ENSURING RELIABLE CLOUD SERVICES IN A FEDERATED ENVIRONMENT: PROACTIVE FAULT TOLERANCE STRATEGIES

Dr. M. Ramasubramanian[1], Nikitha Soma[2], Padamati Prasanna[3], Vaiplavi Kota[4]

Article History: Received: 08.02.2023 **Revised:** 23.03.2023 **Accepted:** 08.05.2023

Abstract

A new paradigm called cloud federation enables cloud providers to work together and share resources to satisfy consumer needs. However, the reliability of cloud services in a cloud federation environment is still a concern due to the potential risks of failure and downtime. To address this issue, this paper proposes a proactive fault tolerance technique that combines prediction, prevention, and recovery mechanisms to reduce the likelihood of faults and improve the system's resilience to faults. The proposed technique employs machine learning algorithms to predict potential faults and takes proactive measures to prevent them from occurring. In the event of a fault, the technique uses recovery mechanisms to minimize service downtime and restore the system to its normal state. The outcomes of the tests demonstrate that the suggested method can greatly raise the dependability of cloud services in a cloud federation setting.

Keywords: Service Providers, Virtual Machines, Faulty, Non-Faulty, Profit, Migration Cost

[1]Professor, Department of CSE, Sridevi Women's Engineering College,Hyderabad, Telanganan, India
[2,3,4]Final Year B.Tech, Department of CSE, Sridevi Women's Engineering College, Hyderabad, Telangana, India.

Email:[1]mailtoraams@gmail.com[2]somanikitha1507@gmail.com,[3]padamati.prasanna4154@gmail.com,[4]kotavaiplavi001@gmail.com

DOI: 10.31838/ecb/2023.12.s3.273

1. Introduction

A crucial piece of technology for the delivery of several IT services is cloud computing. Cloud computing allows organizations to reduce their IT infrastructure costs while providing a flexible and scalable IT environment. Cloud federation is a collaborative network of cloud providers that can share resources to meet the service-level agreements (SLAs) of their customers. However, as the number of service providers in a federation increases, reliability of the system may decrease, leading to more failures. Therefore, proactive fault-tolerance techniques are needed to enhance the reliability of cloud services in a cloud federation environment. One technique for proactive fault tolerance is to use replication. Replication involves creating multiple copies of data or services across different clouds. By replicating data or services, if one cloud provider fails, another provider can still provide the service, ensuring that the SLAs are met. Replication can be done at different levels, such as hardware, software, or data. Another technique for proactive fault tolerance is to use load balancing. Load balancing involves distributing the workload across different clouds in the federation. Load balancing can ensure that no cloud provider is overloaded, which can lead to performance degradation or failure. Load balancing can be done at the network, application, or database level.

Utilising proactive monitoring is a third technique for proactive fault tolerance. Monitoring cloud services in a federation's performance and availability is known as proactive monitoring. Potential faults can be identified and fixed before they happen by monitoring the performance and availability of cloud services. Various tools, including network analyzers, system monitors, and log analysis tools, can be used for proactive monitoring.

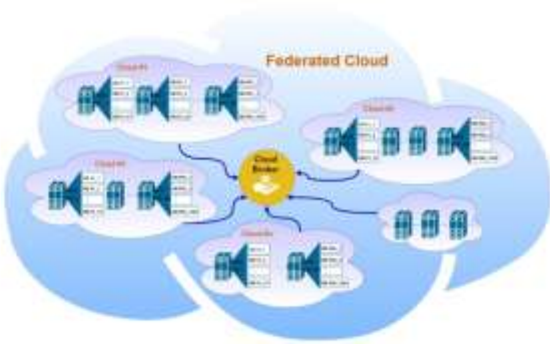


Figure 1

So, proactive fault-tolerance techniques such as replication, load balancing, and proactive monitoring ensures the reliability of cloud services in a cloud federation. By using these techniques, cloud providers can ensure that SLAs are met, and customers can have access to reliable and high-quality cloud services.

Related Work

1. The formation game and process for cloud federations in the environment

There will be a rise in computer resources, which will lead to significant demand for resources. The resources offered by service providers might not be sufficient to meet the demands. As a result, cloud providers must redesign their organisational structures and work to enhance their ability to scale resources dynamically. A useful platform for resolving this service management challenge is provided by federated clouds.We create a cloud federation creation method that enables users to optimise their profit based on the proposed federation formation game. This lacks motivation to secede from the union. Many analyses and experiments have demonstrated that the cloud federation that was created using our suggested mechanism is effective.

2. A game theory-based approach ensures quality and profitability in the development of trusted cloud federations.

In order to satisfy the demands of cloud users, the demand for computing resources has increased as a result of the growth of the cloud market. It might be challenging for a single cloud service provider (CSP) to satisfy all forms of dynamic resource requests while maintaining a certain degree of quality of service (QoS). As a consolidated model, cloud federation involves a number of CSPs sharing their surplus resources with one another in order to generate some financial gain. overcomes QoS restrictions during unexpected increases in resource usage. Since, trusted CSPs are highly sought after in the network. Hence, it is vital to ensure QoS delivery.

3. Measurement, analysis, and implications approach for understanding network failures in data centres

First, we give an extensive examination of network failures in a data centre. We aim to provide answers to a number of fundamental questions through our analysis, We utilise a variety of data sources frequently gathered by network operators to provide answers to these issues. The main conclusions of this study are that the data centre networks exhibit high reliability, common switches like ToRs and AggS are very reliable, load balancers predominate which are short-lived software-related problems that frequently accompany failures. Only 40% of networks have redundancy, which is ineffective for lowering failure rates. and understanding failures have the potential to result in the loss of numerous little packets like keep alive messages and ACKs.

4. Dynamic virtual machine consolidation in heterogeneous cloud data centres with consideration for energy and migration costs:

For today's cloud data centres, energy efficiency has emerged as one of their top priorities. Until, live migration technology is reasonably priced, and data centre and migration costs vary widely. This study looks at the bi-objective optimisation problem to account for restricted migration costs and save as much energy as possible through dynamic VM consolidation. Based on an upper limit estimation approach for the maximum conserved power, a consolidation score function is developed for evaluation and a migration cost estimation method to represent the conflict between these two goals. To maximize the consolidation score based on them, we introduced a greedy heuristic, a swap operation, and an enhanced evolutionary algorithm for grouping.

5. Characterizing cloud computing hardware reliability

In order to provide highly accessible cloud computing services, today's data centres include a number of computers that coordinate work. Many hard drives, memory modules, network cards, processors, etc. make up these servers. They have been developed to reduce failures. The likelihood of encountering such failures is therefore minimal (usually 3-5 years in the business), and they are amplified across all devices hosted in a data centre. Large - scale hardware component failure is more common than uncommon. Business loss and performance degradation may result from hardware failure. By preventing failures from being tolerated, failure understanding enhances operational experience. It assists in lowering the cost of the hardware, resulting in savings for the business.

Existing System

All existing techniques were using reactive and proactive migration. Where reactive will take action upon resources failed, proactive will monitor all resources. Then, calculates probability of faulty machines, if probability of faulty machine high then it will migrate application from faulty to healthy machine.

Drawbacks

1. While existing technique will not concentrate on whether migration taking less resources or high resources.
2. If taking high resources then cloud provider profit will be reduce.

Proposed System

To overcome from this problem, we have introduced Probability Based Fault Management (PBFM) algorithm which uses Proactive technique to migrate application with less migration cost which can increases cloud provider profit.

Benefits

1. Less migration cost
2. Increases cloud provider profit

System Architecture

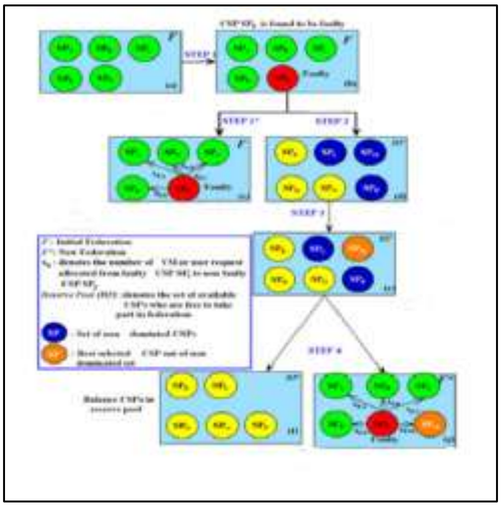


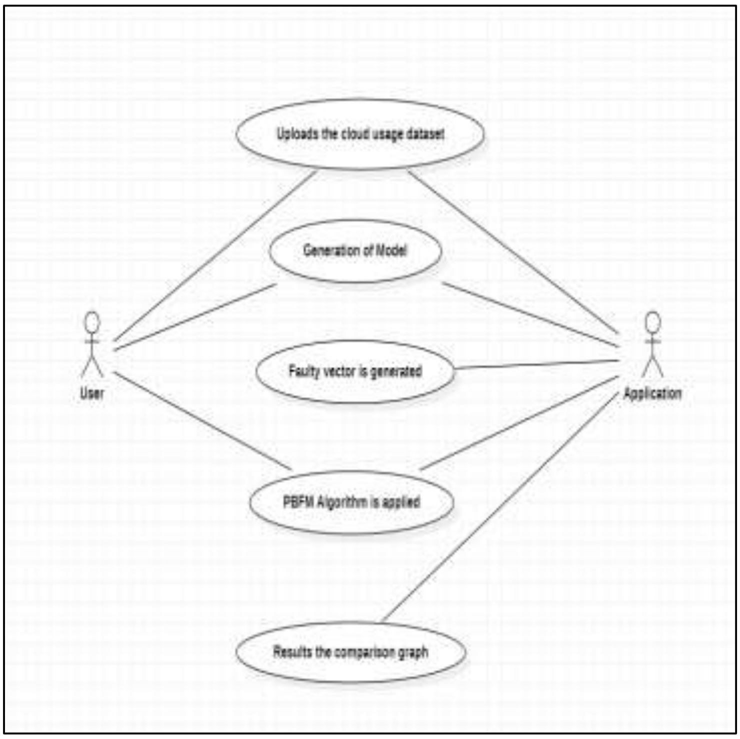
Figure 2

Modules

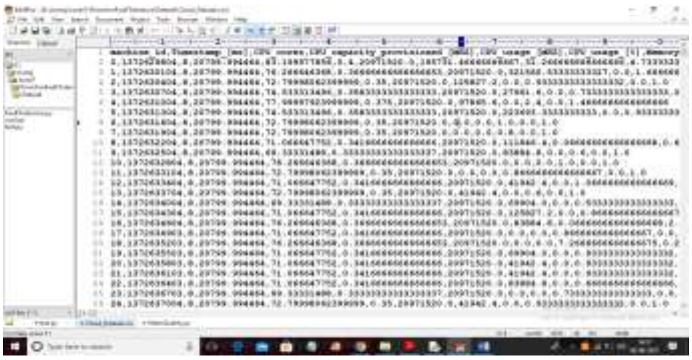
- Data exploration: various techniques are used to analyse the data, including statistical analysis and data visualization. Statistical analysis involves the use of statistical methods to analyse the data and identify any patterns or relationships that may exist.
- Data Pre-processing: It may also involve data integration, which involves combining data from multiple sources. This is particularly important in cloud federation environments, where data may be distributed across multiple cloud providers.
- Splitting data into train & test: It can help to identify potential sources of failure or degradation in service quality. By training the model or algorithm on a subset of the available data and testing it on another subset, it is possible to identify patterns and relationships that may not be apparent in the training data alone.
- Model generation: It involves building a predictive model that can identify potential sources of failure or degradation in service quality and take proactive steps to prevent or mitigate these issues.
- User input: Using this module will upload the cloud usage dataset.
- Prediction: percentage of faulty and non-faulty machines will be displayed.

Use case Diagram

A use case diagram is a form of UML diagram that aids in representing a system's or application's functioning from the viewpoint of the user. It is a graphic representation of actors, use cases, and their connections. Software developers frequently used use case diagrams to represent a system's functional needs.



Implementation



The top row of the above dataset screen lists the dataset's columns, while the following rows list the dataset's values. Details like CPU availability, CPU and memory use, and throughput speed are included in the dataset above.

Test Cases

S.NO	INPUT	If available	Unavailable
1.	Upload Cloud Usage Dataset	Dataset is loaded.	No process will take place.
2.	Build Faulty Vector	Finds all high CPU usage machines and then builds a faulty vector.	No process will take place.
3.	Run PBFM Algorithm	Predicts migration machine for faulty CPU with less cost to increase provider profit.	No process will take place.
4.	Faulty Machine % Graph	Gets faulty and non-faulty machines.	No process will take place.

Algorithms

PAFM: Profit Assured Fault Management Algorithm (PAFM) is a fault management technique used in distributed systems to ensure the optimal allocation of resources and maximize the system's profits even in the presence of hardware or software failures.

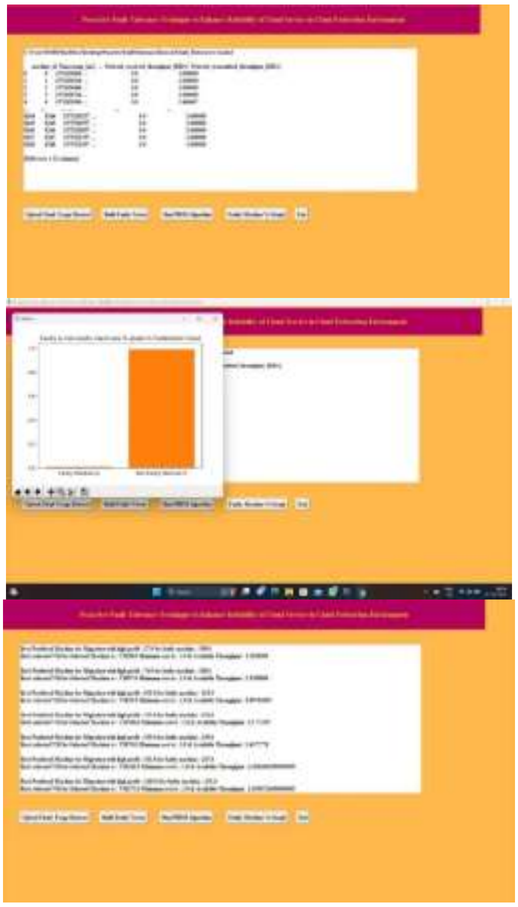
PAFM algorithm uses a set of rules to dynamically manage resources and reconfigure the system in the event of a fault. These rules are based on the current state of the system, such as the available resources, the current workload, and the failure rate of the system components. PAFM aims to minimize the downtime of the system and maximize the utilization of available resources while ensuring that the overall profit is not negatively impacted. PAFM is a powerful fault management algorithm that helps ensure the reliability and availability of distributed systems while maximizing the system's profits. It is an important tool for businesses and organizations that rely on distributed systems to support their operations.

MCAFM: Migration Cost Assured Fault Management Algorithm (MCAFM) is a fault management technique used in distributed systems that take into account the cost of migration during the process of managing the faults. The main goal of this algorithm is that to ensure optimal allocation of resources and maximize the system's profits while minimizing the cost of migration during fault recovery.

MCAFM Algorithm uses a set of rules to dynamically manage resources and reconfigure the system in the event of a fault. These rules are based on the current state of the system, such as the available resources, the current workload, and the failure rate of the system components. MCAFMA aims to reduce the downtime of the system and maximize the utilization of available resources while minimizing the cost of migration.

PBFM: PBFM Algorithm stands for Profit-Based Fault Management Algorithm. It is a technique used for managing the faults, that aims to optimize the allocation of resources and maximize the system's

profits even in the presence of hardware or software failures.
The profit function takes into account various factors, such as the cost of resources, the revenue generated by the system, and the potential losses due to system downtime.



3. Conclusion

In conclusion, proactive fault tolerance techniques are essential for enhancing the reliability of cloud services. These techniques help to detect and prevent potential failures before they occur, minimizing the impact on the system and the users. Through redundancy, load balancing, and other proactive measures, cloud providers can improve their ability to deliver uninterrupted service and maintain high levels of availability for their customers. By implementing these techniques, cloud providers can not only enhance their reputation but also increase customer satisfaction and loyalty, leading to long-term success in a highly competitive market. Ultimately, proactive fault tolerance is crucial for achieving the reliability and resilience required to support modern cloud-based applications and services.

Future Scope

Here are some potential future scope areas for proactive fault tolerance techniques:
Dynamic resource allocation: One area for future development is dynamic resource allocation, which involves dynamically reallocating resources to different cloud providers based on the current workload and available resources. This approach can help prevent overloading and reduce the risk of service disruption.
Multi-level redundancy: Another potential area for improvement is multi-level redundancy, which involves duplicating critical components of the cloud service across multiple cloud providers. This approach can help ensure that even if one cloud provider experiences a failure, the service can continue to function without disruption.
Fault prediction and prevention: It can also be helpful to utilise a proactive fault tolerance strategy that involves foreseeing and preventing errors before they happen. Machine learning algorithms can spot patterns and foresee potential errors by examining data from previous failures. The danger of service interruptions can then be reduced by taking proactive action using this information.
Self-healing systems: The development of self-healing systems that can detect and automatically recover from failures can also be an important area for future research. These systems can reduce downtime and minimize the impact of failures on the end-users.

Blockchain-based fault tolerance: Another potential area for future development is blockchain-based fault tolerance, which can provide a decentralized and secure approach to fault tolerance. By using a distributed ledger to store and verify transactions, blockchain-based systems can help prevent single points of failure and increase the reliability of cloud services.

Hence, Ongoing research and development in these areas can lead to more robust and resilient cloud services that can better meet the needs of businesses and users.

4. References

L. Mashayekhy, M. M. Nejad, and D. Grosu, “Cloud federations in the sky: Formation game and mechanism,” IEEE Trans. Cloud Comput., vol. 3, no. 1, pp. 14–27, First Quarter 2015.

B. Ray, A. Saha, S. Khatua, and S. Roy, “Quality and profit assured trusted cloud federation formation: Game theory-based approach,” IEEE Trans. Services Comput., to be published, doi: 10.1109/ TSC.2018.2833854

P. Gill, N. Jain, and N. Nagappan, “Understanding network failures in data centers: Measurement, analysis, and implications,” in Proc. 10th ACM Comput. Commun. Rev., 2011, pp. 350–361.

Q. Wu, F. Ishikawa, Q. Zhu, and Y. Xia, “Energy and migration cost-aware dynamic virtual machine consolidation in heterogeneous cloud datacenters,” in Proc. IEEE Trans. Services Comput., vol. 12, no. 4, pp. 550–563, Jul./Aug. 2019.

K. Vishwanath and N. Nagappan, “Characterizing cloud computing hardware reliability,” in Proc. 1th ACM Symp. Cloud Comput., 2010, pp. 193–204.

M. Schwarzkopf, D. Murray, and S. Hand, “The seven deadly sins of cloud computing research,” in Proc. 4th USENIX Workshop Hot Topics Cloud Comput., Jun. 2012.

O. Abdul Wahab, J. Bentahar, H. Otrok, and A. Mourad, “Towards trustworthy multi-cloud services communities: A trust based hedonic coalitional game,” IEEE Trans. Services Comput., vol. 11 no. 1, pp. 184–201, Jan./Feb. 2018.

E. N. Elnozahy, L. Alvisi, Y. M. Wang, and D. B. Johnson, “A survey of rollback-recovery protocols in message-passing systems,” ACM Comput. Surv., vol. 34, no. 3, pp. 375–408, 2002.

J. Liu, S. Wang, A. Zhou, S. Kumar, F. Yang, and R. Buyya, “Using proactive fault-tolerance approach to enhance cloud service reliability,” IEEE Trans. Cloud Comput., vol. 6, no. 4, pp. 1191–1202, First Quarter 2018.

M. Dong, H. Li, K. Ota, L. T. Yang, and H. Zhu, “Multicloudbased evacuation services for emergency management,” IEEE Cloud Comput., vol. 1, no. 4, pp. 50–59, Nov. 2014.

B. Rochwerger et al., "Reservoir - when one cloud is not enough", IEEE Comput., vol. 44, no. 3, pp. 44-51, Mar. 2011.

M. M. Hassan, B. Song and E. N. Huh, "Distributed resource allocation games in horizontal dynamic cloud federation platform", Proc. IEEE Int. Conf. High Perform. Comput. Commun., pp. 822-827, 2011.

S. Sotiriadis, N. Bessis, A. Anjum and R. Buyya, "An inter-cloud meta-scheduling (ICMS) simulation framework: Architecture and evaluation", IEEE Trans. Services Comput., vol. 11, no. 1, pp. 5-19, Jan./Feb. 2018.

S. Sotiriadis, N. Bessis, E. G. M. Petrakis, C. Amza, C. Negru and M. Mocanu, "Virtual machine cluster mobility in inter-cloud platforms", Future Gener. Comput. Syst., vol. 74, pp. 179-189, 2017.

M. Salama and A. Shawish, "A QoS-oriented inter-cloud federation framework", Proc. IEEE 38th Annu. Comput. Softw. Appl. Conf., pp. 642-643, 2014.

K. S. Patel and A. K. Sarje, "VM provisioning method to improve the profit and SLA violation of cloud service providers", Proc. IEEE Int. Conf. Cloud Comput. Emerg. Markets, pp. 1-5, 2012.

M. R. M. Assis and L. F. Bittencourt, "A survey on cloud federation architectures: Identifying functional and non-functional properties", J. Netw. Comput. Appl., vol. 72, pp. 51-71, 2016.

I. Goiri, J. Guitart and J. Torres, "Characterizing cloud federation for enhancing providers' profit", Proc. IEEE 3rd Int. Conf. Cloud Comput., pp. 123-130, 2010.

J. Xu and J. A. Fortes, "Multi-objective virtual machine place-ment in virtualized data center environments", Proc. 6th IEEE/ACM Int. Conf. Green Comput. Commun., pp. 179-188, 2010.