Thesis Overview:

A Framework for Migration of SOA based Applications to Microservices Architecture

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Introduction

This Distributed systems have evolved rapidly as the demand for independent design, and deployment of software applications has increased. It has emerged from the monolithic style of client-server architecture to service-oriented architecture, and then to the trending microservices. Monolithic applications are difficult to update, maintain, and deploy as it makes the application code very complex to understand. To overcome the design and deployment challenges in monolithic applications, service oriented architecture has emerged as a style of decomposing the entire application into loosely coupled, scalable, and interoperable services. Though SOA has become popular in the integration of multiple applications using the enterprise service bus, there are few challenges related to delivery, deployment, governance, and interoperability of services. Additionally, the services in SOA applications are tending towards monolithic in size with the increase in changing user requirements. To overcome the design and maintenance challenges in SOA, microservices has emerged as a new architectural style of designing applications with loose coupling, independent deployment, and scalability as key features.

Motivation

Because of the diverse benefits, IT companies have started designing their applications using microservices architecture, and few of them have started migrating their applications to microservices. Due to this paradigm shift in software development, many existing SOA applications are being migrated to microservices. However, some architects are in chaos whether to migrate the application from SOA to microservices or not as they are unaware of the pros and cons of the migration. Also, there is no proper mechanism or strategy to migrate existing SOA applications to microservices. As architects are unaware of the effort and cost required for designing the application from scratch, hence migrating is the best approach. According to a systematic mapping study conducted by Di Francesco et al., the research for the migration to microservices is at an early stage. Moreover migrating applications to the cloud have also aroused for migrating to microservices as it suits better in the cloud environment. Migrating the existing legacy application to microservices minimized the technical debt and improved the maintenance. Because of these benefits, the industry is moving towards microservices, leaving SOA as a legacy system. Since the migration of the SOA based applications to microservices is an open challenge, we consider it as the major research problem in this thesis. However, the migration of systems towards microservices involves multiple difficulties such as (i) not knowing the impact of migration, (ii) not having enough material on migration techniques, and (iii) not being aware of the migration effort. These challenges motivated us to study and propose possible solutions for the migration of SOA based applications to microservices architecture.

Contributions

The aim of the research work presented in this thesis is to help software architects in understanding the technical differences between SOA and microservices architectures and exploit some insights while migrating SOA based applications to microservices architecture. In this section, a summary of the contributions is presented.

1. *Evaluation and comparison of SOA and microservices architecture based applications:*

In this work, the QoS attributes such as coupling, complexity and performance are considered for comparing both SOA and microservices architectures. The complexity of the application is measured with architectural metrics and performance is compared with load testing. A graph based model called *Service Graph* is designed in which each node is a service and the edge between the node represents the dependency among the services. This

service graph plays a vital role in the proposed comparison strategy. The results conclude that though the complexity of microservices based application is high, it exhibits better QoS values compared to SOA application.

2. A service graph based extraction of microservices from monolith services of SOA:

Since it is observed from the above work that microservices architecture is better, we migrate the SOA based applications to microservices architecture. This work presents a 3-step approach to extract the microservices from monolith services of SOA. The concept of *Task Graph* is introduced in this work which helps in choosing the monolith SOA services in the application. Four different algorithms, namely, Service Graph Construction for SOA, Task Graph Construction for each Service of SOA, Microservices Extraction Algorithm and Service Graph Construction for Microservices Architecture are presented. A comparison of extracted microservices with SOA services with respect to coupling is also presented.

3. Effort estimation approach for migration of SOA applications to microservice architecture:

Before the actual migration of the application, estimating the effort required for migration helps the architects and project managers to better plan and execute the migration process. Hence, in this work, *Service Points* approach (based on the service graph concept) is defined which is recasted from the use case points approach of effort estimation. Machine learning concepts such as multiple linear regression and Leave-N-Out policy are applied to the proposed service points approach for better prediction of the effort. Measures such as MRE, MMRE, RMSE, MAE and SA etc. are used to evaluate the accuracy of the proposed model.

4. Patterns for migration of SOA based applications to microservices architecture:

The migration of an application from one architecture to another poses many design challenges. Similarly, migration of SOA based applications to microservices also exhibits many recurring challenges. This work presents patterns for commonly occurring problems during the migration of SOA based applications to microservices architecture. In particular, patterns for decomposition of an SOA service into microservice, size of the microservice and bug detection in the complex microservices application is presented. All these patterns are based on the concept of service graph and task graph proposed in the above works.

Conclusion

This thesis presents a framework for migration of service oriented applications to microservices style which includes the comparison of SOA & microservices applications, algorithms for extraction of microservices, the effort required for migration, and patterns for problems that occur during the migration process. All the proposed algorithms and techniques are demonstrated and evaluated using a standard web-based application.

Future Research Directions

- The comparison between the two architectures is presented in terms of coupling, complexity and performance. The other features such as scalability, maintenance, architecture stability, etc., can be considered for comparison.

- In the algorithms for extraction of microservices, the proposed approach can be enhanced by considering database in the migration approach as each microservice should have individual database.

- The effort estimation approach proposed in uses only a limited dataset of 7 projects. However, the machine learning techniques give better results with more number of projects in the dataset. The proposed approach is applied only on a single case study application, and it can be tested on applications of different domains and large enterprise applications.

- In this thesis, we have proposed a framework for migrating to microservices architecture. However, serverless computing is one of the recent trends and applications can be migrated to serverless computing.

Publications with this Thesis Work

1. Raj V, Ravichandra S. Microservices: A perfect SOA based solution for Enterprise Applications compared to Web Services. In2018 3rd IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT) 2018 May 18 (pp. 1531-1536). IEEE.

2. Raj V, Ravichandra S. Patterns for migration of SOA based applications to microservices architecture. Journal of Web Engineering. 2021 June 30:993-1008.

3. Vinay Raj,Sadam Ravichandra. Performance and complexity comparison of SOA and microservices architectures. International Journal of Communication Networks and Distributed Systems. 2021;27(1):100-117.

4. Vinay R, Ravichandra S. A service graph based extraction of microservices from monolith services of SOA. Software: practice and experience. 2021 Aug;51(8)

5. Raj V, Sadam R. Evaluation of SOA-Based Web Services and Microservices Architecture Using Complexity Metrics. SN Computer Science. 2021 Sep;2(5):1-10.