

Punit Gupta  
Pradeep Kumar Gupta

# Trust & Fault in Multi Layered Cloud Computing Architecture



Springer

# Trust & Fault in Multi Layered Cloud Computing Architecture



Punit Gupta • Pradeep Kumar Gupta

# Trust & Fault in Multi Layered Cloud Computing Architecture

 Springer

Punit Gupta  
Manipal University Jaipur  
Rajasthan, India

Pradeep Kumar Gupta  
Jaypee University of Information Technology  
Solani, India

ISBN 978-3-030-37318-4      ISBN 978-3-030-37319-1 (eBook)  
<https://doi.org/10.1007/978-3-030-37319-1>

© Springer Nature Switzerland AG 2020

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors, and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG  
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

# Preface

Cloud computing is the latest trend in computing field, where the user uses the resources of remote machine for computation of complex tasks which cannot be completed on local machines. The best part of using cloud computing is a pay-per-use model, where users are required to pay only for those resources which they have for a period of time rather than getting paid for the complete year or month. Multilayered cloud computing provides a collaborative environment, where different resources in the form of data center support various services. In multilayered cloud computing, data centers are distributed at different geographical locations and are the heterogeneous set of resources that have varying computational power, architecture, and performance. This varying structure of resources creates an unreliable environment, where it is very difficult to define which resource to be chosen even if they have the same configuration but different performance. Therefore, there is a need for an intermediate layer of the broker to maintain a knowledge bank about the past performance of the resources which can be data center, host, or virtual machine in that case. The broker will be responsible for evaluating the performance and providing a rating to each resource that can be used to make a decision at various levels like selecting a suitable resource for scheduling, load balancing, or migration. One of the reasons for the existence of such mechanism is faulty behavior of the system at every level that can be software failure, network failure, storage failure, and processor failure that may result in degrading the performance of the system.

Trust models are the best suitable mechanism to manage reliability in the cloud environment. This book is all about various mechanisms and ways, where trust model can play a significant role in different multilayered cloud service models. Trust models can be a third party agent to evaluate the performance of the service providers or resources in the cloud environment. The trust model is allowed to interact and grasp all the performance parameters of various service providers. Trust models are also important because various service providers may not share their performance history with each other; in that case, a reliable third party is required to manage a secure and reliable environment between service providers

with appropriate service level agreement. Trust models are basically an agent which keeps an eye on all the activities and events by a service provider that may be any form of failure or number of tasks completed when, where, and with what QoS. The agent is responsible for finding a relationship between all the performance parameters and comes up with a single grading scale to grade the services provided by a service provider over a period of time. The evaluation may be done after every small interval of time to keep them updated.

If we talk about feedback based trust models or relative trust models then one thing that comes into mind is that such models have many flaws and may provide incorrect results for many other trust models of SaaS, PaaS, and IaaS in the cloud. Trust models are responsible for defining a mathematical model which defines the relationship between the performance parameters. Various mechanisms discussed in this book covers all such aspects. If we talk about reliability of the system which is inversely proportional to fault, then the study of fault is also required to have an idea of how reliability is affected by various faults in the system. The work covers various types of fault mechanism and fault-aware techniques to improve the reliability of the system by intelligent allocation and load balancing mechanism in cloud models.

This book is organized in such a manner that it covers the trust-based mechanism for scheduling of workflow and independent task. This book also covers the fault-based mechanisms to improve the reliability of the system and further divided into nine chapters. A brief description of each chapter is discoursed below.

In Chap. 1, we have discoursed a brief introduction to the cloud with its properties that defines cloud computing. This chapter provides an introduction to the cloud with its service models and cloud-layered architecture which gives a brief overview of all the functional units of multi-cloud architecture. The work also discusses various issues in the cloud and approaches to solve the problem in the cloud.

In Chap. 2, the importance of trust models in multilayered cloud architecture is showcased. This chapter discourses various trust models and trust mechanisms to evaluate trust irrespective of where the trust value may be used. Here, a categorization of various trust models provides the reader with a better understanding and overview of how to fit a trust model and find a suitable trust model for a problem. This chapter focuses on various parameters affecting the trust model functioning and its performance. Some of the related works which propose the trust model for the cloud are also discussed here with a comparative analysis of existing approaches.

In Chap. 3, the importance of trust model for task scheduling has been discussed with the role of the trust model in task scheduling for improving the performance of the multilayered cloud. This chapter discourses all the performance parameters affecting the performance of a task scheduling and trust model in the cloud. The work also discusses existing work in the field of cloud computing. This chapter also adds a few proposed approaches to trust-based task scheduling in the cloud and showcases a comparative study of proposed and existing approaches.

Chapter 4 discusses an introduction to trust models of SaaS and PaaS layer with their importance and how the various trust models can improve the performance of the multilayered cloud. The work defines the framework of SaaS and PaaS with its layered architecture to identify the issues in these architectures. The work also shows

the various trust-related parameters that need to be focused on the improvement of security, reliability, and resource management in the cloud environment.

Chapter 5 discusses trust models for workflow scheduling in multilayered cloud. Here, workflow scheduling is considered to be one of the important issues in the cloud. To overcome scheduling of dependent task in a heterogeneous environment, trust and workflow scheduling plays an important role. In this chapter, an introduction to workflow scheduling with parameters affecting workflow scheduling which differs from basic task scheduling is discussed. This work also discusses the existing workflow scheduling algorithms in the cloud along with their issues. At last, the chapter proposes some of the new approaches for workflow scheduling in the multilayered cloud environment.

In Chap. 6, we have discussed fault-aware task scheduling in the multilayered cloud to improve the reliability in the multilayered cloud environment. This chapter discusses the existing fault-aware mechanism for task scheduling in the multilayered cloud with a brief introduction to fault mechanism and type of faults in the multilayered cloud. The chapter also proposes some more approaches for task scheduling in the multilayered cloud and compares them with existing work. A detailed comparative study has been showcased.

In Chap. 7, fault-aware techniques for workflow scheduling in the multilayered cloud have been proposed with some more advanced approaches to overcome the issues of existing fault-tolerant algorithms. This chapter also discusses some of the existing work in the field of workflow scheduling in the multilayered cloud environment.

In Chap. 8, we have discussed various tools which are used to perform various simulations in the multilayered cloud environment along with different simulation parameters. This chapter showcases many simulation environments for various multilayered cloud and parameters which can be turned to get specific analysis. The tool is categorized based on fault simulation, scalability simulation, and many more. This work helps the novice and researchers to identify a simulation environment according to their requirement. The chapter defines various open-source cloud platforms that can be used for installing real multilayered cloud and even making changes in the existing cloud environment.

Finally, Chap. 9 represents various open issues and research problems in a multilayered cloud environment which focus on various issues of security and privacy. Here, we have also considered the advanced role of cloud computing that can be an extension toward fog computing and Internet of Things. This advancement in cloud computing opens a number of issues pertaining to these domains and presents major threats and research problems that can be worked out in the near future.

Further, we believe this book will be of interest to graduate students, teachers, and active researchers in academia, and engineers in industry who need to understand or implement multilayered cloud computing. We hope that this book will provide a reference to many of the techniques used in the field as well as generate new research ideas to further advance the field.



This work would not have been possible without the help and mentoring from many individuals, including Prof. Dr. Vinod Kumar—Vice Chancellor at JUIT, Prof. Dr. Samir Dev Gupta—Director and Dean Academics at JUIT, Prof. Dr. S. P. Ghrera—Head of the department, CSE and IT at JUIT. We would also like to thank Prof. Dr. Ruchi Verma (Assistant Professor—Sr. Grade) at CSE, Ms. Shefali Varshney (Ph.D. Research Scholar) at CSE, Mr. Ravideep Singh (M.Tech-CSE), Ms. Gunjan Gugnani (M.Tech-CSE), Ms. Anandita Thakur (M.Tech-CSE), and Prof. Poonam Rana for their contribution and continuous support.

Rajasthan, India

Punit Gupta

# Contents

<b>1</b>	<b>Introduction to Multilayered Cloud Computing</b>	<b>1</b>
1.1	Introduction	1
1.2	Characteristics of Cloud	3
1.3	Type of Cloud and Its Services	3
1.4	Issues in Cloud Computing	4
1.4.1	Resource Allocation	4
1.4.2	Load Balancing	5
1.4.3	Migration	6
1.4.4	Power-Efficient Resource Allocation and Load-Balancing Algorithms	6
1.4.5	Cost-Efficient Resource Allocation and Load-Balancing Algorithms	6
1.4.6	Fault-Tolerant Algorithms	7
1.4.7	Behavior-Based Algorithms	7
1.4.8	Trust Management	7
1.5	Multilayered Cloud Architecture	8
1.6	Role of Trust in Cloud and Its Various Services	11
1.7	Summary	11
	References	12
<b>2</b>	<b>Trust and Reliability Management in the Cloud</b>	<b>15</b>
2.1	Introduction	15
2.1.1	What Is Trust?	15
2.2	Security Challenges	17
2.3	Role of Trust in Multilayered Cloud	18
2.3.1	Evaluation of Trust	21
2.3.2	Trust Management and Performance Improvement	22
2.4	Existing Trust-Based Solutions in Cloud	22
2.4.1	Cloud Service Registry and Discovery Architecture	24
2.5	Comparison with Various Reported Literature	30