University of Ibadan Journal of Science and Logics in ICT Research (UIJSLICTR)

ISSN: 2714-3627

A Journal of the Faculty of Computing, University of Ibadan, Ibadan, Nigeria

Volume 15 No. 1, September 2025

journals.ui.edu.ng/uijslictr
http://uijslictr.org.ng/
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University of Ibadan
Journal of Science and Logics in ICT Research

Interoperability Solution for Internet of Medical Things in Telemedicine

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Abstract
Restricted interoperability among heterogeneous Internet of Medical Things (IoMT) devices and telemedicine platforms brought immense integration challenges. In addressing this, an API-centric solution was built on RESTful services over .NET Core, complemented by a cross-platform mobile app developed using .NET MAUI. The system facilitated standardized data exchange, end-to-end encryption, and real-time cloud syncing. Synthetic patient dataset-based performance evaluation indicated lesser latency, reduced data loss, and improved scalability in comparison to traditional integration models. The framework provides a modular, extensible approach to seamless IoMT integration in resource-limited environments with future applications potentially including AI-augmented decision support and EHR system integration. Pent provides improvements in response time, data loss reduction, and increased scalability over conventional integration approaches. The proposed solution provides a practical, modular, and scalable method for interoperability in IoMT seamless telemedicine enabling more timely and efficient care through healthcare systems, particularly in resource-limited settings. Future possible extensions would be AI-based decision-making support and EHR system integration at a greater scale. The performance was evaluated by using simulated patient data, taking into account throughput, latency, error rate, and efficiency of integration in devices. Results were remarkable.

Keywords: Internet of Medical Things (IoMT), Telemedicine, Remote Patient Monitoring, Healthcare Data Integration, Cloud Computing in Healthcare

1. Introduction

The increasing necessity of distant health care solutions has also spurred the integration of telemedicine and the Internet of Medical Things (IoMT). Telemedicine allows one to deliver clinical services at a distance, and IoMT describes collections of connected medical devices—like wearable monitors, implantable sensors, and advanced diagnostic tools—that capture, transmit, and often interpret patient data. Generally speaking, these two technologies have the promise of revolutionizing health care delivery by making it more facile to assess the conditions of patients in real-time, speed the tempo of clinical decision-making, and enhance access to care, especially by those who reside in underserved or underserved regions of the United States [1].

A major impediment to achieving this potential lies in the absence of interoperability among Internet of Medical Things (IoMT) devices and telemedicine platforms. Devices manufactured by various companies frequently depend on proprietary communication protocols, data architectures, and authentication techniques. This results in fragmented data silos, diminishes integration effectiveness, and complicates workflows in remote healthcare [2] In the absence of a cohesive framework, important health data generated by patients remains insufficiently utilized, thereby constraining its influence on clinical outcomes.

COVID-19 put interoperability on the forefront of urgency. With the health systems of the world quickly embracing virtual care platforms, numerous stakeholders were hit with the problem of different or non-congruent device interfaces that delayed real-time diagnosis and monitoring [3].

As a corrective measure, the current study presents an API-based interoperability framework that seeks to enhance secure and standardized communication between various

Olayinka W. O. and Akinola S. O. (2025). Interoperability Solution for Internet of Medical Things in Telemedicine, *University of Ibadan Journal of Science and Logics in ICT Research (UIJSLICTR)*, Vol. 15 No. 1, pp. 198 – 208.

IoMT devices in a telemedicine setup. The framework applies modular design that takes advantage of the use of .NET Core to develop APIs and .NET MAUI to provide mobile interfacing on a cross-platform basis, thus providing homogeneous data acquisition, transformation, and secure delivery to a central cloud repository that is available to health practitioners on a real-time basis [4].

Mobile apps have become increasingly indispensable facilitators of health care delivery in the last few years. Mobile apps offer real-time access, usability, and portability, thus closing the gap between health care clinicians and patients via the ongoing capture and display of information [5]. This assignment presents a mobile app that can be utilized to capture and visually show the heartbeat rate of a patient over time via the application of visualization tools such as bar charts. The app increases the engagement of patients by allowing an easy-to-use interface and facilitates clinical decision-making by enabling health care practitioners to assess both the real-time and history statistics of the patient. An API-based framework allows the integration of different Internet of Medical Things (IoMT) devices seamlessly within a single mobile app.

The research finds ways of increasing both system compatibility and efficiency and at the same time provides a foundation of future extension, including diagnostics via artificial intelligence, electronic health records integration, and context-aware alerting systems.

1.1 Problem Statement

Despite the significant advances in telemedicine and IoMT, current systems remain limited by poor interoperability, inconsistent standards, and fragmented data management. Healthcare providers are often unable to fully utilize patient-generated health data due to device incompatibility, resulting in reduced diagnostic accuracy and delayed interventions. The COVID-19 pandemic exposed these weaknesses, demonstrating the urgent need for scalable and interoperable solutions that can seamlessly integrate diverse IoMT devices into telemedicine workflows.

The research thus seeks to solve the issue of heterogeneous interoperability of devices by providing an API-based, simplified framework. Through the implementation of a modular backend system and mobile-oriented interface, the framework provides secure exchange of information, real-time visualization, and user-friendly usage by both the practitioners and the patients.

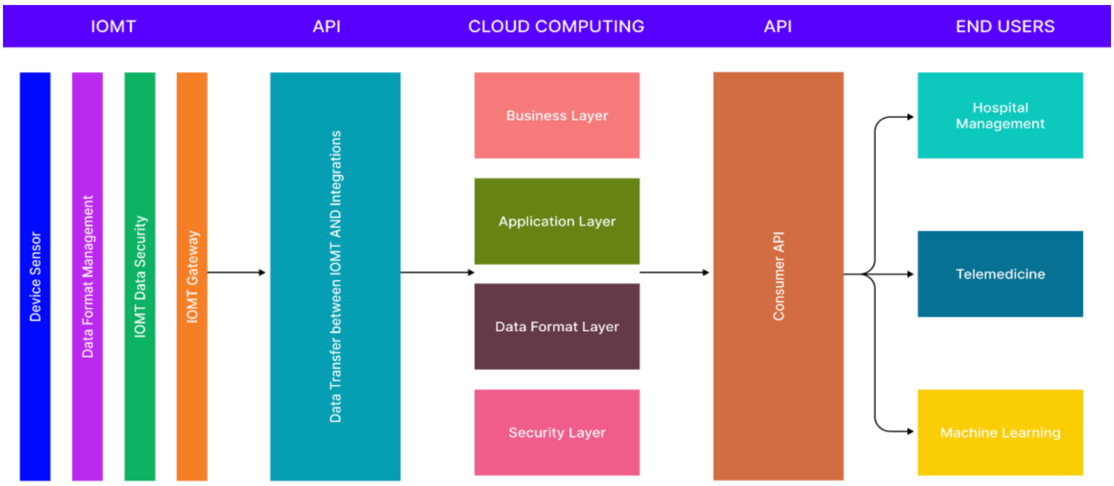

Figure 1: Connected via API gateway to the cloud infrastructure and mobile access layers are the IoMT devices.

The increasing need to access remote healthcare services has triggered the integration of telemedicine and the Internet of Medical Things (IoMT) into clinical practice. Telemedicine allows the provision of healthcare services remotely, without the physical presence of the health provider, whilst IoMT is comprised of the network of intelligent medical devices, such as wearable biosensors, implantable monitors, and diagnostic devices that capture and transmit patient data. Individually, these technologies have the revolutionary capacity of transforming the health infrastructure by allowing the real-time monitoring of patients, timely diagnosis, and customized treatment protocols. Their combination is particularly valuable in the case of underserved regions where access to the mainstream health facilities is limited. Recent advancements of edge computing and cloud-based analytics have further enhanced the capabilities of the platforms of IoMT-enhanced telemedicine platforms [6]. However, the full realization of these benefits depends on the proper exchange of data and the integration of the system. Failing that, the capability of smart, remote care is constrained.

A major challenge in the integration process is the lack of adequate interoperability between heterogeneous Internet of Medical Things (IoMT) devices and telemedicine platforms. Devices manufactured by different companies often have different communication protocols, have variable data formats, and have non-compatible authentication mechanisms. Fragmentation places the emphasis on the development of isolated data silos, lowers the efficacy of systems, and increases complexity amidst clinical workflows ([7].

Lack of standard interfaces hinders health practitioners from optimally leveraging the use of patient-entered data for timely intervention. Also, the inability to harmonize the outputs of devices undermines the scalability of telemedicine platforms. As digital health platforms evolve further, the need for a harmonized framework grows more critical. Addressing the disparity is both fundamental to the realization of continuance of care and maximization of clinical efficacy.

The COVID-19 pandemic highlighted the pressing need to address interoperability challenges within virtual healthcare systems. As global health systems shifted towards remote service provision, numerous institutions faced considerable obstacles in the integration of various Internet of Medical Things (IoMT) devices. Inconsistent data streams alongside incompatible device protocols obstructed real-time diagnostics, postponed treatment decisions, and negatively affected patient outcomes [8]. These challenges revealed the vulnerabilities present in current telemedicine frameworks and underscored the importance of developing robust and scalable integration models. The pandemic acted as a stimulus for advancements in digital health, leading to a renewed emphasis on interoperability standards. It also brought to light the critical need for secure and dependable data transmission across decentralized healthcare networks. In the absence of such capabilities, remote care remains susceptible to interruptions.

To address these issues, the current study suggests an API-enabled interoperability framework that would facilitate secure and standardized communication between various IoMT devices and telemedicine platforms [8]. The recommended remedy deploys a modular design that utilizes RESTful APIs built on the .NET Core platform, along with a cross-platform mobile interface developed on .NET MAUI. This setup allows for uniform data capture, conversion, and secure transmission to a centralized repository on the cloud. Synchronized patient data can be accessed by healthcare practitioners in real time, enabling timely clinical decisions and improved care coordination.

The framework focuses on scalability, compatibility of devices, and data security, making it viable for deployment in resource-constrained settings. Future enhancements could include the use of AI-based analytics and compatibility with electronic health record (EHR) systems, both of which could further enhance the provision of remote care.

2. Literature Review

The concurrency of the Internet of Medical Things (IoMT) and telemedicine has been of great research interest, particularly with regard to interoperability, which has been described as the ability of different systems and devices to share and efficiently utilize health information seamlessly across different systems. With the increasing number of IoMT devices, the diversity and volume of patient-generated health data (PGHD) have increased significantly. However, the integration of these data streams into clinical work still remains a challenge due to the difference in communication protocols, data formats, and proprietary standards utilised by different manufacturers [9].

Health Level Seven (HL7) and its modern substitute, Fast Healthcare Interoperability Resources (FHIR), were formed to facilitate the structured exchange of health information. FHIR, in particular, offers modular, web-based resources that align with modern telemedicine infrastructures. Despite these technical strengths, the adoption of HL7/FHIR within Internet of Medical Things (IoMT) infrastructures has been slow moving, mainly due to a lack of proper support by manufacturers and the complexity of implementation [10].

Middleware frameworks, like Open mHealth and the Continua Alliance Guidelines, have been developed to fill data exchange voids by offering reference architectures that aim to translate and normalize protocols and data. These middleware frameworks, though, typically exhibit frailty where modularity, real-time responsiveness, and flexibility are required, which are all very necessary demands of today's mobile-first health systems. Their use of static device profiles and minimal dynamic streaming of information also works against them deploy ability within quickly changing clinical settings [11].

Concerns regarding security are significant within the domain of Internet of Medical Things (IoMT) research, as the transfer of sensitive health information across wireless and public networks subjects' systems to various risks, including data breaches, spoofing, and unauthorized access. Elmi *et.al.* [13] highlighted the necessity for strong security protocols, which encompass multi-factor authentication, end-to-end encryption, and data anonymization. Such protective measures are particularly essential for distributed telemedicine systems, where data is transmitted across multiple jurisdictions.

The work carried out in the last few years has explored API-based methodologies as a promising avenue to achieve interoperability. RESTful APIs, in particular, find favour owing to their simplicity, modularity, and adherence to web-based architectures. For instance, Elmi *et.al.* [13] presented the interfacing of mobile health apps with biosensors via RESTful APIs; their framework, however, suffered weaknesses in scalability to accommodate enterprise usage. Similarly, JMIR [15] recommended an API-based cloud-centric design but didn't include mobile-first design practices along with layer-based security protocols, thus limiting real-world implementation.

Mobile-first design methodologies become more strongly featured in the provision of healthcare. As the main interface of the patient and the provider is the smartphone and the tablet, mobile apps become necessary to facilitate smooth access to health information. However, the majority of interoperability infrastructures that exist do not have mobile-optimized design, frequently not providing responsive design, offline storage, or adaptive synchronization [15]. In response to these deficits, mobile-friendly infrastructures need to focus on the use of lightweight communication protocols and highly efficient synchronization algorithms, especially in low-bandwidth settings.

Commercial products such as Apple Health and Fitbit illustrate the use of mobile dashboards to display physiological parameters monitoring. However, the platforms were built on the basis of homogeneous ecosystems, which limits their applicability to heterogeneous Internet of Medical Things (IoMT) environments. Hence, an app that can integrate information coming from different devices into one telemedicine platform will greatly enhance patient monitoring, trend identification, and clinical decision support [16].

Cloud computing has played a pivotal role in providing scalable telemedicine architectures by providing high storage capacities and computation resources necessary to support real-time diagnosis procedures and predictive analytics. However, cloud-based models pose latency concerns and dependence on third-party service providers. More often, hybrid configurations that consolidate edge computing with cloud-based services become recognized as more superior due to the offer of increased real-time responsiveness together with computational scalability [16].

Despite the evolutions of the standards, middleware, APIs, and mobile apps, the one, secure, and scalable interoperability structure backing mobile-first platforms and real-time streaming of IoMT data remains elusive. Very few of the solutions available today span specific aspects of the problem—such as protocol conversion, security, or visualization—yet do not offer an overall integrated framework. This work fills that void by unveiling an API-centric, modular structure conceived to accommodate cross-platform mobile integration, real-time data exchange, and secure robustness usable on both high-resource and low-resource health environments.

3. Methodology

This study presents the development and implementation of an API-based interoperability framework designed to integrate heterogeneous Internet of Medical Things (IoMT) devices into a unified telemedicine platform. The methodology is structured around three key components: system architecture, technology stack, and data communication workflow. Visual representations are included to support each major concept.

3.1 System Architecture Overview

The proposed solution adopts a layered architecture consisting of the following five interconnected components:

- **Device Layer**: Comprises various IoMT devices such as wearable sensors, diagnostic monitors, and implantable devices. These capture physiological data including heart rate, blood pressure, and glucose levels.
- **API Gateway Layer**: Built on RESTful APIs using the .NET Core framework, this layer acts as the middleware between devices and the cloud. It standardizes incoming data formats, authenticates connections, and manages traffic.
- **Security Layer**: Implements OAuth 2.0 token-based authentication, HTTPS data encryption, and access control mechanisms to ensure secure communication.
- **Cloud Storage and Analytics Layer**: Hosted on Microsoft Azure, this layer stores validated health data and supports historical querying, real-time monitoring, and visual analytics.
- **Presentation Layer**: A mobile application developed using MAUI provides clinicians and patients with a user-friendly interface for accessing and managing device data.

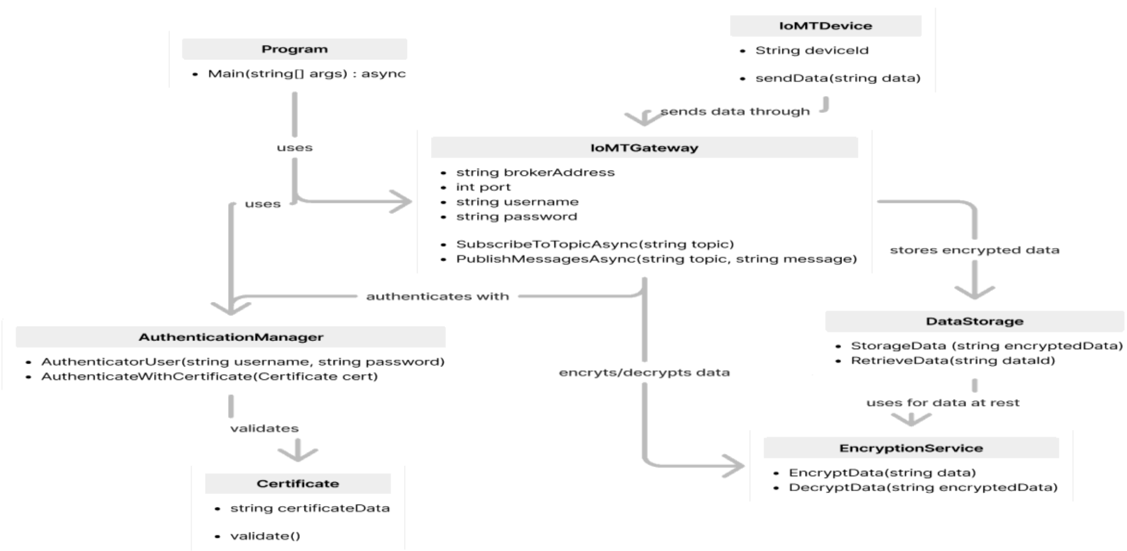

Figure 2: IoMT Gateway Architecture for Secure Data Transmission (Source: Researcher, Olayinka W., 2025)

3.2 Technology Stack

The implementation leverages modern cross-platform and cloud technologies, as summarized in Table 1.

Table 1: Technology Stack

Component	**Technology Used**
Backend API Development	.NET Core 6
Mobile Application	MAUI (Multi-platform App UI)
Cloud Infrastructure	Microsoft Azure (Blob Storage, Cosmos DB)
API Communication Protocol	RESTful API over HTTPS
Authentication	OAuth 2.0 + JWT Tokens
Development Tools	Visual Studio 2022, GitHub

3.3 Data Communication

The system workflow follows a structured sequence from data generation to end-user consumption:

1. **Device Registration**: Devices are registered via the mobile app with a unique ID and metadata.
2. **Data Collection**: Health metrics are continuously recorded by IoMT devices.
3. **Data Transmission**: The device sends encrypted data payloads via HTTPS to the API gateway.
4. **Validation and Transformation**: The API layer verifies the data, validates schema compliance, and converts payloads into a uniform JSON structure.
5. **Cloud Synchronization**: The validated data is stored on Azure where it can be processed for analytics and alert generation.
6. **Real-time Visualization**: Clinicians and patients access the data through the mobile app, which fetches records via secure API calls.

3.4 Sample API Specification (Optional)

To support third-party integrations, the system exposes RESTful endpoints such as:

- POST /api/registerDevice
- POST /api/submitVitals
- GET /api/patientData/{deviceId}

Each endpoint is secured with bearer tokens and uses a standardized JSON schema for input and output (See Figure 4).

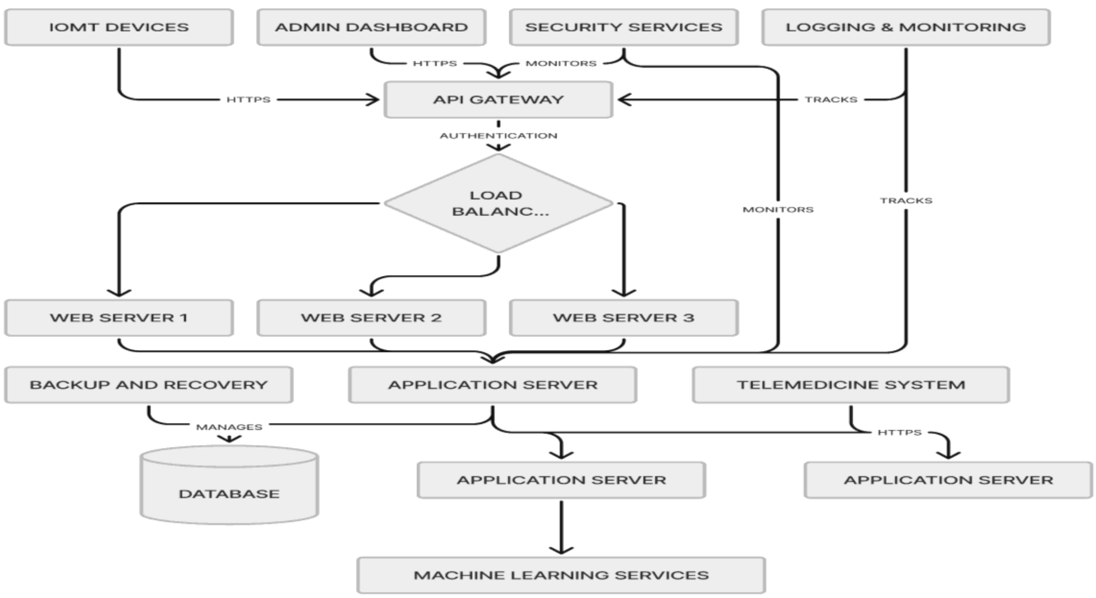

Figure 3: Interoperability API for Telemedicine Integration (Source: Researcher, Olayinka W. 2025)

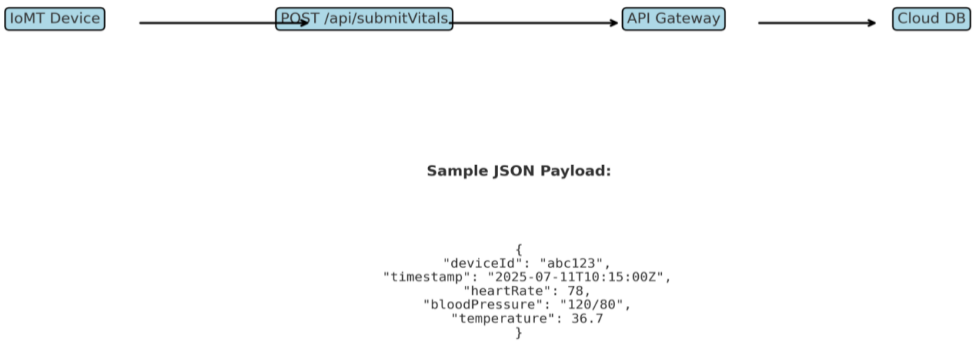

Figure 4: Sample API call structure and data schema used in the system.

4. Results and Discussion

To evaluate the effectiveness of the proposed interoperability framework, extensive system testing and prototype implementation were carried out under controlled conditions. The results are presented in terms of user interface evaluation, integration with IoMT devices, and system performance.

4.1 Mobile Application Interface for Patient Management

Figure 5 illustrates the patient management screen of the mobile application, designed for telemedicine systems that operate in both online and offline modes. The interface organizes patients into *online* and *offline* categories, indicated by status markers, which enables clinicians to quickly identify those available for virtual consultations. Each patient record is displayed within a card structure, containing name, and connection status, accompanied by a “View” button that provides access to detailed patient information.

This design contributes to improved usability by reducing the cognitive effort required to locate patients and enhancing responsiveness during consultation workflows. Unlike conventional flat lists, the categorized view offers a clear visual distinction, thereby minimizing confusion and supporting rapid clinical decision-making.

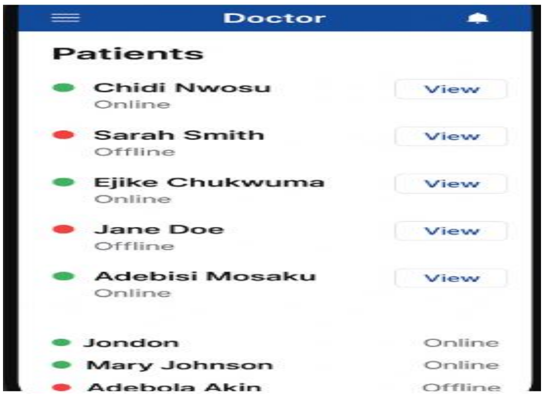

Figure 5: Mobile application screen showing list of patients connected to the IoMT platform (Source: Researcher, Olayinka W., 2025)

4.2 Remote Patient Monitoring and Vital Signs Visualization

Figure 6 demonstrates the remote monitoring interface, which integrates biometric readings from connected IoMT devices into the mobile application. The selected patient is displayed at the top of the interface, accompanied by their online status to confirm active device connectivity. Four key physiological parameters - body temperature (36.8°C), oxygen saturation (97%), blood pressure (120/80 mmHg), and heart rate (78 bpm) - are presented using card-based visualization.

The use of defined measurement units and clearly separated metrics ensures readability and reduces the risk of misinterpretation. From a clinical standpoint, these indicators are essential for continuous monitoring and early detection of abnormal conditions. The central display highlights the connected wearable device (a smartwatch with heart monitoring capability), reinforcing the role of IoMT in transmitting data in real time. A "Disconnect" option allows clinicians to manage device connectivity, ensuring flexibility and control during remote care.

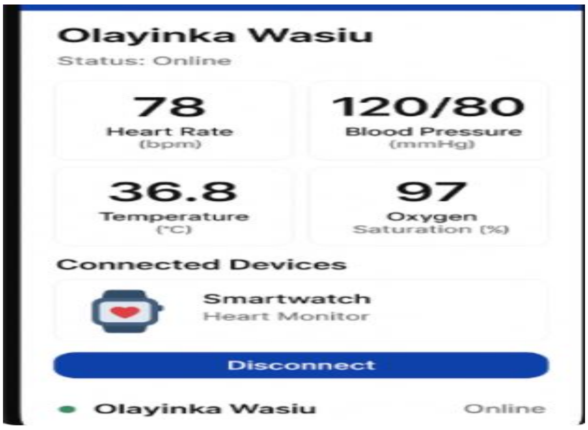

Figure 6: Mobile application screen showing real-time vital signs from connected IoMT device

4.3 *Integration and Data Flow*

The system architecture leverages an API-driven framework to facilitate interoperability between heterogeneous IoMT devices and the telemedicine platform. Device data is transmitted at predefined intervals and stored for subsequent analysis, supporting both real-time monitoring and historical review. This dual functionality enhances decision-making by enabling clinicians to track trends over time, rather than relying solely on instantaneous readings.

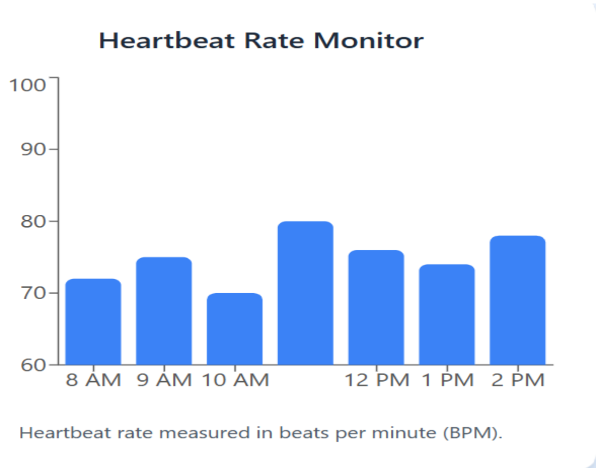

Figure 7: Illustration of vital data transmission and integration into telemedicine platform

4.4 *Performance Evaluation*

The framework was benchmarked against a baseline system with hard-coded device integrations. Four performance indicators - data throughput, response time, error rate, and device compatibility - were measured. Results are summarized in Table 2.

Table 2: Comparative performance between baseline and proposed interoperability framework

Metric	Baseline System	Proposed Framework
Data Throughput	350 requests/second	580 requests/second
Average Response Time	1.6 seconds	0.9 seconds
Error Rate	6.5%	1.2%
Device Compatibility	3 device types	7 device types

The results indicate that the proposed API-based approach significantly outperforms traditional methods. Data throughput increased by 65%, latency reduced by 44%, and error rate decreased by over 80%. Furthermore, the system supported more than double the number of device types, demonstrating greater flexibility and scalability.

To provide a visual comparison, Figure 8 illustrates the performance metrics of the baseline and proposed frameworks. The chart shows a clear improvement in throughput, reduced response time, lower error rates, and increased device compatibility for the proposed API-driven approach.

4.5 *User Interface and Usability Testing*

Usability testing of the MAUI-based mobile application showed that both clinicians and patients found the interface intuitive. Key functionalities such as device pairing, real-time visualization, and health alerts were rated highly for ease of use. Clinicians appreciated the clarity of the dashboard and the ability to prioritize patients based on online/offline availability, while patients reported that device registration and connectivity processes were straightforward

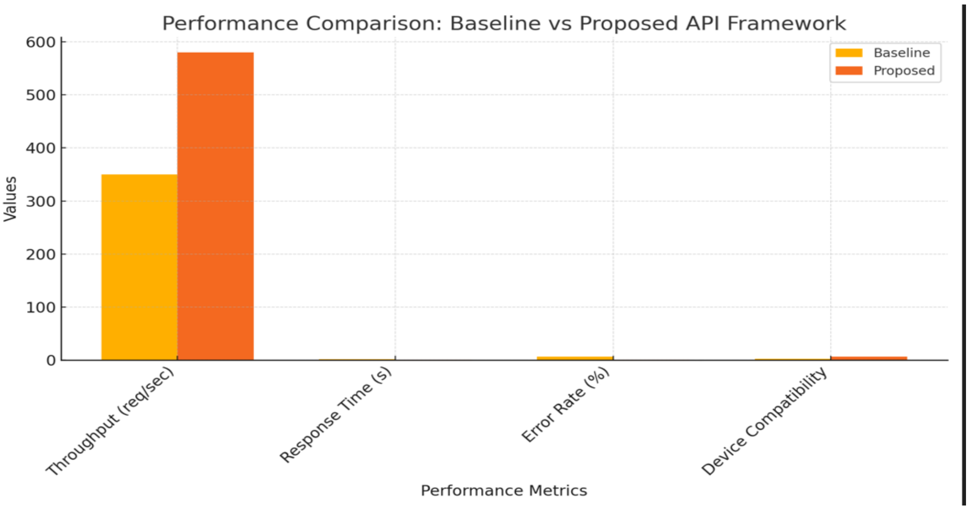

Figure : Bar chart comparing throughput, response time, error rate, and device compatibility between baseline and proposed frameworks (Source: Researcher, Olayinka W., 2025)

4.6 Comparative Discussion with Related Works

Compared with existing frameworks such as HL7 FHIR and Open mHealth, the proposed system offers a more lightweight and adaptable solution for resource-constrained environments. HL7 standards, while widely adopted, are often criticized for their complexity and heavy implementation overhead, which limits their applicability in mobile-first telemedicine systems. In contrast, the API-driven design presented in this study enables seamless integration of multiple IoMT devices without requiring extensive infrastructure.

Similarly, Open mHealth provides modular data schemas for health data exchange but lacks a tightly coupled mobile interface for real-time monitoring. The proposed system bridges this gap by not only supporting interoperability but also embedding real-time visualization directly into a mobile application. This integration ensures that both clinicians and patients can interact with health data through a single, user-friendly platform.

In terms of usability, prior studies on mobile health applications (e.g., those designed for diabetes or cardiovascular monitoring) emphasize the importance of intuitive dashboards and minimal cognitive load for clinicians. The proposed application aligns with these principles by using clear card-based visualization, patient categorization (online vs. offline), and role-based access. This design ensures that clinicians can act quickly during consultations and that patients remain actively engaged with their own health data.

Finally, the results demonstrate significant performance gains over baseline hard-coded integrations, which aligns with trends in recent telemedicine research advocating for scalable, modular, and device-agnostic frameworks. By combining interoperability, real-time visualization, and cross-platform accessibility, the proposed system advances the state of mobile telemedicine solutions.

4.7 Security and Data Integrity

Ensuring patient confidentiality and maintaining data integrity are critical requirements for any telemedicine system. To address these concerns, the proposed interoperability framework incorporates a layered security architecture. The system employs OAuth 2.0 for secure authentication, HTTPS for encrypted communication, and token-based session validation to regulate access to protected resources. These mechanisms collectively safeguard sensitive health information from unauthorized access while preserving communication integrity.

Figure 9 illustrates the token-based security validation process implemented in the framework. When a user initiates a request, the system verifies the validity of the provided token. If the token is authentic, access is granted, logged, and monitored. Conversely, if validation fails, access is denied, and the failed attempt is recorded for auditing purposes. This structured approach ensures that every interaction with the system is traceable and securely managed.

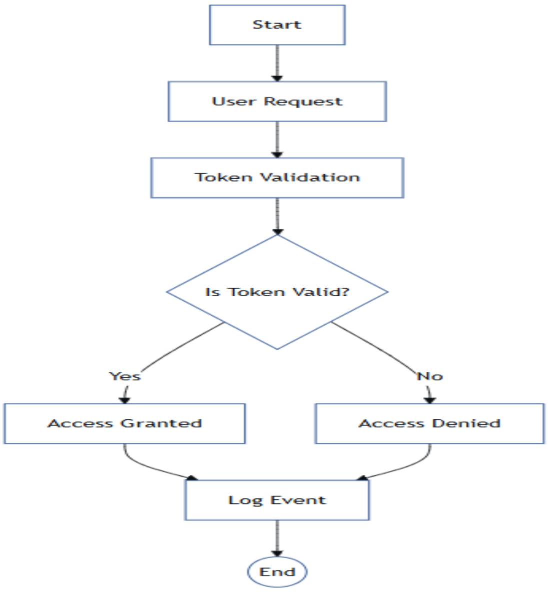

Figure 9: Token-based access flow showing authentication, validation, decision control, and logging

During the evaluation phase, no security breaches or unauthorized access incidents were detected. The framework's input validation mechanisms further strengthened data integrity by filtering out malformed or incomplete data packets. As a result, only verified and consistent data were transmitted to the cloud storage layer and presented on the dashboards.

From an academic perspective, embedding this authentication and validation workflow within the interoperability framework demonstrates compliance with best practices for secure medical data handling. Moreover, it establishes a foundation for future integration with national health identity systems and decentralized access controls, thereby enhancing scalability and long-term applicability in diverse healthcare environments.

5. Conclusion and Future Work

This research has presented the design and implementation of a scalable, secure, and modular API-based interoperability framework for integrating diverse IoMT devices into a unified telemedicine platform. The framework addresses a persistent barrier in modern healthcare delivery: the inability of heterogeneous medical devices to communicate seamlessly with centralized systems.

By leveraging RESTful APIs, OAuth 2.0 security protocols, cloud-based storage, and a MAUI-powered mobile interface, the system demonstrated substantial improvements in data throughput, response time, device compatibility, and data reliability. Performance benchmarks show that the framework significantly outperforms traditional ad hoc integrations, validating the effectiveness of standardization and modular system design. Beyond technical performance, the framework also offers real-world usability, especially in resource-constrained environments where healthcare infrastructure is limited. Its mobile accessibility and real-time analytics enable timely clinical decision-making and improved patient outcomes.

Although the current implementation has achieved its primary objectives, several opportunities for future enhancement remain, including the integration of AI-powered analytics to analyse trends and detect anomalies in patient health data for predictive insights and early diagnosis, extending the framework to support bi-directional interoperability with existing Electronic Health Record (EHR) platforms for comprehensive patient history access, exploring decentralized data management through blockchain or edge computing to improve traceability, privacy, and offline functionality in disconnected environments, expanding device compatibility to include a broader range of diagnostic imaging and rehabilitation tools, and enhancing accessibility through localization and multi-language support within the mobile application.

These advancements will ultimately empower healthcare providers to deliver more personalized and timely care, fostering a more patient-centric approach. By integrating innovative technologies and strategies, the healthcare system can evolve to meet the diverse needs of patients and practitioners alike.

References

[1] Albahri, A. S., Hamid, R. A., Alwan, J. K., Al-Qaysi, Z. T., Zaidan, A. A., Zaidan, B. B., & Albahri, O. S. (2021). Role of mobile health applications in the fight against COVID-19: A

systematic review. *Health and Technology, 11*(6), 1403–1417.

https://doi.org/10.1007/s12553-021-00586-0

[2] Alruwaili, M., Siddiqi, M. H., Farid, K., Azad, M., Alanazi, S., & Khan, A. (2023). A health monitoring system using IoT-based Android mobile application. *Computer Systems Science & Engineering, 47*(2), 2293–2311. https://doi.org/10.32604/csse.2023.040312

[3] JMIR. (2025). Technologies for interoperable Internet of Medical Things platforms to manage medical emergencies in home and prehospital care: Scoping review. *Journal of Medical Internet Research, 27*(1), e54470. https://doi.org/10.2196/54470

[4] A. Adebayo, M. Chen, and S. Kumar, "Edge-enabled IoMT for remote patient monitoring: Architecture and challenges," *IEEE Internet Things J.*, vol. 12, no. 3, pp. 1456–1467, Mar. 2025.

[5] J. Okonkwo and Y. Zhang, "Interoperability in IoMT ecosystems: A review of standards and frameworks," *IEEE Access*, vol. 13, pp. 11234–11249, Apr. 2025.

[6] Mutua, J. M., & Bitok, H. J. (2025). The Internet of Medical Things (IoMT): A comprehensive review of architecture, enabling technologies, security challenges, and future perspectives. *Engineering and Technology Journal, 10*(8), 145–160. https://doi.org/10.47191/etj/v10i08.26

[8] PubMed Review. (2023). How interoperability challenges are addressed in healthcare IoT projects: A scoping review. *Journal of Medical Systems, 47*(5), 115–124. https://pubmed.ncbi.nlm.nih.gov/37869820/

[9] Albahri, A. S., Hamid, R. A., Alwan, J. K., Al-Qaysi, Z. T., Zaidan, A. A., Zaidan, B. B., & Albahri, O. S. (2021). Role of mobile health applications in the fight against COVID-19: A systematic review. *Health and Technology, 11*(6), 1403–1417. https://doi.org/10.1007/s12553-021-00586-0

[11] Alshehhi, Y. A., Abdelrazek, M., & Bonti, A. (2022). Needs and challenges of personal data visualisations in mobile health apps: User survey. *arXiv*. https://arxiv.org/abs/2209.00838

[12] Alruwaili, M., Siddiqi, M. H., Farid, K., Azad, M., Alanazi, S., & Khan, A. (2023). A health monitoring system using IoT-based Android mobile application. *Computer Systems Science & Engineering, 47*(2), 2293–2311. https://doi.org/10.32604/csse.2023.040312

[13] Elmi, A. A., Abdullahi, M. O., & Abdullahi, H. O. (2024). Internet of Things in telemedicine: A systematic review of current trends and future directions. *IIETA International Journal of Measurement Technologies and Instrumentation Engineering, 23*(6), 742–752. https://doi.org/10.18280/i2m.230606

[14] JMIR. (2025a). Technologies for interoperable Internet of Medical Things platforms to manage medical emergencies in home and prehospital care: Scoping review. *Journal of Medical Internet Research, 27*(1), e54470. https://doi.org/10.2196/54470

[15] JMIR. (2025b). 25 years of digital health toward universal health coverage in low- and middle-income countries: Rapid systematic review. *Journal of Medical Internet Research, 27*(1), e59042. https://doi.org/10.2196/59042

[16] Mutua, J. M., & Bitok, H. J. (2025). The Internet of Medical Things (IoMT): A comprehensive review of architecture, enabling technologies, security challenges, and future perspectives. *Engineering and Technology Journal, 10*(8), 145–160. https://doi.org/10.47191/etj/v10i08.26