### Solution Brief

# Red Hat x intel.

## Modular AI-Vision Robotic Control at the Edge

Powered by Intel® AI Edge Technologies and Red Hat® Enterprise Linux®

### Smarter Robotics at the Edge. Real-time Precision. Flexible Integration.

#### **Authors**

#### Intel www.intel.com

Dario Russo Matthias Seidel Candy Wei Ralph Wittmann

#### **Red Hat**

www.redhat.com

David Rapini Fabien Dupont

#### Introduction

In the fast-evolving world of smart industrial automation, achieving scalable, secure, and intelligent automation is a critical advantage. Intel® AI Edge Technologies [1] combined with Red Hat® Enterprise Linux® (RHEL) [2] for Real-Time offer an advanced, adaptable platform for high-precision robotic control. For manufacturing and automation engineers and leaders, system integrators, and edge Artificial Intelligence (AI) developers, the ability to deploy flexible, intelligent robotics is a growing competitive advantage.

The Robot Vision and Control (RVC) demo is based on Robot Operating System 2 (ROS2) and unifies AI-powered perception and precise robotic control at the edge. RVC demonstrates seamless integration of vision, motion, and automation. It showcases the consolidation of multiple workloads with different timing requirements. It is running real-time (RT) as well as non-real-time (Non-RT) applications like RT Control, Human-Machine Interface (HMI), AI inferencing, computer vision, and automation control.

#### System Architecture and Technologies

Figure 1 presents the system architecture diagram of the RVC Demo. It runs on Intel® Edge Control Nodes and Red Hat® Enterprise Linux® (RHEL) for Real-Time. It uses OpenVINO<sup>™</sup> [3] to optimize AI vision workloads across Intel® Central Processing Unit (CPUs), Graphics Processing Unit (GPUs), Neural Processing Units (NPUs).

Key architectural highlights include:

- Plugin-based vision pipeline: Easily swap 2D/3D AI models.
- Hardware abstraction: Replace robots or Intel<sup>®</sup> RealSense<sup>™</sup> cameras with minimal reconfiguration.
- Container-ready: Runs in Docker, and virtual machine environments.



#### Figure 1. System Architecture Diagram



Figure 2. System Block Diagram and Workflow

Intel AI Acceleration: RVC takes full advantage of the various AI capabilities offered by Intel® Edge platforms [1]:

- Intel® CPUs: Leverage built-in instruction sets for efficient AI inference on all Intel<sup>®</sup> Core<sup>™</sup> Ultra processors.
- Intel<sup>®</sup> GPUs: Integrated Intel<sup>®</sup> Arc<sup>™</sup> and Xe GPUs deliver parallel Al processing with OpenVINO<sup>™</sup> acceleration.
- Intel® NPUs: Enable power-efficient, dedicated Al inference - ideal for always-on edge workloads.
- OpenVINO<sup>™</sup> Runtime: Dynamically distributes inference workloads across CPU, GPU, and NPU for optimal performance, offering seamless scalability, enhanced energy efficiency, and cross-platform deployment flexibility.

#### System Workflow

As illustrated in Figure 2, RVC features two core subsystems: the RVC Vision and Control subsystems. The system block diagram integrates these components to deliver real-time perception and intelligent robotic actuation-working together to enable dynamic, high-precision automation at the edge.

The RVC Vision subsystem is responsible for accurately detecting and localizing target objects. It continuously tracks moving objects using a deep neural network in 2D space, then estimates their full 6 Degrees of Freedom (6DoF) pose in 3D space through depthbased PointCloud matching.

The RVC Control subsystem uses the pose of the object to determine the optimal path for moving the robot arm toward the target position. It needs to update the robot in a deterministic way to ensure smooth and precise movement of the robot arm.

In parallel with AI vision and robot control, RVC also runs additional workloads such as:

- Software-based programmable logic control (Soft PLC) for managing conveyor belts, laser breaks, and indicator lights.
- Integrated safety logic immediately halts robot operation upon human detection in the work area based on computer vision.

Red Hat® Enterprise Linux® (RHEL) for Real-Time ensures secure, deterministic performance for mission-critical automation and AI workloads.

#### Conclusion

The RVC demo is a great example of how mixed-criticality workloads-like real-time control, non-real-time and AI workloads-can be consolidated on a single Intel silicon-based edge platform. It is designed to empower manufacturing and automation engineers, system integrators, and edge AI developers to accelerate deployment, adapt more easily, and reduce time-to-market (TTM).

#### References

[1] Intel® AI Edge, Edge AI technologies, Mar. 2025, https://builders.intel.com/intel-technologies/ai-technology/edge [2] Red Hat® Enterprise Linux® for Real Time, 2025 https://docs.redhat.com/en/documentation/red\_hat\_ enterprise\_linux\_for\_real\_time/ [3] OpenVINO<sup>™</sup> toolkit, 2025 https://docs.openvino.ai/2025/get-started.html [4] Intel White Paper, Mar. 2025, "Intel® AI Edge Systems Verified Reference Blueprint with Supermicro - Vision Al"

#### Notices & Disclaimers

- You may not use or facilitate the use of this document in connection with any infringement or other legal analysis concerning Intel products described herein.

Your costs and results may vary.

Intel technologies may require enabled hardware, software or service activation.

You may not use or facilitate the use of this document in connection with any infringement or other legal analysis concerning Intel products described herein. You agree to grant Intel a nonexclusive, royalty-free license to any patent claim thereafter drafted which includes subject matter disclosed herein. The products described may contain design defects or errors known as errata which may cause the product to deviate from published specifications. Current characterized errata are

available on request. ©

No license (express or implied, by estoppel or otherwise) to any Intellectual property rights is granted by this document. All information provided here is subject to change without notice. Contact your Intel representative to obtain the latest Intel product specifications and roadmaps. The products described may contain design defects or errors known as errata which may cause the product to deviate from published specifications. Current characterized errata are available on request.

Intel assumes no responsibility or liability arising out of the application or use of any information, product, or service described herein except as expressly agreed to in writing by Intel. Intel customers are advised to obtain the latest version of device specifications before relying on any published information and before placing orders for products or services. No product or component can be absolutely secure

Intel does not control or audit third-party data. You should consult other sources to evaluate accuracy.