Co-funded by the European Union

AERO · SOFTWARE STACK RELEASE 2

Heterogeneous Computing for the European Cloud

An open, end-to-end software stack for the SiPearl Rhea processor and Arm / RISC-V hardware - from firmware and drivers up to GPU-accelerated AI, built entirely in open source.

THE FULL AERO SOFTWARE STACK

Open-source layers co-designed for the European Processor Initiative (EPI)

EU Cloud Services & Orchestration
Maestro · Knot · FaaSCell — serverless, FaaS & Kubernetes-native

▼

Languages, Runtimes & Libraries
Quarkus · Mandrel · TornadoVM · GPULlama3.java · TeraHeap · LangChain4j

▼

OS, Security & Heterogeneous Acceleration
Elastic Translations · VOSySmonitor · oneAPI Construction Kit (OCK) · SPIR-V · SYCL / DPC++

▼

European Hardware
SiPearl Rhea (Arm Neoverse V1) · Arm Neoverse · RISC-V · GPU accelerators

3 pilots

9 real-world use cases

VALIDATED ON
Ampere Altra · Graviton3 · Grace (Arm Neoverse N1 · V1 · V2)

Funded by the European Union. Views and opinions are however those of the author(s) only and do not necessarily reflect those of the European Union or the HaDEA. Neither the European Union nor the granting authority can be held responsible for them. Project number: 101092850.

AERO has also received funding from UKRI under grants no. 10048318 and 10048915, and the Swiss State Secretariat for Education, Research, and Innovation.

Funded by the European Union

UK Research and Innovation

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Swiss Confederation

Federal Department of Economic Affairs, Education and Research EAER
State Secretariat for Education, Research and Innovation SERI

OS, Security & Heterogeneous Acceleration

The WP3 components that bring AERO up on Rhea - and their Release 2 results.

oneAPI Construction Kit (OCK) v5.0.0

OpenCL & SYCL driver for AArch64 CPUs — the acceleration foundation for the entire AERO stack.

- **100% OpenCL-CTS conformance on AArch64 · LLVM 20 / 21**

Elastic Translations (Leshy)

Coalescing-aware, profiling-assisted huge-page promotion that targets MMU hotspots under fragmentation.

- **+12–20% on memory-heavy workloads · –30% 2 MiB pages**

VOSySmonitor

Arm TrustZone firmware enabling safe & secure mixed-criticality co-execution on Rhea.

- **Validated on Arm FastModels for Rhea bring-up**

Rhea Firmware & Drivers

Boot sequence and device drivers for the SiPearl Rhea platform.

- **Integrated and validated via emulation**

AXHEL — hardware-accelerated encryption

ARM aXceleration for Homomorphic Encryption: SVE / SVE2 modular-arithmetic kernels for Microsoft SEAL (CKKS).

- **NTT, FMA & mod-mul kernels · Neoverse V2 gains over N1**

100%	20%	30%	SVE2
OpenCL-CTS on AArch64 (OCK)	faster (Elastic Translations)	fewer 2 MiB pages (Leshy)	accelerated encryption (AXHEL)

Resources

Horizon Europe · Grant Agreement No 101092850

Languages, Runtimes & Libraries

The WP4 components that program Arm & GPUs — and their Release 2 results.

TornadoVM v3.0.0

JIT-compiles Java to OpenCL, PTX & SPIR-V for CPUs and GPUs; now a full SDK.

- **Java 25 · 700+ tests · FP16 & tensors · RISC-V · SDKMAN!**

GPULlama3.java

GPU-accelerated LLM inference in pure Java; a Quarkus-LangChain4j provider.

- **7 GGUF model families · ~73 tok/s on Grace Hopper**

TeraHeap

Adds a second, device-backed heap to OpenJDK's G1, cutting serialization cost.

- **Up to 45% faster Spark ML · 26% Lucene · –97% SerDes**

SYCL / oneAPI (DPC++)

Cross-platform heterogeneous C++ on Arm via the OpenCL / SPIR-V path.

- **95.5% SYCL-CTS on Arm · AArch64 & RISC-V cross-compile**

Quarkus & Mandrel

Cloud-native Java with a faster GraalVM compiler and smaller runtimes.

- **GraalVM inliner +10% · JEP 493 upstreamed · JFR · Horreum**

LLVM Compiler Optimizations

CPU and GPU code-generation analyses and optimizations across the toolchain.

- **Improved vectorization & GPU codegen for AArch64**

45%	73	32×	95.5%
faster Spark ML (TeraHeap)	tokens/s LLM (GPULlama3)	faster startup (native)	SYCL-CTS on Arm

Resources

Horizon Europe · Grant Agreement No 101092850

EU Cloud Services & Orchestration

The WP5 components for heterogeneous serverless & orchestration - and their results.

Maestro

Kubernetes-native orchestration, extended for heterogeneous hardware, serverless and Firecracker microVMs.

- **Validated on GH200 (Arm) cluster + RISC-V k3s edge**

Knative Serverless Controller

Migrated from JVM to Quarkus native for lightweight, fast and predictable serverless control.

- **32× faster startup (63.7 ms) · image 519 → 214 MB**

FaaSCell

Firecracker snapshot-aware FaaS substrate developed in Rust that makes snapshotting a first-class orchestration concern (QoSnap).

- **>99% of functions meet a 6× SLO at far lower memory**

SnapBPF

eBPF snapshot-prefetching that captures and prefetches function working sets in kernel space.

- **Beats REAP & FaaSnap · ported to Arm Neoverse V2**

32×	>99%	2.4×	RISC-V
faster cold-start (native)	meet 6× SLO (QoSnap)	smaller image (214 MB)	+ Arm, validated at cloud & edge

Resources

Horizon Europe · Grant Agreement No 101092850