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Modeling of a Blockchain-based Cross-Border Payment System in a Secured Cloud Environment

Festus A. Osuolale
Department of Computer Science,
School of Computing
The Federal University of Technology, Akure, Nigeria

David C. Okorie
Department of Computer Science,
School of Computing
The Federal University of Technology, Akure, Nigeria

Yetunde E. Ogunwale
Department of Computer Science,
Faculty of Computing,
University of Ilesa, Nigeria

ABSTRACT
The traditional world of cross-border payments, plagued by delays, high fees, and lack of transparency, is facing a revolution fueled by the convergence of blockchain technology and secure cloud infrastructure. This paper proposes a novel system leveraging blockchain's distributed ledger and smart contracts to facilitate fast, transparent, and cost-effective international transactions. By harnessing the scalability and security of the cloud, the system aims to streamline cross-border payments, reduce intermediary costs, and ultimately reshape the global financial landscape, paving the way for a future of faster, cheaper, and more trustworthy transactions.

General Terms
Blockchain Technology and Cross-Border Payment.

Keywords
Financial Technology, Hedera Blockchain, Digital Ledger Technology, Cloud Computing, Decentralization

1. INTRODUCTION
The increase in global cross-border transactions reveals gaps in currency conversion, regulations, and security. Existing tools like Alipay are hamstrung by government oversight issues, preventing international business. Normal cross-border transactions involve painstaking negotiations and very slow, inefficient fund transfers. Technological developments are driven by a pressing need for an intelligent cross-border system, with blockchain poised to transform the nature of transactions. Blockchain's innovative characteristics involving peer-to-peer transactions, decentralization, and consensus mechanisms that make them popular in many sectors of society are bound to generate a future where international transactions are easy, safe, and profitable, promoting global trade and finance. In 2008, when blockchain technology first appeared on the world stage, initially to facilitate cryptocurrencies like Bitcoin, almost a decade has passed since the world has discussed its transformative potential. Its implementation in financial technology, the way governments are managed, and the supply chain's history show that it is very versatile. Blockchain aspires to build a long-term viable financial system with trusted accounting and fair profit allocation. Through tamper resistant chains, blockchain ensures data integrity in cross-border transactions. Partial authorization for efficient maintenance is offered by consortium blockchains – especially in the case of official digital currency regulations as well. The technology's capacity to simplify procedures significantly catalyzes a novel era of unparalleled financial flexibility, enabling faster, more cost-effective, and fundamentally safe foreign transactions.

2. RELATED WORKS
The fusion of blockchain technology and international payments has come to form a new impetus for research that designs new ideas to overcome the shortcomings of established systems. While some promising strides have been made, several gaps still need to be explored further, and more nuanced approaches in this regard need to be taken. Drawing on the current research, more specific issues and opportunities can be deepened and foundation for a revolutionary future of international financial transactions can be laid..

Kraus (2017) dived into the concept of blockchain-based digital cash, leading to the dreamy conception of a future where peer-to-peer transactions are secured and handy. This approach has huge potential for cross-border payments, eliminating intermediaries, and simplifying processes. However, scalability is one of the significant challenges. So, a thorough investigation is required for consensus mechanisms such as sharding and Byzantine Fault Tolerance if they can handle the transaction volume almost unique to international trade. Furthermore, the regulatory frameworks must adapt to the peculiarities of digital currencies to ensure compliance and contain risks. Finally, the successful integration of digital cash into the current financial infrastructure is essential for universal acceptance. Matters of partnership with banks and financial institutions are crucial to closing the gap between the world of the blockchain and traditional payment channels.

The Shangai Headquarters of the People's Bank of China (2018) study investigates the potential benefits that blockchain technology might offer central banks in terms of increased operational efficiency, transparency, and security. Nevertheless, it emphasizes the need for more research on how blockchain technology affects international financial transactions. Future research efforts should predominantly focus on CBDCs' function in moving international payments so that inter-bank cooperation and foreign exchange procedures can be speeded up. Furthermore, it is crucial to conduct thorough research on the effects a central bank system based on blockchain technology would have on monetary policy and the overall stability of the international financial system.

Zou Chuanwei (2019) researched the integration of digital cash DE/EP into international transactions to determine the extent to which this technology will drive the usage of RMB globally. Even though this investigation brings us the possibility of global recognition of digital money, many obstacles have not been eliminated yet. These challenges range from integrating DE/EP across international borders to requiring standardised protocols and collaboration frameworks globally. Far more research is needed urgently to acquire a complete understanding of the legal and regulatory intricacies associated with the implementation of DE/EP in different jurisdictions. In addition, initiatives that encourage global collaboration and standardisation are necessary to facilitate smooth international transactions and prevent future fragmentation.

Li Haibo (2020) proposed the widespread use of legal digital cash to help deal with issues related to international financial transactions. This strategy may also eliminate the need for intermediaries, reduce transaction costs, and shorten settling time. Alternatively, the establishment of such a system must be weighed very carefully in terms of law and regulation. Therefore, thorough research should be done to assess the potential problems with existing financial regulations and devise a regulatory framework for issuing and circulating unrestricted digital currency. Furthermore, it is even more important to analyze the effect on the current financial institutions to guarantee that any revolutionary changes do not interfere with the current financial setup.

While it is clear from Bloomberg's research (2019) that blockchain technologies have many promising advantages related to cross-border payments, the latter also points to some problems resulting from dissimilar regulations and technology limitations. This research might further consider investing in studying some specific techniques and approaches as a unique way to address these challenges. The main area of research should be the development of easy-to-interoperate blockchain platforms that could fill in the gap between different systems and meet any regulatory requirements. It is also necessary to investigate various alternative consensus mechanisms as well as scalability solutions to help overcome the limitations of the blockchain technologies that are available at this time.

This project's scope is developing a system with integration possibilities for cross-border transactions that use the Hedera Hashgraph Network as a matching tool since it focuses on building upon previous research while exploiting their strengths. Hedera is also an effective solution to scalability issues due to its unique features, such as Byzantine Fault Tolerance and high transaction throughput. Also, as a permission system, it allows better regulation and control. This project aims to create a full-featured and versatile system for effective, protected, low-cost cross-border transactions. This will open the door to a more integrated and inclusive global economy. This will be achieved by integrating these features with the knowledge acquired from previous studies.

3. TRADITIONAL CROSS-BORDER FINANCIAL SERVICES

3.1.1 Cross-Border Technology

Cross-border transactions have become integral to international trade, capital exchange, and business operations. Initially, cross-border transactions were primarily associated with international investments, such as corporate mergers and acquisitions. In these cases, home country banks and international financial institutions played pivotal roles by providing essential services like payment processing, liquidity management, and financial risk mitigation to facilitate these complex business transactions. In today's era of globalization, the landscape has evolved, and a significant portion of cross-border transactions encompasses the trade of goods and commodities in the international market. This expansion includes trade in industrial products, timber, unique local delicacies, and more. As international business activities surge, there's an increasing demand for streamlined, digital financial services to support these operations effectively. Figure 1 shows the process of conventional cross-border payments.

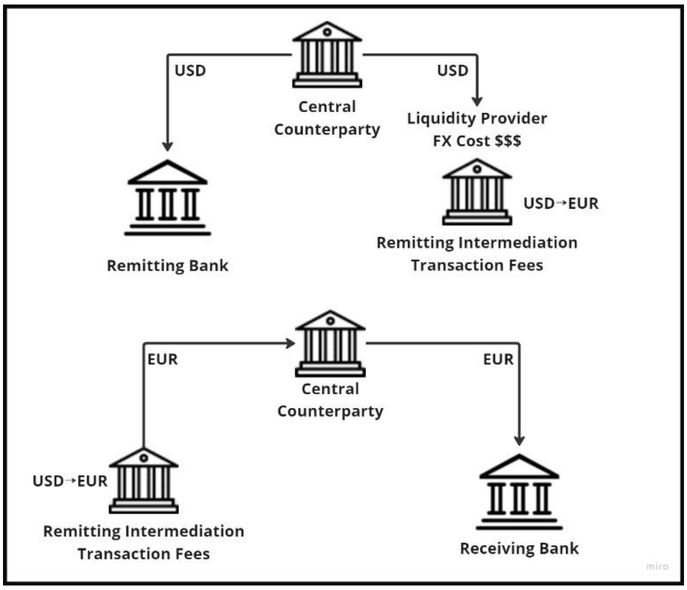

Figure 1: Traditional cross-border process

Nevertheless, conventional cross-border payment systems have been demonstrated to be unwieldy, entailing many banks and intermediary financial organisations. The intricacies involved frequently lead to extended durations for processing financial flow, impeding the rate at which cross-border corporate expansion can occur.

3.1.2 Blockchain Technology

Blockchain, a relatively new technology, lacks a universally accepted definition. It serves as a decentralized credit bridge, offering a tamper-resistant shared ledger. This approach facilitates peer-to-peer accounting by adding an open and transparent database that doesn't require intermediaries to reach credit consensus. Blockchain isn't a singular technology but an amalgamation of foundational technologies like the internet and P2P distributed ledgers. It integrates peer-to-peer networks, encryption algorithms, and decentralized storage. The specific application model of blockchain technology isn't fixed in current applications. Bitcoin and Ethereum represent two successful but distinct stages of blockchain development. A blockchain system comprises layers: data, blocks, networks, consensus, incentives, and contracts.

Yaga et al. (2018) state blockchain as an expanding chain of cryptographically signed, irreversible transactional records that all participants in a network replicate. Li et al. (2019) state blockchain as a distributed database system that is trustable, traceable, and tamper-proof. It is also decentralized and works through several nodes. According to Zhang et al. (2019), blockchain acts as an invariable ledger through which transactions occur in a decentralised fashion. Blockchain-based applications are showing up in various sectors, from IoT to reputation systems and banking-related services. According to Wang et al. (2020), a blockchain is an ample distributed ledger that does away with intermediaries, but the transactions on this platform can be carried out in a safe, transparent, and tamper-proof manner. As Kumar et al. (2021) explained, a blockchain is just like an enormous database called blocks, and it cannot be manipulated or edited. Hayes (2022) and Rodeck (2022) describe blockchain as a distributed and immutable digital ledger that stores information across a network.

3.1.3 Cloud Computing

In the ever-evolving realm of financial technology, blockchain-based cross-border payment systems are poised to revolutionize international transactions. However, their successful implementation hinges upon a robust and scalable underlying infrastructure. This is where cloud computing emerges as a game-changer, offering agility, flexibility, and cost-effectiveness that perfectly complements the needs of these innovative systems.

Buyya et al. (2009) defined cloud computing as a paradigm shift, enabling on-demand access to a shared pool of configurable computing resources like networks, servers, and storage. This shared infrastructure and pay-as-you-go billing models foster unprecedented cost efficiency and agility. Gone are the days of upfront investments in hefty hardware and software; cloud computing empowers users to provision and manage resources on the fly, adapting seamlessly to fluctuating demands. This dynamic nature aligns perfectly with the unpredictable nature of international transactions, ensuring system stability and performance even during peak periods (Ali et al., 2019).

Cloud computing encompasses a set of core components that collectively enable its functionality. These components include servers, which provide the computational power necessary to run applications and process data; storage, which offers scalable and reliable storage solutions for data; databases, which facilitate the organization and retrieval of structured data; and networking, which connects various components of the cloud infrastructure and enables communication between them.

Unlike traditional on-premises IT infrastructure, where organizations are responsible for procuring, managing, and maintaining physical hardware and software assets, cloud computing abstracts much of the complexity associated with infrastructure management. Instead, cloud service providers offer infrastructure and services on a pay-as-you-go basis, allowing users to scale resources up or down based on demand and only pay for what they use.

Therefore, cloud computing is the ideal foundation for building and deploying secure, efficient, cost-effective blockchain-based cross-border payment systems. Its inherent scalability, flexibility, and accessibility pave the way for seamless international transactions, opening doors to a future of streamlined global financial interactions.

3.2 Cloud Computing for Blockchain-Based Cross-Border Payment Systems

The traditional landscape of cross-border payments is riddled with inefficiencies, burdened by high transaction fees, slow settlement times, and limited accessibility. Fortunately, the convergence of cloud computing and blockchain technology, particularly within the context of Hedera Hashgraph, offers a transformative solution.

Cloud resources like virtual servers and storage can be dynamically scaled up or down based on transaction volumes. This eliminates the need for overprovisioning, optimizing costs, and ensuring smooth handling of peak periods (Bandyopadhyay et al., 2020). Hedera's efficient architecture and asynchronous Byzantine Fault Tolerance (aBFT) consensus mechanism further enhance scalability, enabling near-instantaneous transaction processing even during high traffic.

Cloud providers offer a pay-as-you-go model, eliminating the need for hefty upfront investments in hardware and software. This translates to cost-effectiveness, especially for startups and smaller organizations venturing into cross-border payments (Chaudhary et al., 2023). Cloud infrastructure automates routine tasks and maintenance processes, freeing internal resources and reducing operational overhead.

Cloud providers implement robust security measures like data encryption, access controls, and intrusion detection systems. This safeguards sensitive financial data and transaction details within the blockchain system, minimizing the risk of cyberattacks and unauthorized access.

Cloud platforms offer pre-configured environments and tools, simplifying the deployment and management of blockchain applications like Hedera nodes. This reduces development time and complexity, enabling faster time-to-market for cross-border payment solutions.

Cloud platforms automatically handle software updates and infrastructure maintenance, ensuring the system's continuous operation and eliminating the need for manual intervention.

Hedera's blockchain platform is agnostic to the underlying cloud infrastructure. This allows for flexible deployment across cloud providers, promoting vendor neutrality and facilitating integration with existing systems.

Hedera's commitment to open-source development and decentralized governance fosters collaboration and innovation within the blockchain ecosystem. This encourages the development of interoperable tools and services that further strengthen the cross-border payment infrastructure.

3.2.1 Transaction Network Analysis Modeling Approach

Transaction network analysis (TNA) focuses on studying the relationships and interactions between entities within a system, such as the flow of transactions across the Hedera network. Graph theory and social network analysis can be employed to map transaction paths, identify key nodes (validators, payment gateways), and analyze transaction clusters (geographic regions, currency pairs).

TNA reveals interdependencies between participants and transaction types, which is particularly valuable for understanding complex routing dynamics in cross-border scenarios. For instance, it can identify potential bottlenecks based on transaction volume concentrated on specific validators or gateways. However, TNA struggles with quantifying performance metrics like transaction latency or throughput.

3.2.2 *Queuing Theory Modeling Approach*

Queuing theory provides a mathematical framework for analyzing systems where tasks (transactions) arrive at service points (validators) and waits in queues for processing. Different queuing models, like M/M/c or M/G/1, can be applied to model transaction arrivals, service times, and queue lengths on the Hedera network.

Queuing theory excels in quantifying performance metrics like average transaction waiting time, queue length distribution, and system stability under varying loads. This is crucial for understanding the impact of transaction volume surges or network congestion on user experience and system resilience. However, queuing models often require simplifying assumptions about transaction arrival patterns and service times, potentially limiting their accuracy in complex real-world scenarios.

3.2.3 *Simulation Modeling Approach*

Simulation models, often built using software tools like SimPy or AnyLogic, recreate the behavior of the Hedera network and its components (validators, consensus mechanisms) over time. Virtual transactions are injected into the model, allowing researchers to observe system dynamics, measure performance metrics, and test different configuration scenarios.

Simulation models offer the most flexibility and realism, capturing intricate transaction processing details, network dynamics, and external factors like user behavior. They can be used to evaluate proposed system optimizations, assess scalability under high transaction volumes, and identify potential security vulnerabilities. However, developing and maintaining accurate simulation models can be resource-intensive and require specialized expertise.

3.2.4 *Hedera Hashgraph*

Hedera Hashgraph is a promising solution that aims to simplify intricate financial situations, especially in cross-border payments, and can be seen as a potential contender among the wide range of blockchain platforms. Unlike traditional proof-of-work blockchains with scalability and energy inefficiency problems, Hedera leverages a new consensus mechanism called Gossip Byzantine Fault Tolerance (GBFT). This is a major advantage over traditional blockchains. The revolutionary algorithm in question makes transactions possible within seconds, regardless of the network size. This ensures not only its immutability but also its security against potential malicious interventions. Also, Hedera operates in a consortium or permissioned network model, which means authorised nodes endorse transactions collaboratively. Adopting this strategy not only ensures that the organization complies with regulatory norms but also reduces the risks associated with completely public blockchains. Regarding financial applications that span borders, Hedera seems to be a fitting solution because it comes up with an enclosed system that sparks confidence and makes working with multiple stakeholders feasible.

Besides its solid technology architecture, Hedera boasts various attractive features carefully tailored for international financial transactions. The system's transaction throughput is unprecedented, and when considering 10,000 transactions per second, it far surpasses international trade requirements while promising to enable smoothing and rapidly processing transactions. Plus, the native cryptocurrency of the platform, i.e., HBAR, enables transactions to be carried out in a way that is not just environmentally friendly but also cost-efficient. This avoids the heavy cost structures that normally accompany international money transfers.

Since Hedera has shown scalability, security, and compliance with regulatory requirements, it was decided that the system proposed for making payments across international borders should be based on Hedera as its core layer. Elaborating on the intricacies of the system that has been constructed, this part shows how it leverages the strengths of Hedera to transform global financial transactions.

3.2.5 *Security Consideration f Cloud Integration*

The integration of cloud architecture introduces unique security considerations that must be addressed comprehensively to safeguard sensitive data and ensure system integrity. Encryption mechanisms, including data-at-rest and data-in-transit encryption, protect data in transit and at rest within the cloud environment. Access controls and identity management policies are enforced rigorously to restrict unauthorized access to resources and mitigate the risk of data breaches. Furthermore, continuous monitoring and logging mechanisms are implemented to promptly detect and respond to security incidents.

4. SYSTEM ARCHITECTURE

The architectural solution that has been proposed leverages the benefits of the Hedera Hashgraph network, which is famous for fast transaction processing, increased security, and speedy finality. The architecture of a blockchain-based cross-border payment system consists of three major components: blockchain network, payment gateway, and smart contracts.

A customized Payment Gateway function, or PG, is introduced to facilitate and optimize transaction initiation and verification. PG is defined as follows:

$$PG\ (U,V) = \frac{1}{n}\sum_{i=1}^{n}\frac{U_i}{V_i} \qquad 1.1$$

where:

U represents the set of user-specific transaction parameters, V represents the set of verification parameters and n denotes the total number of transactions.

Equation 1.1 ensures that each transaction is weighted according to user-specific parameters and verification requirements, optimizing the payment gateway for a smooth transaction experience.

Blockchain Network Configuration (*BN*) is critical in cross-border payment systems.

The structure of *BN* is defined using a recursive function:

$$BN\ (N, S) = f\ (N, S) \qquad 1.2$$

$$f\ (N, S) = N_i + S_j \qquad 1.3$$

where i and j are indices referencing the nodes and contracts, respectively, starting from the value 1, representing the interplay between nodes and smart contracts in the network. Equation 1.2 delineates the overall network configuration, encapsulating the relationship between nodes and smart contracts. In contrast, equation 1.3 describes the recursive function aggregating the individual contributions of nodes and smart contracts to the network's functionality.

Lastly, smart contracts, denoted as SC, play a critical role in the system. A mathematical representation is utilised to define the functionality of the smart contracts:

$$SC\ (conditions, actions\ = \int_{0\ otherwise}^{1\ if\ conditions\ are\ met}\ ) \qquad 1.4$$

where *conditions* represent the predefined contract conditions, *actions* denote the set of actions executed when conditions are met. The mathematical representation in equation 1.4 denotes a binary function that encapsulates the binary nature of contract execution: it either happens or it doesn't, based on the fulfilment of contractual conditions.

The major components, Payment Gateway, Blockchain Network, and Smart Contracts, are then interlinked through the following mathematical equation:

$$Integrated\ System = PG\ (U, V) \times BN\ (N, S) \times SC \qquad 1.5$$

In equation 1.5, the mathematical expression highlights the contribution of each component to the integrated system's functionality.

As Figure 2 indicates, this network is the structural spine that guarantees the efficient and dependable execution of all transactional activities.

4.1 Subsequent Pages

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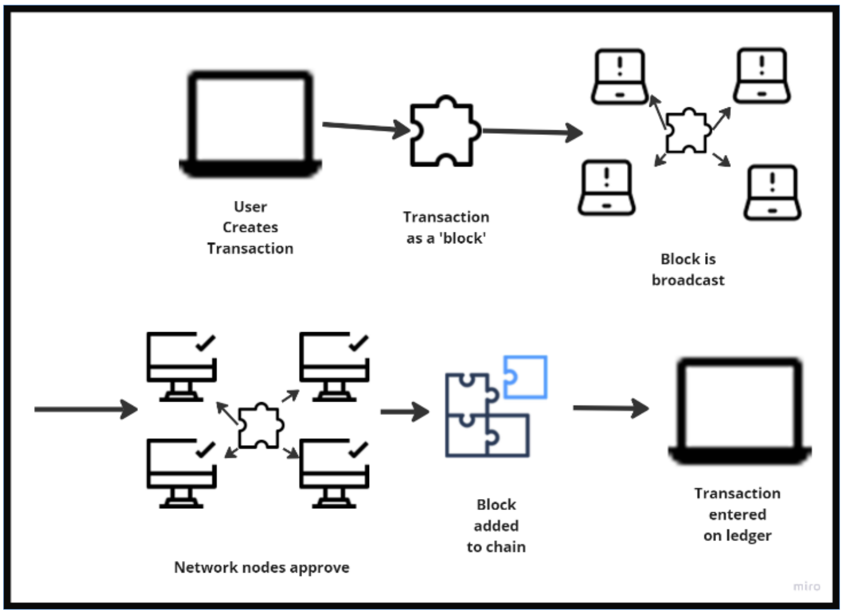


Figure 2: Architecture of a blockchain-based cross-border payment system

Decentralised wallets are the core of this architecture, which makes it easier for users to interact with the blockchain. Such wallets include platforms like MetaMask. HBar tokens, as the native cryptocurrency of the Hedera network, have a critical role. They have a significant role to play in society. As such, tokens such as these lay the groundwork for the operational, transactional roles and price systems. Figure 3 presents a holistic picture of this ecosystem by depicting the dynamic relationship between the Hedera network, decentralised wallets, and the importance of HBar tokens within the system. A visual image that can be located in Figure 3 offers a thorough comprehension of the system's structure and the processes happening between its primary elements.

The Hedera Hashgraph network, which plays a crucial role in the system's design, is a novel approach to blockchain technology. Hedera is a type of blockchain network that uses the well-known hashgraph algorithm; thus, it has better speed, efficiency, and security features when compared to traditional blockchain networks, which involve a chain of blocks. So, this technique allows for reaching a consensus quickly without losing its decentralisation property, which is a common problem with traditional blockchain systems. The functionality of Hedera's network structure to process vast numbers of transactions and simultaneously reduce latency and energy use is very much recognized. Therefore, it is a very good solution for international financial transactions. It leverages the proof-of-stake consensus mechanism, which ensures that the network will remain secure and reliable and minimizes the environmental impact often associated with blockchain technologies.

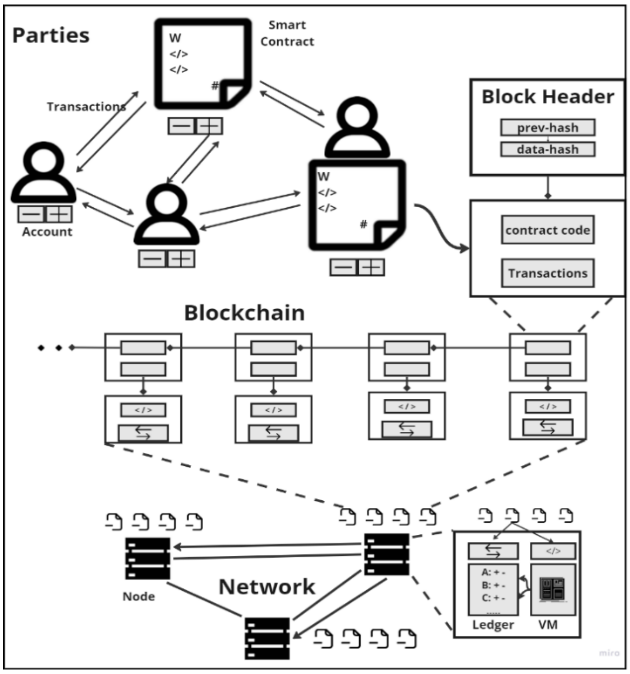


Figure 3: Architecture of blockchain parties involved

4.1.1 Cloud Infrastructure Configuration for Blockchain Deployment

The success of a blockchain-based cross-border payment system hinges upon a robust and secure cloud infrastructure. The first step is choosing the right cloud platform that aligns with your system's needs and budget. Popular options include Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform (GCP). Once a cloud service provider has been chosen, the next step is to provision the necessary resources for hosting blockchain nodes and components. This includes virtual machines (VMs), storage volumes, networking resources, and other infrastructure components.

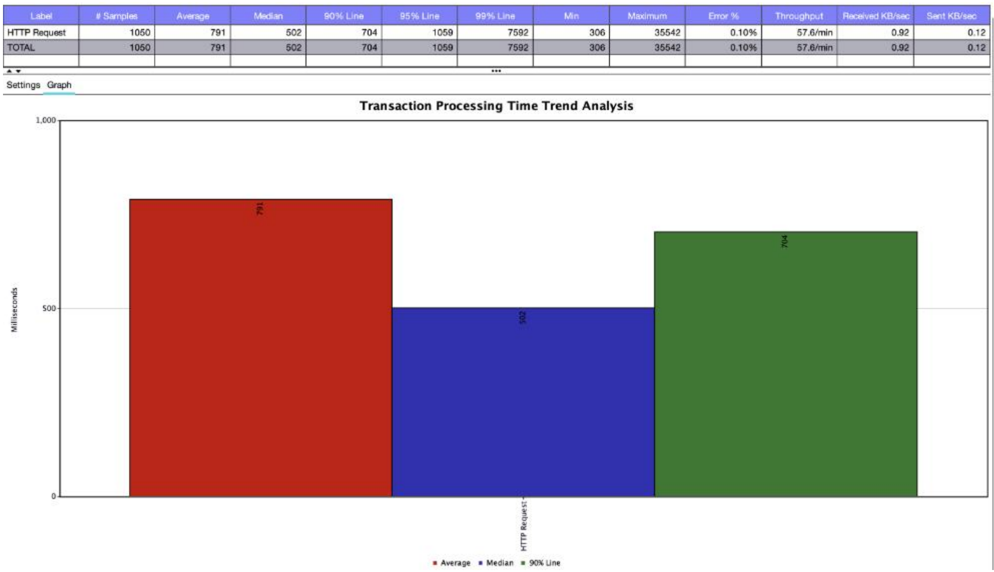
Resource provisioning should be done per the blockchain network's requirements, considering node capacity, storage requirements, and network bandwidth. Amidst these, effective monitoring and management tools are essential for maintaining cloud-based blockchain deployments' health, performance, and security. This includes monitoring key metrics such as CPU utilization, memory usage, network latency, and transaction throughput in real-time, as well as implementing automated alerting and reporting mechanisms to detect and respond to issues proactively. Additionally, cloud management platforms and dashboards provide visibility and control over cloud infrastructure, optimising resource utilisation, troubleshooting problems, and enforcing compliance with organizational policies and regulations.

5. SIMULATIONS, RESULTS AND DISCUSSIONS

The subsequent phase that follows laying out theoretical foundations for the cross-border payment system based on the blockchain concept moves into a pivotal process to validate it. This validation process is performed by means of simulations and thoughtful analysis. In this study, the system's operation, its effectiveness against the pre-specified targets, and its capacity to effect changes in international financial deals are critically assessed. Using a series of precisely built simulations that reflect real-life situations, insights into the system's innate possibilities can be obtained and determine where more improvement is needed. Together with the results presented in this part, the vast research offered helps to prove that what the suggestion is possible and effective. These findings not only justify the possibility of using this system but also pave the way for implementation, which may lead to the large-scale adoption of a similar system within this financial environment.

The graph presented in Figure 4 illustrates the server's performance characteristics of HTTP request handling. Analysis of 1050 samples indicates an average response time of 791 milliseconds (about 1 second). This suggests that while the server is relatively prompt, there is a potential for optimization to enhance the user experience, especially for applications where faster responses are crucial. Delving deeper, the median response time is a quicker 502 milliseconds (about half a second), indicating that more than half of the requests receive responses in less than the average time.

However, when examining the response times at the 90th percentile, a slight increase to 704 milliseconds is observed, suggesting a stable performance for most requests. The test's low error rate of 0.10% reflects a high degree of reliability, although the causes of these few errors should be investigated to bolster the application's robustness. The throughput, measured at 57.6 requests per minute, provides a baseline understanding of the system's capacity but does not, on its own, indicate whether the system's performance aligns with user expectations or demands. Lastly, data transfer volumes are modest, with only 0.92 KB sent per minute, implying that the requests and responses are lightweight and do not contribute significantly to the latency.



Label	# Samples	Average	Median	90% Line	95% Line	99% Line	Min	Maximum	Error %	Throughput	Received KB/sec	Sent KB/sec
HTTP Request	1050	791	502	704	1059	7592	306	35542	0.10%	57.6/min	0.92	0.12
TOTAL	1050	791	502	704	1059	7592	306	35542	0.10%	57.6/min	0.92	0.12

Figure 4: Response time distribution analysis for web transactions

Figure 5: Total requests distribution analysis

The data analysis in Figure 5 shows how the blockchain-based system scales with increased load and how it maintains its performance in handling requests, which is critical for cross-border payment systems where throughput and reliability are key performance indicators.

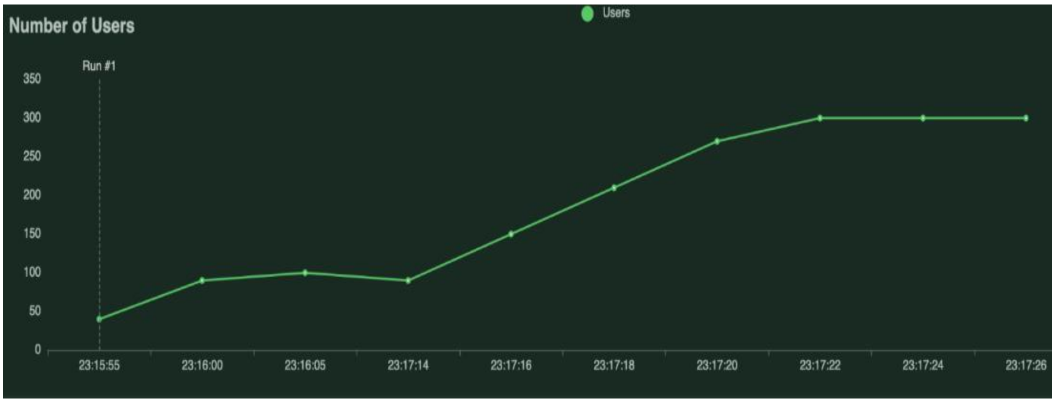


Figure 6: User load impact on response time

The User Load Impact Analysis graph in Figure 6 affirms the system's capacity to manage increasing user volume gracefully. The steady climb in active users, aligned with the system's consistent performance, emphasizes its readiness for real-world application. This scalability is a testament to the resilient design of the blockchain-based payment system, poised to handle growing traffic without diminishing user experience.

Table 1: Developed vs. existing model

Metrics	Existing Traditional System (Western Union)	Developed Blockchain System
Average request time (mins)	2160	10
Average response time (mins)	2880	35
Average latency (mins)	5760	35
Transaction fees (%)	5	1
Transparency	Low	High
Security	Medium	High
Scalability	Inconsistent	Consistent

Figure 7: Latency of traditional cross-border systems

The system's architecture, optimized for blockchain efficiency, ensures smoother transaction processing, a pivotal advancement over existing models, as substantiated in Figure 7 and Table 1 of this study.

Figure 8: User load response times for both systems

As depicted in Figure 8, the blockchain-based system's latency profile underscores its robust architecture, designed for swift and direct transactions. This efficiency is reflected in significantly lower latency times.

6. CONCLUSION

This study demonstrates the potentials of a blockchain-based system to mitigate the inefficiencies and security vulnerabilities inherent in conventional cross-border payment systems. The model has proven to work efficiently under various simulation conditions. The simulations and analysis revealed benefits like faster transaction times, reduced costs, and enhanced security A thorough assessment of the current technological landscape, coupled with comprehensive planning and strategy for seamless integration, is strongly advised. Additionally, dedicating resources towards training and support during the transition phase will be crucial in ensuring a smooth adoption process. However, challenges remain in specific areas like interoperability regulatory compliance. Further research is needed to refine the system and ensure seamless integration into the global financial landscape. By overcoming these hurdles, blockchain-powered cross-border payments have the potential to revolutionize international trade and finance, promoting a more inclusive and frictionless global economy.

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