KLEPSYDRA TECHNOLOGIES

SYSGO EMBEDDING INNOVATIONS

AI/ML for Space Applications on RISC-V: A Fully European Technology Stack Analysis

RISC-V IN SPACE

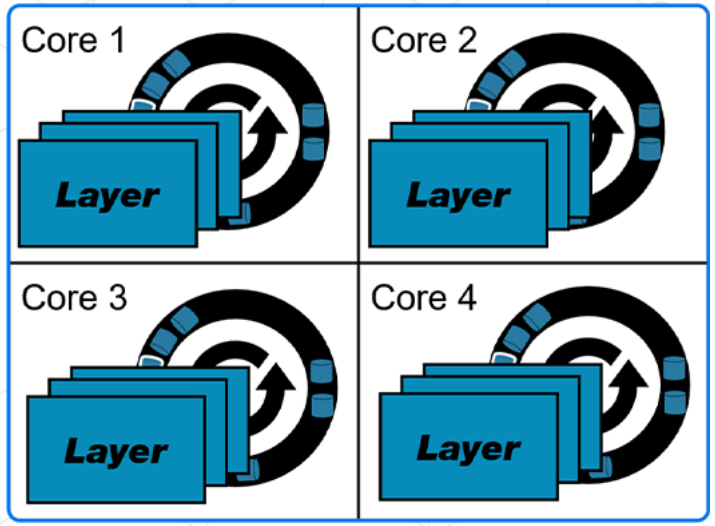
Pablo Ghiglino

Mar 18th, 2025

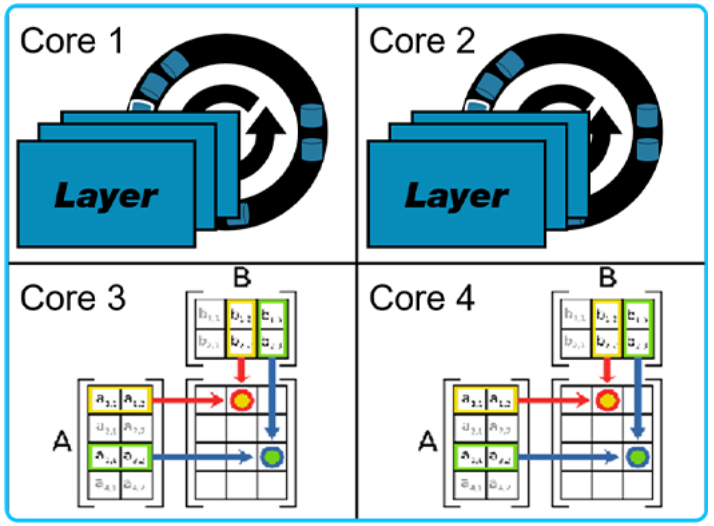
Two Main Data Processing Approaches

KLEPSYDRA TECHNOLOGIES

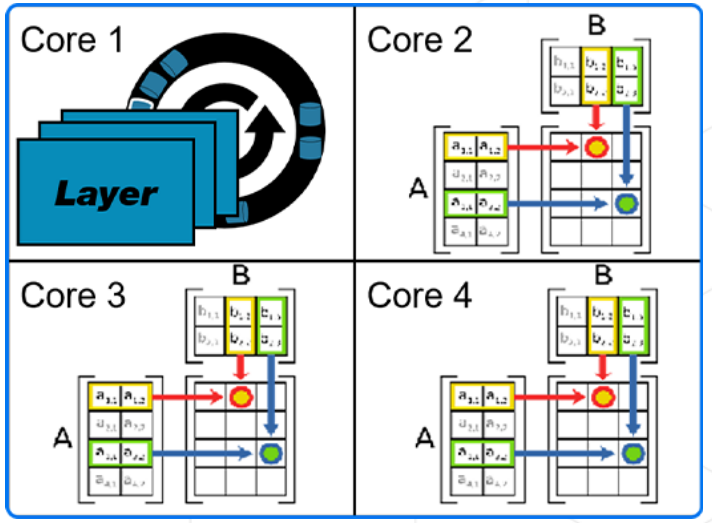
2-DIM Threading Model



- **Low CPU power**
- Mid throughput CPU
- High latency



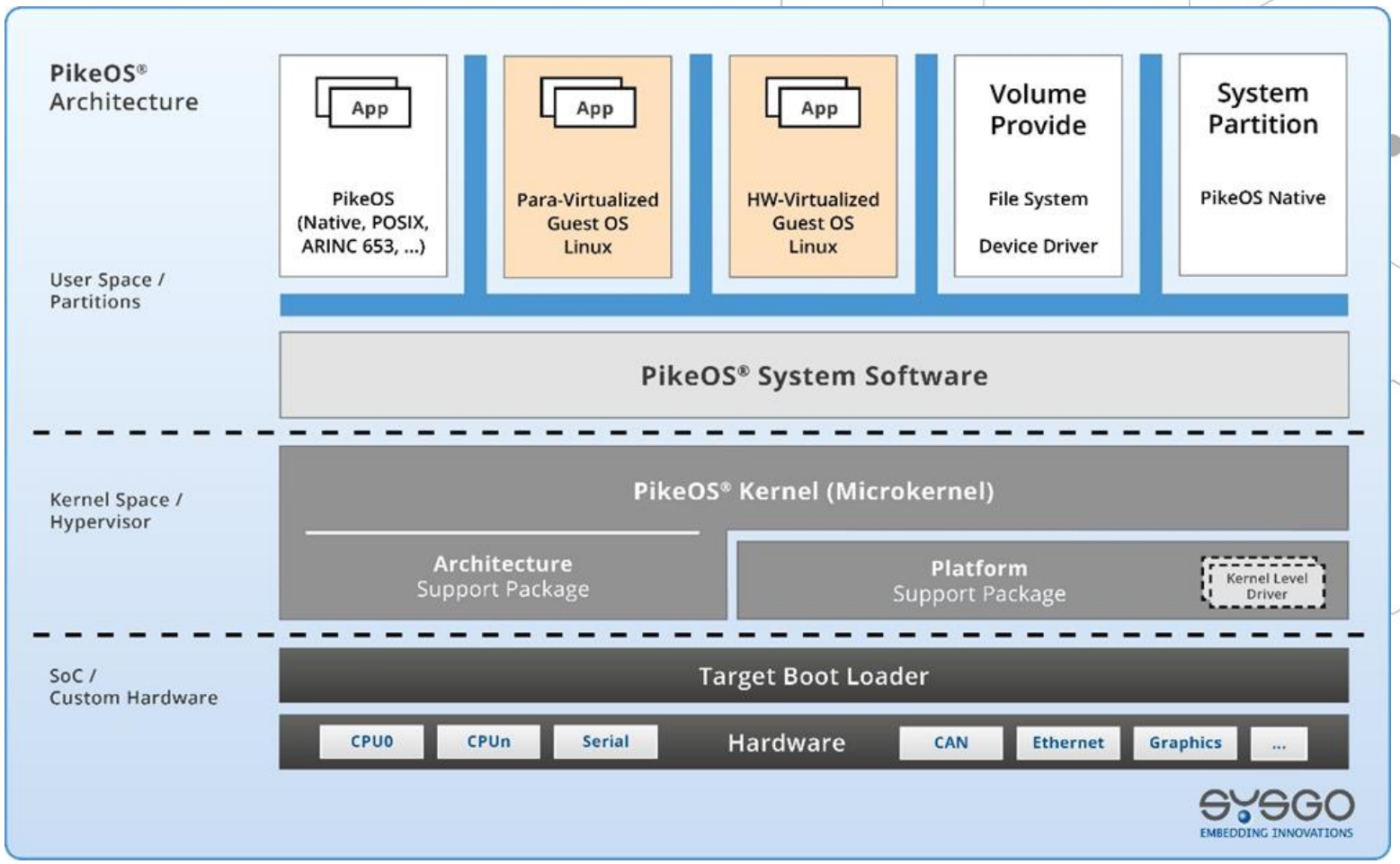
- Mid CPU
- **High throughput CPU**
- Mid latency



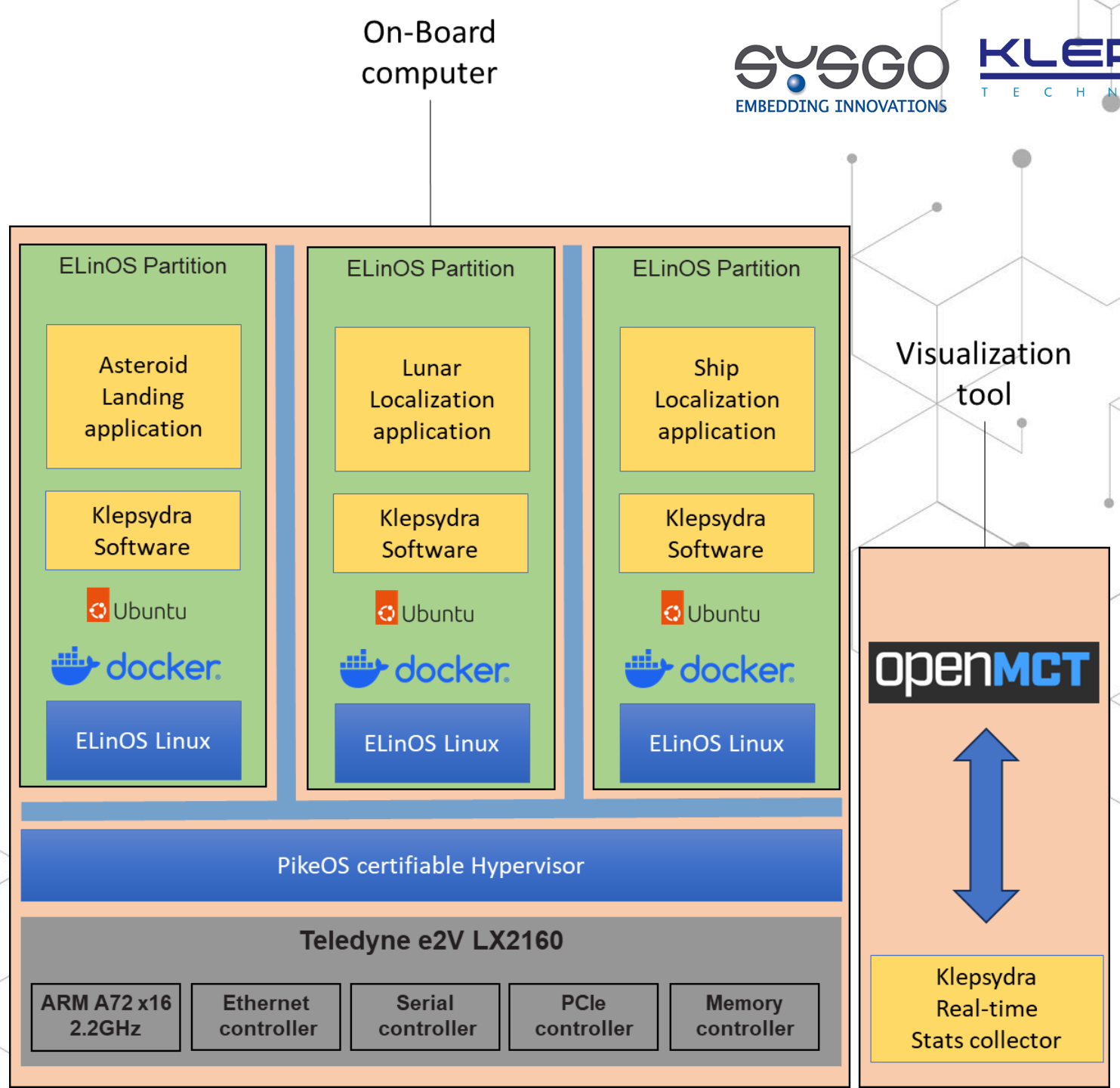
- High CPU
- Mid throughput CPU
- **Low latency**

Hard Real-Time Operating System and Hypervisor

- With safe and secure certified virtualization
  - Up to **ECSS Cat-A**, DO178C DAL-A, **EAL5+**, ISO26262 ASIL-D..
- **Microkernel** architecture
- **Strict spatial and time partitioning**
- **MILS**: Multiple Independent Levels of Security and Safety with multiple guest operating systems
  - Linux, POSIX, ARINC-653, AUTOSAR, Windows
- **Multi-core** processor support
- **No export restriction**



The LX2160 Space Cloud Demo using Klepsydra AI and SYGO PikeOS



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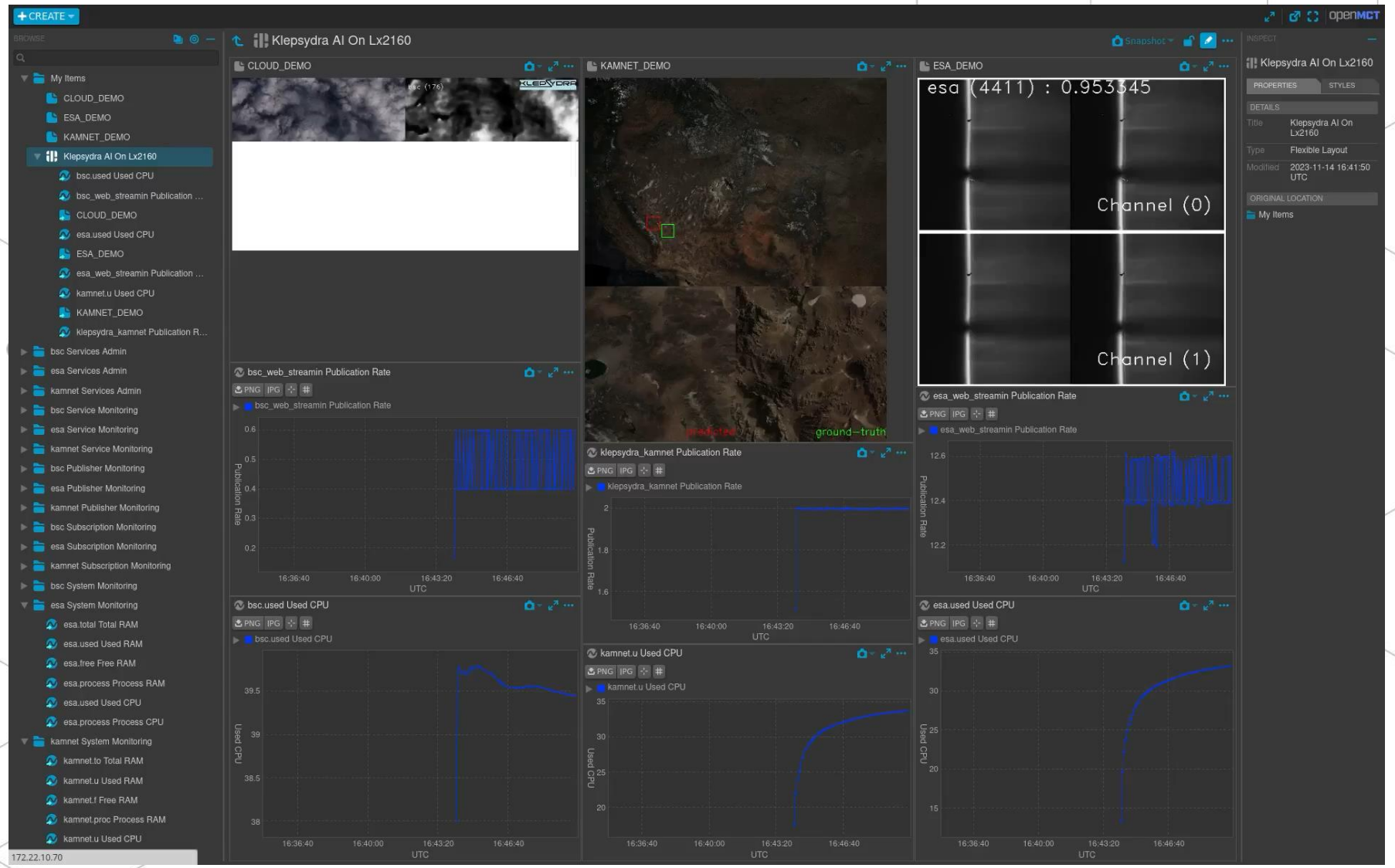


Klepsydra Performance Benchmarks

Advanced Analysis:

- Layer-wise latency breakdown
- Core load distribution

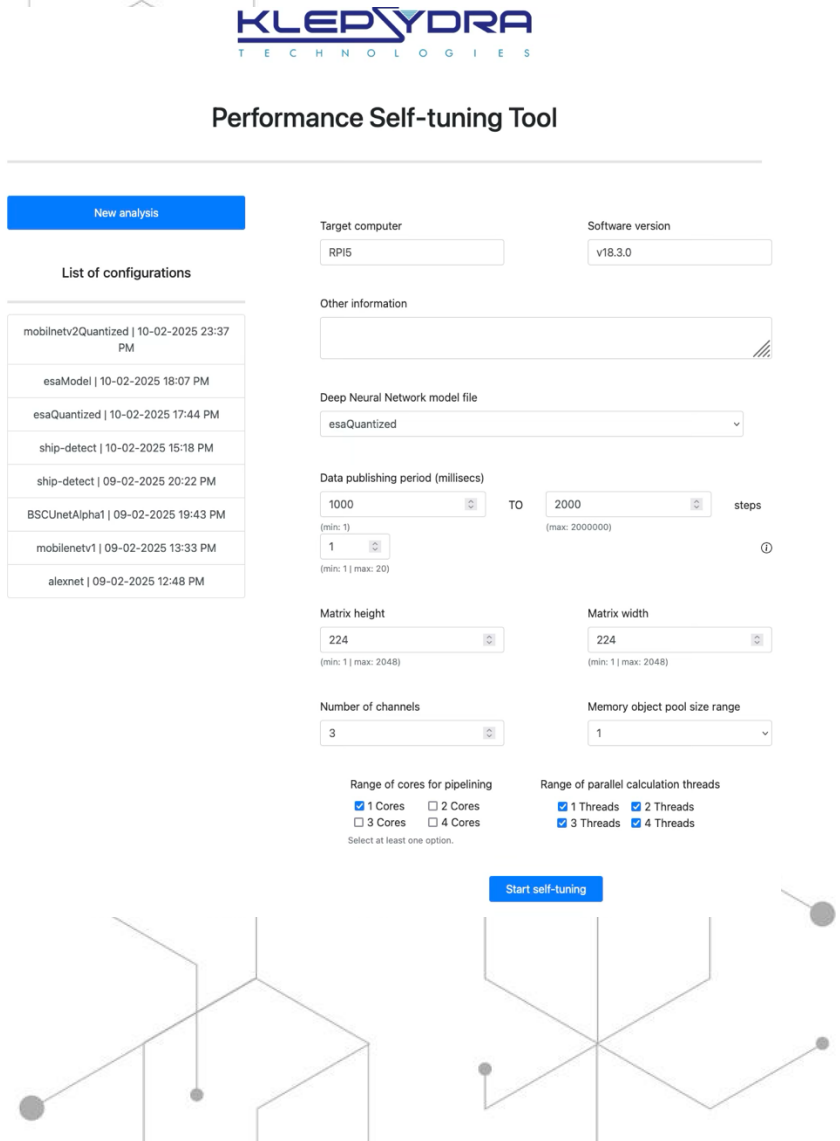
Comparison Capabilities:

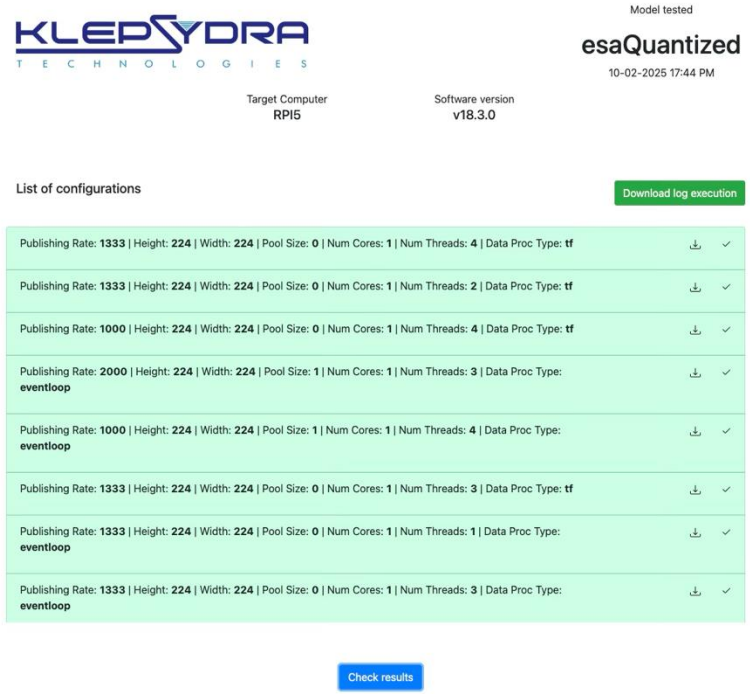
- Benchmarks Klepsydra AI against leading inference engine:
- TensorFlow Lite

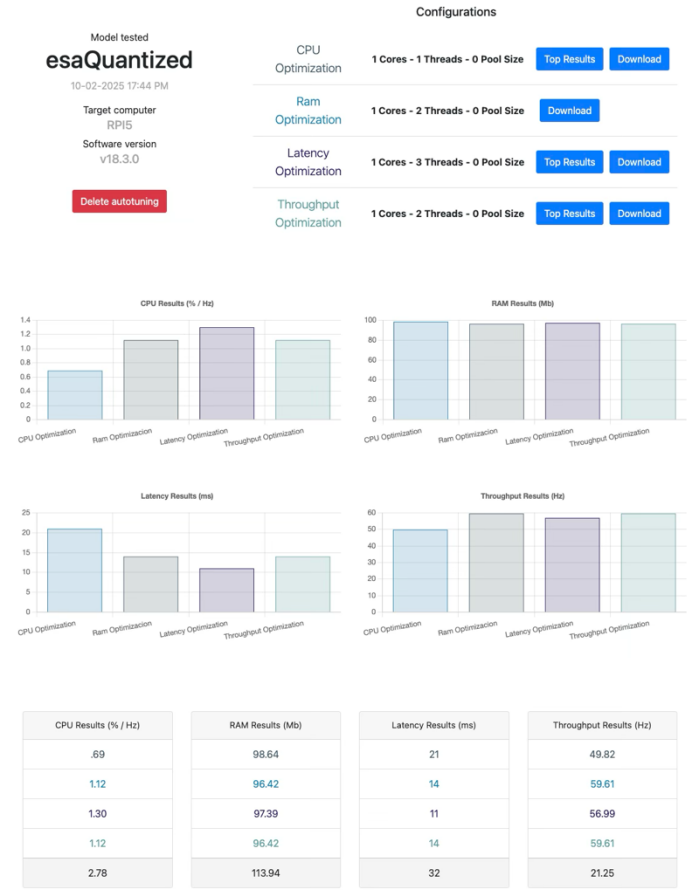
Future support:

- ONNX Runtime
- OpenCV CNN
- ARM-NN

Klepsydra Performance Benchmarks

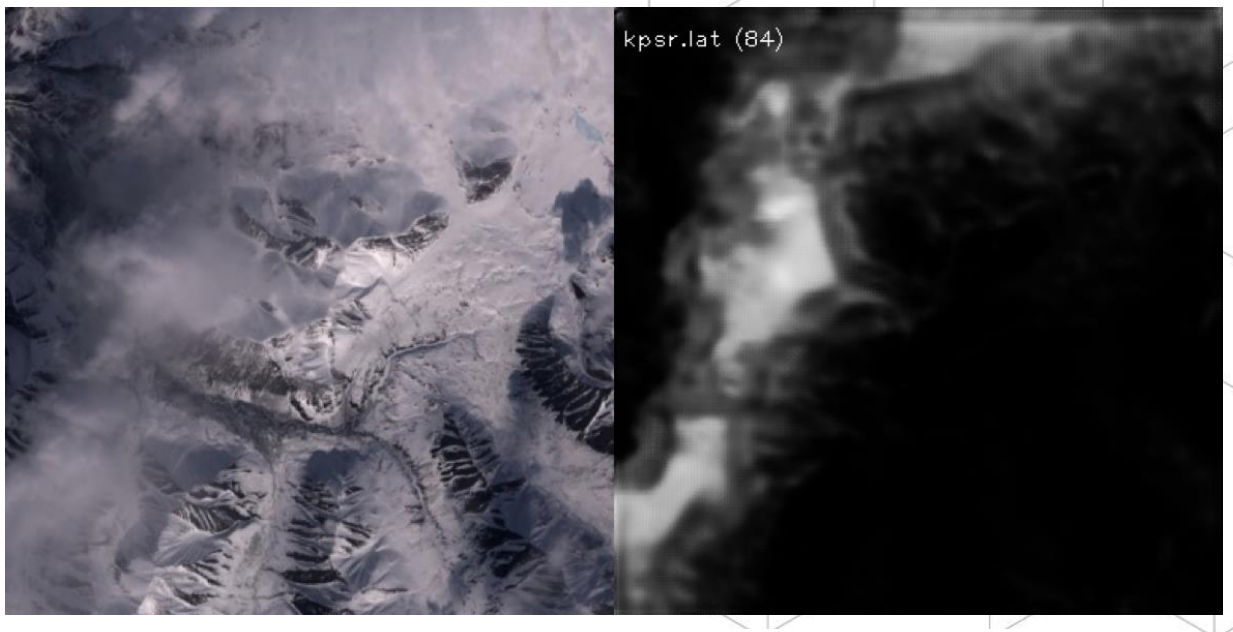


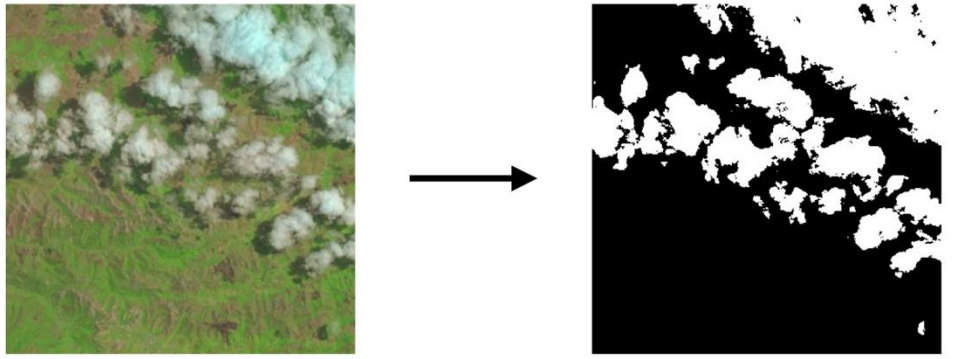




CPU Results (% / Hz)	RAM Results (Mb)	Latency Results (ms)	Throughput Results (Hz)
.69	98.64	21	49.82
1.12	96.42	14	59.61
1.30	97.39	11	56.99
1.12	96.42	14	59.61
2.78	113.94	32	21.25

OBPMark-ML Framework from ESA





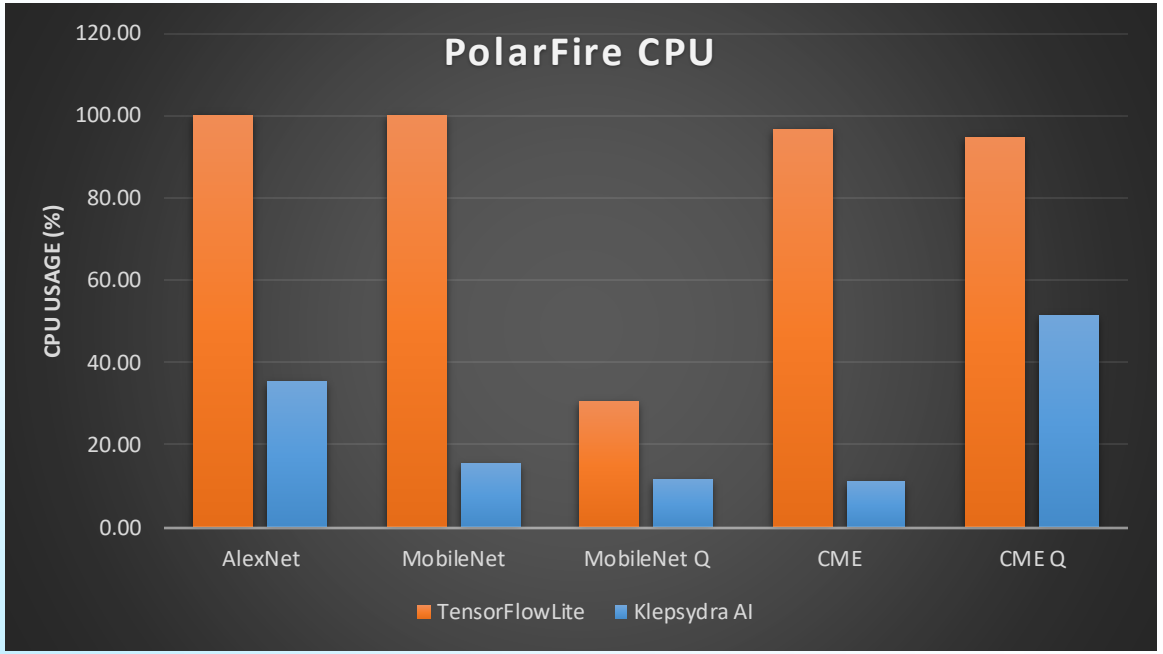
4 Channel Input Image

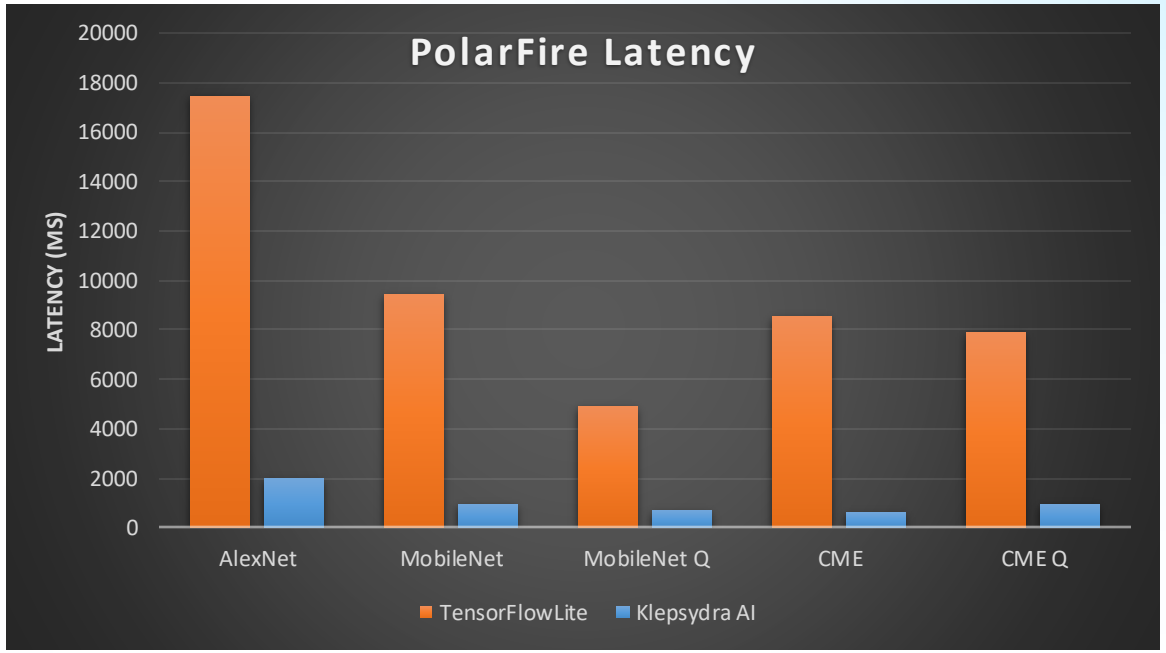
Binary Segmentation Mask

Klepsydra AI Benchmarks

PATTERN Project: Klepsydra AI ported to RISC-V

Performance comparison Klepsydra AI / TensorFlowLite (TFL) for lightweight models

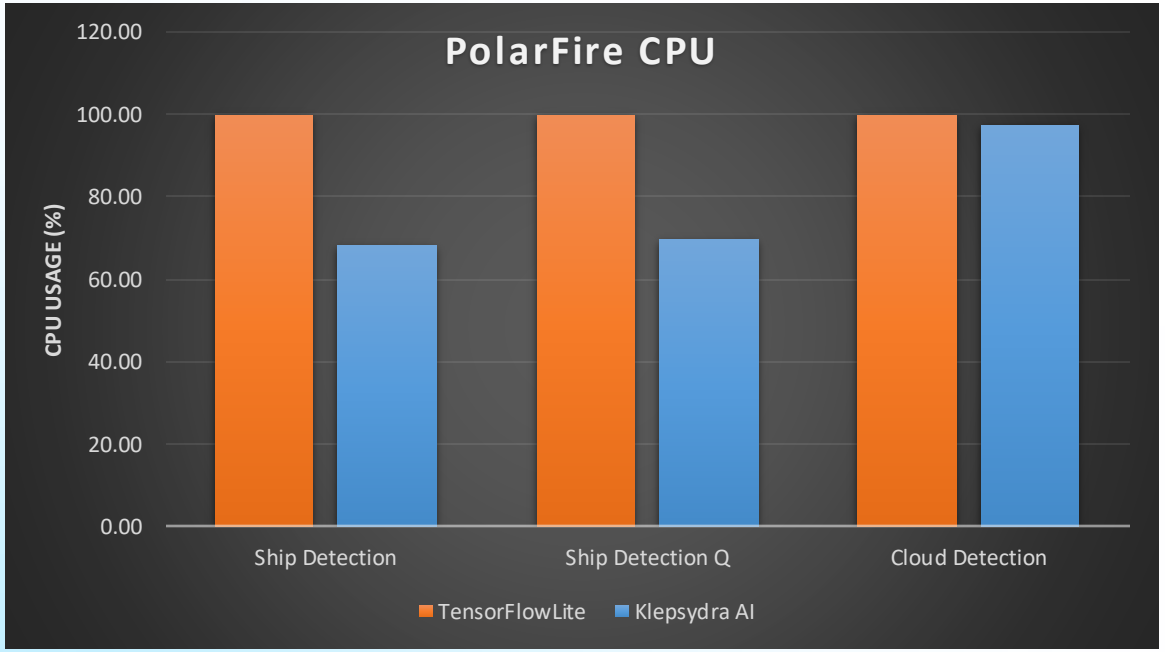


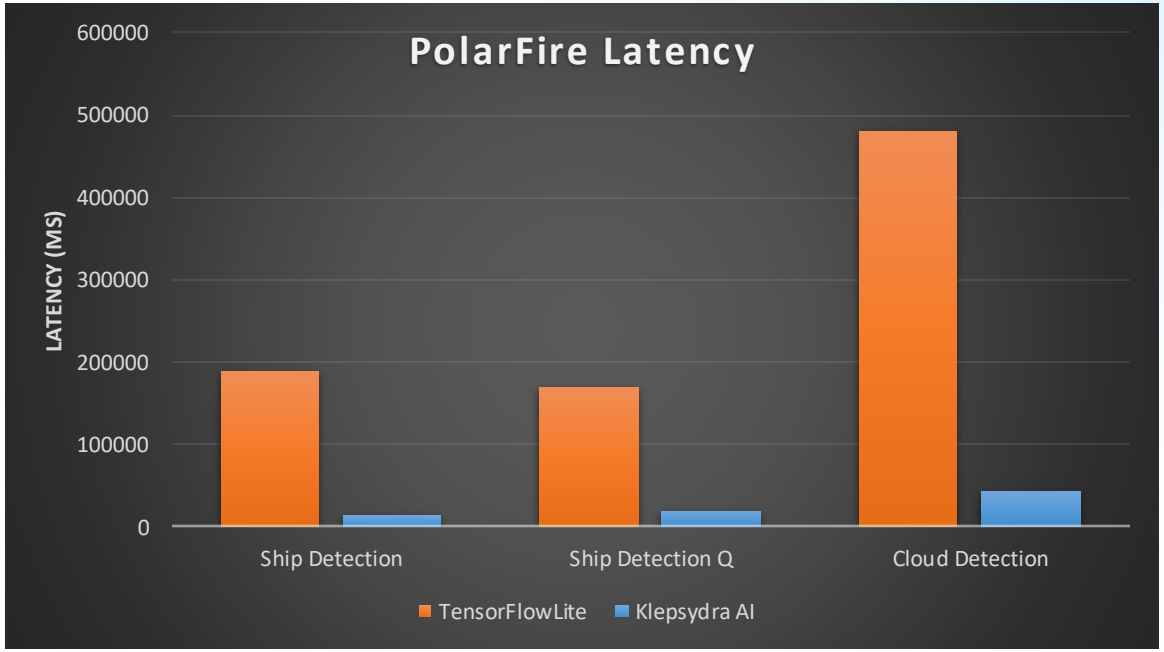


Klepsydra AI Benchmarks

PATTERN Project: Klepsydra AI ported to RISC-V

Performance comparison Klepsydra AI / TensorFlowLite (TFL) for heavyweight models

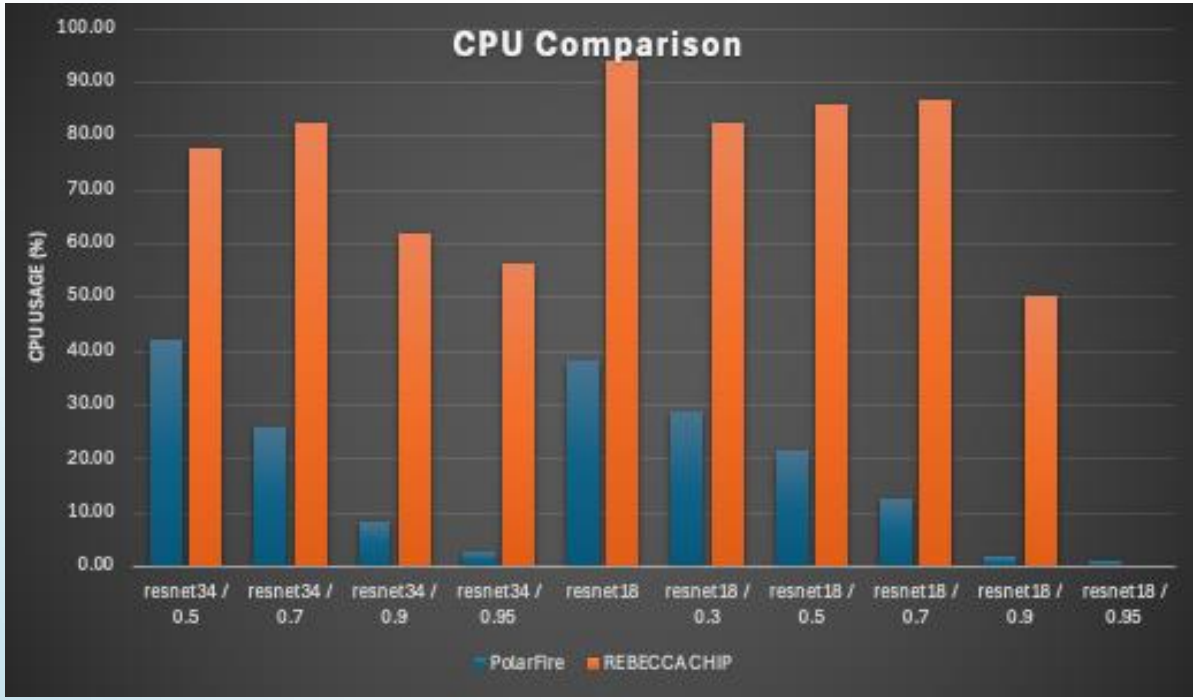


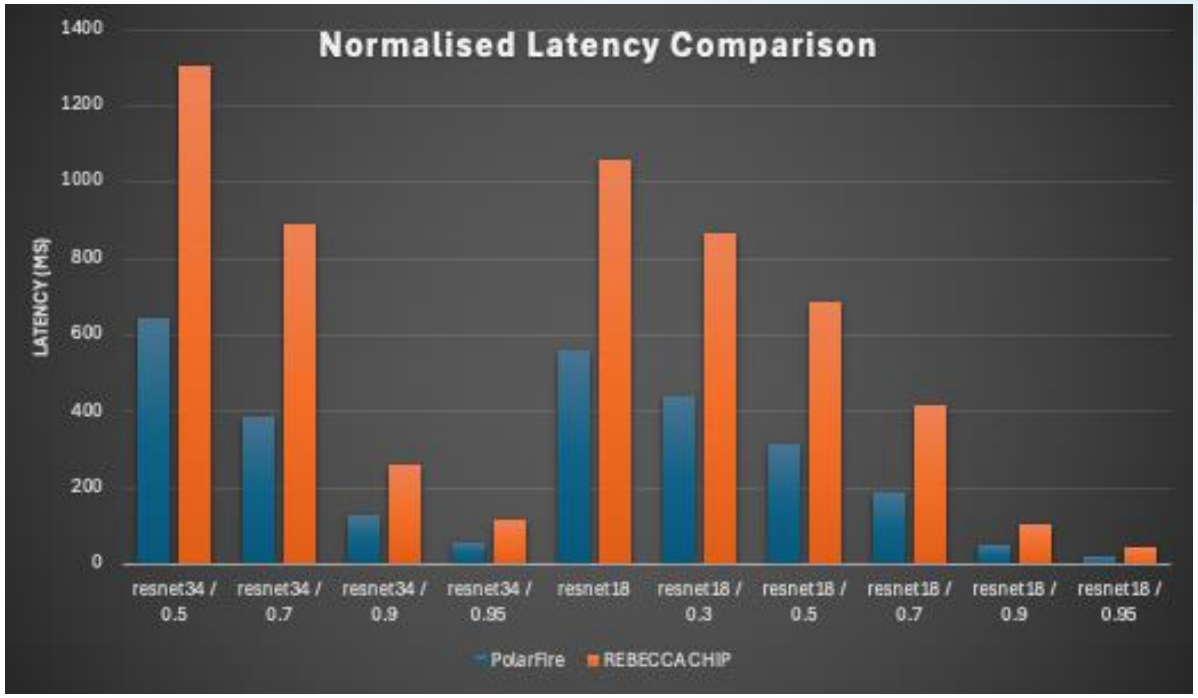


Klepsydra AI RISC-V Benchmarks

REBECCA Project: Lightweight models

Performance comparison Klepsydra AI REBECCA / Polarfire

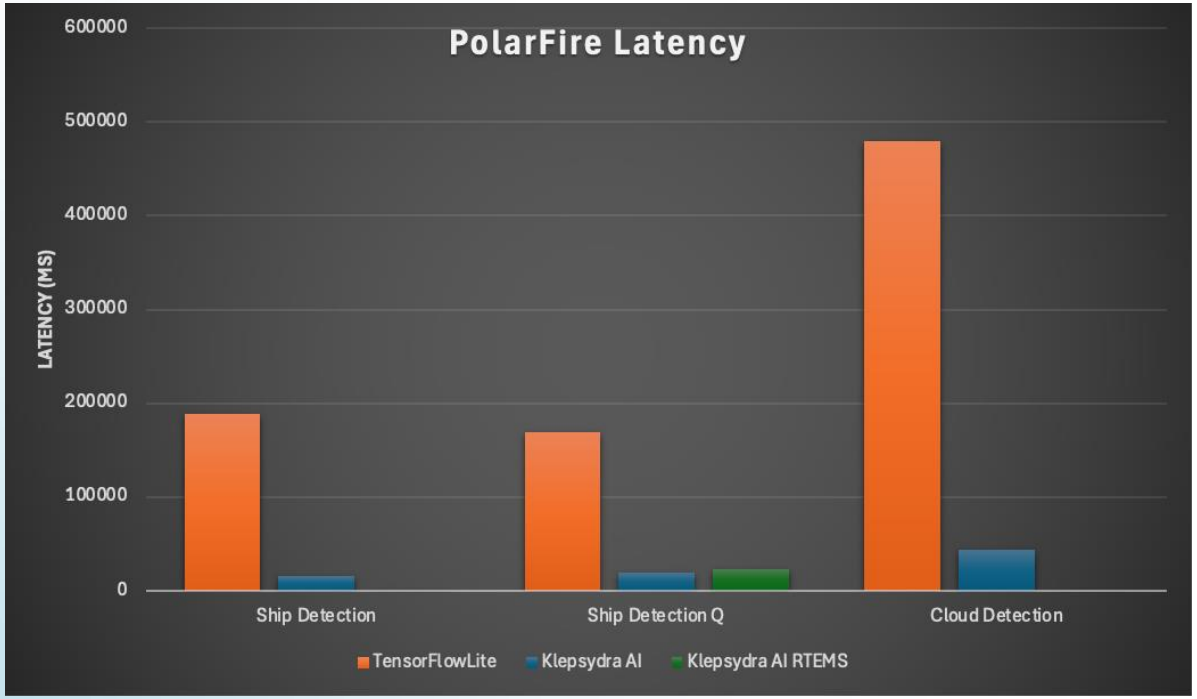


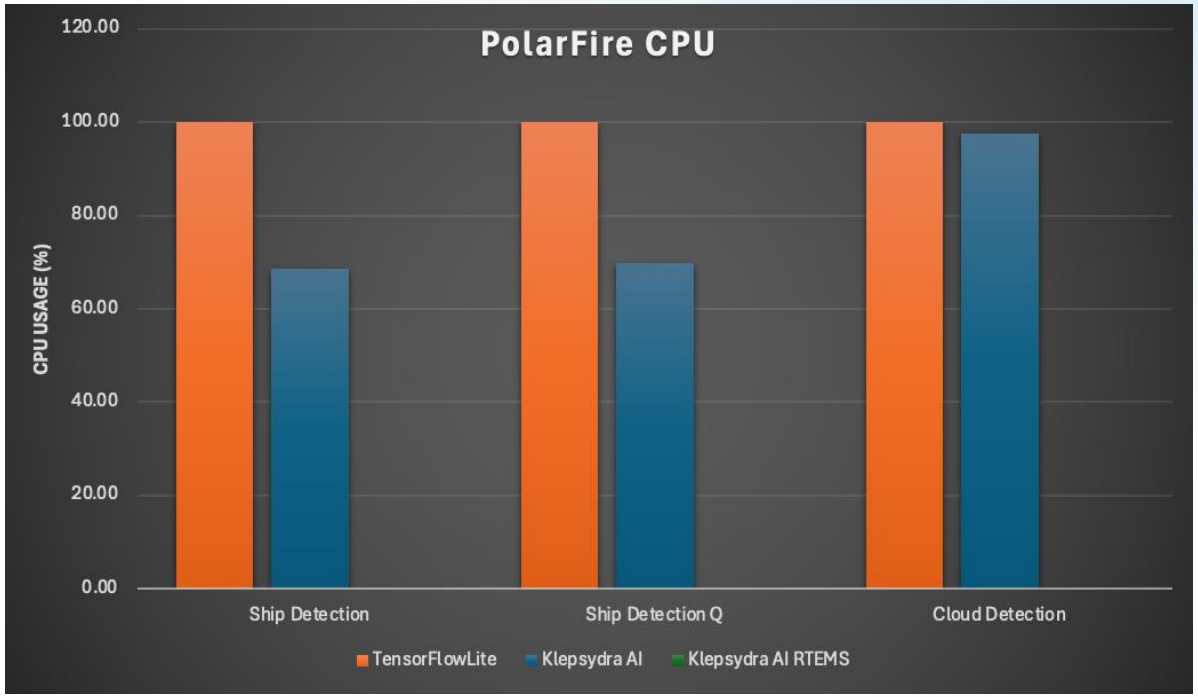


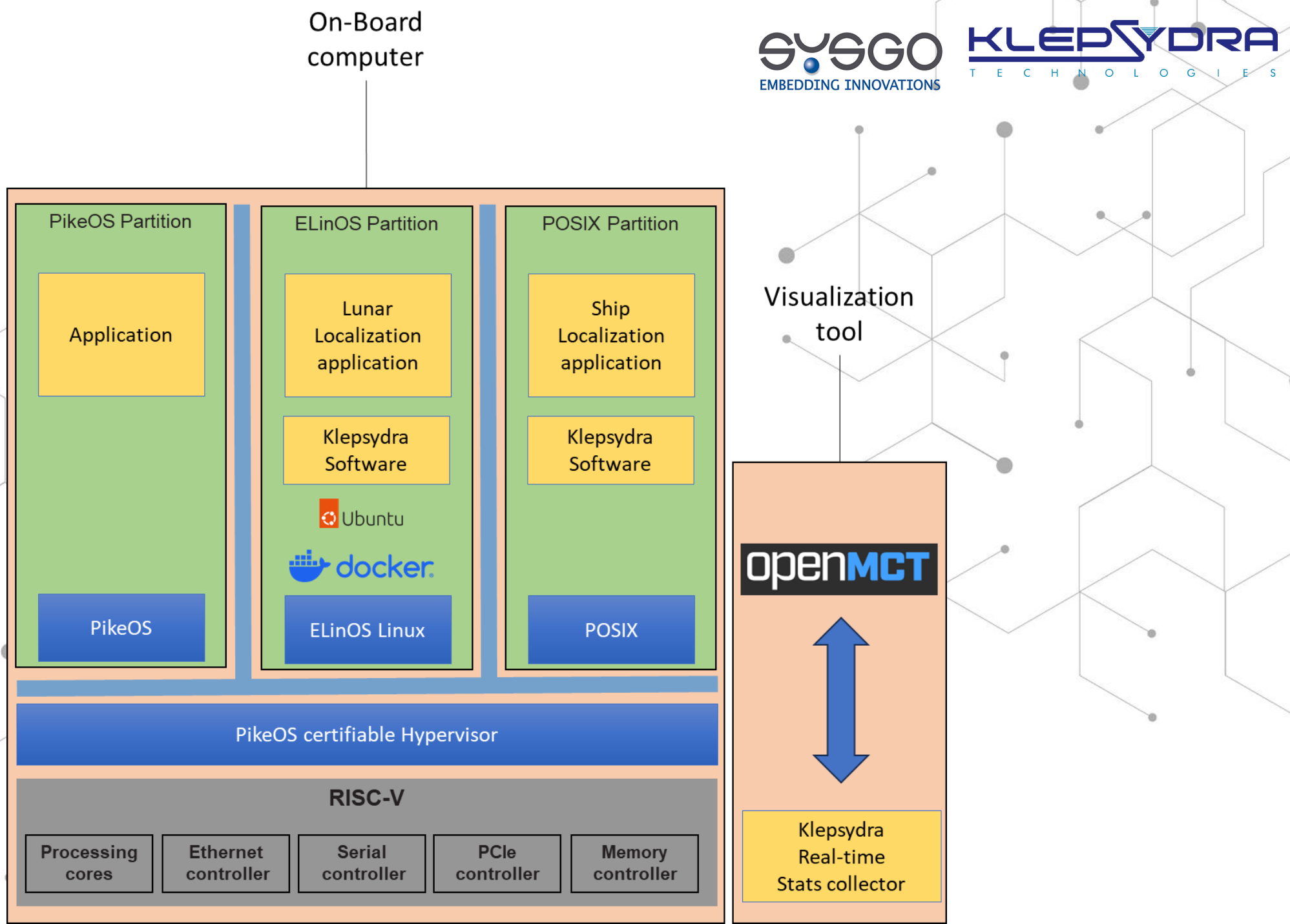
Klepsydra AI RISC-V Benchmarks

REBECCA Project: Heavyweight models

Performance comparison Klepsydra AI REBECCA / Polarfire



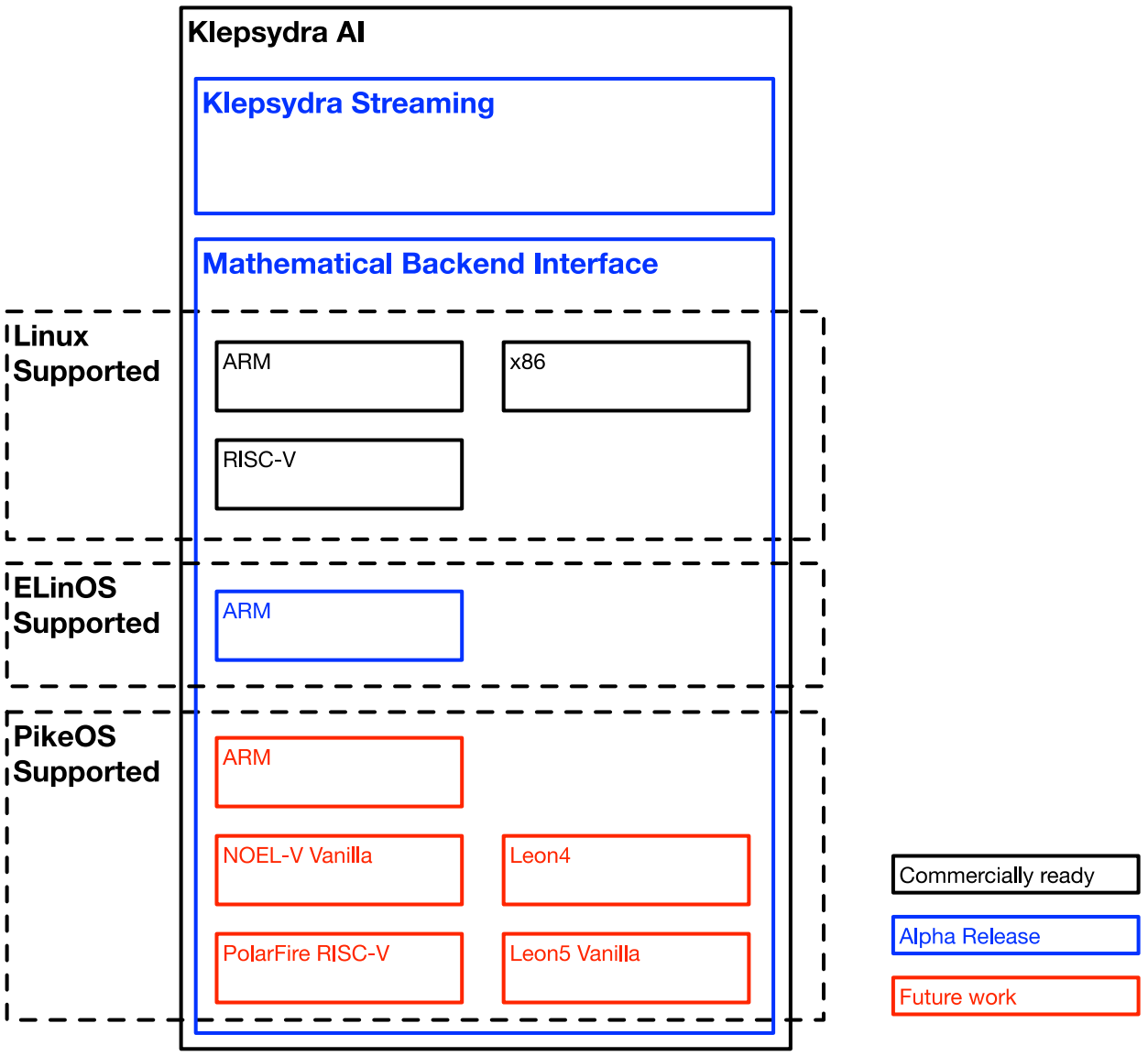



On-Board computer
PikeOS Partition
Application
PikeOS
ELinOS Partition
Lunar Localization application
Klepsydra Software
Ubuntu
docker
ELinOS Linux
POSIX Partition
Ship Localization application
Klepsydra Software
POSIX
PikeOS certifiable Hypervisor
RISC-V
Processing cores
Ethernet controller
Serial controller
PCIe controller
Memory controller
Visualization tool
openMCT
Klepsydra Real-time Stats collector

Klepsydra and SYSGO, Integration roadmap

Breakdown by board:

- ELinOS support to ARM
- Porting of Klepsydra to several CPU-only processors:
  - GR740, GR765 (LEON5/NOEL-V)
  - RISC-V
  - ARM Cortex
- On PikeOS operating system.
- Adoption of Klepsydra SDO to optimize multi-core execution of AI and classical algorithms.



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