**Title:** Technical Design – CLI and Batch Tool Benchmarking in Rust vs. C#

**📌 1. Introduction**

* Project goal and scope (CLI + batch tools only)
* Why Rust vs. C# is being evaluated
* High-level system overview

**🧱 2. Architecture Overview**

* Diagram (optional) showing tool structure: input → processing → output
* Rust and C# parity principles (match logic, IO, error handling)

**⚙️ 3. Tool Implementations Overview**

**a. Manual CSV Processor**

* Functionality: line-by-line filtering, uppercase name
* Rust: cli\_tool.rs
* C#: CsvProcessorManual.cs
* Key differences in approach (e.g., memory management, deserialization)

**b. Batch Age Grouping Job**

* Functionality: group ages into ranges, count
* Rust: batch\_job.rs
* C#: BatchJob.cs
* Description of data structure used (BTreeMap / Dictionary)

**c. Parallel Batch Job**

* Functionality: same as above, but parallel
* Rust: batch\_job\_parallel.rs using Rayon
* C#: BatchJobParallel.cs using Parallel.ForEach
* Merge strategies and thread handling

**🛠 4. Libraries and Tools Used**

| **Language** | **Libraries Used** |
| --- | --- |
| Rust | csv, serde, rayon |
| C# | Native IO, System.Collections.Concurrent, StreamReader |

**🧪 5. Benchmark Configuration**

* Input file: large\_input.csv (structure, row count)
* Output files: explained briefly
* Platform used: OS, CPU, RAM
* Build mode: Release (C# .NET 9.0, Rust --release)
* Repetition: 10+ runs via hyperfine

**📋 6. Benchmark Scenario Definitions**

➡ Include the **3 benchmark scenarios** (you already wrote them!) here

* Manual
* Batch
* Parallel

**🧩 7. Design Rationale**

* Why you chose CSV as the workload
* Why you kept logic and structure matched between languages
* Justification for tools (Rayon, PLINQ, StreamReader, etc.)

**🔄 8. Limitations and Known Differences**

* No async API tool included (by scope)
* Slight overhead differences (e.g. CsvHelper vs serde)
* C# GC vs. Rust zero-cost abstractions

**✅ 9. Conclusion**

* Tools are fully equivalent in function
* Designed to fairly compare core performance characteristics