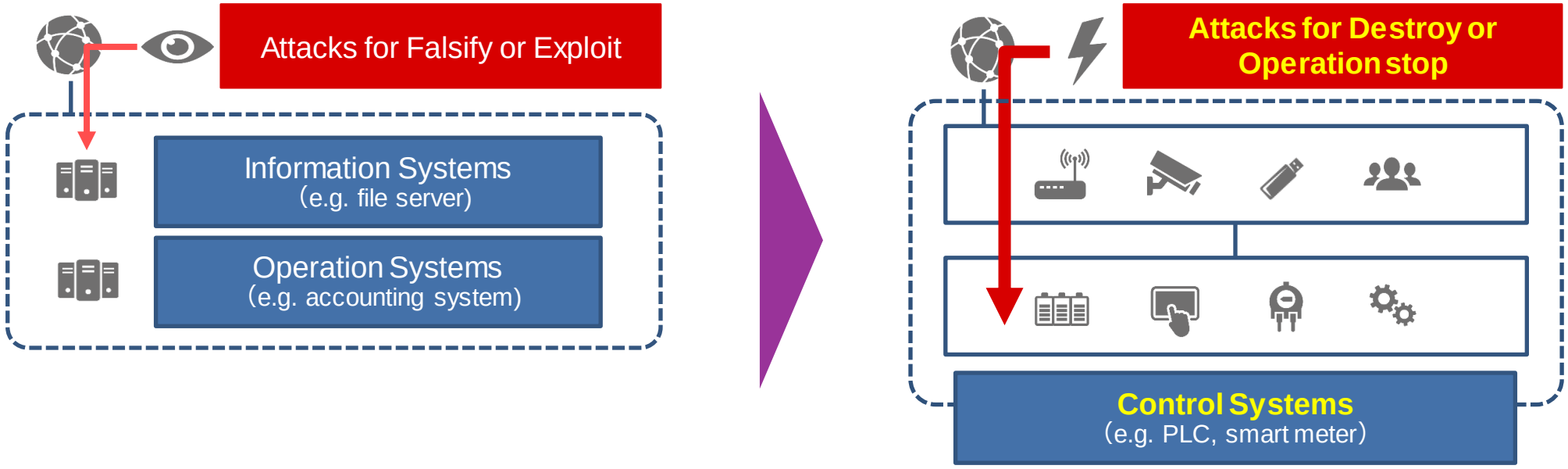
- Datasheet
- User's Manual
- Guide for AI implementation
- API specification

APPENDIX (SECURITY)

E2E SECURITY
THREATS OF CYBER-ATTACK GROWING IN THE ENDPOINT

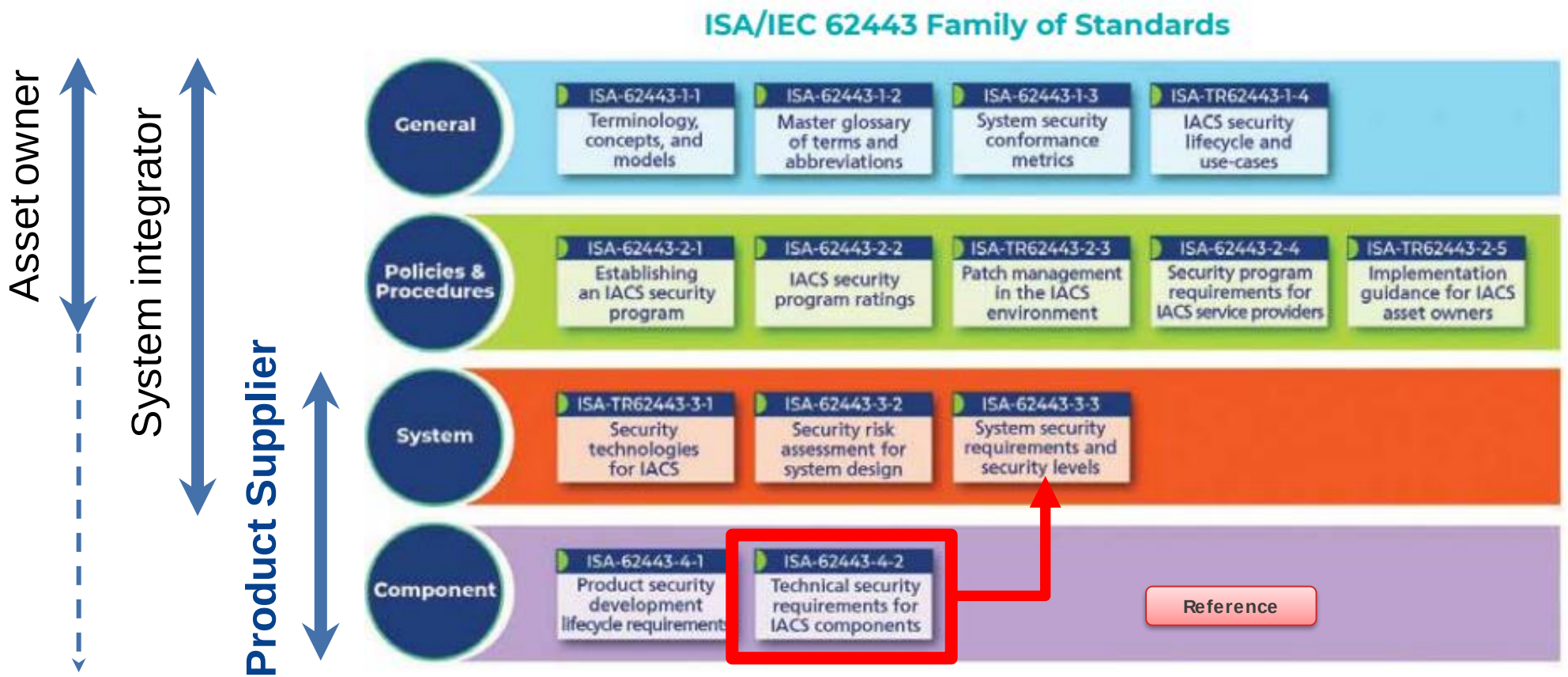
Targets are changing from information assets to control systems

- **With the evolution of IoT,** control systems built on stand-alone networks are becoming targets of cyber-attacks
- Attackers aim to generate **physical impacts** such as operation stops and system destruction
- Security management is shifting from protecting information assets to **protecting the control system itself**



E2E SECURITY

IEC 62443 TARGETS ALL VERTICALS AND PLAYERS



Cited from Quick Start Guide: An Overview of ISA/IEC 62443 Standards, Security of Industrial Automation and Control Systems

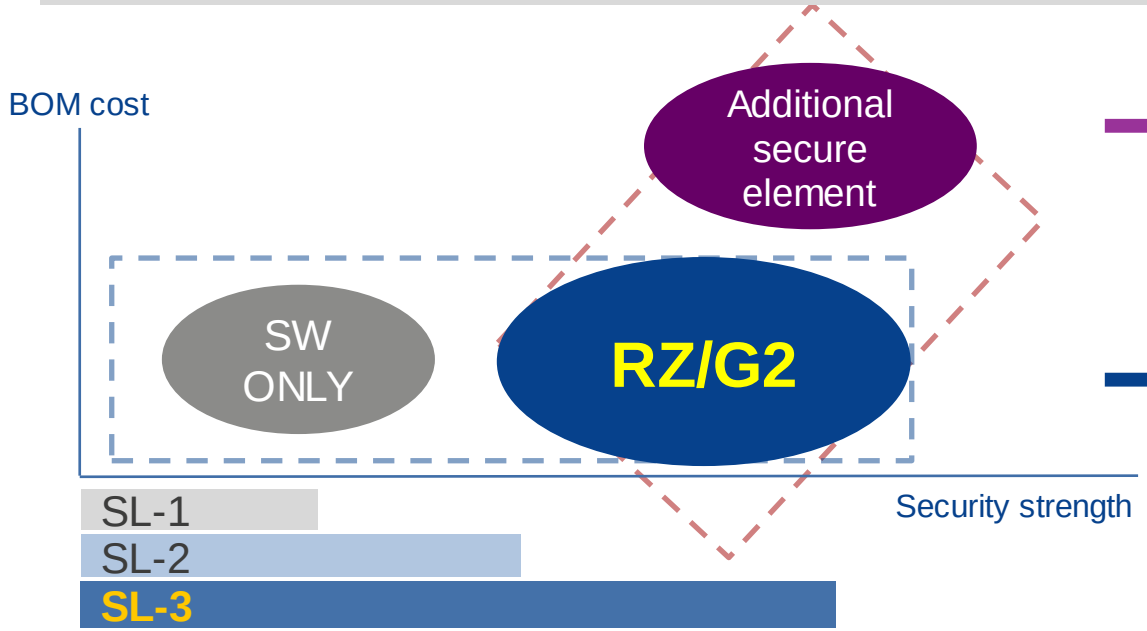
READY-TO-USE RENESAS SOLUTION

E2E SECURITY

Renesas RZ/G2 MPUs provide optimized security between cost vs IEC 62443-4-2 requirement

Sufficient, but not excessive, security features for SL-3 without impacting product cost

INSUFFICIENT	SUFFICIENT	EXCESSIVE
No hardware security, Not compliant with SL-3	RZ/G2 supports **embedded** security IP compliant for **SL-3**	An additional secure element increases BOM cost



Additional secure elements such as Trusted Platform Module approach would improve security, while increasing product cost

RZ/G2 MPU offer effective security IP for SL-3 inside, no additional security HW needed