readme.md for @push.rocks/smartdb

A MongoDB-compatible embedded database server powered by Rust □□⚡ — use the official `mongodb` driver and it just works. No binary downloads, instant startup, zero config.

Install

```
pnpm add @push.rocks/smartdb
# or
npm install @push.rocks/smartdb
```

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What It Does

`@push.rocks/smartdb` is a **real database server** that speaks the wire protocol used by MongoDB drivers. The core engine is written in Rust for high performance, with a thin TypeScript orchestration layer. Connect with the standard `mongodb` Node.js driver — no mocks, no stubs, no external binaries required.

Why SmartDB?

	SmartDB	External DB Server

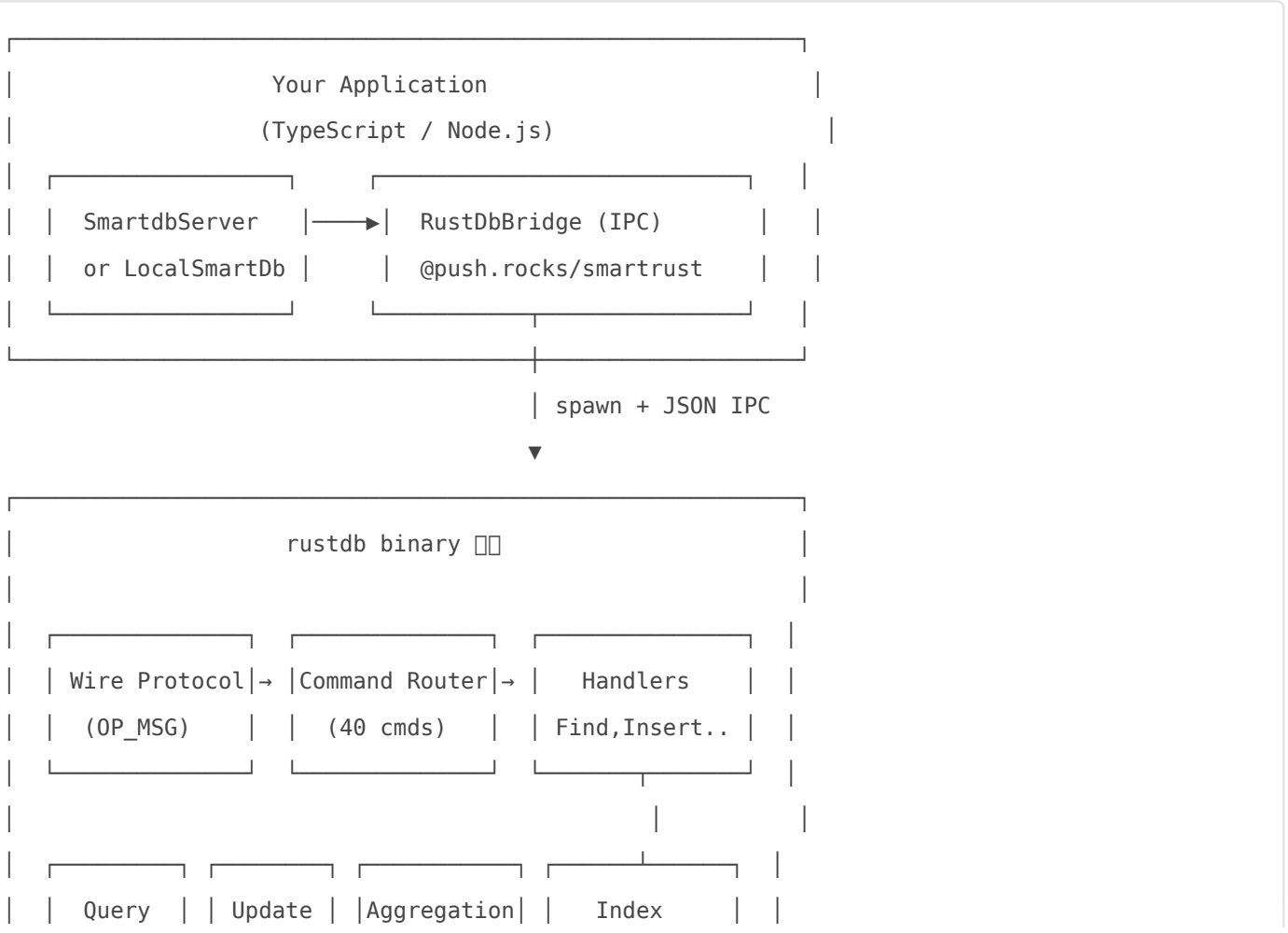
Startup time	~30ms	~2-5s
Binary download	Bundled (~7MB)	~200MB+
Install	`pnpm add`	System package / Docker
Persistence	Memory or file-based	Full disk engine
Perfect for	Unit tests, CI/CD, prototyping, local dev, embedded	Production at scale

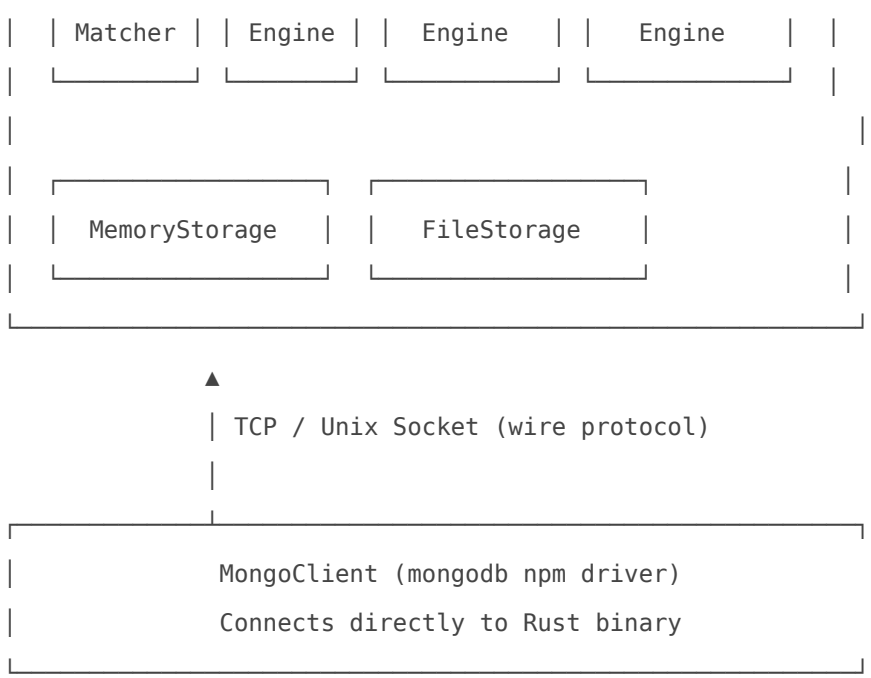
Two Ways to Use It

- □□ `SmartdbServer` — Full control. Configure port, host, storage backend, Unix sockets. Great for test fixtures or custom setups.
- □□ `LocalSmartDb` — Zero-config convenience. Give it a folder path, get a persistent database over a Unix socket. Done.

Architecture: TypeScript + Rust □□

SmartDB uses the same **sidecar binary** pattern as @push.rocks/smartproxy:





The TypeScript layer handles **lifecycle only** (start/stop/configure via IPC). All database operations flow directly from the `MongoClient` to the Rust binary over TCP or Unix sockets — **zero per-query IPC overhead**.

Quick Start

Option 1: LocalSmartDb (Zero Config) □□

The fastest way to get a persistent local database:

```
import { LocalSmartDb } from '@push.rocks/smartdb';
import { MongoClient } from 'mongodb';

// Point it at a folder — that's it
const db = new LocalSmartDb({ folderPath: './my-data' });
const { connectionUri } = await db.start();

// Connect with the standard driver
const client = new MongoClient(connectionUri, { directConnection: true });
await client.connect();

// Use it like any wire-protocol-compatible database
```

```
const users = client.db('myapp').collection('users');
await users.insertOne({ name: 'Alice', email: 'alice@example.com' });
const user = await users.findOne({ name: 'Alice' });
console.log(user); // { _id: ObjectId(...), name: 'Alice', email: 'alice@example.com' }

// Data persists to disk automatically — survives restarts!
await client.close();
await db.stop();
```

Option 2: SmartdbServer (Full Control) □□

```
import { SmartdbServer } from '@push.rocks/smartdb';
import { MongoClient } from 'mongodb';

// TCP mode
const server = new SmartdbServer({ port: 27017 });
await server.start();

const client = new MongoClient('mongodb://127.0.0.1:27017');
await client.connect();

const db = client.db('myapp');
await db.collection('users').insertOne({ name: 'Alice', age: 30 });
const user = await db.collection('users').findOne({ name: 'Alice' });

await client.close();
await server.stop();
```

API Reference

SmartdbServer

The core server class. Manages the Rust database engine and exposes connection details.

Constructor Options (`ISmartdbServerOptions`)

```
import { SmartdbServer } from '@push.rocks/smartdb';

// TCP mode (default)
const server = new SmartdbServer({
  port: 27017,              // Default: 27017
  host: '127.0.0.1',        // Default: 127.0.0.1
  storage: 'memory',        // 'memory' or 'file' (default: 'memory')
  storagePath: './data',     // Required when storage is 'file'
});

// Unix socket mode — no port conflicts!
const server = new SmartdbServer({
  socketPath: '/tmp/smartdb.sock',
  storage: 'file',
  storagePath: './data',
});

// Memory storage with periodic persistence
const server = new SmartdbServer({
  storage: 'memory',
  persistPath: './data/snapshot.json',
  persistIntervalMs: 30000, // Save every 30s
});
```

Methods & Properties

Method / Property	Type	Description
`start()`	`Promise<void>`	Start the server (spawns Rust binary)
`stop()`	`Promise<void>`	Stop the server and clean up
`getConnectionUri()`	`string`	Get the `mongodb://` connection URI
`running`	`boolean`	Whether the server is currently running
`port`	`number`	Configured port (TCP mode)
`host`	`string`	Configured host (TCP mode)
`socketPath`	`string | undefined`	Socket path (socket mode)

LocalSmartDb

Zero-config wrapper around SmartdbServer. Uses Unix sockets and file-based persistence.

Constructor Options (`ILocalSmartDbOptions`)

```
import { LocalSmartDb } from '@push.rocks/smartdb';

const db = new LocalSmartDb({
  folderPath: './data',                 // Required: data storage directory
  socketPath: '/tmp/custom.sock',       // Optional: custom socket (default: auto-generated)
});
```

Methods & Properties

Method / Property	Type	Description
`start()`	`Promise<ILocalSmartDbConnectionInfo>`	Start and return connection info
`stop()`	`Promise<void>`	Stop the server
`getConnectionInfo()`	`ILocalSmartDbConnectionInfo`	Get current connection info
`getConnectionUri()`	`string`	Get the connection URI
`getServer()`	`SmartdbServer`	Access the underlying server
`running`	`boolean`	Whether the server is running

Connection Info (`ILocalSmartDbConnectionInfo`)

```
interface ILocalSmartDbConnectionInfo {
  socketPath: string;      // e.g., /tmp/smartdb-abc123.sock
  connectionUri: string;   // e.g., mongodb://%2Ftmp%2Fsmartdb-abc123.sock
}
```

Supported Operations

SmartDB supports the core operations through the wire protocol. Use the standard `mongodb` driver — these all work:

CRUD

```
// Insert
await collection.insertOne({ name: 'Bob' });
await collection.insertMany([{ a: 1 }, { a: 2 }]);

// Find
const doc = await collection.findOne({ name: 'Bob' });
const docs = await collection.find({ age: { $gte: 18 } }).toArray();

// Update
await collection.updateOne({ name: 'Bob' }, { $set: { age: 25 } });
await collection.updateMany({ active: false }, { $set: { archived: true } });

// Delete
await collection.deleteOne({ name: 'Bob' });
await collection.deleteMany({ archived: true });

// Replace
await collection.replaceOne({ _id: id }, { name: 'New Bob', age: 30 });

// Find and Modify
await collection.findOneAndUpdate({ name: 'Bob' }, { $inc: { visits: 1 } }, { returnDocument:
'after' });
await collection.findOneAndDelete({ expired: true });
await collection.findOneAndReplace({ _id: id }, { name: 'Replaced' }, { returnDocument:
'after' });
```

Query Operators

```
// Comparison
{ age: { $eq: 25 } }     { age: { $ne: 25 } }
{ age: { $gt: 18 } }     { age: { $lt: 65 } }
{ age: { $gte: 18 } }    { age: { $lte: 65 } }
{ status: { $in: ['active', 'pending'] } }
{ status: { $nin: ['deleted'] } }

// Logical
{ $and: [{ age: { $gte: 18 } }, { active: true }] }
{ $or: [{ status: 'active' }, { admin: true }] }
```

```
{ $not: { status: 'deleted' } }

// Element
{ email: { $exists: true } }
{ type: { $type: 'string' } }

// Array
{ tags: { $all: ['mongodb', 'database'] } }
{ scores: { $elemMatch: { $gte: 80, $lt: 90 } } }
{ tags: { $size: 3 } }

// Regex
{ name: { $regex: /^Al/i } }
```

Update Operators

```
{ $set: { name: 'New Name' } }
{ $unset: { tempField: '' } }
{ $inc: { count: 1 } }
{ $mul: { price: 1.1 } }
{ $min: { low: 50 } }        { $max: { high: 100 } }
{ $push: { tags: 'new' } }   { $pull: { tags: 'old' } }
{ $addToSet: { tags: 'unique' } }
{ $pop: { queue: 1 } }       // Remove last
{ $pop: { queue: -1 } }      // Remove first
{ $rename: { old: 'new' } }
{ $currentDate: { lastModified: true } }
```

Aggregation Pipeline

```
const results = await collection.aggregate([
  { $match: { status: 'active' } },
  { $group: { _id: '$category', total: { $sum: '$amount' } } },
  { $sort: { total: -1 } },
  { $limit: 10 },
  { $project: { category: '$_id', total: 1, _id: 0 } },
]).toArray();
```

Supported stages: `$match`, `$project`, `$group`, `$sort`, `$limit`, `$skip`, `$unwind`, `$lookup`, `$addFields`, `$count`, `$facet`, `$replaceRoot`, `$set`, `$unionWith`, `$out`, `$merge`

Group accumulators: `$sum`, `$avg`, `$min`, `$max`, `$first`, `$last`, `$push`, `$addToSet`, `$count`

Indexes

```
await collection.createIndex({ email: 1 }, { unique: true });
await collection.createIndex({ name: 1, age: -1 });    // compound
await collection.createIndex({ field: 1 }, { sparse: true });
const indexes = await collection.listIndexes().toArray();
await collection.dropIndex('email_1');
await collection.dropIndexes();  // drop all except _id
```

Database & Admin

```
await db.listCollections().toArray();
await db.createCollection('new');
await db.dropCollection('old');
await db.dropDatabase();
await db.stats();

const admin = client.db().admin();
await admin.listDatabases();
await admin.ping();
await admin.serverStatus();
```

Bulk Operations

```
const result = await collection.bulkWrite([
  { insertOne: { document: { name: 'Bulk1' } } },
  { updateOne: { filter: { name: 'X' }, update: { $set: { bulk: true } } } },
  { deleteOne: { filter: { name: 'Expired' } } },
]);
```

Count & Distinct

```
const count = await collection.countDocuments({ status: 'active' });
const estimated = await collection.estimatedDocumentCount();
const names = await collection.distinct('name');
```

Wire Protocol Commands

Category	Commands
Handshake	`hello`, `isMaster`, `ismaster`
CRUD	`find`, `insert`, `update`, `delete`, `findAndModify`, `getMore`, `killCursors`
Aggregation	`aggregate`, `count`, `distinct`
Indexes	`createIndexes`, `dropIndexes`, `listIndexes`
Sessions	`startSession`, `endSessions`
Transactions	`commitTransaction`, `abortTransaction`
Admin	`ping`, `listDatabases`, `listCollections`, `drop`, `dropDatabase`, `create`, `serverStatus`, `buildInfo`, `dbStats`, `collStats`, `connectionStatus`, `currentOp`, `renameCollection`

Compatible with wire protocol versions 0–21 (driver versions 3.6 through 7.0).

Rust Crate Architecture □□

The Rust engine is organized as a Cargo workspace with 8 focused crates:

Crate	Purpose
`rustdb`	Binary entry point: TCP/Unix listener, management IPC, CLI
`rustdb-config`	Server configuration types (serde, camelCase JSON)
`rustdb-wire`	Wire protocol parser/encoder (OP_MSG, OP_QUERY, OP_REPLY)
`rustdb-query`	Query matcher, update engine, aggregation, sort, projection
`rustdb-storage`	Storage backends (memory, file) + WAL + OpLog
`rustdb-index`	B-tree/hash indexes, query planner (IXSCAN/COLLSCAN)

Crate	Purpose
`rustdb-txn`	Transaction + session management with snapshot isolation
`rustdb-commands`	40 command handlers wiring everything together

Cross-compiled for `linux_amd64` and `linux_arm64` via @git.zone/tsrust.

Testing Example

```
import { expect, tap } from '@git.zone/tstest/tapbundle';
import { SmartdbServer } from '@push.rocks/smartdb';
import { MongoClient } from 'mongodb';

let server: SmartdbServer;
let client: MongoClient;

tap.test('setup', async () => {
  server = new SmartdbServer({ port: 27117 });
  await server.start();
  client = new MongoClient('mongodb://127.0.0.1:27117', { directConnection: true });
  await client.connect();
});

tap.test('should insert and find', async () => {
  const col = client.db('test').collection('items');
  await col.insertOne({ name: 'Widget', price: 9.99 });
  const item = await col.findOne({ name: 'Widget' });
  expect(item?.price).toEqual(9.99);
});

tap.test('teardown', async () => {
  await client.close();
  await server.stop();
});

export default tap.start();
```

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