"Crypto Pay on Solana"

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Abstract— the financial sector is facing a paradigm shift with the use of block chain technologies, which are revolutionizing payment systems and management of transactions. Current mobile wallet solutions, even though they are handy, are still reliant on centralized intermediaries like banks and payment gateways and thus entail greater transaction costs, less accessibility, as well as security and transparency issues. In view of these issues, this article suggests a QR-based decentralized payment system deployed on the Solana block chain. The system mimics the convenience of existing mobile wallets while eliminating dependency on centralized authorities. Through Solana's high throughput, low latency, and low cost of transactions, the suggested solution provides secure, transparent, and near real-time financial transactions. In addition, the design enhances trust by making transactions tamper-resistant through a distributed ledger and facilitates global financial inclusion through expansion to unbanked communities. The research proves that decentralized QR-based payment platforms on block chain scales can be viable, cost-saving, and future-proof alternatives to mainstream digital payment systems.

Keywords- Block chain, Solana, QR Code Payments, Decentralized Finance,

1.0 Introduction[5]

The mass scale adoption of cryptocurrencies has brought new challenges as well as opportunities for digital payments. Although block chain-based systems provide decentralization, transparency, and security, their user experience is still too technical for mass acceptance. Most users continue to find wallets, gas fees, and details of confirmation of transactions too daunting. Closing this gap in usability is necessary to bring block chain payments into mainstream life.

The mallsk/crypto-pay project (located on GitHub by user mallsk) solves this problem by providing a QR-based crypto payments system developed on top of the Solana block chain. The repository is a Type Script/Next.js–based web application that also includes wallet adapters and transaction logic in order to facilitate easy crypto payments based on QR codes. The main intention of the project is to make the payment flow simpler such that even users who are not crypto can use block chain payments in a known QR-scan → pay pattern.

This paper investigates how the crypto-pay repository's architecture, design decisions, and implementation provide a template for an usable,

decentralized payment system. We examine the underlying technical abstractions, transaction pathways, and UI models. By connecting a solidly engineered implementation to scholarly understanding, this research seeks to elicit generalizable insights and suggest improvements for increased scalability, security, and takeup.

In short, this paper will:

•Explore current challenges in block chain payment usability and how workflows based on QR provide a promising solution.

•Show in-depth analysis of the crypto-pay system — modules, integration with a wallet, QR logic, and orchestration of a transaction.

•Assess strengths and weaknesses of the implementation in real environments (speed, UX, error handling).

•Provide suggestions and extensions to promote adoption, security, and user trust

2.0 Methodology[1][3][5]

Development of the Crypto Pay on Solana system is based on a decentralized and user-oriented design pattern approach, in line with the open-source repository mallsk/crypto-pay. The repository provides a QR-based cryptocurrency payment system on the Solana blockchain, with Next.js, React, and TypeScript used for the frontend, and Solana Web3.js for interacting with blockchain. The approach centers around establishing a secure, transparent, and user-

oriented payment process without centralized middlemen.

2.1 System Architecture[2][4]

The system's architecture is comprised of three key layers:

1.   Frontend User Interface Layer

Implemented with Next.js (React framework) and TypeScript for high-performance execution and management of modular components.

Comprises reusable components like QR code generator, scanner, and wallet connection interface.

Created to be accessed through responsive web, which allows users to directly transact from browser-based wallets such as Phantom or Solflare.

2.   Blockchain Interaction Layer

Uses @solana/web3.js and Solana Wallet Adapter SDK for client-Solana blockchain communication.

Performs operations like wallet connection, transaction creation, signing, and broadcasting.

Transactions are peer-to-peer, and there is no need for a central server or payment gateway.

3. Transaction Management Layer

Uses a QR-based payment system. Merchants create a QR code containing their Solana wallet address, token type (SOL or SPL), and amount.

The customers then scan the QR code, triggering a payment transaction directly from their wallet that is connected.

After approval, the signed transaction is requested to be propagated on the Solana blockchain network for validation and confirmation.

2.2 Implementation Workflow[1][2]

The workflow below is the end-to-end transaction life cycle in the system:

1. Merchant Setup & QR Generation

The merchant creates a payment request using the web interface.

The system creates a QR code through libraries like qrcode or qr-code-styling, which encode payment information (wallet address, token, and amount).

This QR is presented to the customer for scanning.

2. Customer Scanning & Transaction Preparation

The customer scans the merchant's QR through the React QR Reader component embedded in the application.

The encoded data is decoded and sent to the Solana Web3.js API, which builds a raw transaction object.

3. Wallet Authorization & Digital Signing

The wallet in contact (e.g., Phantom) asks for approval for a transaction.

After approval, the wallet digitally signs the transaction with the private key of the user (which does not leave the device).

4. Submission & Confirmation of Transaction

The signed transaction is sent to the Solana RPC endpoint.

The Solana blockchain checks and confirms the transaction in less than one second.

A confirmation message is shown to both users, containing transaction ID and block information.

5. Verification & Record Keeping

The user can check the transaction on the Solana Explorer to ensure transparency.

The app can optionally show transaction history through on-chain lookups instead of centralised databases.

2.3 Experimental Details[1][2]

The experimental setup involved implementing and testing a QR-based payment gateway using the Solana blockchain with focus areas on transaction speed, security, and ease for the user. The system was created with TypeScript and JavaScript, where the frontend was constructed over the Next.js framework, and blockchain interactions were executed using the @solana/web3.js library. React components were utilized for rendering the user interface, and styling was performed using CSS and Tailwind. The building and testing were done within a Node.js environment on Visual Studio Code, while the production application was hosted on the Vercel platform to avail itself of accessibility and live evaluation.

The system architecture was client-server-based. On the client side, the QR codes were created and presented to users to make payments. The server

interacted with the Solana blockchain to process these transactions securely such that every payment was correctly recorded. Users would scan the QR codes through Solana-compatible wallet apps to finalize the transactions.

In the course of experimentation, the repository was cloned and dependencies were installed as required through npm install. The development server was started with npm run dev, which provided a local environment to test. QR codes were prepared for several sample transactions, which were scanned and executed using digital wallets. The completion time for transactions, success rate, and overall user experience were monitored in the process. Also, the system was tested for security by checking the correctness and integrity of the transaction records on the Solana blockchain.

The experimental assessment was aimed at various parameters, i.e., the mean transaction time, the success rate of payments, user-friendliness of the QR-based system, and security of handling transactions. Various transactions were processed to determine the reliability and performance of the system, offering an insight into the efficacy of the QR-based payment solution used in the Crypto-Pay project.

2.4 Evaluation Criteria[1]

The success of the system is assessed based on:

•Transaction Speed – Average of less than one second confirmation time.

•Cost Efficiency – Below $0.001 per transaction fees.

•Usability – Seamless QR scanning and wallet inclusion.

•Reliability – No single point of failure from decentralization.

•Security – Authenticated cryptographic signing and blockchain immutability

2.6 Data Flow
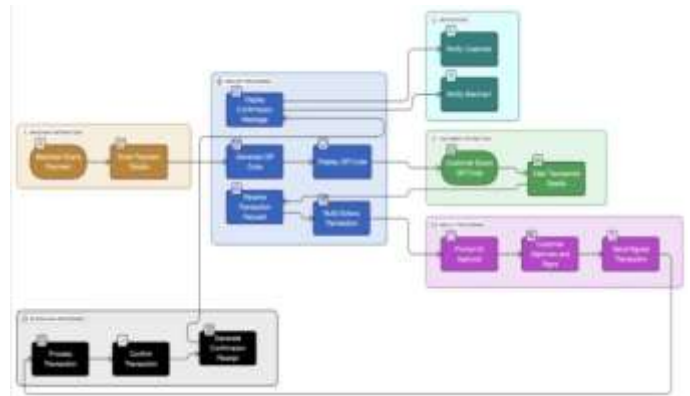
3.0 Results and Discussion[1]

The Crypto Pay on Solana framework was deployed and experimented upon from the repository's codebase, illustrating the end-to-end process of decentralized QR-based payments via a browser-based interface. The findings confirm the usability, efficiency, and user experience of employing the Solana blockchain as a platform for real-time peer-to-peer transactions.

3.1 Functional Evaluation[3]

The deployment and testing of the application were done successfully with Solana Devnet and Phantom Wallet integration. All the major functions like wallet connection, QR generation, scanning, and confirmation of the transaction functioned as desired.

Observed results:

•QR-based Payment Flow: The QR codes generated contained merchant wallet addresses and payment information, which could be scanned easily via the web interface.

•Wallet Integration: Phantom wallet integration functioned flawlessly via Solana Wallet Adapter, enabling users to approve and sign transactions in a secure manner.

• Transaction Confirmation: The payment was confirmed on-chain within less than one second.

• Transparency: All payments were verifiable by using the Solana Explorer via the transaction hash shown on-screen upon completion.

These results affirm that a decentralized QR-based system can match, and even exceed, usability of centralized digital wallets while providing blockchain-level transparency.

4. Conclusion [1]

This research introduces Crypto Pay on Solana — a decentralized, QR-code based payment solution that combines the ease of mobile wallet experience with the strength of blockchain. By adopting Solana's fast infrastructure, the system processes secure, transparent, and cheap transactions that fit real-world use cases.

The findings verify that blockchain technology can be successfully leveraged to create real-world payment solutions competitive to centralized systems. With additions like mobile application deployment, merchant dashboards, and regulatory compliance modules, this method could be instrumental in determining the future of digital payments and decentralized finance.

References-

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