BLOCKCHAIN SIMULATOR

Introduction:

Blockchain technology is a decentralized, immutable ledger system that ensures secure and transparent recording of transactions. This project implements a simplified blockchain simulator in Java, providing hands-on experience in mining, transaction management, and chain integrity verification. It emphasizes fundamental blockchain principles such as hashing, proof-of-work, and linked data structures.

Abstract:

The Blockchain Simulator is designed to mimic the core functionalities of a blockchain network. Users can create transactions, mine blocks with configurable difficulty, and validate the integrity of the chain. The project demonstrates how blocks are linked cryptographically and how proof-of-work prevents unauthorized tampering. JSON output is used to visualize the chain, providing a clear representation of its structure and contents.

Tools Used:

- Programming Language: Java
- Libraries: Gson 2.10.1
- IDE: IntelliJ IDEA
- Concepts: Object-Oriented Programming, SHA-256 hashing, Data Structures, Proof-of-Work

Steps Involved in Building the Project:

1. Setup Project Structure:

    - Organized source code into `model` (Block, Transaction, Blockchain) and `util` (StringUtil) packages. Added Gson library to handle JSON output.

2. Implement Block and Transaction Classes:

- Each block contains a hash, previous hash, timestamp, nonce, and list of transactions.
- Transactions store sender, receiver, and amount information.

3. Proof-of-Work Mining:

- Configurable difficulty determines how many leading zeros the hash must have.
- Mining involves iteratively adjusting the nonce until the hash meets difficulty requirements.

4. Blockchain Class:

- Maintains a list of blocks.
- Provides methods to add new blocks and validate the chain integrity.

5. Chain Validation & JSON Output:

- Validates that each block's `previousHash` matches the hash of the preceding block.
- Exports the chain as JSON for visual confirmation and reporting.

6. Testing:

- Simulated multiple transactions and blocks.
- Verified mining, chain integrity, and JSON output.

Conclusion

This project provides a foundational understanding of blockchain mechanics, including cryptography, transaction handling, and consensus simulation. By completing this simulator, key concepts of decentralized ledger technology and secure data structures are reinforced. Future enhancements can include digital signatures, wallet management, networked peer nodes, REST APIs, and dashboard visualization for real-time blockchain monitoring.