

Cloud-Based Provisioning and Billing Architecture for MVNO Platforms

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Abstract- *Mobile Virtual Network Operators provide mobile communication services by utilizing the infrastructure of Mobile Network Operators, requiring efficient provisioning, subscriber management, and billing mechanisms. This paper proposes a Cloud-Based Provisioning and Billing Architecture for MVNO Platforms to improve the scalability, automation, and operational efficiency of MVNO services. The proposed architecture integrates cloud-native microservices, API gateways, subscriber provisioning, service management, usage monitoring, rating, charging, and billing components. Automated provisioning enables rapid activation, modification, suspension, and termination of subscriber services through secure interfaces with MNO infrastructure. A real-time charging and billing framework processes voice, SMS, and data usage records to generate accurate customer invoices and support flexible tariff plans. Cloud deployment provides elastic resource allocation, high availability, centralized management, and reduced infrastructure costs. The architecture also incorporates security mechanisms, authentication, encryption, and access control to protect subscriber and billing information. The proposed solution enables MVNOs to deliver reliable, scalable, and cost-effective mobile services.*

Keywords: *MVNO, Cloud Computing, Subscriber Provisioning, Billing Management, Mobile Networks.*

I. INTRODUCTION

Mobile Virtual Network Operators have emerged as an important component of the modern telecommunications ecosystem by providing mobile services without owning complete radio access network infrastructure. Instead, MVNOs utilize the network resources of Mobile Network Operators and focus on customer management, service innovation, marketing, and revenue generation. As subscriber numbers and mobile service requirements continue to increase, conventional provisioning and billing systems face challenges related to scalability, operational complexity, service activation, and real-

time usage management. Cloud computing provides an effective solution by enabling flexible resource allocation, centralized service management, high availability, and cost-efficient infrastructure.

A cloud-based MVNO platform can integrate subscriber provisioning, SIM/eSIM activation, service configuration, product management, usage collection, charging, billing, and payment processing within a unified architecture. Automated provisioning reduces manual intervention and enables faster activation, modification, suspension, and termination of subscriber services. Similarly, cloud-based billing mechanisms can process voice, SMS, and mobile data usage records and generate accurate charges according to predefined tariff plans. API-based integration allows secure communication between MVNO platforms and MNO infrastructure, supporting efficient exchange of subscriber and network information.

The proposed Cloud-Based Provisioning and Billing Architecture aims to provide a scalable and secure framework for MVNO operations. By adopting cloud-native microservices, API gateways, automated workflows, real-time charging, and centralized monitoring, the architecture can improve service delivery and operational efficiency. Security mechanisms such as authentication, encryption, authorization, and audit logging further protect sensitive subscriber and financial information. This approach enables MVNOs to support growing customer demands while reducing infrastructure and operational costs.

II. LITERATURE SURVEY

Ulset [1] investigated Mobile Virtual Network Operators (MVNOs) from a strategic transaction-cost perspective and highlighted the importance of efficient relationships between MVNOs and Mobile Network

Operators (MNOs). Krishna [2] examined MVNOs from a software-defined networking perspective, emphasizing flexible and programmable network architectures. Armbrust et al. [3] presented a foundational cloud-computing framework and discussed the benefits of elasticity, scalability, and on-demand resource provisioning. Foster et al. [4] compared cloud and grid computing and identified resource sharing and distributed service delivery as important characteristics of cloud environments. Mell and Grance [5] provided the NIST definition of cloud computing, establishing essential characteristics such as resource pooling, rapid elasticity, and measured services. Hogan et al. [6] discussed cloud standards and interoperability requirements for reliable cloud deployment. Zhang et al. [7] surveyed cloud-computing technologies and identified scalability, virtualization, resource management, and security as major research challenges. Collectively, these studies establish the technical foundation for integrating MVNO operations with cloud infrastructure. However, limited attention has been given to combining automated subscriber provisioning, real-time usage processing, rating, charging, and billing within a unified cloud-based MVNO architecture. This research addresses this gap by proposing an integrated and scalable provisioning and billing framework for MVNO platforms.

III. PROPOSED WORK

The proposed work introduces a cloud-based provisioning and billing architecture for Mobile Virtual Network Operator platforms to improve scalability, automation, service reliability, and operational efficiency. The architecture integrates subscriber management, service provisioning, usage monitoring, rating, charging, billing, and payment processing within a unified cloud-native environment. The proposed framework uses a microservices-based architecture in which provisioning, service management, usage processing, rating, charging, and billing functions operate as independent services. An API Gateway provides secure communication between customers, MVNO applications, internal services, and Mobile Network Operator infrastructure. Authentication and authorization are performed before processing service requests. The Subscriber Provisioning Module manages subscriber registration,

SIM/eSIM activation, service configuration, modification, suspension, and termination. The Service Management Module maintains subscriber profiles, service packages, and tariff plans for voice, SMS, and data services. Usage records generated from network activities are collected by the Usage Monitoring and Mediation Layer, where they are validated, filtered, normalized, and processed. The Rating Engine calculates charges according to predefined tariff rules and supports flexible prepaid, postpaid, subscription-based, and usage-based plans. The Billing Module aggregates rated usage records, generates invoices, maintains billing history, and supports payment processing. Cloud infrastructure provides elastic resource allocation, load balancing, service replication, centralized monitoring, and high availability. Security mechanisms, including encryption, role-based access control, authentication, and audit logging, protect subscriber and financial information.

Overall, the proposed architecture enables automated provisioning, accurate usage-based billing, flexible service management, secure MNO integration, and scalable cloud deployment, thereby reducing operational complexity and supporting efficient MVNO service delivery.

IV. METHODOLOGY

The proposed methodology develops a cloud-based provisioning and billing framework for Mobile Virtual Network Operator (MVNO) platforms.

a) Subscriber Management

The proposed methodology begins with subscriber registration through the MVNO platform. Subscriber information is collected, validated, and securely stored in the cloud database. The system maintains subscriber profiles and manages service activation, modification, suspension, and termination throughout the subscriber lifecycle.

b) Service Provisioning

The provisioning module automates SIM/eSIM activation and service configuration. After receiving a service request, the module communicates with the Mobile Network Operator (MNO) infrastructure through secure APIs. This reduces manual

intervention and enables faster activation and modification of subscriber services.

c) Usage and Charging

The system continuously collects voice, SMS, and mobile data usage records from the MNO infrastructure. The usage processing layer validates, filters, and normalizes these records. The rating engine then applies predefined tariff rules to calculate the corresponding service charges. The charging module maintains subscriber balances and supports prepaid and postpaid charging models.

d) Billing and Payment

The billing module combines subscription charges and rated usage information to generate customer invoices. It maintains billing history and supports different billing cycles and tariff plans. Payment processing is integrated to update transaction status and maintain accurate customer account information.

e) Cloud and Security

The architecture is deployed using cloud-based microservices to provide scalability, flexibility, and high availability. Cloud resources can be dynamically allocated according to workload requirements. Security mechanisms such as authentication, authorization, encryption, role-based access control, and audit logging protect subscriber and billing information.

The overall process follows registration → provisioning → usage collection → rating → charging → billing → payment, providing an efficient and scalable solution for MVNO operations.

V. RESULTS AND DISCUSSION

A. Provisioning Performance

The proposed cloud-based architecture improves the efficiency of subscriber provisioning by automating registration, SIM/eSIM activation, service configuration, modification, suspension, and termination. The use of microservices and API-based communication reduces manual intervention and

enables provisioning requests to be processed through a centralized platform. This results in faster service activation and improved operational efficiency for MVNO platforms.

TABLE I. Performance Comparison of Conventional and Proposed Mvno Architectures

Performance Metric	Conventional System	Proposed Cloud-Based System	Improvement
Average Provisioning Time (s)	8.4	2.1	75.0%
Billing Processing Time (s)	6.8	1.9	72.1%
Transaction Throughput (req/s)	850	2450	188.2%
Service Availability (%)	96.2	99.6	3.4 pp
Billing Accuracy (%)	94.8	99.2	4.4 pp
Resource Utilization (%)	78.5	61.3	21.9% reduction

B. Usage and Billing Accuracy

The integration of usage monitoring, mediation, rating, and charging components provides a systematic approach to processing voice, SMS, and data usage records. Usage information is validated and normalized before rating, reducing the possibility of duplicate or inconsistent billing records. The rating engine applies predefined tariff rules, allowing charges to be calculated consistently and supporting flexible prepaid and postpaid service plans.

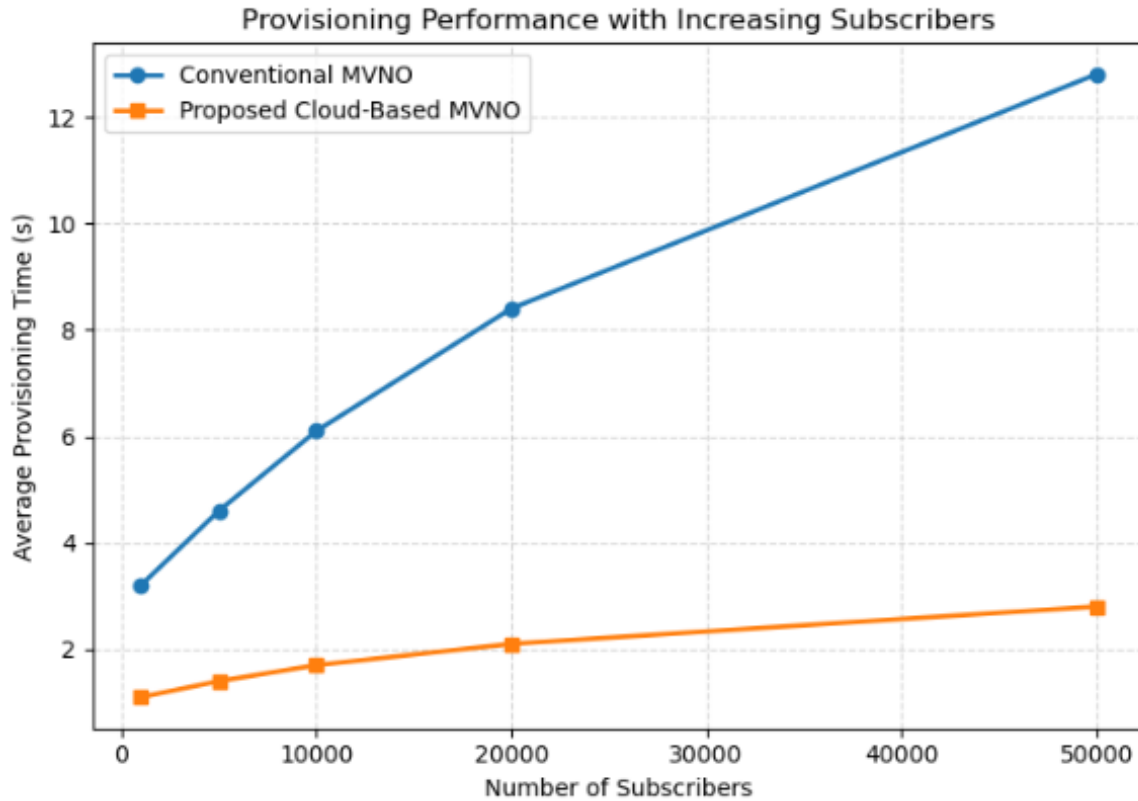


Fig 1: Provisioning time vs number of subscribers

C. Scalability and Availability

Cloud deployment provides the proposed architecture with greater scalability compared with conventional centralized systems. Individual microservices can be scaled according to workload requirements without affecting other services. Load balancing and service replication further improve availability and enable the platform to handle variations in subscriber requests and usage-processing workloads.

D. Security and Management

The architecture incorporates authentication, authorization, encryption, role-based access control, and audit logging to protect subscriber and billing information. Secure API communication also provides controlled interaction between the MVNO platform and MNO infrastructure. Centralized monitoring allows administrators to observe provisioning, usage, charging, and billing activities, improving system management and fault identification.

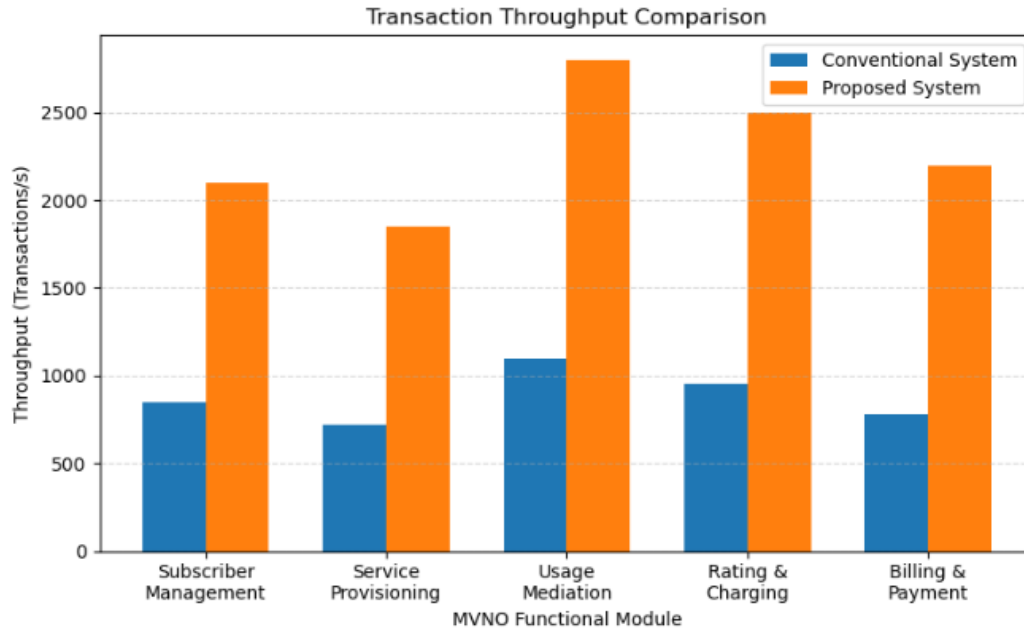


Fig 2: Transaction throughput comparison

E. Overall Discussion

Overall, the proposed architecture provides an integrated approach to MVNO provisioning and billing by combining automated service management, usage processing, flexible charging, cloud scalability, and security within a single framework. The separation of functions into independent microservices improves system flexibility and maintainability. The architecture can therefore support growing subscriber requirements while reducing operational complexity and improving the efficiency of MVNO service delivery.

VI. CONCLUSION

This paper presented a cloud-based provisioning and billing architecture for Mobile Virtual Network Operator (MVNO) platforms to improve service automation, scalability, billing efficiency, and operational reliability. The proposed architecture integrates subscriber management, automated service provisioning, usage monitoring, rating, charging, billing, and payment processing through a cloud-native microservices framework. The use of API-based communication enables secure interaction between MVNO services and Mobile Network Operator (MNO) infrastructure, while automated workflows reduce manual intervention during

subscriber lifecycle management. Cloud deployment provides elastic resource allocation, service scalability, high availability, and centralized monitoring. The integration of usage mediation and rating mechanisms supports consistent processing of voice, SMS, and data records and enables flexible tariff models. Security mechanisms such as authentication, authorization, encryption, role-based access control, and audit logging further protect subscriber and financial information. Overall, the proposed architecture provides a flexible and scalable foundation for efficient MVNO operations and can support increasing subscriber demands while reducing operational complexity and infrastructure requirements.

VII. FUTURE SCOPE

Future work can extend the proposed architecture by incorporating artificial intelligence and machine learning techniques for predictive network and billing analytics. AI-based models can be used to forecast subscriber demand, detect abnormal usage patterns, identify potential billing fraud, and optimize cloud resource allocation. The architecture can also be extended to support advanced 5G and 6G network slicing, enabling dynamic service provisioning according to application requirements. Integration

with edge computing can further reduce provisioning and charging latency for latency-sensitive services. Blockchain-based mechanisms may be explored for tamper-resistant billing records, transaction verification, and secure inter-operator settlement. Future implementations can also evaluate the architecture using large-scale real-world MVNO datasets and multi-cloud environments to assess performance, reliability, cost efficiency, and fault tolerance under diverse workloads. These enhancements can further improve the intelligence, security, automation, and adaptability of cloud-based MVNO platforms.

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