Failure Prediction And Detection In Cloud Datacenters

Punvil Bambharolia, Prajeet Bhavsar, Vivek Prasad

Abstract: Cloud computing is a novel technology in the field of distributed computing. Usage of Cloud computing is increasing rapidly day by day. In order to serve the customers and businesses satisfactorily, fault occurring in datacenters and servers must be detected and predicted efficiently in order to launch mechanisms to tolerate the failures occured. Failure in one of the hosted datacenters may propagate to other datacenters and make the situation worse. In order to prevent such situations, one can predict a failure proliferating throughout the cloud computing system and launch mechanisms to deal with it proactively. One of the ways to predict failures is to train a machine to predict failure on the basis of messages or logs passed between various components of the cloud. In the training session, the machine can identify certain message patterns relating to failure of data centers. Later on, the machine can be used to check whether a certain group of message logs follow such patterns or not. Moreover, each cloud server can be defined by a state which indicates whether the cloud is running properly or is facing some failure. Parameters such as CPU usage, memory usage etc. can be maintained for each of the servers. Using this parameters, we can add a layer of detection where in we develop a decision tree based on these parameters which can classify whether the passed in parameters to the decision tree indicate failure state or proper state.

Index Terms: Cloud computing; failure prediction; failure detection; cloud datacenters; probability and statistics; Bayesian probability; machine learning

1 INTRODUCTION

Cloud computing is one of the new buzzwords in the world of computer science and engineering. One of the main features that cloud service providers offers its customers is the ability to pay per use. Cloud computing also incorporates self-service and thus aiming at Autonomic computing. It also aims at providing businesses with a scalable and adaptive environment. Businesses are provided with various deployment models to choose from. Some of the deployment models include public cloud. Public cloud hosts all the data and resources on public servers which can be accessed by everyone. Private cloud is another type of model where the data is hosted on datacenters located on premise locations. Community cloud is another type of model where a set of organizations or businesses share a cloud datacenter. Hybrid model is a solution to insufficient capacity of the private cloud. Organizations are provided with an ability to subscribe to public cloud services when facing insufficient resources. This is termed as "cloud bursting" [1]. According to [1], cloud provides myriad of advantages which the local data centers cannot. These includes scalability, data security, fault tolerance, pay per use, dynamic resource allocation and much more. As a result, many giant organizations and local businesses are opting to migrate the local data in datacenters onto the cloud. It provides a level of abstraction and thus obviates the need for the users to manage the complex hardware and infrastructure. Being said that, there are many Quality of Service (QoS) parameters which the cloud service providers (CSPs) need to provide as per the Service Level Agreements (SLAs) with their customers. One important parameter is availability of resources [2].

2 LITERATURE SURVEY

Author Name	Paper Name	Year Published	Problems	Open Research Issues
Yukihiro Wantabe, Hiroshi Otsuka, Masataka Soneda, Shinji Kikuchi and Yasuhide Matsumoto	Online Failure Prediction in Cloud Datacenters by Real-Time Message Pattern Learning	2012	Various types of message logs communicated between components	In the future, accuracy can be improved by including more parameters.
Qiang Guan, Ziming Zhang and Song Fu	Ensemble of Bayesian Predictors and Decision Trees for Proactive Failure Management in Cloud Computing Systems	2012	Assumption that training dataset is labeled;	In future, integrating two failure management approaches will lead to better dependability.
Husanbir Pannu, Jianguo Liu, Qiang Guan and Song Fu	AFD: Adaptive Failure Detection System for Cloud Computing Infrastructures	2012	The runtime performance data is usually unlabeled and thus a prior failure history is not always available.	Integrating the proactive and reactive failure management approaches like check pointing and redundant execution can increase the fault detection accuracy.

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Failure Prediction And Detection In Cloud Datacenters:

Smart Data Intelligence R. Asokan,Diego P. Ruiz,Vasile-Daniel Păvăloaia,2025-11-07 This book presents high quality research papers presented at 5th International Conference on Smart Data Intelligence ICSMDI 2025 organized by Kongunadu College of Engineering and Technology at Trichy Tamil Nadu India during January 2025 This book brings out the new advances and research results in the fields of algorithmic design data analysis and implementation on various real time applications It discusses many emerging related fields like big data data science artificial intelligence machine learning and deep learning which have deployed a paradigm shift in various data driven approaches that tends to evolve new data driven research opportunities in various influential domains like social networks health care information and communication applications *Cloud Reliability Engineering* Rathnakar Achary,Pethuru Raj,2021-04-11 Coud reliability engineering is a leading issue of cloud services Cloud service providers guarantee computation storage and applications through service level agreements SLAs for promised levels of performance and uptime Cloud Reliability Engineering Technologies and Tools presents case studies examining cloud services their challenges and the reliability mechanisms used by cloud service providers These case studies provide readers with techniques to harness cloud reliability and availability requirements in their own endeavors Both conceptual and applied the book explains reliability theory and the best practices used by cloud service companies to provide high availability It also examines load balancing and cloud security Written by researchers and practitioners the book s chapters are a comprehensive study of cloud reliability and availability issues and solutions Various reliability class distributions and their effects on cloud reliability are discussed An important aspect of reliability block diagrams is used to categorize poor reliability of cloud infrastructures where enhancement can be made to lower the failure rate of the system This technique can be used in design and functional stages to determine poor reliability of a system and provide target improvements Load balancing for reliability is examined as a migrating process or performed by using virtual machines The approach employed to identify the lightly loaded destination node to which the processes virtual machines migrate can be optimized by employing a genetic algorithm To analyze security risk and reliability a novel technique for minimizing the number of keys and the security system is presented The book also provides an overview of testing methods for the cloud and a case study discusses testing reliability installability and security A comprehensive volume Cloud Reliability Engineering Technologies and Tools combines research theory and best practices used to engineer reliable cloud availability and performance *Green, Pervasive, and Cloud Computing* Zhiwen Yu,Christian Becker,Guoliang Xing,2020-12-04 This book constitutes the refereed proceedings of the 15th International Conference on Green Pervasive and Cloud Computing GPC 2020 held in Xi an China in November 2020 The 30 full papers presented in this book together with 8 short papers were carefully reviewed and selected from 96 submissions They cover the following topics Device free Sensing Machine Learning Recommendation Systems Urban Computing Human Computer Interaction Internet of Things and Edge

Computing Positioning Applications of Computer Vision CrowdSensing and Cloud and Related Technologies [Proceeding of the International Conference on Computer Networks, Big Data and IoT (ICCBI - 2019)](#) A. Pasumpon Pandian,Ram Palanisamy,Klimis Ntalianis,2020-03-04 This book presents the proceedings of the International Conference on Computing Networks Big Data and IoT ICCBI 2019 held on December 19 20 2019 at the Vaigai College of Engineering Madurai India Recent years have witnessed the intertwining development of the Internet of Things and big data which are increasingly deployed in computer network architecture As society becomes smarter it is critical to replace the traditional technologies with modern ICT architectures In this context the Internet of Things connects smart objects through the Internet and as a result generates big data This has led to new computing facilities being developed to derive intelligent decisions in the big data environment The book covers a variety of topics including information management mobile computing and applications emerging IoT applications distributed communication networks cloud computing and healthcare big data It also discusses security and privacy issues network intrusion detection cryptography 5G 6G networks social network analysis artificial intelligence human machine interaction smart home and smart city applications **Database Systems for Advanced Applications. DASFAA 2023 International Workshops** Amr El Abbadi,Gillian Dobbie,Zhiyong Feng,Lu Chen,Xiaohui Tao,Yingxia Shao,Hongzhi Yin,2023-09-27 This volume constitutes the papers of several workshops which were held in conjunction with the 28th International Conference on Database Systems for Advanced Applications DASFAA 2023 held in Tanjin China in April 2023 The 23 revised full papers presented in this book were carefully reviewed and selected from 40 submissions DASFAA 2023 presents the following four workshops 9th International Workshop on Big Data Management and Service BDMS 2023 8th International Workshop on Big Data Quality Management BDQM 2023 7th International Workshop on Graph Data Management and Analysis GDMA 2023 1st International Workshop on Bundle based Recommendation Systems BundleRS 2023 **Electrifying Compliance: Harnessing Standards and Safety for AI, Cloud, and Data Centers** Chirag Devendrakumar Parikh,2025-10-21 It s with great happiness that I would like to acknowledge a great deal of people that get helped me extremely through the entire difficult challenging but a rewarding and interesting path towards some sort of Edited Book without having their help and support none of this work could have been possible *Large-Scale Disk Failure Prediction* Cheng He,Mengling Feng,Patrick P. C. Lee,Pinghui Wang,Shujie Han,Yi Liu,2020-08-05 This book constitutes the thoroughly refereed post competition proceedings of the AI Ops Competition on Large Scale Disk Failure Prediction conducted between February 7th and May 15 2020 on the Alibaba Cloud Tianchi Platform A dedicated workshop featuring the best performing teams of the competition was held at the 24th Pacific Asia Conference on Knowledge Discovery and Data Mining PAKDD 2020 in Singapore in April 2019 Due to the COVID 19 pandemic the workshop was hosted online This book includes 13 selected contributions an introduction to dataset selected approaches of the competing teams and the competition summary describing the competition task practical challenges evaluation metrics etc [International Aerospace](#)

Simplifying Datacenter Fault Detection and Localization Arjun Roy,2018 The proliferation of distributed internet services has reaffirmed the need for reliable and high performance networks not only in the WAN bringing users to the services but within the datacenters where services themselves reside Services consist of distributed applications running across thousands of servers within datacenters with stringent performance scaling and reliability requirements To support these requirements datacenter networks are comprised of thousands of servers links and ports and over hundreds of switches providing multiple paths between any pair of servers Because any given component has a small but non zero failure rate the large number of components means that failures are endemic inside datacenters Unfortunately not all failures are easily diagnosable within datacenter environments In particular datacenters are susceptible to insidious parasitic performance loss due to a class of network component fault known as partial faults where a component is nominally healthy but intermittently drops or delays traffic These faults have been noted as being particularly difficult to detect and localize though mitigation can be straightforward once the faulty component is determined Pinpointing partial faults quickly is crucial because they are capable of inflicting a disproportionately high toll on application performance Unfortunately partial faults can confound existing fault detection methods in several ways including interactions between the fault itself application traffic characteristics and networking hardware For example network switches may fail to detect a fault due to unreliable or otherwise insensitive monitoring capabilities Traffic volume and variability may complicate analysis of server based application and network metrics as well as mask fault impact Moreover the myriad paths available to network flows complicate localization even if servers do detect partial faults However this work shows that the scale and regular design of contemporary datacenters can simplify partial fault localization In particular the combination of large scale load balanced multipath topologies and high volume datacenter traffic enables simple low overhead application agnostic and root cause agnostic partial fault localization via passive link by link outlier analysis of application network performance I validate the effectiveness of my approach within large scale first party production datacenters and examine the additional challenges and complexities raised by third party cloud datacenters   **A Hierarchical Framework for Memory Failure Prediction in Reliable Cloud Services** Qiao Yu,2025   Madhusudhan H. S.,Satish Kumar T,Punit Gupta,Dinesh Kumar Saini,Kashif Zia,2024-05-02 One of the major developments in the computing field has been cloud computing which enables users to do complicated computations that local devices are unable to handle The computing power and flexibility that have made the cloud so popular do not come without challenges It is particularly challenging to decide which resources to use even when they have the same configuration but different levels of performance because of the variable structure of the available resources Cloud data centers can host millions of virtual machines and where to locate these machines in the cloud is a difficult problem Additionally fulfilling optimization needs is a complex problem Reliable and

Intelligent Optimization in Multi Layered Cloud Computing Architectures examines ways to meet these challenges It discusses virtual machine placement techniques and task scheduling techniques that optimize resource utilization and minimize energy consumption of cloud data centers Placement techniques presented can provide an optimal solution to the optimization problem using multiple objectives The book focuses on basic design principles and analysis of virtual machine placement techniques and task allocation techniques It also looks at virtual machine placement techniques that can improve quality of service QoS in service oriented architecture SOA computing The aims of virtual machine placement include minimizing energy usage network traffic economical cost maximizing performance and maximizing resource utilization Other highlights of the book include Improving QoS and resource efficiency Fault tolerant and reliable resource optimization models A reactive fault tolerance method using checkpointing restart Cost and network aware metaheuristics Virtual machine scheduling and placement Electricity consumption in cloud data centers Written by leading experts and researchers this book provides insights and techniques to those dedicated to improving cloud computing and its services   *A Framework for Efficient Management of Fault Tolerance in Cloud Data Centres and High-performance Computing Systems* Bashir Mohammed,2019   Software Architecture-based Failure Prediction Atef S. Mohamed,2012 Depending on the role of software in everyday life the cost of a software failure can sometimes be unaffordable During system execution errors may occur in system components and failures may be manifested due to these errors These errors differ with respect to their effects on system behavior and consequent failure manifestation manners Predicting failures before their manifestation is important to assure system resilience It helps avoid the cost of failures and enables systems to perform corrective actions prior to failure occurrences However effective runtime error detection and failure prediction techniques encounter a prohibitive challenge with respect to the control flow representation of large software systems with intricate control flow structures In this thesis we provide a technique for failure prediction from runtime errors of large software systems Aiming to avoid the possible difficulties and inaccuracies of the existing Control Flow Graph CFG structures we first propose a Connection Dependence Graph CDG for control flow representation of large software systems We describe the CDG structure and explain how to derive it from program source code Second we utilize the proposed CDG to provide a connection based signature approach for control flow error detection We describe the monitor structure and present the error checking algorithm Finally we utilize the detected errors and erroneous state parameters to predict failure occurrences and modes during system runtime We craft runtime signatures based on these errors and state parameters Using system error and failure history we determine a predictive function an estimator for each failure mode based on these signatures Our experimental evaluation for these techniques uses a large open source software PostgreSQL 8 4 4 database system The results show highly efficient control flow representation error detection and failure prediction techniques This work contributes to software reliability by providing a simple and accurate control flow representation and utilizing it to detect

runtime errors and predict failure occurrences and modes with high accuracy   <u>A Methodology for Analysis of Failure Prediction Data</u> Stanford University. Computer Systems Laboratory,F. A. Nassar,1985   **Fault Prediction Approach** Dhana Laxmi,2019-03-28 Project Report from the year 2019 in the subject Computer Science Software grade A course Doctoral Degree language English abstract This research works seeks to explore and provide an improved fault detection approach for inspection and fault detection It systematically investigate and characterize software faults and faults to improve fault detection and prevention mechanisms in the quality software development process Firstly it contributes an Adaptive PSO based association rule mining techniques for software fault classification using ANN This task categorizes real defects by finding the best support and reliability to have the best policy for software fault classification using ANN Secondly it provides a Fault Prediction Approach FPA based on probabilistic models to perform software testing in Software Inspection This describes a cost effective way to accurately detect the defects by performing software inspection to develop quality software The proposed FPA probes stochastic methods using the modified Naive Bayes classification to estimate the possible faults in the experimental environment to suggest novel defect control development Software reliability engineering has become very important as the complexity of the system has increased exponentially with technological advances The fact that all systems today depend on many other systems and interfaces is not only an application error but also a number of environmental factors that lead to failure The impact of these failures depends on the nature of the system but many of them cause customer dissatisfaction and business loss System testing and fault detection have become the most important processes in the software life cycle Various failure prediction models can be analyzed and suggested so that failures can be detected at an early stage and many test efforts can be saved Software development has many defects in the design phase In the past many examples of software development   **Online Failures Detection for Parallel Computing Systems Based on Time Prediction Information** Ting-Yu Lin,2019   *Hardening Cloud and Datacenter Systems Against Misconfigurations* Tianyin Xu,2017 Misconfigurations a k a configuration errors from a system s standpoint are among the dominant causes of today s catastrophic system failures that turn down cloud scale services and affect hundreds of millions of end users Despite their wide adoption traditional fault tolerance and failure recovery techniques are not effective in dealing with configuration errors especially in large scale software systems deployed in cloud and datacenters To make the matters worse even the tolerance and recovery mechanisms themselves are often misconfigured in the real world which impairs the immune system of the entire cloud and datacenters This dissertation explores two fundamental questions towards the solutions for the inevitable misconfigurations how to build reliable cloud and datacenter systems in the face of configuration errors moreover how to prevent misconfigurations in the first place by better configuration design The goal is to enable software systems to proactively anticipate and defend against misconfigurations rather than reacting to their manifestations and consequences This dissertation presents three key principles of systems design and implementation for hardening cloud

and datacenter systems against misconfigurations anticipating misconfigurations early detection of configuration errors and simplicity oriented configuration design The dissertation demonstrates that applying these principles can effectively defend cloud and datacenter systems against misconfigurations Moreover the dissertation presents the corresponding techniques and tool support that can automatically and systematically apply these principles to existing systems software The main technical insight is that configurations are essentially used by the systems while configuration errors are mostly manifested through the faulty execution that uses erroneous configuration values Therefore by analyzing the system s code that uses configuration values one can understand and make use of system level information of configurations to build defense against potential errors This dissertation first presents Spex that enables systems to anticipate misconfigurations Spex automatically infers configuration constraints from a system s source code and then leverages the constraints to test the system s resilience to misconfigurations and detect error prone configuration design handling On step further the dissertation introduces PCheck to automatically generate checking code which captures configuration errors at the system s initialization phase to prevent their late manifestations and the corresponding failure damage Going beyond this dissertation presents simplicity oriented configuration design towards more usable and less error prone software configuration The key idea is to apply the user centric philosophy to design configuration as an interface configurations are essentially the interface for controlling and customizing system behavior but have rarely been treated as it is The dissertation shows that configurations in today s systems software can be significantly simplified and effectively navigated with the understanding of how they are actually used in the field **Failure Prediction for High-performance Computing Systems** Narate Taerat,2012

Performance Anomaly Detection and Resolution for Autonomous Clouds Olumuyiwa Ibidunmoye,2017 Fundamental properties of cloud computing such as resource sharing and on demand self servicing is driving a growing adoption of the cloud for hosting both legacy and new application services A consequence of this growth is that the increasing scale and complexity of the underlying cloud infrastructure as well as the fluctuating service workloads is inducing performance incidents at a higher frequency than ever before with far reaching impact on revenue reliability and reputation Hence effectively managing performance incidents with emphasis on timely detection diagnosis and resolution has thus become a necessity rather than luxury While other aspects of cloud management such as monitoring and resource management are experiencing greater automation automated management of performance incidents remains a major concern Given the volume of operational data produced by cloud datacenters and services this thesis focus on how data analytics techniques can be used in the aspect of cloud performance management In particular this work investigates techniques and models for automated performance anomaly detection and prevention in cloud environments To familiarize with developments in the research area we present the outcome of an extensive survey of existing research contributions addressing various aspects of performance problem management in diverse systems domains We discuss the design and

evaluation of analytics models and algorithms for detecting performance anomalies in real time behaviour of cloud datacenter resources and hosted services at different resolutions We also discuss the design of a semi supervised machine learning approach for mitigating performance degradation by actively driving quality of service from undesirable states to a desired target state via incremental capacity optimization The research methods used in this thesis include experiments on real virtualized testbeds to evaluate aspects of proposed techniques while other aspects are evaluated using performance traces from real world datacenters Insights and outcomes from this thesis can be used by both cloud and service operators to enhance the automation of performance problem detection diagnosis and resolution They also have the potential to spur further research in the area while being applicable in related domains such as Internet of Things IoT industrial sensors as well as in edge and mobile clouds

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