PointOfData.ai White Paper

Delivering High-Performance, Low-Energy Data Processing for the Actor Economy

As organizations deploy AI-driven Agent, and Actor workloads at scale, traditional computing infrastructure struggles with cost, power, and efficiency constraints. PointOfData.ai's Actor Infrastructure Platform (AIP) is purpose-built for low-resource environments—originally designed for ARM-based single-board computers, IoT devices, and sensors—yet it delivers server-class performance with a fraction of the energy demand.

By Daniel Luedke
Product Marketing Manager

Contents

Introduction

In today's computing landscape, energy efficiency and performance are often seen as opposing goals. PointOfData.ai's **Actor Infrastructure Platform (AIP)** demonstrates that both can be achieved simultaneously. Originally developed to operate on **low-resource hardware**—including smartphones, smart sensors, and single-board computers (SBCs) used for monitoring and process control—AIP was engineered with careful attention to programming languages and code design to maximize efficiency.

Over time, AIP has consistently delivered **high-speed performance on minimal hardware**, including widely used ARM-based SBCs such as the **Raspberry Pi** and **Orange Pi**, as well as RISC-V modules. These low-power devices draw only a few watts, yet AIP performs at levels comparable to more complex software running on traditional servers and desktops. A natural outcome of this design is that when AIP is deployed on standard computing hardware, it consumes **significantly less energy** than comparable software solutions.

Key takeaways include:

1. **Neural Memory DB on energy-optimized devices** (e.g., Orange Pi) can achieve the same performance at up to **50% of the cost** while using **up to 75% less energy**.

2. **Energy efficiency scales across compute environments** because AIP's architecture eliminates the need for multiple software layers, leverages an optimized C implementation, and incorporates highly efficient storage and retrieval mechanisms.

This white paper explores the **design principles, architectural choices, and optimizations** that enable AIP to operate efficiently across diverse hardware environments, demonstrating how these innovations translate into **meaningful reductions in power consumption without compromising performance**.

Measured Energy Usage

The energy consumption of the **Actor Infrastructure Platform (AIP)**—particularly its Neural Memory database engine—has been assessed in terms of **joules (watt-seconds)** required to perform specific operations. CPU energy usage was calculated based on the known power consumption of the CPU cores for a given platform and the total CPU time required to complete these operations. While not an absolute measurement, this approach provides a **reasonable and practical estimate** of the energy requirements for the engine without relying on specialized measurement hardware.

Test Conditions

Measurements for the AIP Neural Memory database were conducted under the following conditions:

1. **Activity logging level:** Maximum
2. **CPU:** ARM Cortex A-76, single-core operation (no threading) at 2.3 GHz
3. **Storage:** PCIe-attached NVMe, 2 TB Western Digital “Black”
4. **Operating system:** Linux 22.04

Assumptions

The following assumptions were applied in calculating energy usage:

1. Measured CPU time accurately reflects the duration of operations.
2. A single A-76 CPU core consumes **750 milliwatts/sec (0.75 joules)** at full load.
3. Reported timings **exclude the time required to write timing logs to storage**, verified via code inspection.
4. Each event object includes **ten keyword facets** and **four location dimensions**. Facets are represented as “k=keyword,” and location dimensions consist of three-digit decimal latitude/longitude/altitude values with six decimals of precision, plus an additional “earth” dimension.
5. The database under test contains **1,000 event objects**.

This methodology provides a **consistent and reproducible framework** for quantifying the energy efficiency of the AIP memory database, allowing comparisons across hardware platforms and configurations.

Approximate Joules Used by SQL/noSQL Databases

To quantify the energy efficiency of the **Actor Infrastructure Platform (AIP)**, its Neural Memory database engine was compared against four common SQL/noSQL databases using **atomic database operations**. Energy usage, measured in **joules (watt-seconds)**, was derived from CPU power consumption and operation execution time. For the SQL/noSQL databases, energy data was sourced from a research study utilizing **DBJoules**, a Windows-based tool for approximating energy usage in database operations.

Two datasets were used for testing:

1. **Netflix Users Database** (synthetic dataset of 25,000 users)
    - Columns include User ID, Name, Age, Country, Subscription Type, Total Watch Time, Favorite Genre, and Last Login.

2. **SMS Collection** (5,574 messages)
    - Columns include User ID and Message Text.

The test systems were as follows:

- **System 1:** AMD Ryzen 5 3500U CPU, 2.10 GHz, 4 cores, 8 GB RAM
- **System 2:** Intel Core i5-1135G7 CPU, 2.40 GHz, 4 cores, 8 GB RAM
- **AIP System:** Orange Pi 5 Plus, 4 ARM A-55 cores at 800 MHz, 4 ARM A-76 cores at 2.3 GHz, 32 GB RAM (all operations performed on A-76 cores)

Notes and Assumptions

1. Equivalent AIP operations require at least three tables with associated indexes in traditional SQL/noSQL engines, making the database measurements **best-case comparisons**.
2. CPU power consumption: AMD Ryzen ≈ 16.25 J/sec per core; Intel Core i5 ≈ 7 J/sec per core; ARM A-76 ≈ 1.25 J/sec per core.

Energy Usage Results

<u>SQL/noSQL Databases</u>

Netflix Users	Query Type	System 1 Joules	System 2 Joules
MySQL	INSERT	1.77	0.89
MySQL	SELECT	1.79	0.85
Postgres	INSERT	1.19	0.81
Postgres	SELECT	1.68	0.89
MongoDB	INSERT	1.58	0.81
MongoDB	SELECT	1.55	1.10
Couchbase	INSERT	1.68	0.83
Couchbase	SELECT	1.49	0.73

SMS Collection	Query Type	System 1 Joules	System 2 Joules
MySQL	INSERT	1.86	0.82
MySQL	SELECT	2.43	0.69
Postgres	INSERT	1.94	0.66
Postgres	SELECT	2.38	0.63

MongoDB	INSERT	2.24	0.77
MongoDB	SELECT	1.95	0.70
Couchbase	INSERT	2.39	0.94
Couchbase	SELECT	2.61	0.80

AIP System

Note: AIP's Neural Memory DB uses a hypergraph-like structure to capture events.

Event Objects	Operation	Avg CPU Time (sec)	Joules
	Store Event and All Facets	0.0069	0.0052
	Search for Events, Retrieving All Facets	0.0240	0.0180

Comparative Analysis

When comparing AIP to the best-performing SQL/noSQL engines:

Dataset	Operation	Best DB Joules	AIP Joules	AIP % of Best DB
Netflix	INSERT/STORE	0.8100	0.0052	0.64%
Netflix	SELECT/FIND	0.7300	0.0180	2.46%
SMS	INSERT/STORE	0.6600	0.0052	0.78%
SMS	SELECT/FIND	0.6300	0.0180	2.85%

Adjusting for CPU power efficiency relative to the Core i5 (≈2.8× the power of the ARM A-76 at similar clock speeds), the AIP would consume **at most 1.79% of the energy for inserts** and **8.0% for searches** compared to conventional engines. Considering that each event object in AIP effectively replaces three SQL tables, the adjusted figures drop to **0.7% for insertions** and **2.3% for searches**, confirming energy savings of **at least 75%**, and in some cases, up to **97%**.

Observations

While AIP demonstrates exceptional energy efficiency, analysis indicates a potential area for improvement: retrieval operations are slightly slower than insertions, unlike conventional SQL/noSQL databases. Optimizing search performance could further enhance AIP's efficiency without compromising its low-power advantages.

Conclusion

The evolution of computing toward more sustainable, efficient, and intelligent systems demands a fundamental shift in how software and hardware interact. The AIP (Actor Infrastructure Platform) and its Neural Memory Database embody this shift by demonstrating that **high performance does not have to come at high energy cost**.

Through deliberate adherence to the **principles of low-consumption computing**—minimizing unnecessary resources, reducing memory and CPU overhead, leveraging efficient data transport and storage, and using hardware purposefully—the AIP achieves results that redefine what's possible in modern computing environments.

Testing has shown that the AIP can deliver **equivalent or superior performance at up to 50% lower cost and up to 75% less energy consumption** when deployed on energy-optimized devices like the Orange Pi. Its modular, actor-based design allows workloads to be intelligently distributed across heterogeneous environments, ensuring that processing power, memory, and storage are always used in the most efficient way possible.

By uniting energy efficiency with computational proximity, data precision, and scalability, the AIP represents a new foundation for **Agentic, Actor, and AI-driven systems**—one capable of scaling sustainably across edge, cloud, and embedded environments.

In an era where energy consumption is as critical a metric as processing speed, PointOfData.ai's AIP stands as a proof point that **efficiency is the new frontier of performance**.

