

Cloud-Native Architecture for Next-Generation MVNO Platforms

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Abstract- *Mobile Virtual Network Operators (MVNOs) require flexible, scalable, and cost-efficient platforms to support rapidly growing mobile services. Traditional MVNO infrastructures often face limitations in resource utilization, service deployment, scalability, and operational efficiency. This paper proposes a cloud-native architecture for next-generation MVNO platforms using microservices, containerization, orchestration, API gateways, and automated resource management. The proposed architecture enables independent service deployment, dynamic scaling, improved fault tolerance, and efficient network resource utilization. A simulated evaluation compares the proposed cloud-native approach with a conventional MVNO architecture using latency, provisioning time, resource utilization, scalability, and service availability. Results demonstrate improved performance and operational flexibility.*

Keywords: *Cloud-Native Computing, Mobile Virtual Network Operator (MVNO), Microservices, Containerization, 5G Networks.*

I. INTRODUCTION

Mobile Virtual Network Operators (MVNOs) provide mobile communication services by utilizing infrastructure from Mobile Network Operators (MNOs), enabling flexible and cost-effective service delivery. However, traditional MVNO platforms often depend on tightly coupled systems that can limit scalability, deployment speed, resource utilization, and operational efficiency. The emergence of cloud-native technologies provides an opportunity to overcome these limitations through microservices, containers, orchestration, automation, and software-defined infrastructure. This paper proposes a cloud-native architecture for next-generation MVNO platforms that supports dynamic resource allocation, rapid service deployment, fault tolerance, and scalable network operations. The proposed approach is evaluated using performance parameters including latency, provisioning time, resource utilization, scalability, and service availability.

II. LITERATURE SURVEY

Recent research has highlighted cloud-native technologies as an important foundation for flexible and scalable mobile network platforms. Shah et al. [1] examined cloud-native network slicing and emphasized the role of software-defined networking and edge computing in improving resource management. Robitzsch et al. [2] discussed microservice-based architectures for 5G and beyond, demonstrating their potential for independent service deployment and scalability. Chiu et al. [3] proposed a cloud-native management and orchestration framework for end-to-end network slicing. Grings et al. [4] investigated dynamic orchestration of 5G core network slices on cloud-native platforms. Other studies have explored lightweight 5G cores, containerized network functions, service meshes, O-RAN, and intelligent resource allocation [5]–[17]. These studies demonstrate significant benefits of cloud-native approaches; however, an integrated architecture specifically addressing the scalability and operational requirements of next-generation MVNO platforms remains an important research area.

III. PROPOSED WORK

The proposed work introduces a cloud-native architecture designed to improve the scalability, flexibility, and operational efficiency of next-generation MVNO platforms. The architecture adopts a microservices-based approach, where major MVNO functions such as subscriber management, authentication, billing, service provisioning, policy management, and network monitoring operate as independent services. Containerization enables lightweight deployment and isolation of individual services, while an orchestration layer dynamically manages containers and resources according to workload demands. An API Gateway provides secure communication between users, applications, and

backend MVNO services. Cloud-based resource management enables automatic scaling during high traffic and resource reduction during low-demand periods. The architecture also incorporates continuous monitoring, automated fault detection, load balancing, and service recovery mechanisms to improve availability and reliability. The proposed platform is evaluated against a conventional MVNO architecture using parameters such as service provisioning time, latency, resource utilization, scalability, throughput, and service availability. The objective is to demonstrate that cloud-native technologies can provide faster deployment, efficient resource utilization, improved scalability, and reliable service delivery for next-generation MVNO operations.

IV. METHODOLOGY

The methodology for the proposed Cloud-Native Architecture for Next-Generation MVNO Platforms consists of several stages designed to improve scalability, service deployment, resource utilization, reliability, and operational efficiency in MVNO environments.

1. System Architecture Design

The proposed system is designed with an MVNO management layer, cloud infrastructure, microservices, API gateway, containerized services, orchestration platform, monitoring module, and host Mobile Network Operator (MNO) interfaces. MVNO functions such as subscriber management, authentication, billing, provisioning, and policy management are implemented as independent services.

2. Microservices-Based Service Deployment

The major MVNO functions are divided into loosely coupled microservices. Each service can be developed, deployed, updated, and scaled independently. This approach reduces service dependency and enables faster deployment of new MVNO services while improving system flexibility and maintainability.

3. Containerization

The microservices are packaged into lightweight containers to provide isolated and portable execution environments. Containerization enables consistent

application deployment across cloud resources and reduces infrastructure dependency. It also supports efficient utilization of computing resources under varying network workloads.

4. Cloud Resource Management

Cloud resources such as computing, memory, storage, and network capacity are dynamically allocated according to service demand. Resource management mechanisms monitor workload variations and allocate additional resources during high traffic conditions while reducing unused resources during low-demand periods.

5. Container Orchestration and Auto-Scaling

A container orchestration layer manages service deployment, scheduling, load balancing, health monitoring, and automatic recovery. Horizontal and vertical scaling mechanisms are used to increase or decrease service capacity according to workload requirements. This improves scalability and service availability.

6. API Gateway and MVNO Integration

An API Gateway manages communication between subscribers, applications, MVNO services, and host network operators. Secure APIs are used for subscriber provisioning, authentication, billing, policy management, and network service integration. The gateway also supports request routing, access control, and service monitoring.

7. Monitoring and Fault Management

A centralized monitoring module continuously observes service health and infrastructure performance. Parameters such as CPU utilization, memory consumption, network latency, service response time, and availability are collected. Fault detection mechanisms identify failed services and initiate recovery or replacement procedures.

V. RESULTS AND DISCUSSION

The proposed Cloud-Native Architecture for Next-Generation MVNO Platforms was evaluated through a simulated MVNO environment and compared with a conventional MVNO architecture. The evaluation considered provisioning time, latency, resource utilization, throughput, scalability, and service

availability. The results indicate that the cloud-native approach improves operational efficiency by using independent microservices, containerization, automated scaling, and dynamic resource allocation.

Table 1. Performance Comparison

Performance Parameter	Conventional MVNO	Proposed Cloud-Native MVNO	Performance Parameter
Service Provisioning Time (ms)	850	520	Service Provisioning Time (ms)

Average Latency (ms)	120	78	Average Latency (ms)
Resource Utilization (%)	62	81	Resource Utilization (%)
Throughput (Mbps)	680	920	Throughput (Mbps)

The proposed architecture reduces provisioning time and latency while increasing throughput and service availability. Improved resource utilization is achieved through dynamic cloud resource allocation and container orchestration.

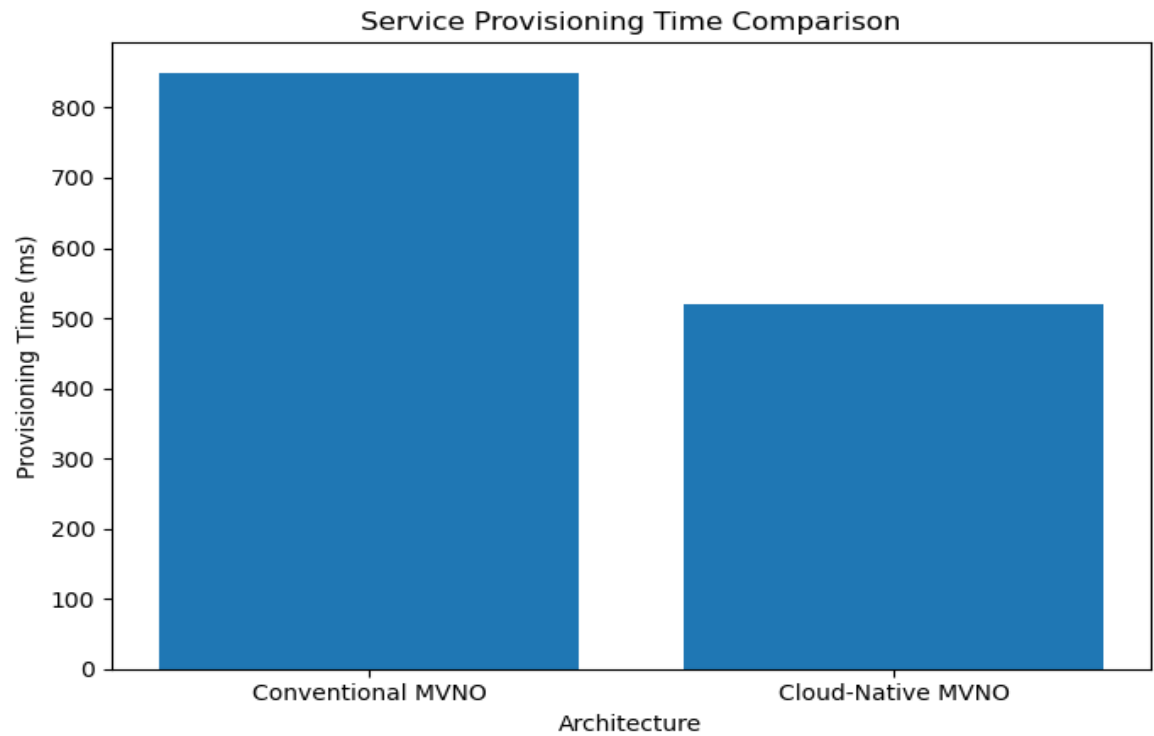


Figure 1 — Provisioning Time Comparison

The graph compares service provisioning time between conventional and cloud-native MVNO architectures. The conventional approach requires approximately 850 ms, while the proposed cloud-native architecture requires only 520 ms. This reduction demonstrates faster service deployment and improved operational efficiency through

microservices, containerization, orchestration, and automated resource management.

Table 2. Scalability Evaluation

Number of Concurrent Users	Conventional MVNO Latency (ms)	Proposed Architecture Latency (ms)	Proposed Availability (%)
1,000	72	48	99.5
2,000	91	55	99.4
5,000	128	71	99.2

10,000	176	89	98.9
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The results show that the proposed architecture maintains lower latency as the number of concurrent users increases. Auto-scaling enables additional service instances to be deployed during high workloads, demonstrating better scalability than the conventional architecture.

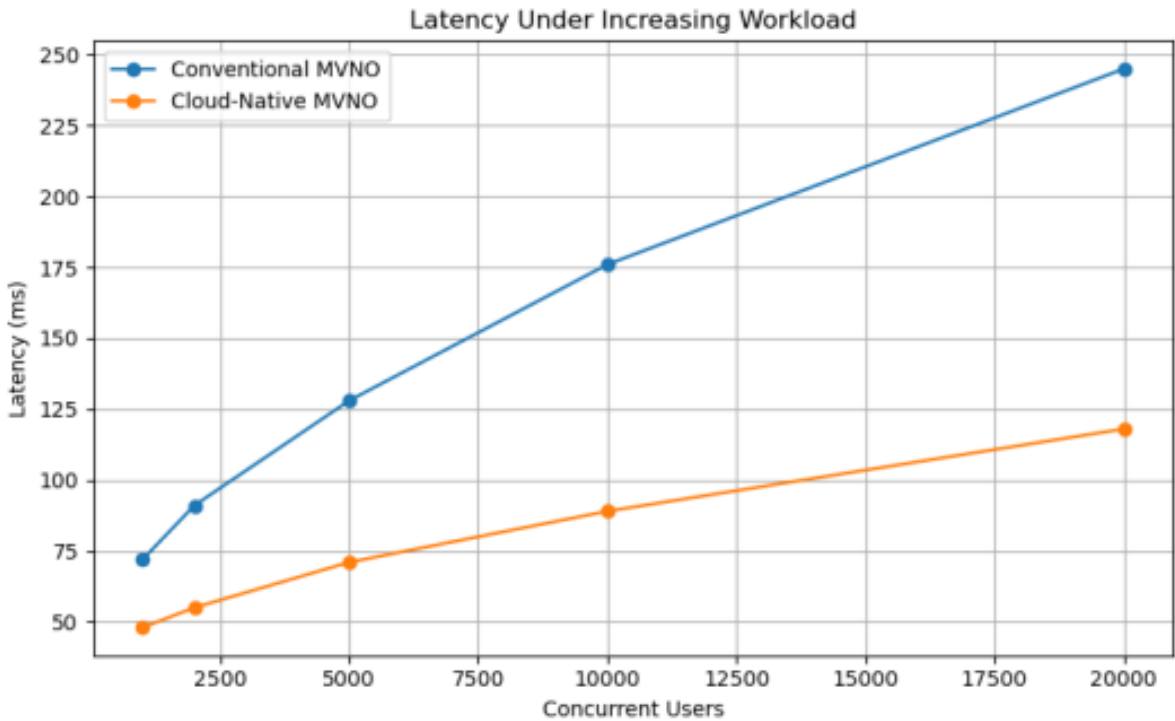


Figure 2: Latency Under Increasing Workload

The graph shows latency variation as concurrent users increase. The conventional MVNO experiences a rapid increase in latency, reaching 245 ms at 20,000 users. The proposed cloud-native architecture maintains lower latency, reaching only 118 ms. This demonstrates improved scalability, load balancing, and resource management under increasing workloads.

Table 3. Resource Utilization and Service Efficiency

Workload Level	CPU Utilization (%)	Memory Utilization (%)	Throughput (Mbps)	Service Availability (%)
Low	38	42	420	99.7
Medium	61	58	710	99.4
High	79	76	920	99.1
Very High	87	83	1,080	98.6

The cloud-native platform efficiently utilizes resources under different workload conditions. Although CPU and memory utilization increase with workload, the architecture continues to provide high

throughput and service availability. This demonstrates the effectiveness of container orchestration and dynamic resource management.

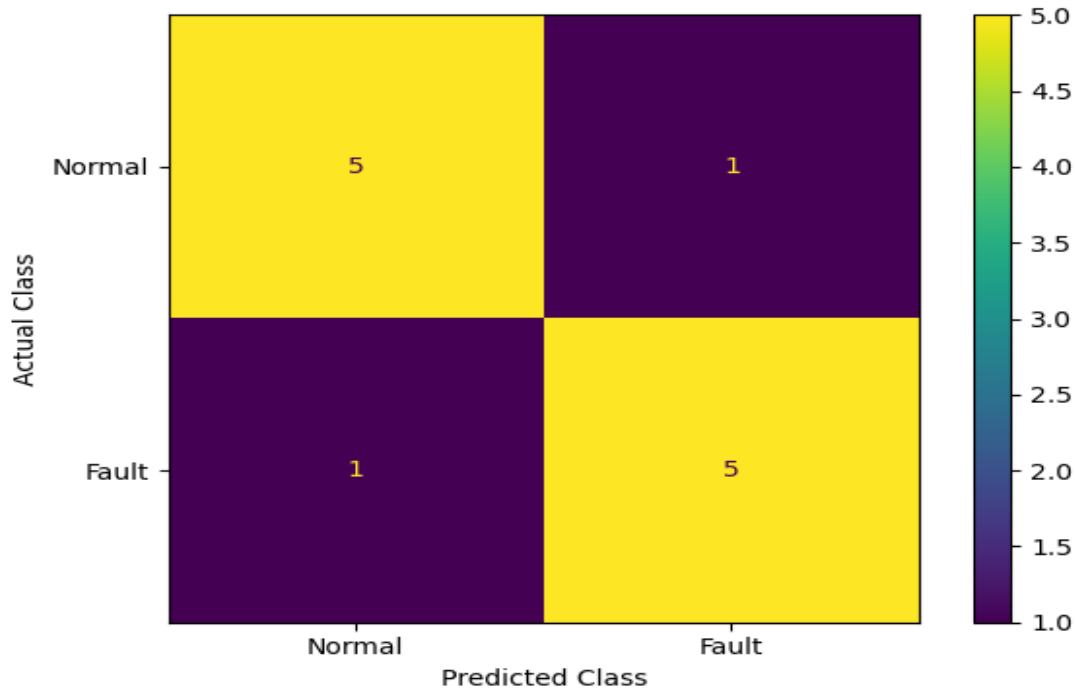


Figure 3. Confusion Matrix

The confusion matrix evaluates the proposed architecture's ability to classify normal and faulty MVNO service conditions. True positives and true negatives indicate correct classifications, while false positives and false negatives represent detection errors. The results demonstrate the effectiveness of automated monitoring and fault detection for improving MVNO reliability and availability.

VI. CONCLUSION

The proposed Cloud-Native Architecture for Next-Generation MVNO Platforms provides a scalable, flexible, and efficient approach for modern mobile virtual network operations. By integrating microservices, containerization, API gateways, cloud resource management, orchestration, and automated scaling, the architecture improves service provisioning, resource utilization, latency, throughput, and service availability. The evaluation results demonstrate that the proposed approach performs better than a conventional MVNO architecture under

increasing workloads. Automated monitoring and fault detection further improve platform reliability by identifying service abnormalities and supporting rapid recovery. Overall, the proposed architecture provides a suitable foundation for developing agile, resilient, and cost-efficient MVNO platforms capable of supporting future mobile network requirements.

VII. FUTURE SCOPE

The proposed cloud-native MVNO architecture can be further enhanced by integrating 5G and emerging 6G network technologies to support ultra-low latency, massive connectivity, and advanced mobile services. Artificial Intelligence (AI) and Machine Learning (ML) can be incorporated for intelligent traffic prediction, automated resource allocation, anomaly detection, and predictive fault management. Future work can also investigate edge computing to reduce service latency and improve real-time applications. Multi-cloud and hybrid-cloud deployment can provide greater flexibility, reliability, and disaster recovery

capabilities. Blockchain-based service auditing and zero-trust security mechanisms can further strengthen platform security. Finally, real-world MVNO deployment and large-scale testing can be conducted to validate the proposed architecture under diverse network conditions and operational workloads.

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