Scaling TrustChain to One Million Blocks on Mobile Devices

Storage Performance Evaluation and Benchmarking

Motivation

Smartphones are the most widely used networked devices, but are constrained by strict **storage** and **I/O limits**, making traditional blockchains impractical. **DAG-based** systems such as **TrustChain** offer a lightweight alternative, but its mobile-functionality has never been systematically studied. This research addresses that gap, evaluating **storage scalability** and performance optimizations, like **batching** and **compression**.

RQ — *"What performance and storage trade-offs arise from batching (flush interval k) and compression when a mobile TrustChain node grows from 10^3 to 10^6 blocks?"*

Methodology

A minimal **TrustChain** core was developed in **Rust** from scratch and exposed to **Android** via a lightweight JNI bridge. All cryptographic, validation, and storage logic runs natively in Rust. Designed for **cross-platform** compatibility (Android and iOS). Transport uses Raw UDP with retries and timeouts, and **QUIC** via **Iroh**'s encrypted peer-to-peer streams with discovery.

Benchmarks ran on a physical **Samsung Galaxy S8** (ext4, Android 9) and a **Pixel-6 emulator** (F2FS, Android 16).

Experimental Harnesses: **Isolated Storage CLI** and **In-app RTT** (**Raw UDP** and **Iroh**)

Workload Matrix Storage CLI:

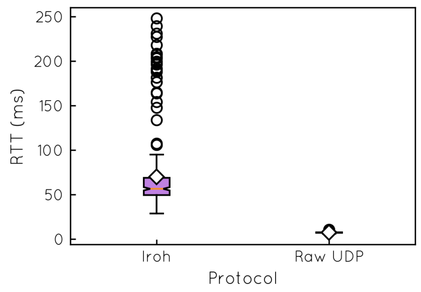
- **Chain length:** N = 10^3 – 10^6 blocks
- **Payloads:** 128–4096 Bytes
- **Flush modes:** memory or disk :k with k ∈ {50, 100, 500, 1000}
- **Compression:** none, Zstd-1/3/9 & LZ4-1

Metrics Captured Storage CLI:

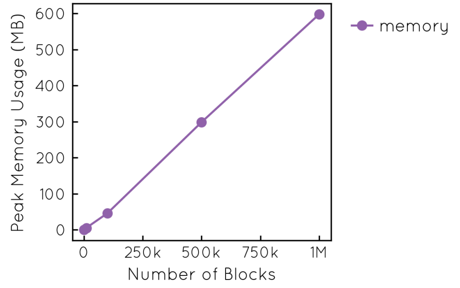
- **Insert latency** (mean ms/block)
- **CPU time** (ms/block)
- **Peak RAM** (MB)
- **On-disk footprint** (GB)

Results

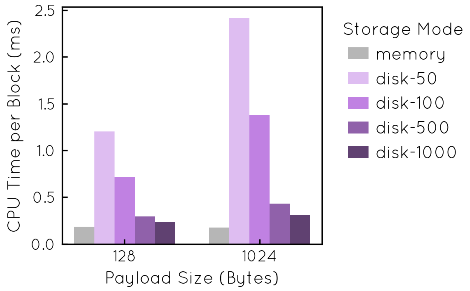
Iroh vs Raw UDP (RTT)



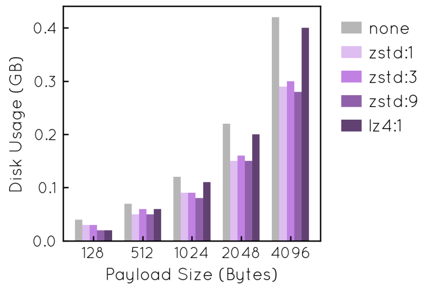
Blocks vs. peak memory usage (memory mode)



Storage mode vs. CPU time per block (100k blocks)



Compression mode vs. disk usage (100k blocks)



Conclusion

1 Million Blocks on Mobile:
≈ 0.5 GB on-disk, < 600 MB peak RAM

Best Flush Strategy:
disk:500 batches → ~ 8 ms/block, 45 % less CPU compared to small k

Top Compression:
LZ4-1 & Zstd-1 → 20–30% storage savings, < 10 ms/block overhead

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