

ENHANCING ENDPOINT INTELLIGENCE

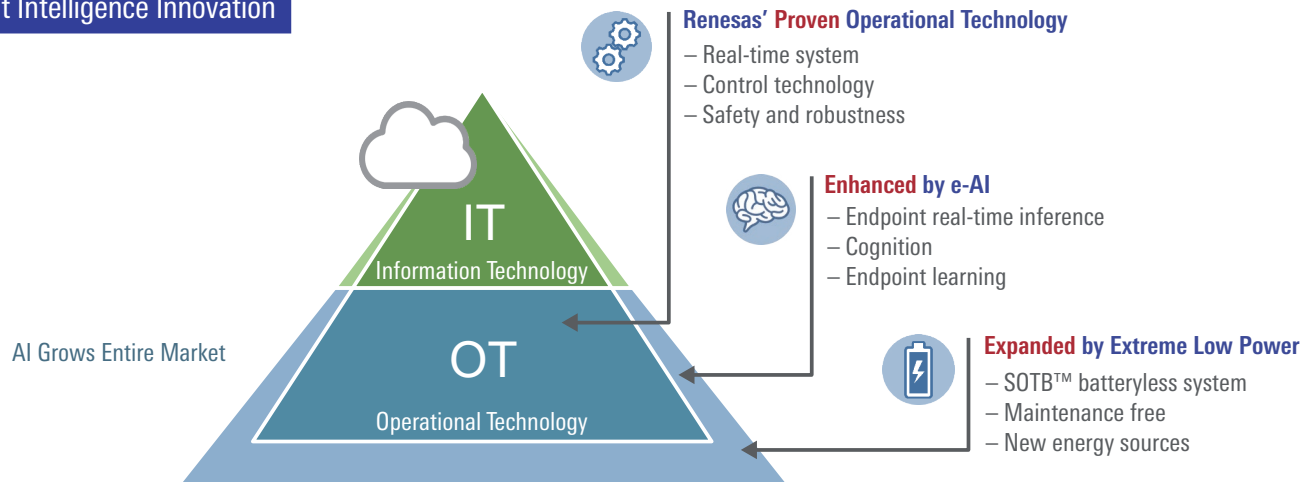
With Embedded Artificial Intelligence (e-AI) from Renesas



Real-time Intelligence without Cloud Lag

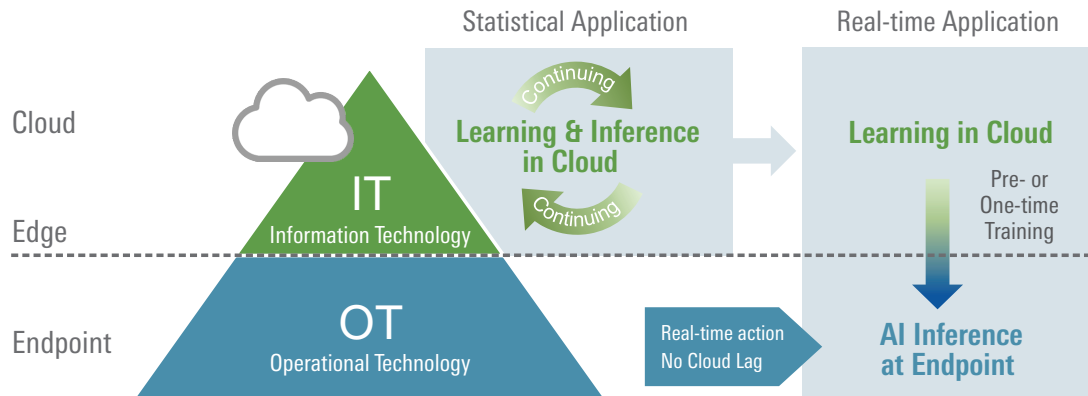
Artificial Intelligence is rapidly driving growth in the information technology (IT) and operational technology (OT) domains. For years, Renesas has been a leader in OT endpoint applications with microprocessor and microcontroller solutions. Leveraging that experience, Renesas' e-AI solutions are enhancing OT-based systems and products that we use around us every day by placing AI where it matters the most – at the endpoint – while decoupling dependency on the Cloud for real-time decisions and real-time action. Additionally, Renesas will expand e-AI application possibilities with the use of its exclusive extreme low-power process technology, Silicon On Thin Buried Oxide or SOTB™, to enable batteryless solutions powered only by harvested ambient energy. Think of the possibilities.

Endpoint Intelligence Innovation



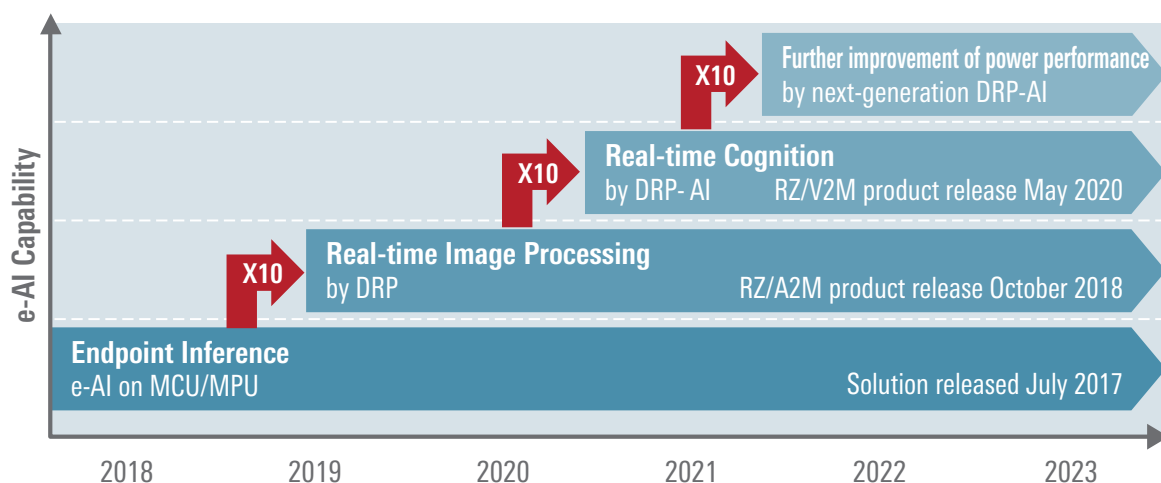
e-AI: Local Real-time AI by Inference

- Traditional statistical AI applications execute completely in the Cloud
- Real-time applications cannot tolerate cloud lag at the endpoint
- e-AI takes immediate action locally through inference from cloud-trained AI neural networks



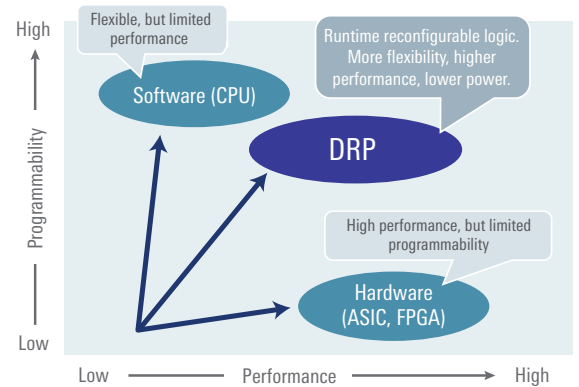
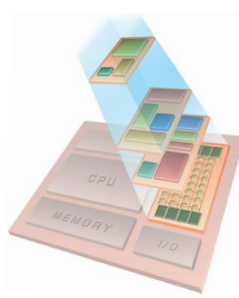
e-AI Capability Advancements

- Renesas is evolving e-AI. From MCU to MPU and then to Embedded-AI MPU, AI performance improves with each step
- Exclusive Dynamically Reconfigurable Processor (DRP) technology accelerates image processing, object recognition, AI, and cognitive decision making
- Each advance in DRP (see below) brings 10 times the computing power of the previous generation



Dynamically Reconfigurable Processor (DRP)

- **DRP**
 - Dynamically reconfigurable acceleration hardware
 - Offloads burden of specialized tasks from main processor
- **Extreme Efficiency**
 - Higher performance and lower power than use of CPU, GP-GPU, DSP, or FPGAs
- **Flexibility**
 - It is possible to execute different tasks by switching DRP libraries, even while the MPU is operating
 - Continuous new functions available to previously shipped products extend product life
- **Acceleration**
 - Image processing: edge detection, gray level, feature extraction, and more
 - Next: AI acceleration



Accelerate Video Processing with DRP

Process	Execution Time (ms)	
	DRP	CPU
Canny Edge Detection	9.3	138.3*
Harris Corner Detection	13.8	294.1*
QR Marker Detection	31.3	223.0**

* CPU: Using OpenCV (cv::medianBlur+cv::Canny)

** QR Marker detection: ZBar (cv::medianBlur+Zbar detection)

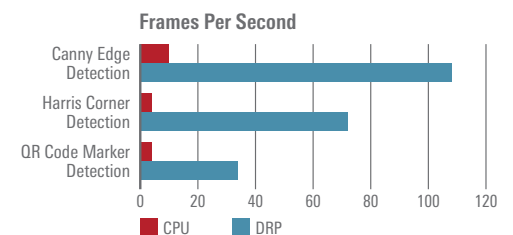


Image size: 800x480 WVGA
Image color: Grayscale 8BPP
CPU: RZ/A2M Cortex-A9 @ 528 MHz
DRP: Frequency 33 MHz ~ 66 MHz

RZ/A2M Microprocessor with DRP – Hardware Acceleration for e-AI

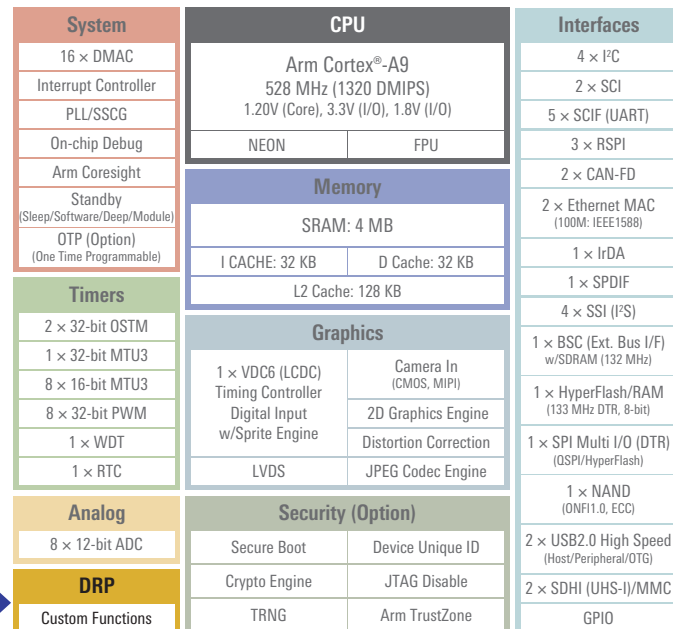
Performance and Flexibility

- **Ideal for Human Machine Interface (HMI)**
 - Multiple video output standards
 - Multiple graphics engines
- **Accelerate Image Recognition**
 - Boost image processing x10 with DRP
 - MIPI CSI camera interface
- **Advanced Security**
 - Secure boot, communication, and update

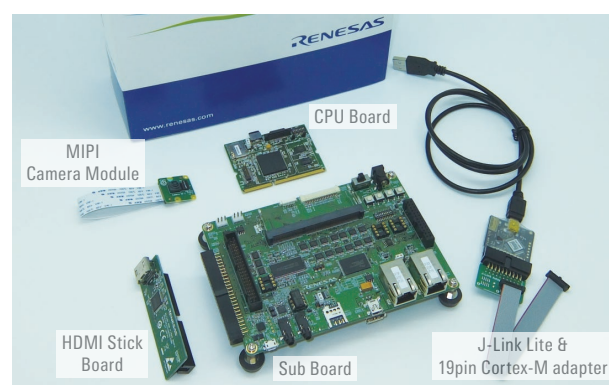
Software Package for AI+HMI

- RTOS, drivers, and middleware
- DRP tools, libraries, and application layer
- Smart configurator for SDK
- Quick and efficient camera/display graphical configuration with real-time feedback
- Seamless integration with TES Guiliani GUI framework

RZ/A2M Microprocessor Block Diagram



New in RZ/A2M



RZ/A2M Awarded
2018 Product of The Year
by Electronic Products

RZ/A2M Evaluation Platform

- Supports DRP evaluation
- MIPI Camera Module (MIPI CSI)
- HyperMCP with HyperFlash™ and HyperRAM™
- RGB conversion board for HDMI display
- 2ch Ethernet communication
- Other peripheral functions, such as SDHI and USB

Kit Part Number: RTK7921053S00000BE

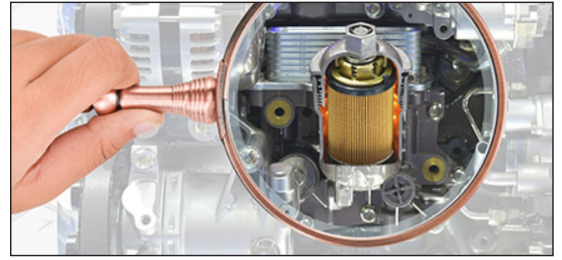
Learn more:

<https://www.renesas.com/RZA2M>

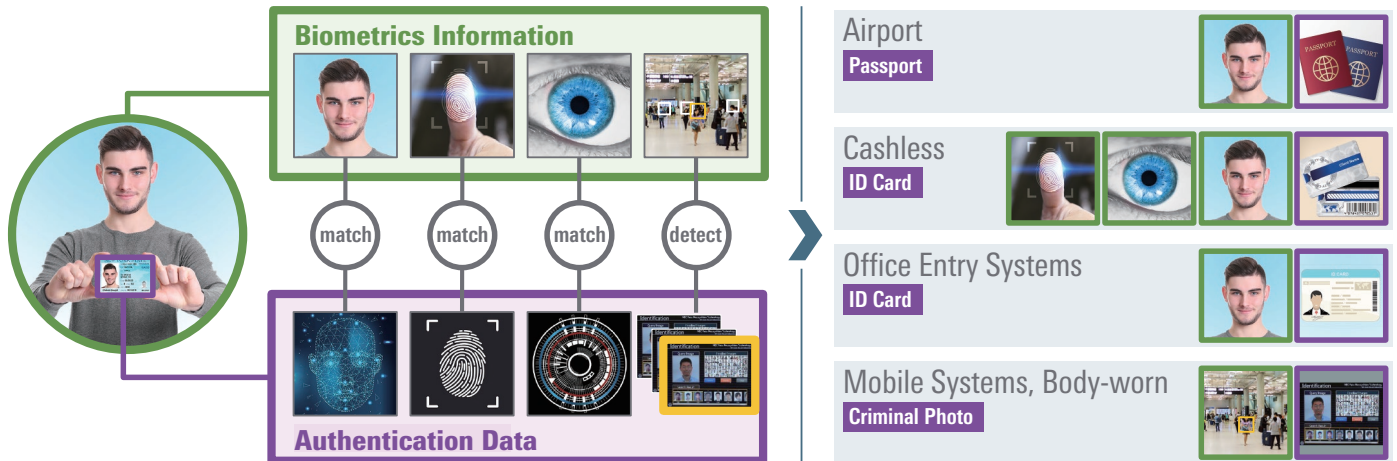
e-AI Use Cases

e-AI Failure Prediction for Motors

- Detects previously invisible faults in real time by minutely analyzing oscillation waveforms from motors through current, vibration, or sound
- Predicts failure before it occurs to enable early warning
- Improves service quality, avoids downtime, and reduces maintenance costs



e-AI Multimodal Biometrics Authentication by Image Recognition



e-AI Deployed at Renesas Semiconductor Factory

Smart Factory moves from Preventive Maintenance to Predictive Maintenance

- Successfully detected defective wafers using e-AI, same as human experts could do
- Reduced false alarms from 50 incidents per month to ZERO
- Anomaly detection rate improved by 6x
- Reduced engineering resources required to respond
- Eliminated requirement to set statistical thresholds

Renesas installed over 150 AI units into one of its own semiconductor factories, with 3,000 more AI units on the way

Renesas Naka Wafer Fabrication Factory



Add-on AI Units



Learn more about Renesas e-AI solutions at:

<https://www.renesas.com/e-ai>

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