T100-DB

The World's First Truly AI-Native Database System

Project Roadmap

A Strategic Path to Foundational AI Data Infrastructure

This document outlines the strategic roadmap for the T100-DB project, detailing our phased development plan, core architectural vision, and commitment to building a robust open-source community. Our approach is designed to de-risk the project by focusing on core functionality first, iteratively adding complexity, and generating tangible assets at each stage to secure sustained support and foster broad adoption.

I

Strategic Vision and Core Architecture

1.1. Defining the T100-DB Mission: Foundational Infrastructure for the AI Era

The core mission of the T100-DB project is to develop, foster, and sustain an open-source, high-performance, distributed vector database architected from the ground up to address the unprecedented scale and latency demands of modern Artificial Intelligence (AI) workloads. This includes, but is not limited to, generative AI, large-scale scientific computing, and real-time analytics. We position T100-DB not as a niche application, but as a foundational infrastructure tool, analogous to indispensable components of the scientific Python ecosystem.

1.2. Core Architectural Blueprint: A Distributed, Column-Oriented Foundation

The architecture of T100-DB is designed as a cohesive system where each component complements the others to achieve our performance and scalability goals:

- **Data Model:** A Column-Family (Wide-Column) Store for managing massive, distributed datasets with high write and read throughput, superior to traditional row-oriented models for AI workloads. This flexible, schema-less design is exceptionally well-suited for evolving and heterogeneous data structures.

- **Indexing and Search:** Implementation of the Hierarchical Navigable Small World (HNSW) algorithm for Approximate Nearest Neighbor (ANN) search, providing industry-leading performance, combining super-fast search speeds with excellent recall in high-dimensional vector spaces.

- **High-Performance Data Exchange (IPC):** Adoption of Apache Arrow as the canonical in-memory format for all data, enabling zero-copy data sharing between processes and efficient bulk data transport via Arrow Flight.

- **Network Transport:** Leveraging Aeron for all critical inter-node communication, ensuring extremely low-latency, high-throughput, and predictable messaging, including fault tolerance via Aeron Cluster (Raft consensus).

- **Data Integrity and Security:** A multi-layered defense strategy including Write-Ahead Logging (WAL) for transaction durability, robust Data Checksumming for corruption protection, granular Authentication and Role-Based Access Control (RBAC), and optional End-to-End Encryption (E2EE) for confidentiality.

1.3. Core Language Selection: A Deliberate Choice

- **Julia (The Core Engine):** Chosen for its unparalleled performance in scientific and numerical computation, composable parallelism, and direct ecosystem alignment, providing high-level productivity and high performance in a single environment.

- **Python (The API Layer):** Selected as the high-level API due to its ubiquity in AI, ensuring a frictionless developer experience and seamless integration with the entire data science ecosystem.

- **Go (The CLI & Tooling):** Utilized for all command-line and operational tooling, delivering robust, dependency-free, and lightning-fast binaries for DevOps automation and management.

II

Phased Development and Operational Excellence

Translating our ambitious architectural vision into a stable, high-performance product requires a disciplined, phased execution plan. This roadmap is designed not only to build the product but also to build credibility and traction at each stage, which is essential for our parallel funding approach.

Phase 1: Minimum Viable Product (MVP) (Months 1-6)

- **Goal:** To rapidly develop and demonstrate the core, single-node performance and functionality of T100-DB. The objective is to create a tangible asset that proves the viability of the core technical thesis.

- **Key Features:**
  - **Core Storage Engine:** Implementation of the fundamental column-family data model using Julia, capable of storing and retrieving vector and metadata payloads.
  - **In-Memory HNSW Index:** A fully functional, in-memory implementation of the HNSW algorithm for high-performance ANN search on a single node.
  - **Basic API and CLI:** A minimalist Python API for basic CRUD (Create, Read, Update, Delete) operations and vector search, accompanied by a simple Go-based Command-Line Interface (CLI).
  - **Apache Arrow Integration:** Internal data structures will be based on the Apache Arrow columnar format from day one, ensuring an efficient in-memory foundation.

  Target Outcomes: A demonstrable, high-performance single-node prototype validating core concepts, ready for initial technical presentations and foundational grant applications.

Phase 2: Private/Public Beta (Months 7-15)

- **Goal:** To introduce distributed capabilities and validate the product with a select group of early adopters, such as academic research labs and friendly startups in the target domains. This phase is about gathering critical feedback and hardening the system.

- **Key Features:**
  - **Distributed Architecture:** The single-node architecture will be extended to a full distributed system, integrating Aeron for inter-node

communication and implementing the Raft consensus protocol via Aeron Cluster for metadata and cluster coordination.

  - **Data Sharding and Replication:** Implementation of techniques for partitioning data across the cluster and replicating it for fault tolerance.
  - **Durability and Integrity:** The Write-Ahead Logging (WAL) protocol will be implemented to ensure transaction durability, and data checksumming will be integrated at the storage and network layers to guarantee data integrity.
  - **Initial Security Model:** A foundational authentication and Role-Based Access Control (RBAC) framework will be put in place to manage access in a multi-user environment.
  - **Core Observability:** The initial observability stack, based on OpenTelemetry, Prometheus, and Grafana, will be deployed to monitor the health and performance of the beta clusters.

Target Outcomes: A stable, distributed beta product with early user feedback, demonstrating scalability and reliability, suitable for larger grant applications and early commercial engagements.

Phase 3: Stable 1.0 Release (Months 16-24)

- **Goal:** To achieve a stable, production-ready version of T100-DB, suitable for broad adoption and enterprise use.

- **Key Features (Building on previous phases):**
  - **Comprehensive Performance Optimization:** Rigorous memory management (pre-allocation, in-place operations), advanced concurrency (composable multi-threading, GPU acceleration), and vectorization techniques to ensure low and predictable latency.
  - **Advanced Security Features:** Full implementation of End-to-End Encryption (E2EE), robust authentication methods (including enterprise identity provider integration), and comprehensive RBAC.
  - **Robust Error Handling & Recovery:** Enhanced fault tolerance, refined recovery mechanisms, and comprehensive logging.
  - **World-Class Documentation:** High-quality, complete, and accessible documentation for all user personas (developers, DevOps, data

scientists), including getting started guides, API references, and operational manuals.

- **Community Growth & Support:** Fully established community channels (Discourse, real-time chat), a clear contributor pathway, and initial community support infrastructure.

Target Outcomes: A production-ready T100-DB 1.0 release, capable of handling mission-critical AI workloads, supported by a growing community and robust operational tooling, ready for widespread adoption and commercial scaling.

III

Community and Governance Integration

Our development roadmap is intrinsically linked with our commitment to building a vibrant and well-governed open-source community. We will continuously foster an environment of transparency, inclusivity, and collaboration. Our Code of Conduct and formal Governance Document will evolve alongside the project, ensuring that decision-making processes are clear and that all participants feel valued and empowered. High-quality documentation will serve as a critical bridge, converting users into active contributors and accelerating adoption.

IV

A Foundation for the AI Era

The T100-DB project is set to deliver a high-performance, open-source database that will fundamentally accelerate innovation across artificial intelligence and scientific research. Our meticulously designed architecture, built upon a modern and purpose-driven technology stack, addresses the critical demands of the AI era, providing a unified, efficient, and powerful platform for diverse workloads. This roadmap outlines a clear, de-risked path to achieving our vision, ensuring that T100-DB becomes an essential, trusted, and foundational piece of infrastructure, empowering the next generation of scientific discovery and artificial intelligence.

Signature: Director of Operations & Core Engineering Team