

# ENHANCING ENDPOINT INTELLIGENCE

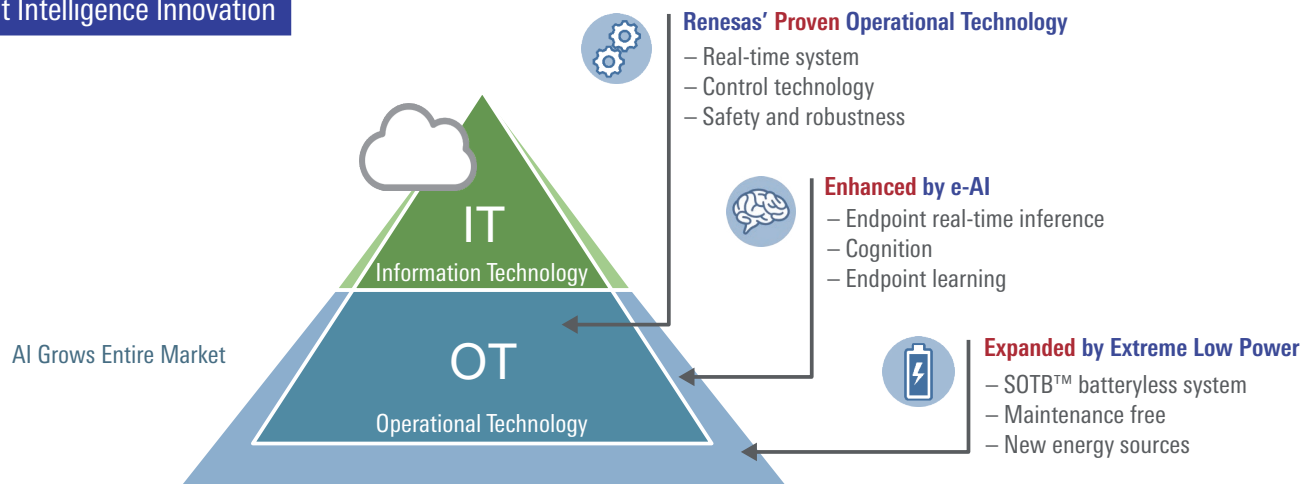
With Embedded Artificial Intelligence (e-AI) from Renesas



## Real-time Intelligence without Cloud Lag

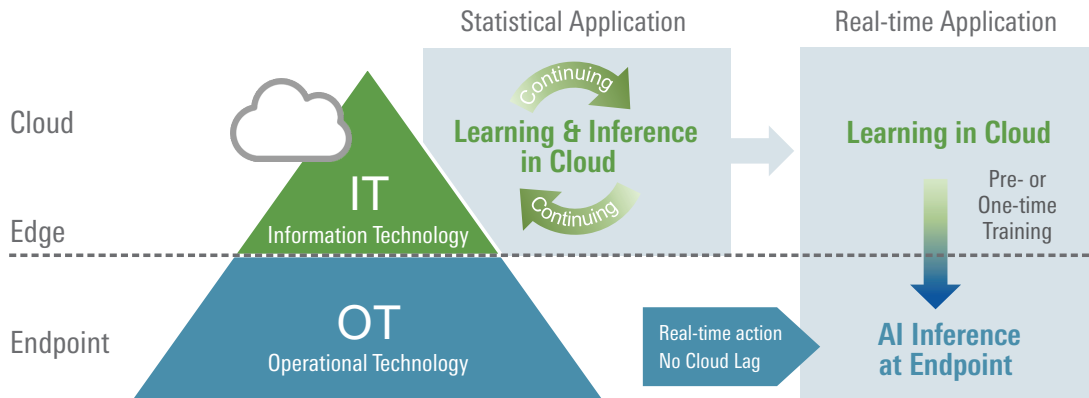
Artificial Intelligence is rapidly driving growth in the information technology (IT) and operational technology (OT) domains. For years, Renesas has been a leader in OT endpoint applications with microprocessor and microcontroller solutions. Leveraging that experience, Renesas' e-AI solutions are enhancing 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



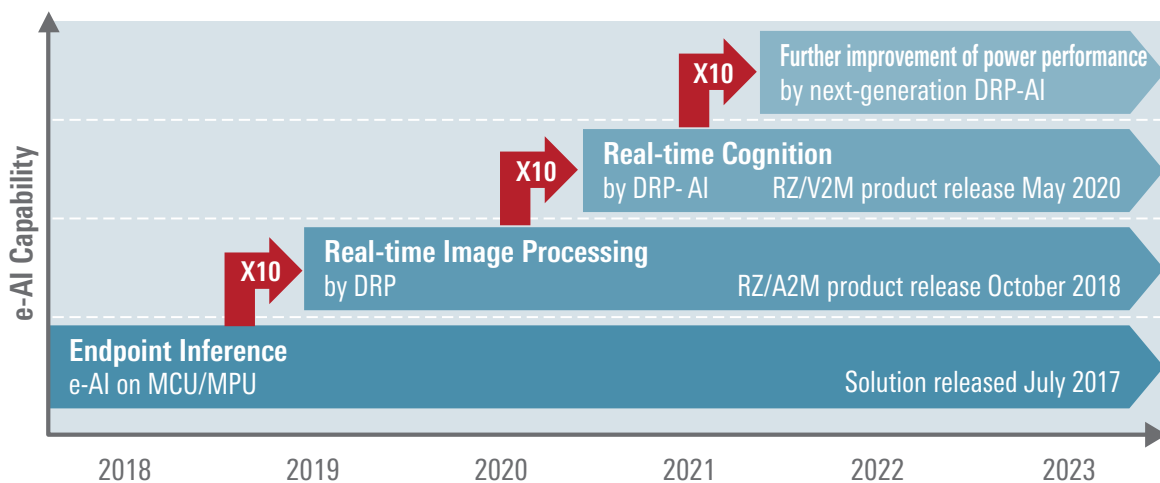
## e-AI: Local Real-time AI by Inference

- 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



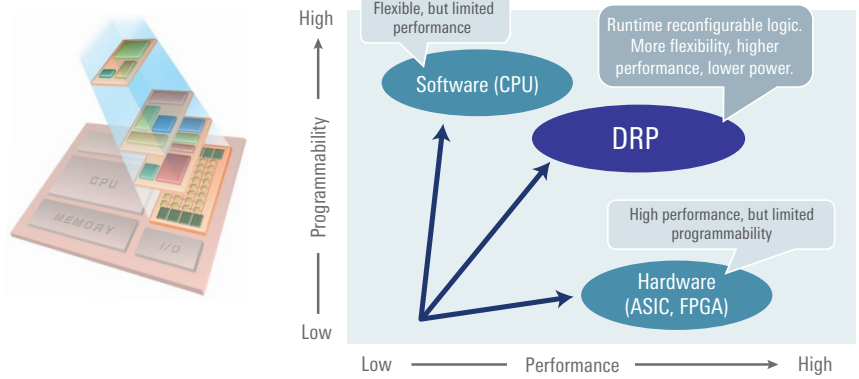
## e-AI Capability Advancements

- 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)

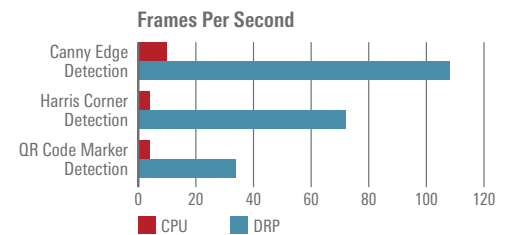


Image size: 800x480 WVGA  
 Image color: Grayscale 8BPP  
 CPU: RZ/A2M Cortex-A9 @ 528 MHz  
 DRP: Frequency 33 MHz ~ 66 MHz

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

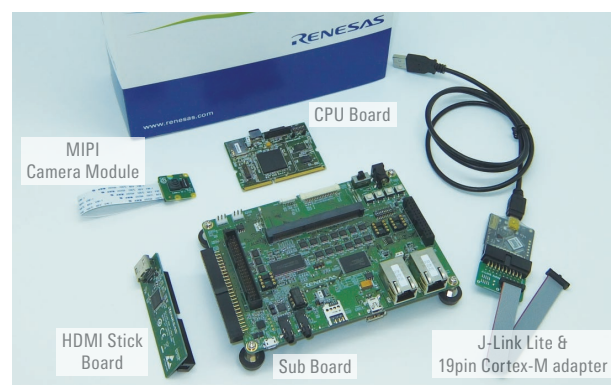
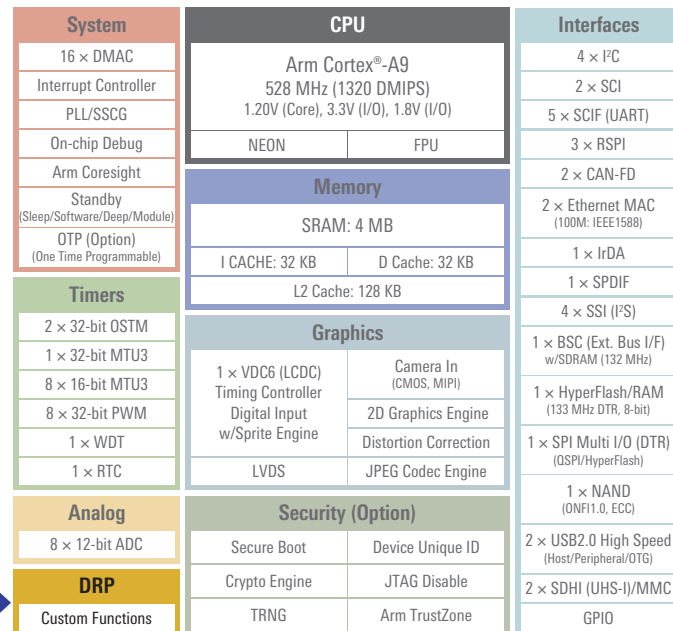
### Performance and Flexibility

- **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



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

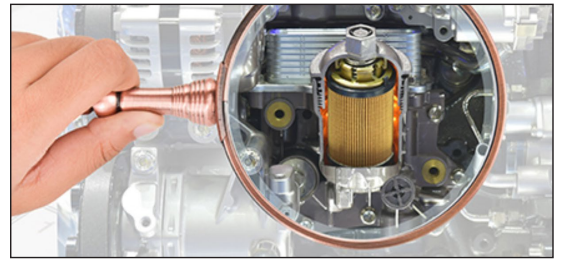
Learn more:

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

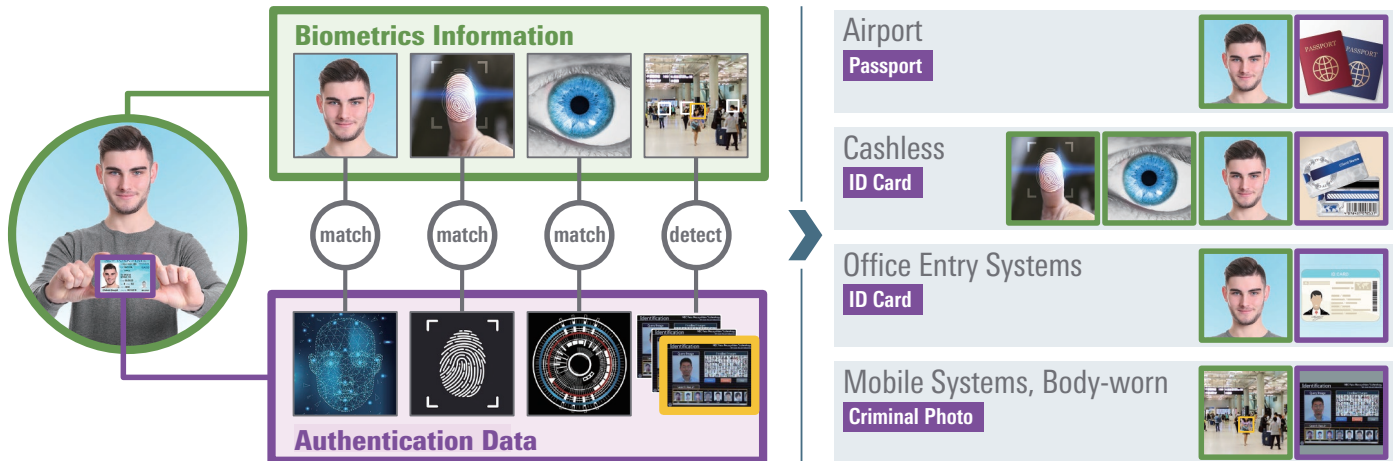
## e-AI Use Cases

### 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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