Microservices Architecture in DevOps

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***Abstract*—This doctoral research proposal is designed to address the challenges on employing microservices architecture (MSA) in DevOps. These two practices are relatively recent trends on the crowded street of software engineering paradigms. We believe that the coexistence of these practices may bring new challenges for architects about making and implementing decisions of microservices in DevOps. We plan to gain a deep understanding of the challenges/solutions, architecture description, migration, refactoring, and evolution in MSA with DevOps. Our expected outcome would be: (i) a systematic mapping study on MSA in DevOps, (ii) an evidence based framework for synthesizing MSA challenges/solutions in DevOps, (iii) recommendations for documenting MSA in DevOps based on industrial practices, (iv) a migration process from monolithic applications/architecture to MSA in DevOps, and (v) empirical reports on MSA refactoring and evolution in DevOps.**

Keywords—Microservices Architecture, DevOps, Systematic Mapping Study

I. INTRODUCTION

Microservices Architecture (MSA) got significant attention from industry and research community in recent years. Companies like Guardian, Amazon, Netflix, and many others migrated their products from traditional service oriented or monolithic applications to microservices systems [1]. The major emphasis of MSA is on building the lightweight services that should meet the cohesive needs of business functions [2]. This architectural style promotes isolation, autonomy, share-nothing philosophy, and service choreography [3]. MSA supposed to increase the agility, developer productivity, application scalability, reliability and maintainability. It is also suitable choice for iterative development process like agile and DevOps [1]. We aim to explore the role of MSA in DevOps.

DevOps is emerged from the collision of two closely related agile terms: first is "agile infrastructure" or "agile operations" and second is expending understanding of the collaboration between "development and operations" [4]. It has been observed that adopting DevOps brings many challenges for architect(-ing), including organizational culture, immaturity of tools, and infrastructure support etc. It is also challenging for architects that how MSA should design to support DevOps phases, for example continuous delivery, deployment, and operations.

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II. RELATED WORK

So far, many research papers have been published as case studies, surveys, and experience reports on MSA with different context and development processes. We found three secondary studies that present systematic mapping studies on MSA [1,5,6]. Alsshuqayran *et al*. compiled the architectural challenges in microservice based systems, modelling diagrams, and quality requirements from 33 studies [5]. Pahl and Jamshidi present the systematic mapping study of 21 primary studies for classification of the research directions in microservices [6]. Francesco *et al*. present the emerging trends and research gaps from 71 MSA based studies. This systematic mapping study conformed the close relationship between microservice MSA and DevOps [1].

We also find some primary studies that highlight the architecting issues in DevOps [7-9]. For example, Kang *et al*. present the architectural design challenges associated with cross configuration, maintaining state, and host resource management [7]. Few other challenges like late engagement with operational staff, migration planning, poor alerting back-out planning may affect the system when architecture is poorly considered in DevOps [8]. Jaramillo *et al*. report the challenges associated with building a poor MSA. These challenges are bringing failure isolation, maximizing the observability, providing the scalability, automation of the requirements and testing [9].

To the best of our knowledge, there is no study on MSA in DevOps that particularly discusses the role of microservices architecture in DevOps. Therefore, we have decided to conduct the comprehensive research in this area as PhD dissertation.

III. RESEARCH DESIGN

The objective of this research is to empirically investigate MSA in DevOps. The main research questions (RQs) are formulated as following:

TABLE I. RESEARCH QUESTIONS

Research Question	Motivation
RQ1: What architectural challenges are reported in literature and industry that microservices based systems face?	The aim of this RQ is to investigate MSA challenges in DevOps from research and practice. We plan to use systematic mapping study and industrial survey for identficaiton of the challenges.
RQ2: What architectural solutions are employed	The aim of this RQ is to provide the solutions for identified challenges. This RQ can be answered through evidence from

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to address the challenges?	systematic mapping studies, industrial surveys, and exploratory case studies.
RQ3: How MSA is described in DevOps?	The objective of this RQ is to explore the methods, techniques, tools, models, and patterns etc. for describing MSA in DevOps.
RQ4: How does monolithic applications/architecture can migrate to MSA in DevOps ?	The aim of this RQ is to proposing a migration process for monolithic application to MSA architecture based on DevOps. .
RQ5: How does MSA refactor in DevOps?	This is another area that is not investigated much [1]. The aim of this RQ is to empirically report the MSA refactoring process from industry.
RQ6: How does MSA evolve in DevOps?	The aim of this RQ is to report the ways in which MSA evolves in DevOps from industrial projects through exploratory case studies.

IV. Research Methods

A. Systematic Mapping Study

We will use systematic mapping study for identifying the architectural challenges and solutions from published literature on MSA in DevOps [10], as systematic mapping studies are one among the key research methods for comprehensive literature review.

B. Survey

The second method for exploring the microservices architectural challenges/solutions will be industrial survey from practitioners who are involved in developing microservices architecture based systems with DevOps. We expect there will be some multiple variables with many indicators and might be we need to test several hypotheses for identification of MSA challenges/solutions, so we decided to use the cross-sectional survey. Cross-sectional survey design is good for determining the relationship between multiple factors (e.g. MSA and DevOps). Besides that, we also have a plan to conduct follow-up semi structure interview(s) from the survey participants where required.

C. Case Study

We assert that there is still little empirical work has been done on microservices architecture in DevOps. We plan to use exploratory case studies for getting a better understanding and seeking insight of MSA in DevOps. Through case studies, we can bring multiple sources of evidence against small number of instances [11]. The other reason for using the case study is the nature of our research questions that highly depend on the context and actors of the organization. Therefore, we will design and execute the "multiple embedded case studies" in those organizations who are involved with DevOps practice for developing microservices systems.

D. Data Analysis Method

We expect a large amount of qualitative and quantitative data from the systematic mapping study, surveys, and case studies. For qualitative data, our data analysis technique will be a "constant comparison" method that was originally presented by Glaser and Strauss and then refined by many others [12]. For quantitative data, statistical techniques such as measures of central tendency, variability variance, and standard deviation etc. will be used. We also have a plan to send the results of this study to participants (those who are willing) for further validation.

V. Expected Contribution

The expected contributions of this PhD research are: (i) a systematic mapping study on MSA in DevOps, (ii) an evidence based framework for synthesizing MSA challenges/solutions in DevOps, (iii) recommendations for documenting MSA in DevOps based on industrial practices, (iv) a migration process for monolithic application/architecture to MSA in DevOps, and (v) empirical reports on MSA refactoring and evolution in DevOps.

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