RENESAS
BIG IDEAS FOR EVERY SPACE

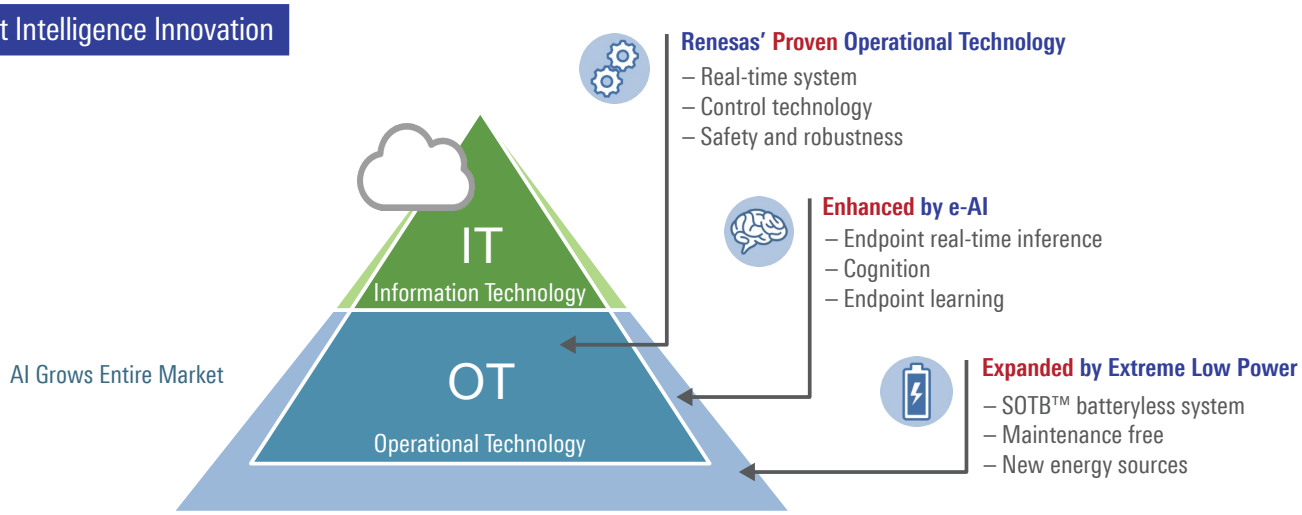
ENHANCING ENDPOINT INTELLIGENCE

With Embedded Artificial Intelligence (e-AI) from Renesas

Real-time Intelligence without Cloud Lag

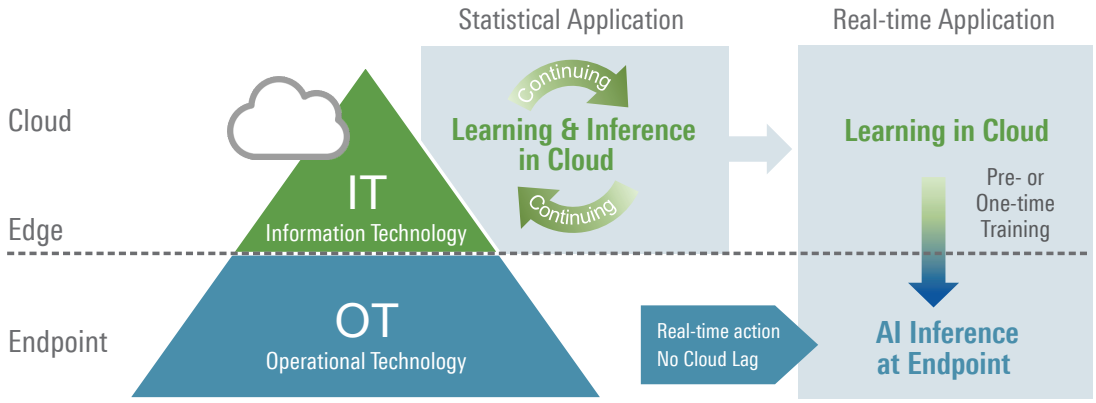
Artificial Intelligence is rapidly driving growth in the information technology (IT) and operational technology (OT) domains. For years, Renesas has been a leader in OT endpoint applications with microprocessor and microcontroller solutions. Leveraging that experience, Renesas' e-AI solutions are enhancing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



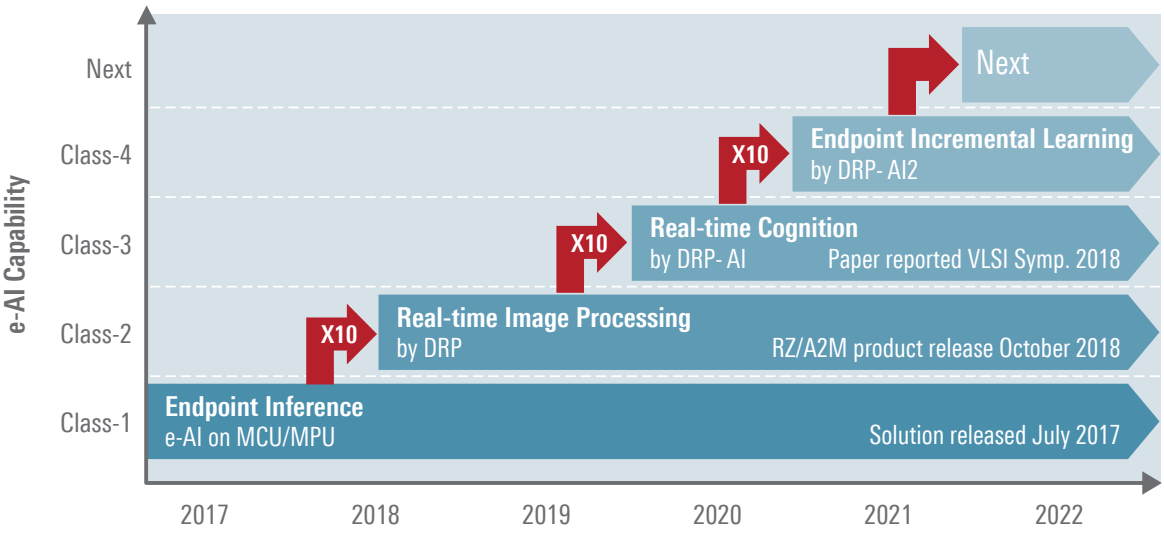
e-AI: Local Real-time AI by Inference

- 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



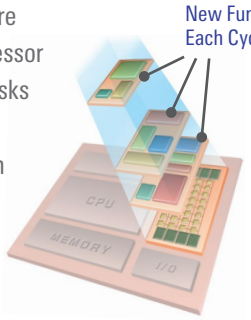
e-AI Capability Advancements

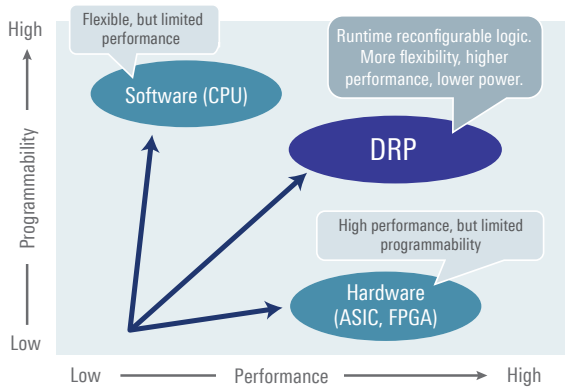
- Renesas is evolving e-AI. Classes 1 through 4, and beyond, increase capability incrementally at each step while keeping similar power consumption
- Exclusive Dynamically Reconfigurable Processor (DRP) technology and architecture accelerate image processing, object recognition, AI, and cognitive decision making
- Each evolution step represents 10 times the previous computing power due to DRP (see below) advancement
- Class 4 represents capability of incremental learning without connection to the Cloud to solve complex graphical problems and process multi-sensor inputs for robotics



Dynamically Reconfigurable Processor (DRP)

- DRP – Reconfigurable Acceleration Hardware
  - Multi-application, massively parallel processor
  - Offloads main processor for specialized tasks
- Extreme Efficiency
  - Higher performance and lower power than use of CPU, GP-GPU, DSP, or FPGAs
  - Reduced memory requirements and memory access
- Flexibility
  - Run-time reconfigurable logic can execute different tasks as needed on each DRP processor cycle
  - Continuous new functions available to deployed 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)

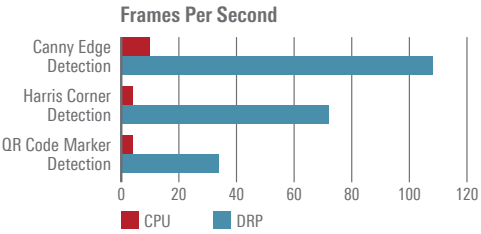


Image size: 800x480 WVGA
Image color: Grayscale 8BPP
CPU: RZ/A2M Cortex®-A9 @ 528 MHz
DRP: Frequency 33 MHz ~ 66 MHz

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

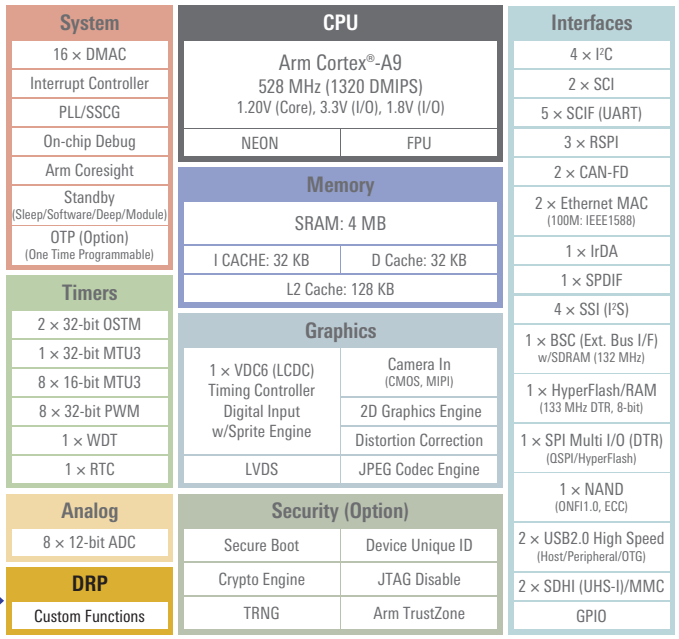
RZ/A2M Evaluation Platform

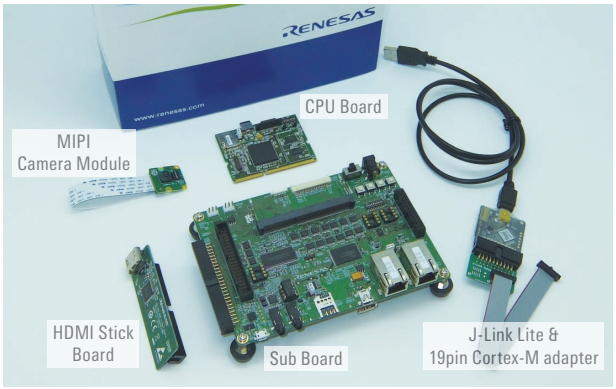
- Supports DRP evaluation
- MIPI Camera Module (MIPI CSI)
- HyperMCP with HyperFlash™ and HyperRAM™
- RGB conversion board for HDMI display
- 2ch Ethernet communication
- Other peripheral functions, such as SDHI and USB

Kit Part Number: RTK7921053S00000BE

Learn more:
https://www.renesas.com/RZA2M

RZ/A2M Microprocessor Block Diagram



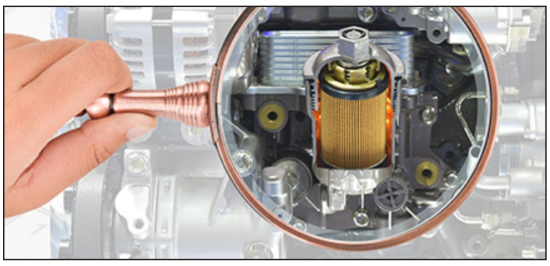


RZ/A2M Awarded 2018 Product of The Year by Electronic Products

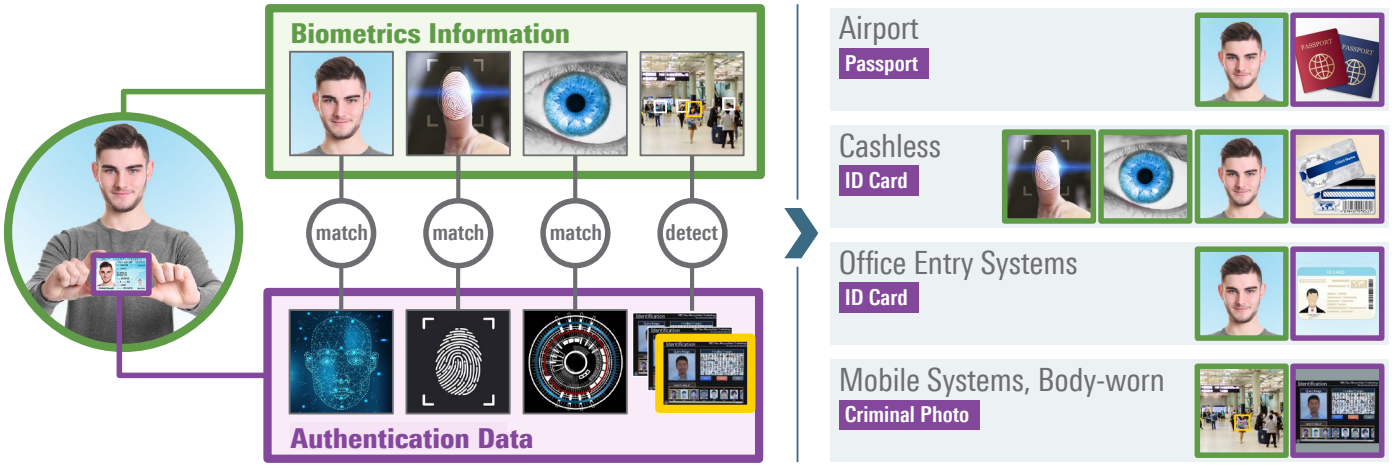
e-AI Use Cases

Class 1: 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



Classes 2 and 3: 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