UNIVERSITI TEKNOLOGI MARA

DECENTRALIZED COORDINATION DURING PLANNING AND EXECUTION PHASE OF MAPE-K FOR AUTONOMIC CLOUD ENVIRONMENT

AHMAD IZZUDDIN BIN YUSOF

Thesis submitted in fulfillment
of the requirements for the degree of
Master of Science
(Computer Science)

Faculty of Computer and Mathematical Sciences

November 2018

ABSTRACT

Managing coordination between Autonomic Managers in the autonomic cloud environment requires an effective control mechanism to handle issues, namely, the coordination conflict between Autonomic Managers during planning and execution phase of MAPE-K framework. This framework provides a primary control loop in managing automated adaptation process with multiple autonomic managers. Existing work have address autonomic managers being designed to address certain problem, but issue remains in coordinating the autonomic manager within decentralized environment for an appropriate and effective global self-adaptive management. The objective of this research is to show and prove that coordination between Autonomic Managers with negotiation and synchronization protocol during planning and execution phase respectively, able to resolve this issue and providing better overall control within the adaptation process. This research introduces a new specialty and novelty coordination model by combining negotiation and synchronization during planning and execution phase accordingly based on the MAPE-K control loop. Negotiation allows two parties to discuss to meet particular agreement while synchronization controls execution process according to agreed negotiation result. This new coordination model is evaluated by using the enhanced CloudSim simulator by integrating with a message broker. The result from the experiment shows that combination of negotiation and synchronization can manage coordination conflicts during a runtime adaptation.

ACKNOWLEDGEMENT

First and foremost, I would like to thank God Almighty for giving me the opportunity to embark on my Master and completing this long and challenging journey successfully.

Thank you to all who have been supporting this work especially Dr Azlan Ismail, and Prof. Dr. Siti Zaleha Zainal Abidin. The achievements of this Master thesis would not have been accomplished without the guidance and help from my supervisors. I would like to express my honest appreciation to them for giving me the opportunity of following my Master work, for their encouragements and availability throughout the years of my study, for their insightful direction, for their patience, and for their total support.

I would like to thank my wife, Asfa Zuhairen Hassan and all my 4 little sons, Adam, Aariz, Ariff and Aqeel, for their total support and understanding within and outside work, and for all the things that make me moved on to complete this thesis. Alhamdulillah.

TABLE OF CONTENTS

		Page
CONFIRMATION BY PANEL OF EXAMINERS		**ii**
AUTHOR'S DECLARATION		**iii**
ABSTRACT		**iv**
ACKNOWLEDGEMENT		**v**
TABLE OF CONTENTS		**vi**
LIST OF TABLES		**ix**
LIST OF FIGURES		**x**
CHAPTER ONE: INTRODUCTION		**1**
1.1	Background	1
1.2	Problem Statement	2
1.3	Research Objectives	3
1.4	Contributions	4
1.5	Limitation of Study	4
1.6	Thesis Organization	4
CHAPTER TWO: LITERATURE REVIEW		**6**
2.1	Overview	6
2.2	The Main Concepts	6
2.2.1	Cloud Overview	6
2.2.2	Multi-Cloud Environment	7
2.2.3	Cloud Marketplace and Cloud Broker	9
2.2.4	Self-adaptive Systems with MAPE-K control loop	10
2.2.5	Self-adaptive in Cloud Environment	11
2.2.6	Decentralized Self-Adaptive Approaches	12
2.2.7	Decentralized Self-Adaptation	12
2.2.8	Decentralized Control Patterns	13
2.2.9	Comparison between decentralized self-adaptive patterns	17
2.2.10	Challenges in Coordinating Decentralized AMs in MC	19

2.3 Basic Decentralized Coordination 21
2.4 Basic Interaction in Decentralized environment 23
2.5 The Needs for Coordinating the Planning and Execution Phase 24
2.6 Existing Work on Decentralized Coordination 25
2.7 Decentralized Coordination with Negotiation protocol 27
2.8 Decentralized Coordination with Synchronization protocol 28
2.9 Conclusion 29

CHAPTER THREE: RESEARCH METHODOLOGY 30
3.1 Introduction 30
3.2 The research method 30
3.3 Phase 1: Preliminary Study 32
3.4 Phase 2: Model Design 32
3.5 Phase 3: Simulation Design 33
3.6 Phase 4: Evaluation 33
3.7 Conclusion 34

CHAPTER FOUR: MODEL DESIGN - DECENTRALIZED COORDINATION MODEL FOR AUTONOMIC CLOUD ENVIRONMENT 35
4.1 Overview 35
4.2 Context of Scenario 35
4.3 Conceptual Architecture 36
4.4 Overall Idea 39
4.5 Detailed Model Design 40
4.5.1 Coordination Process Flow for Planning and Execution Phase 41
4.5.2 Negotiation Process 43
4.5.3 Synchronization Process 44
4.5.4 Decentralized Coordination Policies 47
4.5.5 Communication via Cloud Broker 49
4.6 Data Perspective 51
4.6.1 Local knowledge state during negotiation and synchronization 51
4.6.2 Local knowledge and need-to-know information 51
4.7 Conclusion 52