AgriDAO: A Decentralized Agricultural Ecosystem for Transparent Provenance and Ethical Financing Using Blockchain

By
Md. Riajur Rahman
(Student ID: M240105051)
(Batch: 15)

A PROJECT REPORT

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BOARD OF EXAMINERS

The project titled "**AgriDAO: A Decentralized Agricultural Ecosystem for Transparent Provenance and Ethical Financing Using Blockchain**" submitted by Md. Riajur Rahman, Student ID: M240105051, Batch: 15, has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Master of Science in Computer Science and Engineering on January 14, 2026.

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DECLARATION

I hereby declare that this project report entitled “AgriDAO: A Decentralized Agricultural Ecosystem for Transparent Provenance and Ethical Financing Using Blockchain” has been prepared by me and has not been submitted, in whole or in part, for any other degree or diploma at any other university or institution.

Md. Riajur Rahman
Candidate

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ABSTRACT

Agriculture plays a critical role in developing economies, yet supply chains suffer from lack of transparency, intermediary dependence, and unethical financing. AgriDAO is a decentralized agricultural ecosystem ensuring transparent product provenance, ethical financing, and community governance using blockchain. It adopts a hybrid Web2/Web3 architecture with off-chain metadata and on-chain cryptographic hashes. DAO governance enables stakeholder decision-making, and smart contract escrow ensures secure, interest-free transactions. Experiments show high performance and scalability, making it suitable for real-world use.

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Chapter 1: Introduction

1.1 Background

Agriculture is central to Bangladesh's economy, but farmers face price manipulation, limited financing, and opaque supply chains. Blockchain offers decentralized, tamper-proof, and transparent data management.

1.2 Problem Statement

Centralized supply chains are vulnerable to manipulation. Farmers rely on interest-based financing. Existing traceability solutions lack integrated governance and ethical financing.

1.3 Objectives

- Blockchain-based product provenance
- DAO-based decentralized governance
- Secure escrow-backed marketplace
- Hybrid Web2/Web3 architecture for scalability

1.4 Scope of the Project

Includes system design, smart contract development, backend/frontend implementation, and performance evaluation on a blockchain testnet. Regulatory and KYC aspects are out of scope.

1.5 Research Questions

- RQ1: How effectively can hybrid Web2/Web3 architecture support provenance with interactive response times?
- RQ2: Can DAO governance and escrow mechanisms reduce intermediaries and enable fair, interest-free transactions?
- RQ3: What are the performance and scalability characteristics under varying data volumes and caching strategies?

Chapter 2: Literature Review

Previous research on blockchain in agriculture primarily targets traceability and food safety. Governance often remains centralized, limiting farmer participation. Ethical, interest-free financing in agriculture is rarely implemented on blockchain. AgriDAO unifies:

1. Blockchain-anchored provenance
2. DAO-based governance
3. Smart contract escrow for interest-free transactions

Chapter 3: System Architecture and Design

3.1 Overall Architecture

Three-tier hybrid architecture: client layer, application layer, data layer.

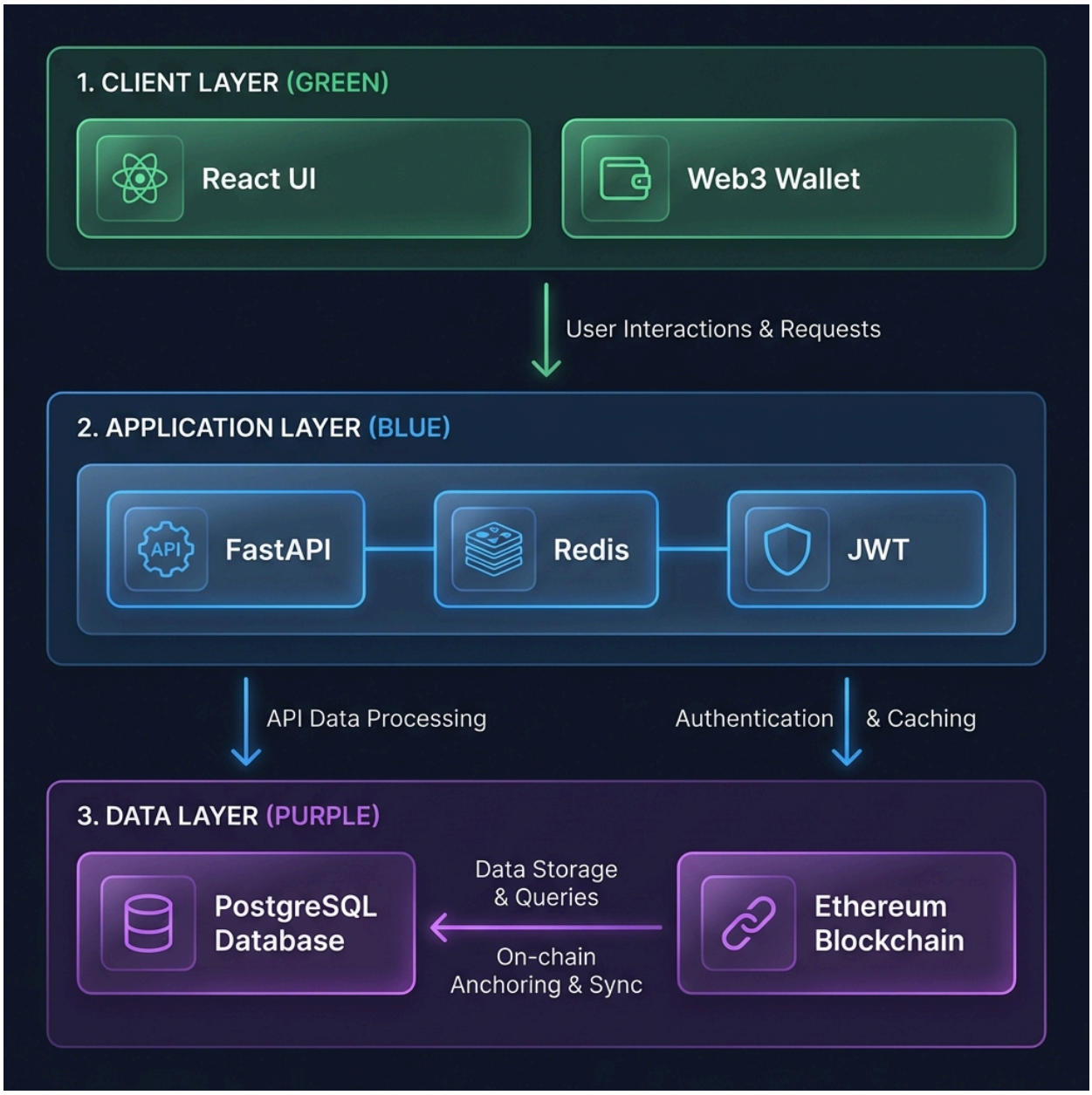

Figure 1: High Level System Architecture

3.2 Client Layer

React SPA with Web3 wallet integration for secure blockchain interactions.

3.3 Application Layer

FastAPI backend for business logic, authentication, and blockchain sync. Asynchronous tasks ensure responsiveness.

3.4 Data Layer

PostgreSQL stores metadata; Ethereum Sepolia anchors hashes; Redis improves caching.

3.5 Threat Model and Trust Assumptions

Potential adversaries: Malicious farmers, buyers, colluding carriers, compromised off-chain database.

Assumptions: On-chain smart contracts are tamper-resistant. Off-chain data can be altered, detected via anchored hashes. Web3 private keys control accounts.

Mitigations:

- Provenance verification via hash check
- Escrow ensures fair transaction
- DAO proposals recorded on-chain
- Backend considered honest-but-curious

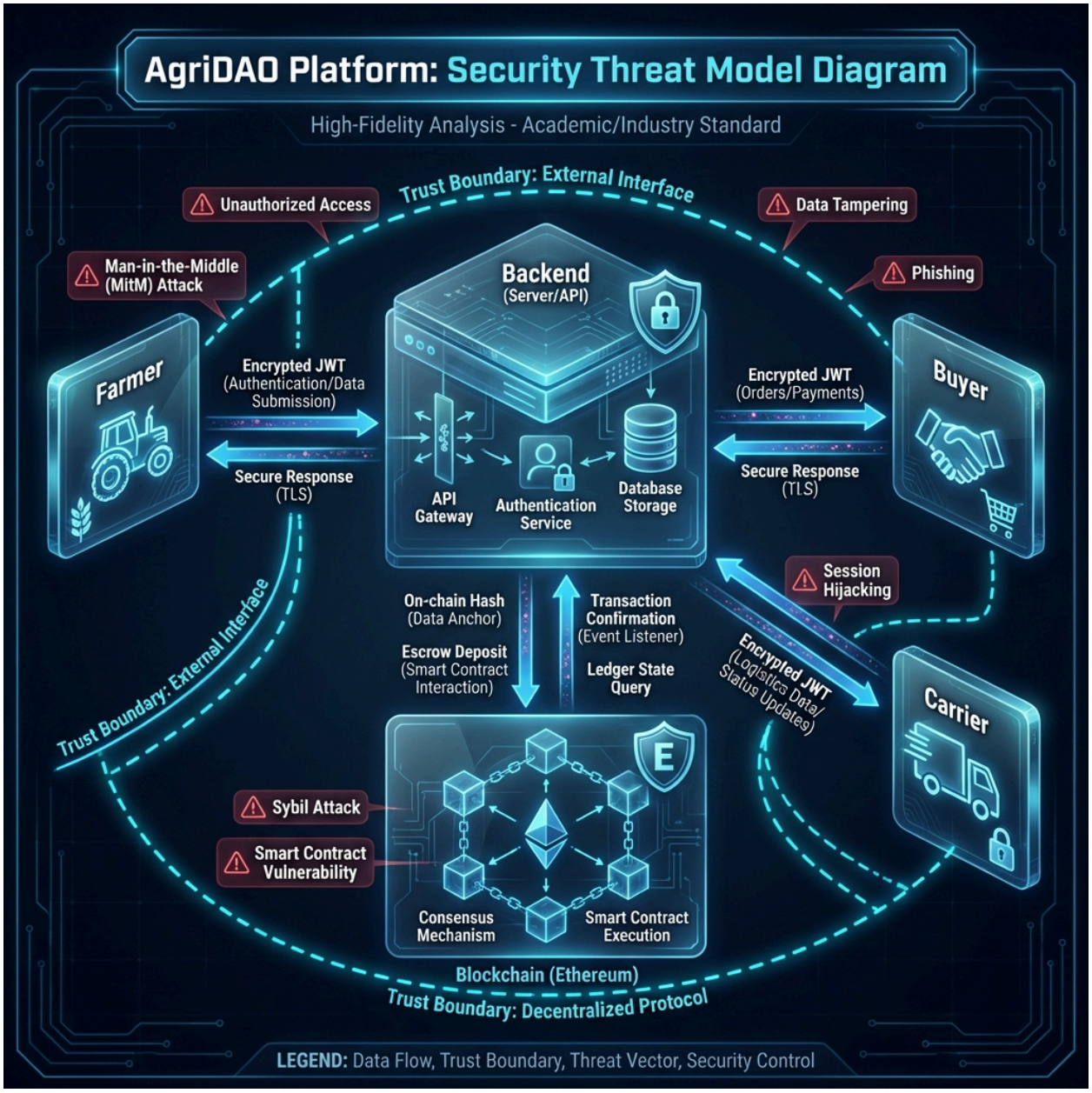

Figure 2: Threat model showing farmer, buyer, carrier, backend, and blockchain with trust boundaries.

Chapter 4: Implementation

4.1 Smart Contract Development

Two primary contracts: DAO governance (AgriDAO.sol) and Marketplace Escrow (MarketplaceEscrow.sol).

4.1.1 Key Smart Contract Interfaces

DAO Contract:

- submitProposal(title, description, actionData)
- vote(proposalId, support)
- executeProposal(proposalId)
- Events: ProposalSubmitted, VoteCast, ProposalExecuted, ProposalRejected

Marketplace Escrow Contract:

- createEscrow(farmer, carrier, amount, productHash)
- confirmDelivery(escrowId)
- raiseDispute(escrowId, reason)
- resolveDispute(escrowId, outcome)
- Events: EscrowCreated, DeliveryConfirmed, DisputeRaised, DisputeResolved

Product mapping: mapping(bytes32 => bytes32) public productHashes;

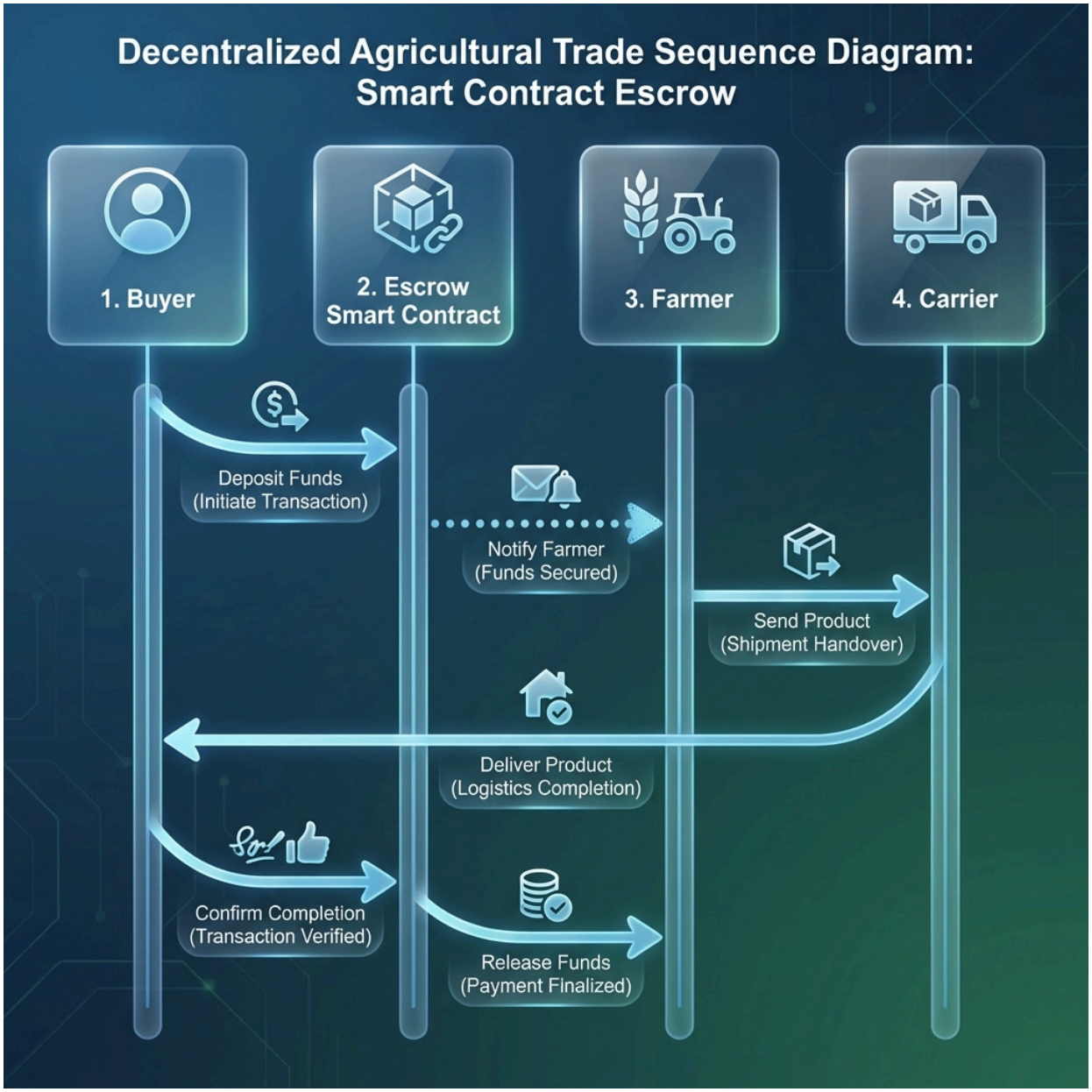

Figure 3: Marketplace Escrow Sequence

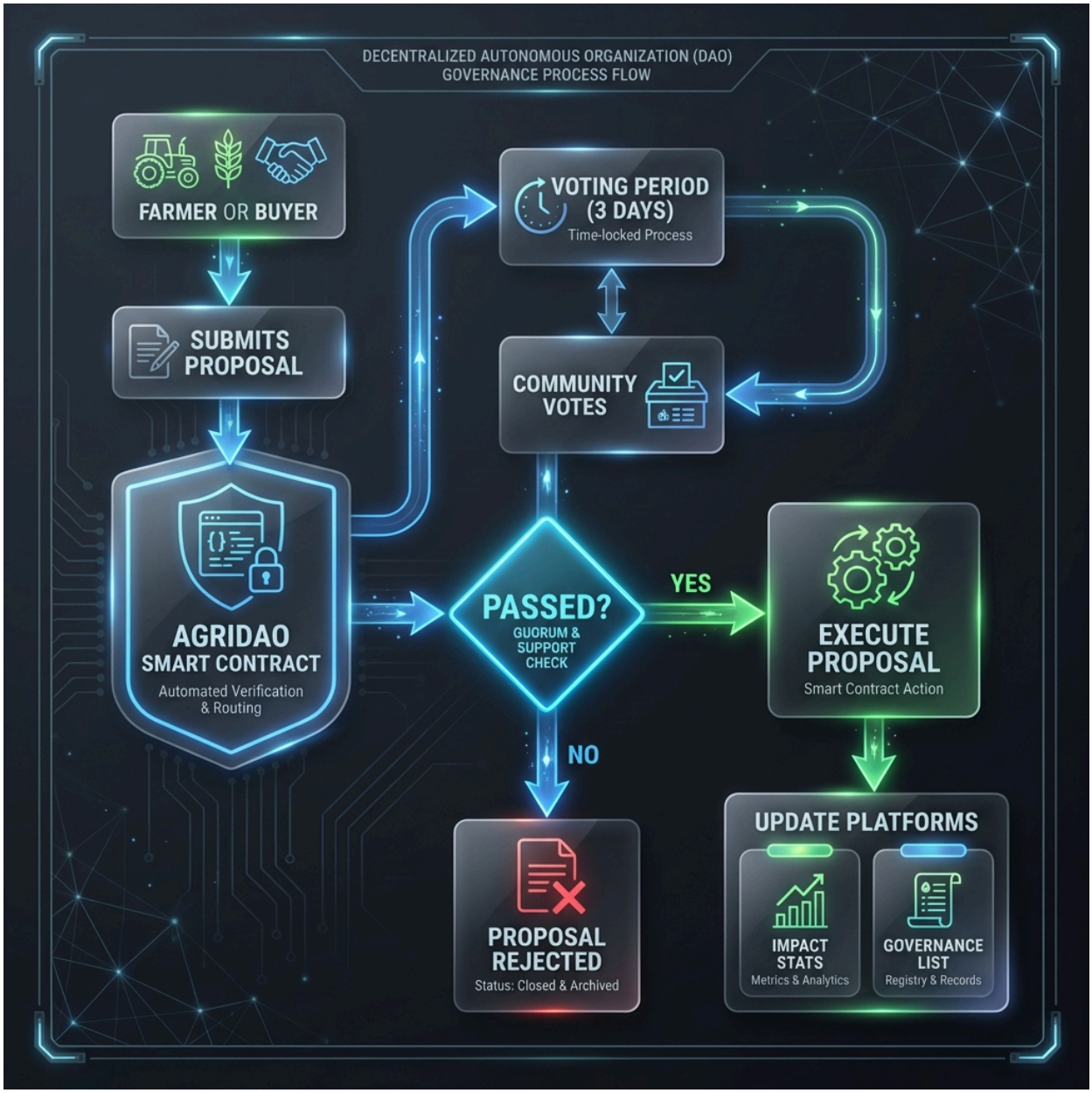

Figure 4: DAO Governance Flow

4.2 Backend Implementation

FastAPI + SQLModel; blockchain interaction via Web3.py; Redis caching for latency reduction.

4.3 Frontend Implementation

React + Tailwind CSS with Web3 wallet authentication.

Chapter 5: Performance Evaluation

5.1 Experimental Setup

VM: X vCPUs, Y GB RAM, Z Mbps connectivity. Backend: FastAPI, PostgreSQL, Redis in Docker. Frontend: React SPA. Synthetic workload 10–500 users.

5.2 Workload & Metrics

- Reads 60%: product details, provenance, listings
- Writes 30%: create/update products, anchor hashes
- Governance/Escrow 10%: DAO proposals, votes, escrows
- Metrics: HTTP response time, throughput, blockchain latency

5.3 Impact of Caching

Without Redis: ~250 ms; With Redis: <40 ms. Asynchronous blockchain writes ensure responsiveness.

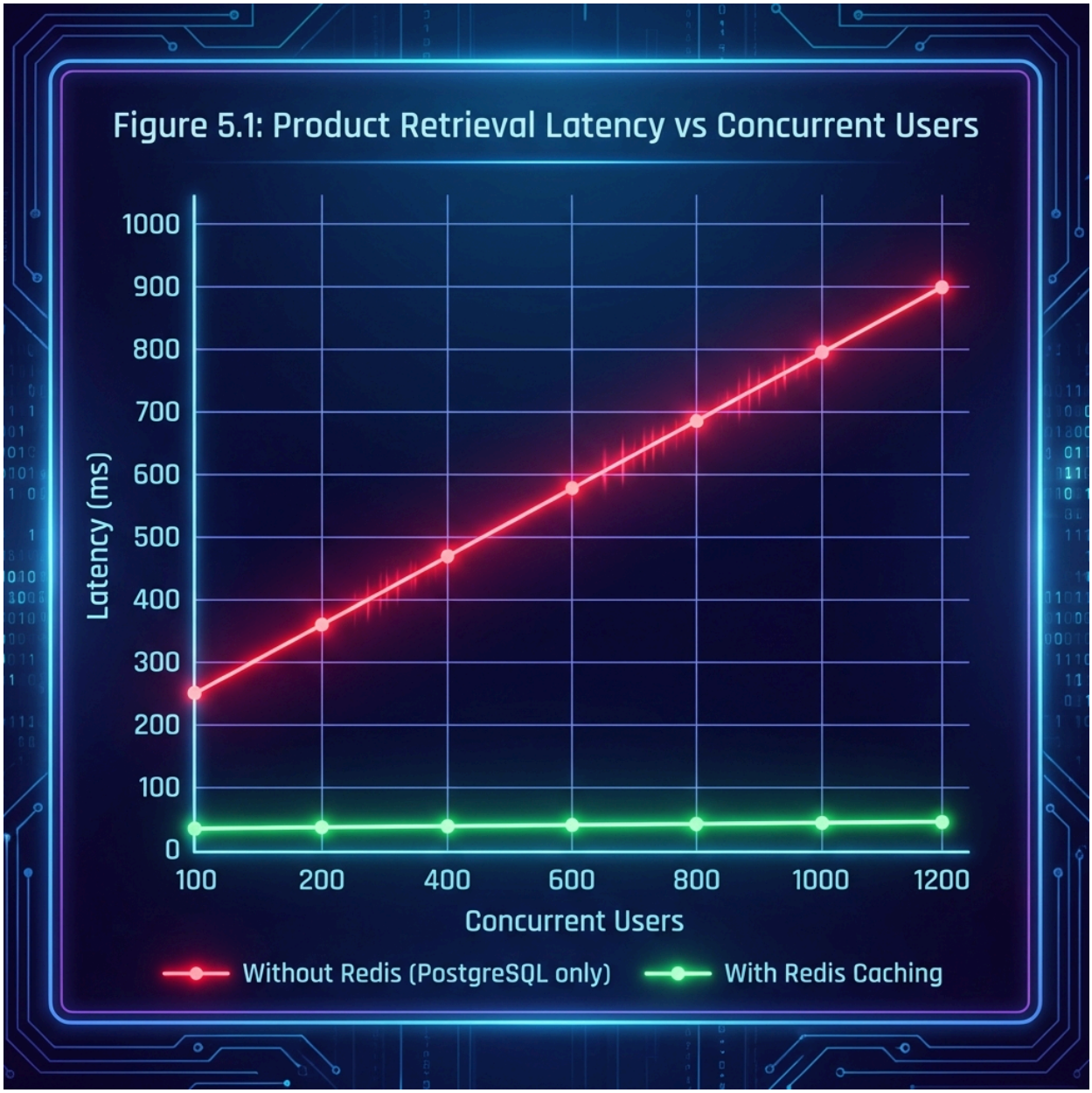

Figure 5: Product retrieval latency vs concurrent users

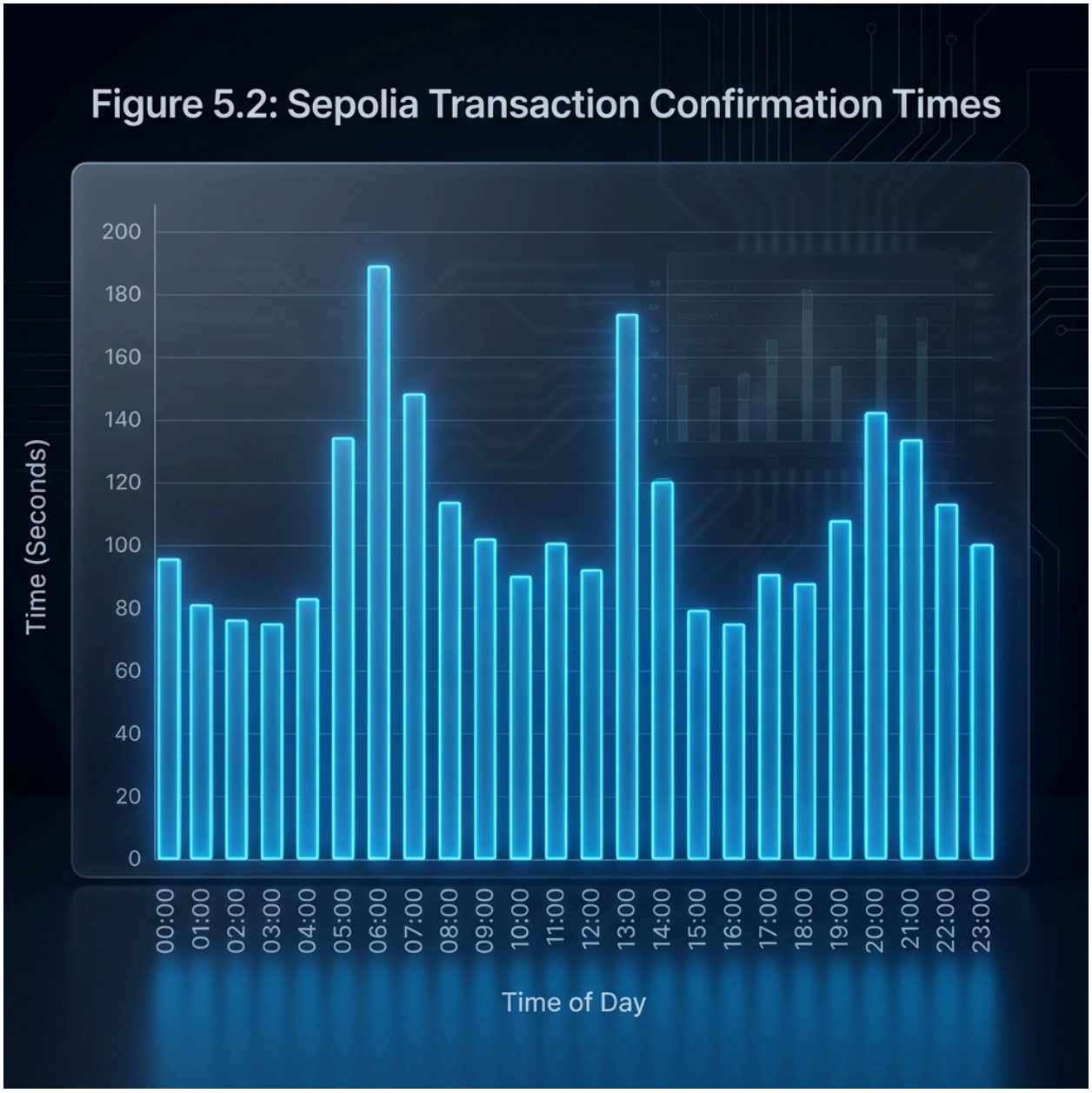

Figure 6: Sepolia transaction confirmation times

5.4 Blockchain Overhead

Async execution; Sepolia confirmations: several seconds to tens of seconds.

5.5 Scalability Discussion

Database indexing + Redis hit ratio crucial. On-chain only stores hashes. Throughput degrades gracefully under high concurrency.

Chapter 6: Results and Discussion

- Hybrid architecture balances immutability with scalability
- Gas-efficient design
- DAO governance enhances community participation
- Escrow ensures fair, interest-free transactions

Chapter 7: Limitations and Future Work

7.1 Limitations

- Testnet deployment only
- High-level security analysis; no formal audits
- Identity/KYC not implemented
- Limited real-world farmer onboarding

7.2 Future Work

- AI-based crop analytics
- Carbon credit tokenization
- Mobile app development
- Mainnet deployment with partners
- Identity/Sybil-resistant governance (DIDs, verifiable credentials)
- Smart contract and backend audits
- Pilot deployment in Bangladesh for usability, economic impact

Chapter 8: Conclusion

AgriDAO demonstrates practical blockchain use in agriculture, enabling transparent provenance, ethical financing, and decentralized governance. Offers scalable, trustworthy solution for farmers and consumers.

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