IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 5, May 2024

DOI: 10.17148/IJARCCE.2024.13523

Microservices Approach for Cloud-Based Healthcare Solutions

Rafiya Sultana[1], Saba Parveen S[2], Sinchana K[3], V Shelly Poojita[4], Prof. Vinutha Prashanth[5]

Department of Computer Science and Engineering, Rao Bahadur Y Mahabaleshwarappa Engineering College,

Ballari-583103- Affiliated to VTU Belagavi[1-5]

Abstract: E-Healthcare systems have recently developed a considerable attention for service providers of health care and their consumers. They are classified into different categories such as electronic healthcare records, and personal records. The healthcare records focus especially on information storage and exchange of information. Users of healthcare applications are facilitated by the Access to health information systems, such as electronic records, patient test reports, personal health record banks, real-time data from wearable sensors, monitoring devices, and Internet of things (IoT) systems. The usage of healthcare systems has increased greatly due to belief of patients in health data. The healthcare applications offer a complex set of services to many stakeholders like patients, doctors, nurses etc. Each stakeholder has his own objectives. Thus, the context, and domain of the healthcare application become overwhelming. This leads to more complexity in terms of development. Compared to the conventional creation of non-healthcare applications, developing healthcare applications as monolithic systems based on SOA is more complex, time-consuming, difficult to plan and administer, and expensive in terms of development and maintenance. The service of technical and specialized approaches in architecture style, data processing, database storage formats, and technology are reasons for interoperability issues in healthcare applications. This project develops a framework of micro services for the development of healthcare services using cloud computing infrastructure. Microservices based techniques provide lightly coupled and fine-grained methodology. This paper presents a micro-services technique that improves performance, scalability, and efficiency. This study develops a methodology for developing and implementing cloud-based healthcare apps in an appropriate manner. As a result, it supports both system analysis and system design. Both quantitative and qualitative results are presented that highlight the benefits of the microservices strategy.

Keywords: Micro-service architecture, Cloud Computing, Spring Boot Framework, Monolithic Architecture, SOA (Service oriented architecture), Healthcare system.

I. INTRODUCTION

E-Healthcare systems have gained significant attention from healthcare service providers and consumers alike. These systems are categorized into different types, including electronic healthcare records (EHRs) and personal health records (PHRs). EHRs primarily focus on storing and exchanging health-related information among healthcare providers, facilitating seamless access to patient data across various medical facilities. PHRs, on the other hand, are maintained by individuals themselves, allowing them to manage and share their personal health information such as medical history, allergies, medications, and test results. These healthcare records play a crucial role in information storage and exchange, enabling healthcare professionals to access and update patient information efficiently. Additionally, users of healthcare applications benefit from access to various health information systems, including E-records, test reports, and personal health record banks created by patients.

Real-time monitoring devices, wearable sensors, and IoT-based systems further enhance accessibility to healthcare information by providing continuous monitoring of vital signs, activity levels, and other health parameters. The usage of healthcare systems has seen a significant increase, driven by patients' trust in health data. Patients now have easier access to their health information, improved communication with healthcare providers, and personalized healthcare interventions. Healthcare providers can deliver more efficient and effective care, make better-informed decisions, and improve patient outcomes through the use of E-Healthcare systems. Overall, these systems have revolutionized modern healthcare delivery, promoting patient-centered care and advancing the quality and accessibility of healthcare services.

Developing healthcare applications presents a formidable challenge due to the intricate web of services they entail and the diverse objectives of each stakeholder involved. This complexity stems from the unique context and domain of healthcare, which often overwhelms developers with multifaceted requirements. Compared to standard applications, healthcare app development is notably intricate, demanding meticulous planning and administration. Moreover, it incurs inflated costs in both development and maintenance, along with consuming substantial time.

DOI: 10.17148/IJARCCE.2024.13523

The technical and specialized nature of healthcare necessitates tailored approaches in architecture, data processing, storage formats, and technology employment, contributing to interoperability issues. With healthcare costs soaring, providers are increasingly turning to remotely accessible solutions to alleviate financial strain. However, existing healthcare systems remain costly for both patients and providers, exacerbating need for more efficient solutions. Consequently, there's a growing trend towards designing and developing healthcare applications within a cloud environment, with a heightened emphasis on scalability to meet evolving service demands.

II. EXISTING SYSTEM

In healthcare services, application development is considered the most complex and time- consuming phase. It needs a lot of upkeep because it is time consuming and hard to plan. Strict adherence is required for healthcare applications, which have a vast application scope that includes associates, service classifications, and a classified system. Traditional methods of application design in the healthcare industry, such as monolithic and service-oriented architecture (SOA), lead to issues with service availability, remote access to services, service provisioning, scalability, and the integration of healthcare systems. Because of this, healthcare systems that are simpler to plan and create, cost less money for requirement maintenance, and allow for agile testing are required.

The issue statement tackles the various challenges inherent in healthcare application development, which greatly impact the efficiency, cost-effectiveness, and overall effectiveness of healthcare systems. In development of healthcare applications is more complex and time demanding. Healthcare applications must conform to tight regulatory standards while accommodating a large spectrum of functionality, including varied classifications of services and classified systems.

Moreover, typical development methodologies, such as monolithic and service-oriented architecture (SOA), are regarded as inappropriate for satisfying the special demands of healthcare applications. These approaches face several obstacles, including service availability issues, constraints in remote access to services, difficulty in service providing, scalability concerns, and complexities in integrating diverse healthcare systems. Such constraints hamper the seamless operation and interoperability of healthcare services, eventually limiting the delivery of quality patient care. In response to these issues, there arises a vital need for innovative, user-friendly, and cost-effective solutions in healthcare application development.

Khaleq & Ra [2] concentrated on creating a scalability architecture at the container level for microservice applications, where the primary quality of service criterion to be upheld is reaction time. According to their study, scalability of applications imposes quality of service constraints that necessitate a tailored scaling strategy.

A clinical support system for vital signs that helps physicians make diagnostic decisions was proposed by Forkan and Khalil [3]. The objective was to create a sophisticated, autonomous monitoring and decision-support system using patients' compound indications to foresee abnormalities and monitor basic vital signs. To make the system interoperable, the scientists used classification algorithms to forecast the numbers and associated abnormalities. EC2 instances were utilized in the planned task.

III. PROPOSED SYSTEM

A. Background

A comprehensive approach to the development lifecycle of healthcare apps is outlined in the Micro Service based Healthcare Application Framework. Figure 1 displays the high-level view of the suggested framework for the analysis and creation of healthcare apps. A potential development project has two phases to its lifecycle. The requirements elicitation and analysis step is the first section. A repository houses and manages all of the requirements and data. The design, development, and implementation of the services are covered in the second phase of the lifecycle. On their own, these standalone services provide a comprehensive capability.

They might, nevertheless, cooperate with one another in an integrated application. The four main stages of the microservices-based healthcare application framework are depicted in Figure 1. The needs are acquired from many stakeholders during the predevelopment stage. All stakeholders have their concerns about industry practices, standards, laws, and compliances taken into account. The needs are categorized into domain-specific groups, which are then further subdivided into contexts, throughout the analysis and design process.

© IJARCCE This work is licensed under a Creative Commons Attribution 4.0 International License

International Journal of Advanced Research in Computer and Communication Engineering
Impact Factor 8.102 ⁘ Peer-reviewed & Refereed journal ⁘ Vol. 13, Issue 5, May 2024
DOI: 10.17148/IJARCCE.2024.13523

Every context creates a unique microservice. The system architects identify several technologies and tools for the microservices design. For the purpose of designing and developing tasks from the system, different teams are organized. The primary responsibilities of the development phase include creating the system specifications, microservices, coding, and testing.

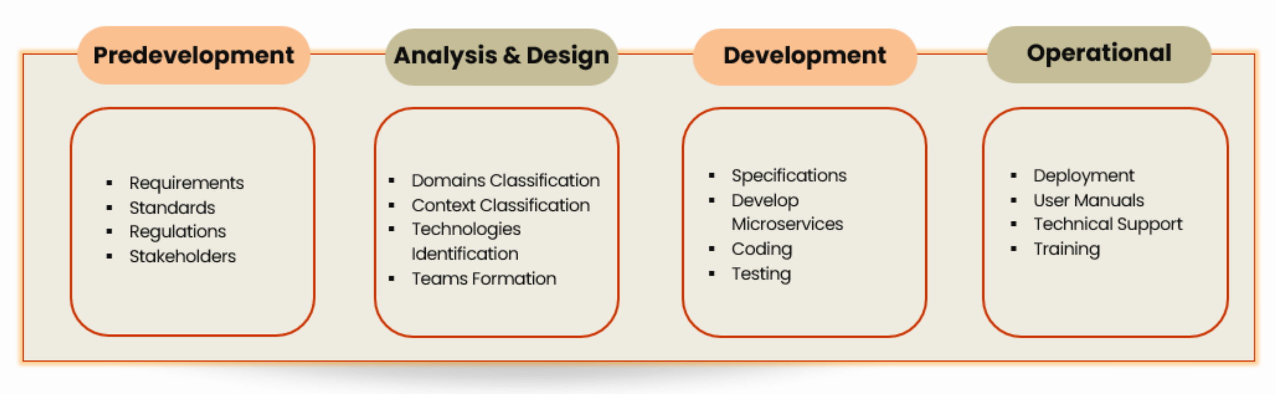

Fig. 1 Phases of Proposed Framework

B. Healthcare Application Design

The framework has a stack view structure. Stakeholders provide input on the needs for the health care system that will be developed during the requirement elicitation phase. The functional and non-functional needs are then divided by the requirement engineers. The systems domain experts receive the accepted final requirements from the stakeholder after that. These specialists' primary responsibilities include defining the service contexts and determining the business domains for the necessary functions.

The system developers can break down the complexity of the system into more manageable components—more precisely, coarse-grained articles—by identifying the business domains. Subsequently, every business domain is divided into increasingly granular microservice objects.

The delivery of one is the responsibility of each micro service. All of the business logic and implementation specifics are sent to the application developers for development once the micro services are designed. Here, microservice development will be facilitated by DevOps practices. Users' data is processed and stored entirely on cloud servers. From their local devices, individuals utilize web browsers to access the healthcare micro services. User data is processed and stored entirely on cloud servers.

Figure 2 displays the functional view of the healthcare application architecture for the micro services. System developers then break down the system's complexity into manageable components, known as coarse- grained articles, by identifying business domains. Each business domain is further divided into granular microservice objects. Upon development completion, microservices are deployed in a cloud environment for consumer use.

In summary, the healthcare application architecture employs microservices to provide modular and scalable solutions, enabling efficient development and deployment of healthcare services in a cloud environment.

International Journal of Advanced Research in Computer and Communication Engineering
Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 5, May 2024
DOI: 10.17148/IJARCCE.2024.13523

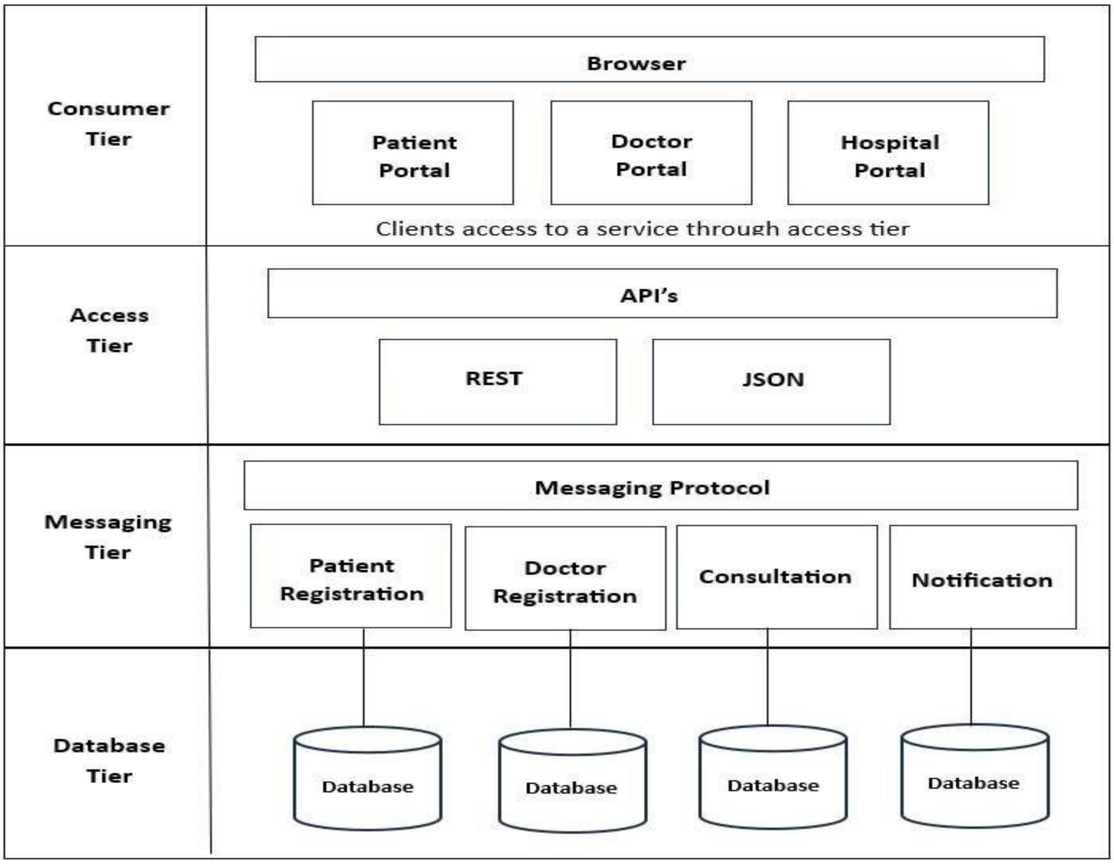

Fig. 2 Functional View of Healthcare Application

Additionally, each business sector has a variety of distinct microservice projects that are characterized and classified as specific events. Figure 3 depicts the architectural flow representation of services. Four microservices, including patient, physician, notification, and consulting services, make up the application.

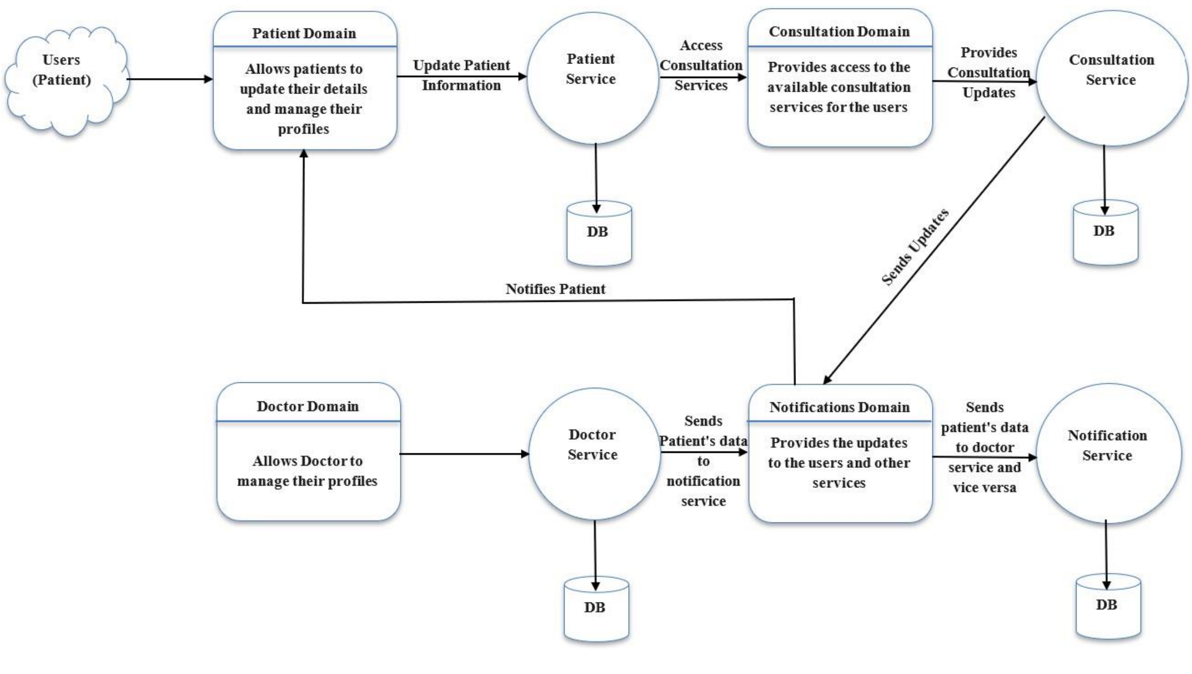

Fig. 3 Microservices Schematic Flow

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁙ Peer-reviewed & Refereed journal ⁙ Vol. 13, Issue 5, May 2024

DOI: 10.17148/IJARCCE.2024.13523

1) Patient Service:

The process's first stage will involve enrolling clients, such as patients, surgeons, and specialists. The microservice for patient registration is created by the business element's patient administration layer. The single business element space is addressed by the patient management layer. It includes small-scale administrations linked to medical professionals, patients, and urgent care centres. Among the microservices kept up to date in the patient management layer are patient registration, patient removal, and patient history. Through the technology, patients can complete a questionnaire from the comfort of their homes, designed by their healthcare practitioners. Each question is carefully answered by the patient; some can be answered with a simple "Yes" or "No," while others would need a detailed explanation. When all of the questions have been answered, the patient simply shows up.

2) Doctor Service:

After undergoing surgery, patients typically require consultations with the surgeon every two weeks to ensure proper recovery. During these consultations, the specialist examines the patients to ensure they are recovering well. The process begins with the surgeon asking various questions about the general treatment, inquiring about any bothersome symptoms regarding the patient's health, and discussing specific examination results from the operation. Surgeons may also provide advice to the patients and explain if further treatment is necessary. They can also offer guidance on activities that patients need to be cautious with. In the case of open surgeries, patients are required to visit the clinic in person. However, for many post-operative consultations such as laser treatment surgeries, doctors can provide advice over the phone or online, eliminating the need for patients to personally visit the clinic.

3) Notification Service:

The surgeons are informed of form submissions through a notification microservice. The specialist or doctor at his/her most punctual time looks at all the appropriate responses given by the patient and provides medical advice. Meeting structure will be spared in the distributed storage. The notice administration will be conjured once more, informing the patient about the conveyance of the specialist's restorative guidance. Additionally, the medical clinics can utilize the patients' record in the event that the patient is admitted to emergency clinic at some other event. The proposed system efficiently resolves the follow-up communication issue for the patients who live in remote areas and need post-surgery consultancy from their surgeons. The system does not only settle the interaction problem between patients and doctors but also is cost efficient in terms of being available, accessible and portable.

4) Consultation Service:

These are the services that direct and control all the interview correspondence among various clients for example patients, professionals, specialists and emergency clinics or facilities. They likewise deal with the surveys, their reactions either from the specialists or from different clients of system. Questionnaire service is expressly summoned and instated by the discussion administration at whatever point the patient requests an appointment from surgeons or doctors.

IV. RESULTS AND DISCUSSIONS

This research aimed to compare the SOA and microservice approaches for best utilization of the cloud resources and for best practical approach. For that purpose, both quantitative and qualitative case studies are used. Firstly, a case study of a healthcare application is deployed in the cloud using micro service and SOA approaches. Secondly, a survey of a number of professionals working in software development is conducted for qualitative comparison of the approaches. For cloud resource utilization, the micro service-based application is compared with SOA application using 3 parameters which are average response time, the possession of virtual machines and total number of dropped requests. Microsoft Azure, a PaaS layer cloud, was used for the deployment of the applications. The implementation of a healthcare application allowing patients to book appointments with doctors online and engage in virtual communication with healthcare providers offers transformative benefits to both patients and medical practitioners. By enabling patients to schedule appointments conveniently through a digital platform, the application enhances accessibility to healthcare services, breaking geographical barriers and reducing the time and effort traditionally associated with appointment scheduling. Moreover, the integration of online communication channels empowers patients to engage directly with their doctors, facilitating timely inquiries, discussions about health concerns, and follow-ups without the need for physical visits. This real-time interaction fosters a proactive approach to healthcare management, where patients feel more involved in their treatment plans and can receive prompt medical advice, ultimately leading to better health outcomes. Additionally, the streamlined workflow for healthcare providers enhances operational efficiency, enabling practitioners to focus more on delivering quality care rather than administrative tasks. Overall, such a healthcare application not only improves patient experience and engagement but also contributes to the optimization of healthcare delivery, aligning with modern expectations for convenient and accessible healthcare services.

© IJARCCE This work is licensed under a Creative Commons Attribution 4.0 International License

International Journal of Advanced Research in Computer and Communication Engineering
Impact Factor 8.102 ⁙ Peer-reviewed & Refereed journal ⁙ Vol. 13, Issue 5, May 2024
DOI: 10.17148/IJARCCE.2024.13523

Fig 1: Patient Registration

Patient registration is a crucial process in healthcare facilities, as it's the first step in creating a record for each patient and establishing a relationship between the patient and the healthcare provider.

Fig 2: Doctor Registration

Doctor registration typically refers to the process by which a physician or healthcare provider becomes registered or licensed to practice medicine in a particular jurisdiction.

International Journal of Advanced Research in Computer and Communication Engineering
Impact Factor 8.102 ⪤ Peer-reviewed & Refereed journal ⪤ Vol. 13, Issue 5, May 2024
DOI: 10.17148/IJARCCE.2024.13523

Fig 3: Hospital Registration

Hospital registration typically refers to the process by which hospitals or healthcare facilities obtain the necessary licenses, accreditations, and certifications to operate legally and provide medical services to patients.

V. CONCLUSION

The healthcare application development, resulting in the identification of the problems of the traditional approaches in service availability, remote access to services, service provisioning, scalability, healthcare systems integration with each other. We presented a microservice architecture for creating healthcare apps in order to solve these problems. The viability of implementing the suggested scheme in the cloud was demonstrated by our experimental evaluation of our microservice framework implementation; in comparison to service-oriented architecture, the suggested approach demonstrates a notable decrease in response time and the number of dropped requests as well as a significant increase in resource utilisation. We conducted a qualitative study among several developers to evaluate our method from the standpoint of software development; the survey's analysis indicates that developers prefer to utilise the microservice-based framework because of its well-proven

REFERENCES

[1] S. M. Riazul Islam, D. Kwak, M. Humaun Kabir, M. Hossain, and K.-S. Kwak, ‘‘The Internet of Things for health care: A com- prehensive survey,’’ *IEEE Access*, vol. 3, pp. 678–708, 2015, doi: 10.1109/ACCESS.2015.2437951.

[2] A. Abdel Khaleq and I. Ra, ‘‘Intelligent autoscaling of microservices in the cloud for real-time applications,’’ *IEEE Access*, vol. 9, pp. 35464–35476, 2021, doi: 10.1109/ACCESS.2021.3061890.

[3] A. Forkan and I. Khalil, ‘‘A clinical decision-making mechanism for context-aware and patient-specific remote monitoring systems using the correlations of multiple vital signs,’’ *Comput. Methods Programs Biomed.*, vol. 139, pp. 1–16, Feb. 2017, doi: 10.1016/j.cmpb.2016.10.018.

[4] M. Bitsaki, G. Koutras, H. Heep, and C. Koutras, ‘‘Cost-effective mobile- based healthcare system for managing total joint arthroplasty follow- up,’’ *Healthcare Inform. Res.*, vol. 23, no. 1, pp. 67–73, 2017, doi: 10.4258/hir.2017.23.1.67.

[5] H. F. El-Sofany and I. A. T. F. Taj-Eddin, ‘‘A cloud-based model for medical diagnosis using fuzzy logic concepts,’’ in *Proc. Int. Conf. Innov. Trends Comput. Eng. (ITCE)*, Feb. 2019, pp. 162–167, doi: 10.1109/ITCE.2019.8646624.

[6] H. Calderón-Gómez, L. Mendoza-Pittí, M. Vargas-Lombardo, J. Manuel Gómez-Pulido, J. Luis Castillo- Sequera, J. Sanz-Moreno, and G. Sención, ‘‘Telemonitoring system for infectious disease prediction in elderly peo- ple based on a novel microservice architecture,’’ *IEEE Access*, vol. 8, pp. 118340–118354, 2020, doi: 10.1109/ACCESS.2020.3005638.

 This work is licensed under a Creative Commons Attribution 4.0 International License