Central Bank Digital Currency (CBDC)

CSB/CSE Capstone Project 2024
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Introduction

Abstract

Our project tackles the need for secure, scalable CBDC platforms to support national digital currencies. Using Oracle Database Blockchain Tables, PL/SQL, REST APIs, and sharding, we developed a system that ensures **efficient, high-volume digital transactions**. The project focuses on designing a scalable and secure backend architecture, with testing demonstrating its ability to handle high-volume digital transactions efficiently, providing a strong foundation for CBDC implementation.

Background

As more nations explore CBDCs, existing financial systems face challenges in scalability, security, and regulatory compliance for digital currencies. Our project aims to provide a robust CBDC solution, leveraging **blockchain and sharding** technologies to offer a **secure, scalable, and efficient digital currency platform** that meets regulatory standards and supports future digital financial ecosystems.

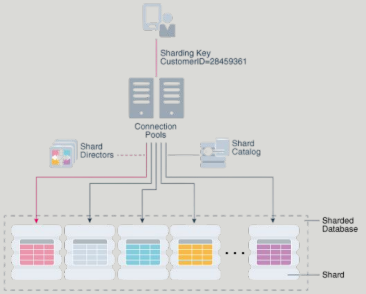
Solution

Scalability & Load Distribution

Our project explores linear scalability by increasing the number of **database shards**, each capable of handling specific subsets of transactions. Bypassing the catalog database and directly connecting to specific shard databases ensures **higher throughput** and consistent performance.

Sharding Strategy

We started with a non-sharded database and decided to shard by **organizational ID** to improve scalability. Sharding by organizational ID ensures intra-organization operations remain single-shard, leveraging faster local transactions, while cross-organization operations use distributed transactions.

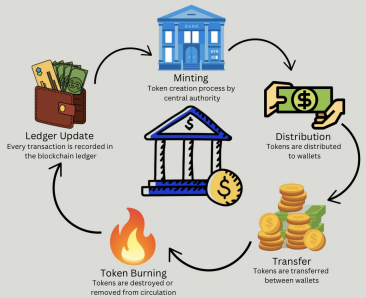


Performance Benchmarking & Testing

We used **Artillery** to benchmark the CBDC system's performance, testing scenarios like token transfers and burns to simulate real-world usage. Initial tests on vanilla tables established baseline metrics, guiding optimizations for scalability and ensuring readiness for high transaction volumes.

System Architecture

The architecture leverages Oracle's database sharding technologies, combined with advanced PL/SQL capabilities, to manage **tokenization lifecycles (minting, burning, transaction history)**. It also supports features such as bank-to-bank transfers and daily transaction limits.



Results

Outcome

Our CBDC platform achieved a **secure, scalable digital currency environment**, successfully implementing Oracle Blockchain Tables, sharding, and performance benchmarking. Testing validated the system's ability to handle high transaction volumes efficiently.

Key Learnings/Challenges

We gained deep insights into **database scaling**, particularly with sharding and distributed transactions. Working across security, scalability, and user experience components taught us the importance of modular, adaptable design.

Future Improvements

1. Implement a fully working frontend GUI
2. Adopt an agile testing approach earlier in the development cycle to enable faster optimization of sharded environments
3. Explore enhanced real-time monitoring tools to improve transaction tracking and further reduce latency
4. Incorporate **DIDs** (from another Oracle Capstone project) to strengthen security