Distributed Ledger System For Cloud Resource Billing Transparency

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***Abstract*— The swift uptake of cloud computing services has brought with it new complexities in tracking and billing for resource usage, frequently resulting in disagreements between customers and service providers as a result of unclear pricing models. This study investigates the use of Distributed Ledger Technology (DLT) to improve transparency, trust, and accuracy in cloud resource billing. By taking advantage of the distributed and immutable aspect of distributed ledgers, bill records can be recorded, stored, and audited in real-time by anyone involved in an immutable manner. This removes dependence on centralized bill authorities and reduces tampering and manipulation of the data. Our proposed blockchain framework tracks resource consumption metrics, such as compute time, storage, and bandwidth used, directly on a distributed ledger. Smart contracts eliminate manual billing computations and payments, providing consistency and fairness. With this system, users obtain verifiable information on their billing history, while providers enjoy fewer operational disagreements and higher customer trust. Our paper presents the system architecture, principal technical challenges, possible performance overheads, and feasible solutions for deployment at scale. Finally, this research illustrates how the convergence of distributed ledger systems with cloud billing systems presents a revolutionary entry point to the development of an increasingly open and responsive cloud economy.**

Keywords*— *Ledger, Blockchain, Billing , software.

I. INTROUCTION

The usage of computing resources by businesses and individuals has evolved into scalable, adaptable, and economical solutions thanks to cloud computing. Transparent and accurate accounting of resource application is becoming essential due to the growing use of Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), and Software-as-a-Service (SaaS) models by enterprises. The majority of cloud billing systems in use today are centralized, giving the service provider complete control over resource measurement, usage tracking, and cost estimation. Lack of transparency, inaccurate invoicing, and eroded consumer and cloud provider assurance are all consequences of centralized control.

Because to cloud computing, both individuals and organizations may now access computing resources in scalable, flexible, and affordable ways. As more businesses use Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), and Software-as-a-Service (SaaS) models, it is increasingly essential to bill for the utilisation of resources in a clear and precise manner. With today's mostly consolidated cloud billing systems, the service provider has complete control over resource measurement, use tracking, and cost estimation. centralized control results in inaccurate invoicing, a lack of transparency, and eroded consumer and cloud provider trust in oneself.

Cloud computing is transforming how individuals and businesses use computing resources into scalable, adaptable, and affordable solutions. Since more businesses are using Platform-as-a-Service (PaaS), Software-as-a-Service (SaaS), and Infrastructure-as-a-Service (IaaS) models, it is now essential to bill for resource utilization in a clear and correct manner. Because most cloud billing methods are currently consolidated, the service provider has complete control over resource measurement, use tracking, and cost estimation. The trust between cloud providers and customers has been damaged by centralized governance, which often results in inaccurate billing and a lack of transparency.

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II. LITERATURE REVIEW

A. ***Blockchain-Based Cloud Billing for Transparency and Trust(Sharma, P., Chen, J., Sheth, A.)*** This article introduces a blockchain-based billing system with the vision of minimizing disputes in cloud services. Using Ethereum smart contracts, they implement resource monitoring and charge calculation automatically in real time. The authors state that blockchain guarantees billing information cannot be modified, thus is tamper-proof and can be audited by the customer. They also mention

future problems with regards to blockchain scalability if implemented on huge cloud platforms. Their model demonstrates an extremely high increase in user-cloud vendor trust levels, but they need to conduct intensive cost optimization owing to blockchain operation transaction costs.

B. ***A Secure and Transparent Blockchain-Based Cloud Resource Billing Framework(Zhang, Y., Deng, R.H., Weng, J.)*** The authors propose a blockchain architecture in which usage of cloud resources is monitored as transactions. They introduce an off-chain storage method to deal with large data sets of resources in order to prevent bloating of the blockchain. Their design enables billing transparency and security with lower overhead. The paper by simulation proves higher billing verification rate and customer satisfaction. They conclude that there must be more privacy-preserving methods in order not to publish user resource usage patterns. The research stresses the significance of coordination between transparency and confidentiality in distributed ledger applications.

C. ***Cloud-Based Billing Using Smart Contracts(Alshamrani, A., Chowdhury, M.)*** This research examines the use of smart contracts to bill cloud resource usage automatically. The authors develop a prototype where users get real-time usage of resources along with corresponding bills without relying on cloud providers' statements. Their architecture relies on permissioned blockchain networks to offer faster transaction speeds and cheaper rates. The authors conclude that smart contracts eliminate human intervention and manipulation in billing. Smart contract weaknesses and the challenge of writing secure smart contracts are also mentioned, citing the importance of extensive contract testing.

D. En Route to Transparent Cloud Billing: Blockchain-Based Metering and Auditing(Singh, S., Chana, I.) This article describes blockchain integration for metering and auditing the use of resources in cloud infrastructures. The authors suggest a multi-layer architecture where information regarding the resources is verified before being stored in the blockchain. The authors believe that this improves auditing and prevention of overbilling by the service providers. The article also illustrates an evaluation of reduced billing inconsistencies. However, processing delay is identified as a problem, especially in the case of heavy loads. The authors believe that hybrid systems consisting of off-chain as well as on-chain processes can make a realistic compromise between performance and transparency.

E. Blockchain for Trusted Cloud Computing: An Application in Billing(Fan, K., Jiang, W., Li, H., Yang, Y.) The authors propose a trustworthy cloud billing system using blockchain to solve the problem of distrust in conventional cloud services. Their system permanently stores all service transactions and resource usage data entries. They highlight how consensus algorithms ensure only valid entries are added to the ledger. Experimental results show enhanced billing accuracy and user trust. They mention, however, that high latency and energy consumption in conventional proof-of-work blockchains can limit scalability, and lightweight consensus mechanisms are better suited to cloud environments.

F. Blockchain and IoT Data-Based Decentralized Cloud Billing(Kumar, N., Goudar, R.H.)This paper considers the potential of combining IoT data with blockchain in decentralized cloud billing. The authors propose an ecosystem where IoT sensors track usage of resources and report directly to blockchain-based smart contracts for billing. Their approach does away with the requirement for cloud providers to meter, providing users with more autonomy. Simulation results show improved billing transparency and reduction in fraud. They also discuss issues of sensor data security and computation cost of synchronizing IoT data with blockchain.

G. Distributed Ledgers for Transparent Cloud Resource Management(Patel, P., Pathak, N.) The authors propose a distributed ledger architecture for open billing and resource management in multi-cloud environments. Their architecture facilitates cross-provider interoperability, enabling users to track usage across different cloud providers. They illustrate an example of a use case where users can audit billing against on-chain recorded actual consumption. Results indicate higher user satisfaction and billing dispute resolution rates. They also identify issues in maintaining consistency across different cloud vendors' metering standards, which necessitates standardization efforts alongside technology adoption.

H. ***Equitable Cloud Billing through Smart Contracts(Xu, X., Pautasso, C., Zhu, L.)*** This study centers on the use of smart contracts to execute fair and auditable billing processes for cloud services. The authors propose a three-tiered architecture in the form of cloud providers, blockchain networks, and customers under the management of smart contracts that execute all the billing processes. They show how the mechanism can prevent discriminatory charging and establish trust among customers. The study also points out that while blockchain makes transparency possible, it can generate performance bottlenecks if adequately optimized. Future studies recommend the use of machine learning to support predictive billing based on usage patterns.

I. ***CloudChain: Blockchain-Based Secure Cloud Framework(Chaudhary, R., Yousafzai, A., Ikram, M.)*** CloudChain demonstrates a security-enhanced blockchain design that, among other aspects, boasts transparent billing as one of its main applications. The authors include resource consumption tracking in the blockchain ledger in a way that clients are able to audit bills autonomously. The research offers important security and billing transparency enhancements. Among

the given limitations is the high cost of maintaining blockchain nodes in a distributed cloud environment. The authors propose future enhancement using lightweight blockchain design or sidechains for less critical billing data, enhancing efficiency.

J. ***Blockchain and Trusted Execution Environment-based Auditable Cloud Billing(Kiani, A., Salah, K., Jayaraman, R.)*** This article discusses how blockchain can be blended with Trusted Execution Environments (TEEs) to make cloud billing auditable. TEEs provide secure and precise monitoring of resources while blockchain captures measurements for traceability. The authors demonstrate how integrating TEEs with blockchain provides low computational cost with high trust. Their system provides billing auditability without disclosing sensitive client information. While the model provides satisfactory security, the paper points to vulnerabilities if the TEEs themselves are under attack, and multi-layered verification techniques would be required.

III. ROLE OF DISTRIBUTED LEDGER SYSTEM FOR CLOUD RESOURCE BILLING TRANSPARENCY

The usage of computing resources by businesses and individuals has evolved into scalable, adaptable, and economical solutions thanks to cloud computing. Transparent and accurate accounting of resource utilisation is becoming essential due to the growing use of Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), and Software-as-a-Service (SaaS) models by organisations. The majority of cloud billing systems in use today are centralised, giving the service provider complete control over resource measurement, usage tracking, and cost estimation. Lack of transparency, inaccurate invoicing, and eroded consumer and cloud provider confidence are all consequences of entralisation.

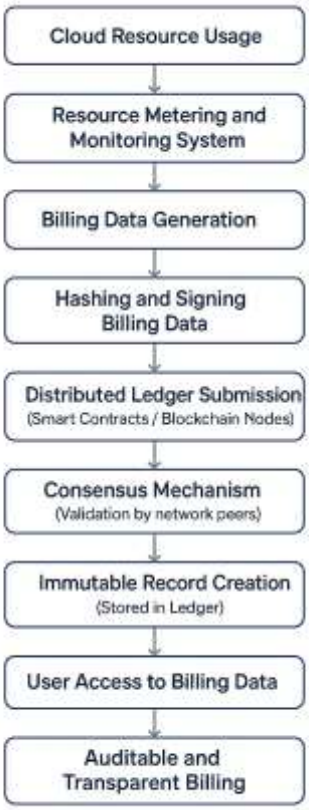

Fig.1 Flow chart for the distributed ledger.

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IV. PERFORMANCE METRICS

1. Transaction Throughput

Definition:
Transaction throughput refers to the number of transactions the distributed ledger system can process per second (TPS).

Importance:
In a cloud billing context, real-time tracking of thousands or millions of micro-transactions is essential. High transaction throughput ensures that resource usage records are updated promptly without delays.

Measurement:
Measured by counting the number of successful billing transactions recorded on the blockchain per second under various load conditions.

2. Latency

Definition:
Latency measures the delay in time between the initiation of a billing transaction and its verification on the ledger.

Importance:
Low latency is essential to achieve near real-time billing notification, particularly in pay-per-use cloud schemes.

Measurement:
Measured by measuring the average time of transactions being verified and settled in the blockchain under varying network loads.

3. Scalability

Definition:
Scalability is the performance capability of the system as the number of users, transactions, or nodes increases.

Importance:
In multi-user, multi-provider large-scale cloud deployments, a scalable system provides consistent billing performance without degradation.

Measurement:
Proven by simulating growing numbers of billing transactions and users, and measuring system behavior in terms of throughput and latency.

4. Security and Data Integrity

Definition:
Security assesses the system's resistance to unauthorized access, fraud, and tampering. Data integrity guarantees that billing records are accurate and unchanged.
Because billing entails financial information, security and the integrity of usage records must be ensured to establish user trust.

Measurement:
Measured by penetration testing, attack simulations, and cryptographic validations of ledger information over time.

5. Transparency and Auditability

Definition:
Transparency is the availability of billing transactions to authorized entities, whereas auditability pertains to the ease with which billing information can be verified independently.

Importance:
High transparency and auditability avoid billing conflicts and increase accountability among providers and consumers.

Measurement:
Measured by performing independent audits and checking whether billing records on the ledger coincide correctly with actual resource usage reports.

6. Cost Efficiency

Definition:
Cost efficiency measures the operating cost incurred in maintaining the distributed ledger system, such as computational resources, storage space, and transaction fees.

Importance:
An economically priced billing system is one that prevents transparency from costing service providers or consumers an unsustainable amount of money.

Measurement:
Measured by calculating the average cost per billing transaction and comparing it with legacy centralized billing systems.

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