

COSMEX Project Close-out Report

Project Identification

Field	Value
Project Name	COSMEX - Cardano L2 Order Book Exchange
Project Number	1100102
Project Manager	Alexander Nemish
Start Date	March 11, 2024
Completion Date	November 26, 2025
GitHub Repository	https://github.com/lantr-io/cosmex

KPI Analysis

Category Requirements

This project was submitted under the **Cardano Use Cases: Concept** category, which required demonstrating a novel use case for Cardano technology.

- **Novel Cardano Use Case:** Developed a Layer-2 order book exchange using star-shaped state channels—a specialized adaptation of Hydra Head protocol optimized for trading
- **Open Source:** Full codebase published under open source license at <https://github.com/lantr-io/cosmex>
- **Documentation:** Technical Whitepaper and Litepaper published with complete protocol specification
- **Proof of Concept:** Working implementation demonstrated on Cardano Preprod testnet with verified transactions

Project KPIs

- **Smart Contract Implementation :** CosmexValidator.scala - 4-phase state machine with 7 redeemers
- **PoC Exchange Server:** WebSocket server with real-time order matching
- **On-chain Channel Operations:** Verified transactions on Cardano Preprod testnet
- **Test Suite:** Property-based and unit tests in `/src/test/scala/cosmex/`

Performance Summary

Key Achievements

1. State Channel Smart Contract

- Implemented 4-phase state machine: Open \rightarrow SnapshotContest \rightarrow Trade-sContest \rightarrow Payout
- Ed25519 signature verification for snapshot authentication
- Balance preservation invariants enforced on-chain
- Trade execution validation with price-time priority

2. Off-Chain Exchange Implementation

- WebSocket API for real-time trading
- Limit order support (BUY/SELL) with automatic matching
- Multi-client channel management
- Snapshot signing protocol between clients and server

3. On-Chain Verification

- Alice's channel opening: tx/56f68c24...
- Bob's channel opening: tx/302c1584...

Impact

COSMEX demonstrates a viable path for Cardano L2 order book exchanges with:

- **Zero slippage:** Centralized matching without AMM price impact
- **MEV protection:** No front-running possible in private channels
- **Non-custodial:** Users retain cryptographic control; can always withdraw via contestation
- **Provable solvency:** On-chain state machine guarantees fund availability

Community Value

This project advances Cardano's L2 ecosystem by providing an alternative to Hydra that is:

- Simpler to deploy (star topology vs. full mesh)
- More flexible (users join/leave anytime without unanimous consent)
- Lower operational burden (no full node requirement for clients)

Documentation Evolution

Whitepaper

- **Initial Draft (Jan 2025):** Basic concepts: deposit/withdraw flow, contestation period, high-level design
- **Final v0.1 (Nov 2025):** Expanded with: detailed 4-phase state machine specification, Mermaid diagrams, security model, comparison with Hydra/AMMs, complete protocol flow, rebalancing mechanism

Litepaper

- **Initial Draft (Jan 2025):** Draft overview emphasizing “provably solvent” and “RealFI” messaging
 - **Final v0.1 (Nov 2025):** Restructured as technical summary: added “The Problem” and “The Solution” sections, technology overview, cleaner architecture diagram
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Key Learnings

Technical Insights

1. **Script Size Optimization:** Cardano’s script size limits required intensive optimization—reducing the validator from ~15200 to ~11730 bytes through custom ScriptContext structures and pattern optimization.
2. **Evolving with Scalus:** The project upgraded through 15+ Scalus versions (0.2-SNAPSHOT → 0.14), requiring ongoing adaptation but enabling improved optimizations and Plutus V3 migration.
3. **State Channel Design:** The star-shaped topology proved simpler than full mesh networks while providing off-chain trading with on-chain security guarantees.
4. **L2 Design Space:** Cardano’s L2 landscape has room for specialized solutions beyond Hydra—application-specific state channels can offer simpler deployment.

Challenges & Solutions

1. **Protocol Design Iterations:** We explored three solutions for secure channel opening/closing, evaluating trade-offs between security, simplicity, and UX. A Hydrozoa L2-inspired approach remains a candidate for future enhancements.
2. **Security Edge Cases:** Real-world prototyping exposed edge cases around contestations and withdrawals that required significant hardening effort.
3. **Testnet Integration:** Testing on preprod/preview revealed issues invisible in emulator: clock skew, slot configuration differences, confirmation delays, and Blockfrost indexing lag.

These challenges led to a Delivery Schedule Change Request, extending the timeline while maintaining all original deliverables.

Final Thoughts

COSMEX successfully demonstrates that specialized Layer-2 solutions for Cardano are both feasible and practical. The project achieved all proposed deliverables: a working smart contract, proof-of-concept exchange server, verified testnet transactions, and comprehensive documentation.

The star-shaped state channel architecture proved to be a viable alternative to full Hydra for exchange use cases, offering simpler deployment while maintaining the core properties of non-custodial trading with on-chain security guarantees.

We believe this project contributes valuable knowledge to the Cardano ecosystem about L2 design patterns, and provides a foundation that could be extended to production use with additional engineering investment. The open-source codebase and detailed documentation should help other developers exploring similar solutions.

The experience reinforced that Cardano's extended UTxO model and Plutus smart contracts are well-suited for state channel protocols, and that the Scalus toolchain significantly improves developer productivity for complex validator development.

Documentation & Links

Source Code

- **Repository:** <https://github.com/lantr-io/cosmex>

Technical Documentation

- Whitepaper | PDF
- Litepaper | PDF

Demo

- **Trading Demo Video:** <https://www.youtube.com/watch?v=A7XQOaOktvQ>

Close-out Video

<https://www.youtube.com/watch?v=sBm4BxZp5P4>

Future Plans

- Mainnet deployment with production-grade infrastructure
- Integration with existing Cardano wallets
- Additional trading pairs and order types

- Community partnerships for liquidity provision