

Open Source Hardware / Software Collaboration by Renesas & Retronix

COSCUP 2025

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High Performance Computing Product Group
Renesas Electronics Corp

2025-8-9

Who we are

Who I am

Engaged in OSS Software Enablement for R-Car SOC at Renesas

- Activities at Renesas (OSS development for R-Car SoC)
 - Write an R-Car driver code → Submit to the community upstream
 - Review code with the maintainer → Add device support into the mainline
 - Work with the community to maintain the code with every kernel version
 - Send team engineers to the community developer conference/meet-up
- External Activity (work with the community and consortium)
 - Leads LF project (AGL, Xen, Zephyr, yocto, CIP, OpenSSF), COVESA
 - Contribute to SOAFEE, Open SDV Initiative, Jaspar, Autosar, and others
 - Create POC using various contributed combining OSS components
 - Work with the community to realize OSS-based Safety (like ISO26262)

Support industry initiatives those aim large-scale OSS software

Who Renesas is

Renesas empowers a safer, smarter and more sustainable future where technology helps make our lives easier.

A leading global provider of microcontrollers, Renesas combines our expertise in embedded processing, analog, power and connectivity to deliver complete semiconductor solutions. These Winning Combinations accelerate time to market for automotive, industrial, infrastructure and IoT applications, enabling billions of connected, intelligent devices that enhance the way people work and live.



* Consolidated, as of December 31, 2024



Headquarters

Tokyo, Japan



Approx. 23,000

employees *



Operating in

30+ countries



1,348.5 billion yen

revenue in 2024



Approx. 20,000

patents & pending applications

Renesas solution offerings

Our mission is to develop a safer, healthier, greener, and smarter world by providing intelligence to our four focus growth segments: Automotive, Industrial, Infrastructure, and IoT that are all vital to our daily lives, meaning our products and solutions are embedded everywhere.



Automotive

Highly reliable vehicle control,
safe and secure
autonomous driving,
Eco-friendly electric vehicles



Industrial

Lean, flexible and
smart industry



Infrastructure

Robust infrastructure,
enabling
safety and efficiency



IoT

Comfortable, safe and
healthy lifestyles
through IoT

Broad and Scalable Product Portfolio

Microcontrollers & Microprocessors, System-on-Chips (SoCs)



High-end 32/64-bit MPUs
High-resolution HMI, Industrial network & real-time control



Advanced 32-bit MCUs
Arm ecosystem, Advanced security, Intelligent IoT



High Power Efficiently 32-bit MCUs
Motor control, Capacitive touch, Functional safety, GUI

RISC-V
products

General-purpose 64-bit MPUs (RZ/Five Group)
Application-specific 32-bit MCUs



Ultra-low Energy 8/16-bit MCUs
Bluetooth® Low Energy, SubGHz, LoRa®-based Solutions
Automotive actuators & sensors, Low-end ECUs



Automotive 32-bit MCUs
Rich functional safety and embedded security features



Automotive SoCs
Next generation of automotive computing

Analog and Power Devices

- Analog products
 - Clocks & Timing
 - Interface & Connectivity
 - Memory & Logic
 - Power & Power management
 - Programmable Mixed-signal, ASIC, & IP products
-
- RF products
 - Sensor products
 - Space & Harsh environment
-
- Timing
 - Wireless Power
 - Battery Management
 - Power Devices
- Power Management
 - Sensors
 - Video & Display

Renesas is committed to healthy growth of Open Source

We are a first-class citizen in the OSS community

- We follow "Upstream First" to fully eliminate in-house tree. Always work with community to add new device support into mainline kernel.
- We continue maintaining merged code for EVERY version of kernel, and that contribute a lot to security patch backport effort.
- We adopt LTS kernel for the production BSP, and migrate them every year.
- Strive to be OPEN not only for the code, but also for document and dev-board access.

Merged Linux kernel patch number count

From Apr.16 2005 to Jul.24 2025

Total 1,265,698 patches from 907 companies

No.1	Unknown	239,127	18.89%
No.2	Intel	132,016	10.43%
No.3	Red Hat	97,489	7.70%
No.4	Hobbyists	79,729	6.30%
No.5	Novell	48,974	3.87%
No.6	Linaro	46,423	3.67%
No.7	IBM	40,870	3.23%
No.8	AMD	40,483	3.20%
No.9	Google	37,618	2.97%
No.10	Huawei	26,651	2.11%
No.11	Renesas Electronics	24,606	1.94%
No.12	Oracle	22,952	1.81%
No.13	Texas Instruments	18,634	1.47%
No.14	Samsung	18,585	1.47%
No.15	NVIDIA	15,597	1.23%
No.16	ARM	12,713	1.00%
No.17	NXP	12,399	0.98%
No.19	Mellanox Technologies	11,521	0.91%
No.21	QUALCOMM	10,027	0.79%
No.23	Broadcom	9,654	0.76%
No.27	Linux Foundation	7,718	0.61%
No.28	Code Aurora Forum	7,079	0.56%
No.29	Analog Devices	6,742	0.53%
No.31	MediaTek	5,647	0.45%
No.33	Marvell	5,275	0.42%
No.35	Freescall	4,699	0.37%
No.38	STMicroelectronics	4,269	0.34%
No.39	Facebook	4,266	0.34%

https://www.remword.com/kps_result/all_whole.html

Who Retronix is

ABOUT Retronix

Founded in 2006, Retronix Technologies is a leading Taiwanese provider of embedded IoT solutions and smart automotive electronics. As the first to launch Renesas R-Car-based platforms in Taiwan, it delivers CMS, digital clusters, and custom ECUs with deep software-hardware integration.



Retronix has become a Renesas Preferred Partner as well as an R-Car Consortium Proactive Partner.

Work Scope & Core Capabilities

-  Embedded platform bring-up: R-Car V4H, V3H2, H3/M3
-  OS support: Linux, QNX, Android Automotive (from IPL to application)
-  Hardware design: architecture, layout, BOM optimization
-  Sensor & SerDes integration: Sony, OVT, ONSEMI, Maxim
-  System platform: BSP, drivers, MCU firmware, R46 pre-test
-  Software stack: middleware, ISP tuning, CNN/DOF/GPU, AI Vision SDK
-  In-house lab tuning, optical testing, and full ECU system development

Raptor R-Car V4H High-Performance AI SOM



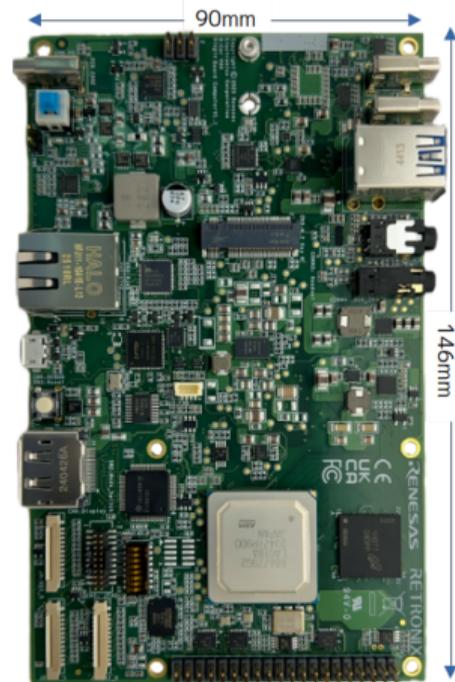
"SparrowHawk" yet another embedded AI hacker board

HW / SW concept

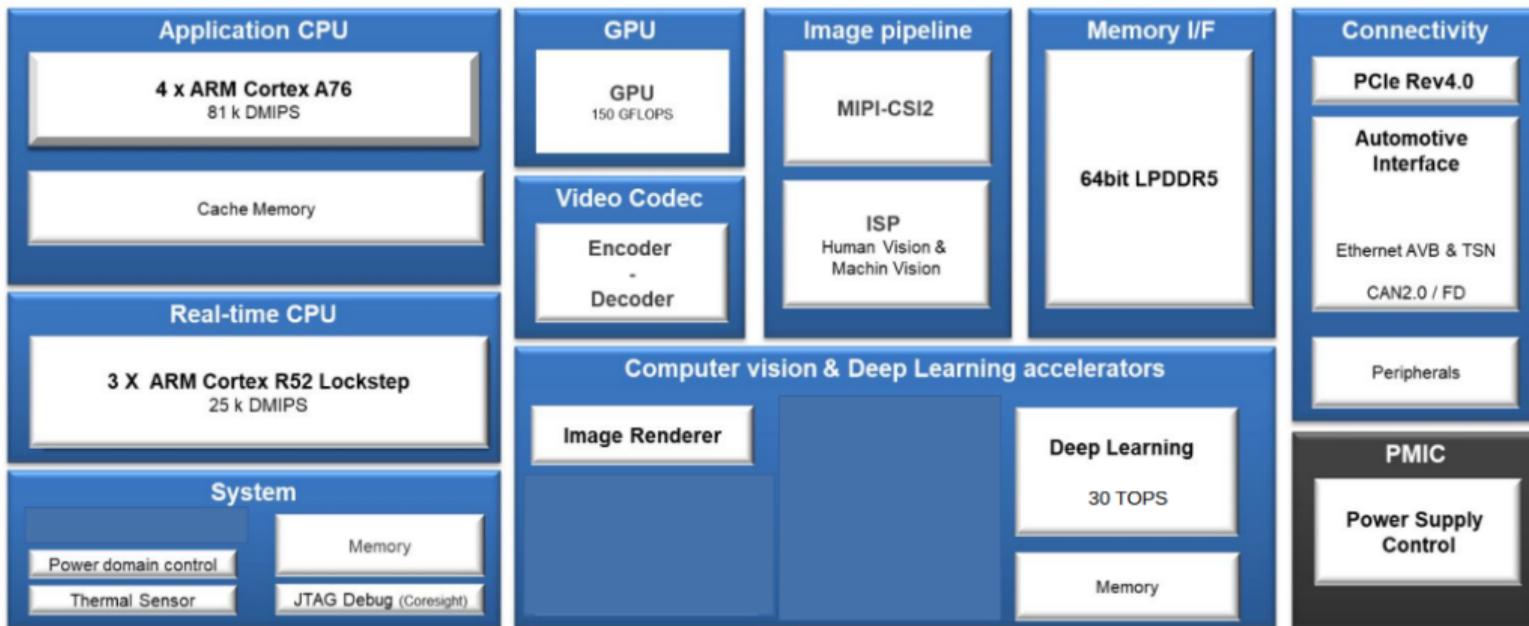
SparrowHawk: Accelerated Edge AI capable hacker board

Single Board Computer using Renesas R-CarV4H

- CPU = 4x CA76 (81k DMIPS), 3x CR52
- GPU = IMG AXM-8-256 (150GFLOPS)
- NPU = Renesas CNNIP engine (30TOPS)
- RAM/ROM = 8GB/16GB LPDDR5, 64MB QSPI Flash
- Camera = 2x 4-Lane MIPI Camera RPi Style
- Ethernet = 1x 1Gbps (AVB support)
- PCIe = 1x M.2 Key-M, USB = 4x USB 3.0 Port
- Audio = 1x Headphone, 1x Audio Input
- I/O = RPi HAT style 40-Pin header



R-Car V4H: Renesas 4th generation Vision Processing SoC



<https://www.renesas.com/en/products/r-car-v4h#overview>

SparrowHawk: Open SDK

An OSS stack to enable edge-AI applications

- Eliminate time-consuming paper NDA requirement
- Easy-to-Access (board, SW, Document,..)
 - Camera: MIPI-camera (RPI camera)
 - Power: USB PD (65W - 100W)
- Collection of cutting-edge OSS components
 - uboot (2025.07)
 - Linux (6.12 = latest LTS kernel)
 - Ruby Installer to select userland
 - Userland: yocto (Scarthgap 5.0) / Debian (bookworm 12) / And more
 - OSS AI tool support (ONNX, PyTorch, TVM,...)



index : kernel/git/geert/renesas-devel.gi

Renesas Kernel ARM SoC Development Tree

about summary refs log tree commit diff stats

Branch
topic/renesas-defconfig
master
next
renesas-dts-for-v6.17
renesas-drivers-for-v6.17
renesas-dt-bindings-for-v6.17
renesas-r9a09g087-dt-binding-defs
renesas-arm-defconfig-for-v6.17
renesas-dts-for-v6.16
renesas-arm-defconfig-for-v6.16

Commit message
Merge tag 'v6.16' into topic/renesas-defconfig
Merge tag 'v6.16' into renesas-devel
Merge branches 'renesas-arm-defconfig-for-v6.17'
arm64: dts: renesas: r9a09g057h44-rz2h-evk: En
soc: renesas: Sort Renesas Kconfig configs
dt-bindings: soc: renesas: Document R-Car V4M-
dt-bindings: clock: renesas,cpg-msr: Document
ARM: shmobile: defconfig: Refresh for v6.16-rc2
arm64: dts: renesas: rzg3e-smarc-som: Reduce I2
ARM: shmobile: defconfig: Enable more support

Tag
renesas-defconfig-v6.16
renesas-devel-2025-07-28-v6.16
renesas-devel-2025-07-28-v6.16-rc7
renesas-devel-2025-07-28-v6.16-rc6
v6.16
v6.16-rc7
v6.16-rc6
renesas-dts-for-v6.17-tag2
renesas-drivers-for-v6.17-tag2
renesas-dt-bindings-for-v6.17-tag2

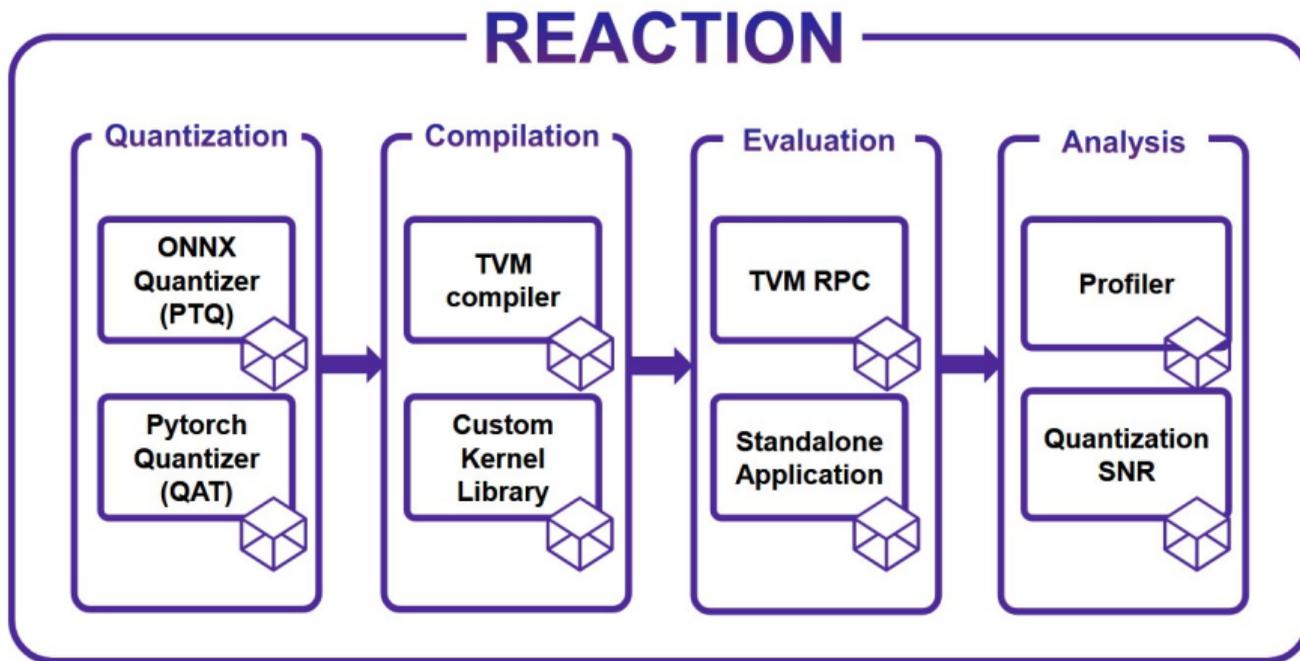
Download
renesas-devel-renesas-defconfig-v6.16.tar.gz
renesas-devel-2025-07-28-v6.16.tar.gz
renesas-devel-2025-07-28-v6.16-rc7.tar.gz
renesas-devel-2025-07-28-v6.16-rc6.tar.gz
renesas-devel-6.16.tar.gz
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renesas-devel-renesas-drivers-for-v6.17-tag2.tar.gz
renesas-devel-renesas-dt-bindings-for-v6.17-tag2.tar.gz

Age
20 hours
21 hours
22 hours
34 hours
39 hours
2 days
2 days

Commit message
Merge tag 'v6.16' into renesas-devel **HEAD** **re**
Merge tag 'v6.16-rc7' into renesas-devel **renesas**
Merge tag 'v6.16-rc6' into renesas-devel **renesas**
Linux 6.16 **v6.16**
Merge tag 'timers-urgent-2025-07-27' of git://git.
Merge tag 'spi-fix-v6.16-rc7' of git://git.kernel.org
Merge tag 't2c-for-6.16-rc8' of git://git.kernel.org

Accelerated Edge-AI support

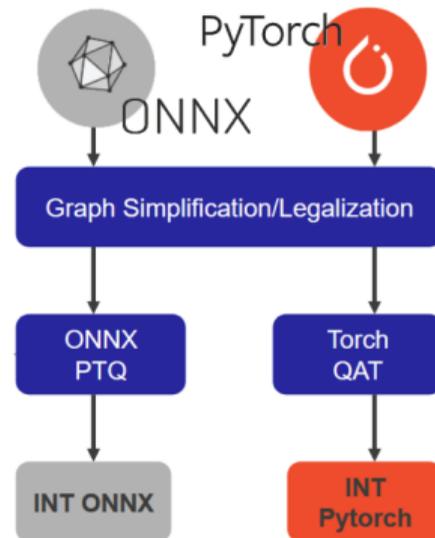
Renesas Edge AI Compilation Tool Into Optimized Networks



REACTION: AI-assisted low-code and user-friendly tools

Optimal way to utilize AI acceleration with your model

- Granular control of each step of model conversion
- Support ONNX, PyTorch format inputs
- Supports BYOM, BYOD and BYOC
- Optimization (Quantization) for edge-AI execution
 - Post Training Quantization (PTQ)
 - Quantization Aware Training (QAT)
- Unify multiple steps in single toolchain
- Custom node implementation



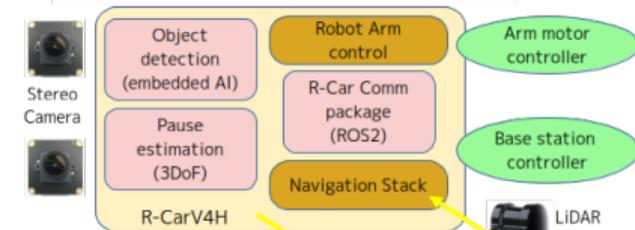
Renesas plan to provide CNNIP-optimized model at our Model Zoo

SparrowHawk AI application example: Autonomous SLAM Robot

Our Autonomous Robotics prototype

- Stereo image processing
 - Visual SLAM (depth detection)
 - Accelerated object detection (YOLOv8)
 - 3-DoF Pose estimation
- Autonomous Robot-base navigation
 - URDF (Unified Robot Description Format) for accurate robot modeling
 - SLAM (Simultaneous Localization and Mapping) for map building and localization in dynamic environments
 - Nav2 for path planning and autonomous navigation

R-CarV4H "SLAM by ROS2" prototype



Stress-free resource Access

Code access (maintained in github named rcar-community)

The screenshot shows the GitHub organization page for "rcar-community". At the top left is the organization's logo, a stylized green and white grid. Below the logo are navigation tabs: Overview (selected), Repositories (6), Discussions, Projects, Packages, and People. The "Popular repositories" section contains six items:

- sparrow-hawk-doc**: Github pages for sparrow-hawk board. Includes a photo of a green circuit board.
- linux**: Forked from torvalds/linux. Linux kernel source tree. Language: C. Includes the Linux penguin logo.
- meta-sparrow-hawk**: BitBake. Includes the Yocto Project logo.
- kernel-apt-repository**: apt repository for debian based c. Language: Shell. Includes the Debian logo.
- rcar-community-board**: HTML. Includes the RubyInstaller logo.
- rcar-community.github.io**: Github pages for rcar-community. Marked as Public.

On the right side, the "People" section states: "This organization has no public members. You must be a member to see who's a part of this organization." Below it, the "Top languages" section shows: Shell (green dot), C (black dot), BitBake (blue dot), and HTML (red dot). At the bottom right, there is a purple oval containing the text "More SW to come".

<https://github.com/rcar-community>

Document access (we edit contents progressively)

Sparrow Hawk Contents

1. Introduction
2. Hardware
 1. Sparrow Hawk Information
 2. Sparrow Hawk Picture
 3. Switches Assignment
 1. Boot mode
 2. Other switch
 4. Debug Serial
 5. Caution
3. Software Version List
4. Quick Start How To
 1. How to build
 2. How to flash
 1. Flashing loader
 2. Flashing OS image into SD card
 3. How to boot
 4. How to run applications
 1. Software support list
 2. CAN
 3. Audio
 4. GPIO
 5. I2C
 6. USB3.0
 7. UART
 8. Thermal
 9. M.2
 10. Pi Camera
 11. Pi Display
 12. Pi Active Cooler
5. Tips
6. Known Issues & Restrictions

Introduction

This is the page for Sparrow Hawk board with R-Car V4H provided Retronix Technology inc.

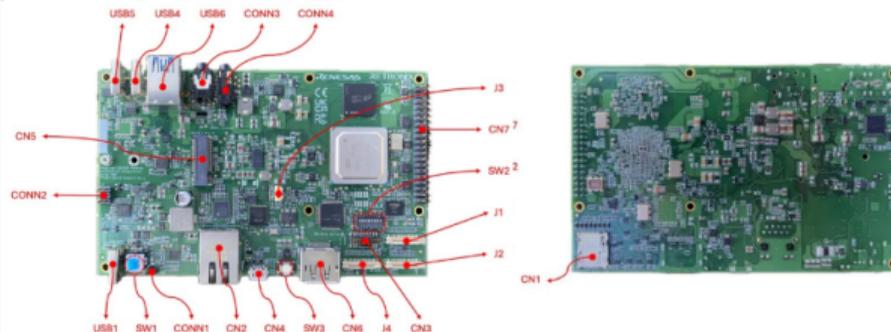
Hardware

Sparrow Hawk Information

R-Car V4H SoC Version	Board Information	Where to buy
v3.0	Click here	Click here

Sparrow Hawk Picture

left: top view, right: bottom view

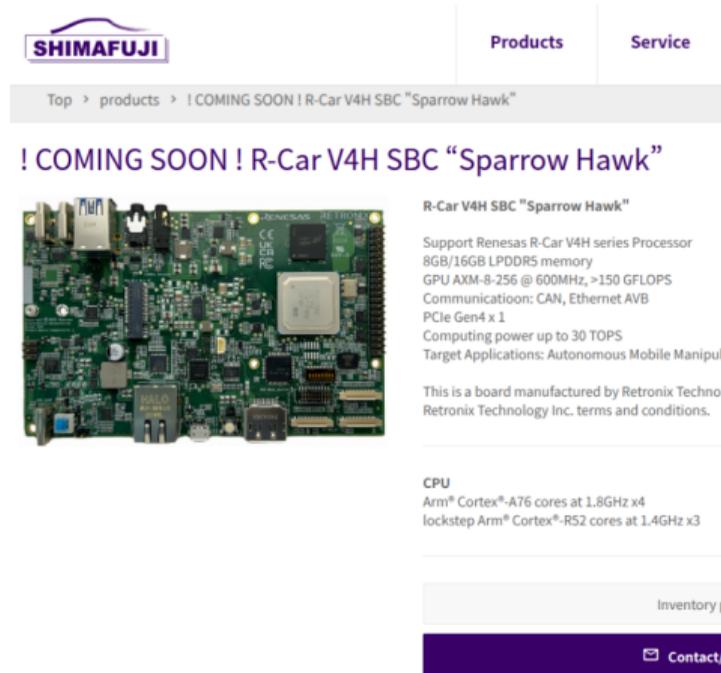


<https://rcar-community.github.io/Sparrow-Hawk/index.html>

Where you can find (purchase) SparrowHawk?

You can buy SparrowHawk from online web store

- We are hoping that SparrowHawk (=SH) penetrate to broader industry, researcher, startups, and academia.
- Initially, SH is a product of Retronix (not Renesas). And they plan to sell SH through various online web channel.
- So far, SHIMAFUJI which is Japanese embedded board reseller, start treating SH.
- <http://www.shimafuji.co.jp/en/products/2207>



The screenshot shows the Shimafuji website's product page for the R-Car V4H SBC "Sparrow Hawk". The page features the Shimafuji logo at the top left, navigation tabs for "Products" and "Service", and a breadcrumb trail: "Top > products > ! COMING SOON ! R-Car V4H SBC "Sparrow Hawk"". The main heading is "! COMING SOON ! R-Car V4H SBC "Sparrow Hawk"". Below the heading is a photograph of the green printed circuit board (PCB) populated with various components, including a large square processor chip, several capacitors, and connectors. To the right of the image, the product name "R-Car V4H SBC "Sparrow Hawk"" is listed, followed by a list of specifications: "Support Renesas R-Car V4H series Processor", "8GB/16GB LPDDR5 memory", "GPU AXM-8-256 @ 600MHz, >150 GFLOPS", "Communication: CAN, Ethernet AVB", "PCIe Gen4 x 1", "Computing power up to 30 TOPS", and "Target Applications: Autonomous Mobile Manipul...". Below the specifications, a note states: "This is a board manufactured by Retronix Technol Retronix Technology Inc. terms and conditions." Further down, the "CPU" section lists "Arm® Cortex®-A76 cores at 1.8GHz x4" and "lockstep Arm® Cortex®-R52 cores at 1.4GHz x3". At the bottom right, there is a "Contact" button with an envelope icon.

Our challenges & Summary

Hacker board challenges - and How We Raise the Bar

- Challenges in modern Hacker Boards
 - Hardware is getting powerful, but **software complexity** increases.
 - Open source tools **often lack integration and documentation**.
 - **Access to hardware resources** is limited due to NDA, license, or ecosystem lock-in.
 - **Balancing performance, openness, and developer usability is difficult.**
- Our Commitment with SparrowHawk
 - Keep SDK maintained with **upstream-first** OSS components.
 - **Simplify access** - NDA-free, well-documented, and freely available code & tools.
 - Engage with developer feedback - **shape the future of embedded AI together.**
 - **Collaborate with global OSS communities and share real use cases.**

Summary

- We developed **SparrowHawk hacker board** using Renesas **R-CarV4H** SoC.
- R-CarV4H is high-performance SoC including, **30TOPS** embedded-AI, **81kDMIPS** Quad-Arm Cortex, **150GFLOPS** GPU, and more.
- As R-CarV4H can support **multiple camera input**, you can develop advanced image processing **embedded-AI application**, like **autonomous robot**.
- We deliver advanced embedded-AI development environment **"REACTION"** to encourage you to run your own model using embedded-NPU capability. We believe this enables the development of attractive embedded-AI applications.
- We prepare **paper NDA less, stress-free**, SW development resources utilizing cutting-edge OSS resources.