International Journal of Emerging Technology in Computer Science & Electronics (IJETCSE)
ISSN: 0976-1353 Volume 26 Issue 1 – JANUARY 2019.

A Systematic Survey of Fault Tolerance in Cloud Environment

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***Abstract*— Cloud computing take around the IT field potentially as-service-on-demand. The resources in cloud are dynamically scaled in an expensive manner. Utilization of service in cloud computing has an abundant advantage in terms of cost reduction, efficiency and storage capacity. Fault tolerance in cloud is a vital issue which guarantees the availability and reliability of cloud application. Several IT industries face inherent vulnerability due to operation scaling process. Depends upon the network topologies, the functioning of the data begin. Thus, the faults in cloud systems have to be effectively handled to achieve the effectiveness of the cloud data systems. This paper aims to provide a better understanding of several techniques which are used to deals with the fault in cloud. It also states the efficient techniques studied for identifying the significant research directions in this area. This paper paves the way for upcoming researchers to study about the significance of the fault tolerance mechanism in cloud systems.**

***Index Terms*— Fault tolerance, Cloud computing, Availability, Reliability and the Research directions.**

I. INTRODUCTION

The recent developments made in cloud computing and its services creates a better impact in industry and the academic due to its distributive nature. Cloud computing is the recent technology that runs on different applications of the business model. It is generally classified into three basics, namely, Software as a Service (SAAS), Platform as a service (PAAS) and Infrastructure as a service (IAAS) [1]. Instead of running on applications, they make use of multi-tenant model which support the growth of business environment. It's been finding that the cloud services are important in view of infrastructure and the application [2]. Since, cloud is a self-service oriented model; the collaboration of those models requires a higher level of concentration to support the business platform [3].

An important goal in the distributed system is to design an efficient fault tolerance mechanism which is a key challenge in cloud computing. The development of software system in cloud has to accommodate the failure events [4]. By the occurrence of the fault in the system, performance of the system degrades. In order to achieve the robustness and reliability, the failure should be handled and accessed properly. This in turn results in dissatisfaction of the customers that show the low service provider [5]. In the other point of view, when the reliability is high and the performance is low in this case the user request for service should wait for a long period. This in turn relies on the dissatisfaction of the customers. Based on the fault tolerance policies there are many fault tolerance techniques are involved in the cloud environment [6].

Data replication is used to improve the reliability performance in the distributed environment which involves the sharing information to ensure the consistency between the redundant resources such as hardware and software [7]. Data replication is classified into two types, namely, static and dynamic. The static is been designed at the database establishment of reallocation mechanism, dynamic is changing in the read- write pattern and it sends to the centre of the read- write activity in order to reduce the overhead involved in the sending and receiving the messages [8]. In distributed system, the data replication is classified into two fundamental classes, viz, primary backup replication and active replication. The primary replication is designed in such as way that one server act as a primary, the other are the backup the client sends the request to primary followed by this to sends the backup where there synchronized and response [9]. In case of the primary fails one of the backup acts as a primary. In active replication the number of server will replicate the objects and client presented in the similarly organized to the entire non faulty server which holds the replica [10].

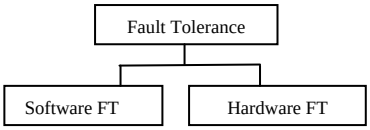
The rest of the paper is organized as follows: Section II presents the related work and Section III presents the conclusion.

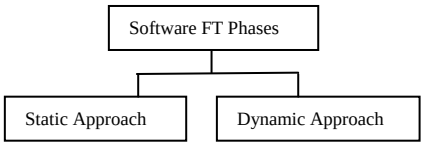
II. LITERATURE SURVEY

This section discusses related works of the fault tolerance mechanism in cloud computing system.

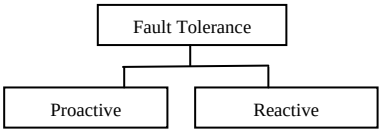
A. FAULT TOLERANCE AND ITS CLASSIFICATION

The fundamental types of fault tolerance are Software fault tolerance and Hardware fault tolerance. The Software fault tolerance can be divided by two phases such as static and dynamic approaches which are parallel to the hardware fault tolerance approach [11].





The Hardware fault tolerance are recovered from the system, since the failure caused by the hardware components. The fault tolerance is of two types, namely, proactive and reactive. The reactive phase will reduce the impact of failure, whereas the proactive fault tolerance is used for predicting the failures [12].



The main motive of fault tolerance is on degrading the data operations i.e data corruption, missing of data and the other one is the Hardware failure such as fault and slow virtual machine and storage exception. There are majorly classified into two phases, namely, error detection, which provides the hint of the operation that is been under process. The second one is the error recovery, which convert the erroneous system state into error Free State [13].

B. RELATED WORKS

Wenbin Dai (2018)[14], suggested that, Distributed Support System (DSS) [14] is initialized in real time scenario to control the management for business automation system. The knowledge based on Autonomic Service Manager (ASM) is shifted from the Programmable Logic Controller (PLC) to the cloud for decision making. In order to maintain the system operation, some of the necessary configuration are been carried out between Fault Tree Analysis (FTA) and the ASM. By using water processing approach, the cloud-based DSS deployed with the local and the public cloud server. To show that the suggested cloud DSS on local server are capable of providing real –time supervisory control using self healing test. In case of the public cloud, the issues like response time and network latency didn't meet its requirements. The drawbacks faced in this study, is the water heating depicts the scalability of the commands. In order to equalize the computational and response time of certain commands, a shorter downtime was achieved. And the Self-healing time taken is higher than the targeted cycle time.

In Yanchun Wang (2018)[15], stated that Criticality-based Fault Tolerance for Multi-Tenant SBSs (CFT4MTS) is developed for fault tolerance strategies for SBS based on service critical components. Component services are ranked by the critically and the service of been allocated by the service redundancy. To improve the effectiveness and the efficiency, the set of experiments are been compared using the three approaches that relies in a range of factor. The computational results showed the decreases in risk of the system quality for the multi- tenant SBSs. Still, some of the issues arise based on service utility, the quality parameters were studied. This proved the incomparability of the cloud systems. And the normalization of the data has been initiated to degrade curse of dimensionality. So, the probability distributions of service failure and quality degradation are domain specific.

Guangshum Yao (2017)[16], the author has presented an imbalance characteristic of fault tolerance. The re –submission of data has an advantage of resource utilization and thus the strategy reduces the context fault in task completion time. The ICFWS are having the advantages on both the resubmission and the replication fault tolerance for scheduling [16]. Based on the deadline division, each task from the fault tolerance strategy using the re submission and the replication are been selected. And it reserves the time interval for each task by taking on-demand resource modeling in the deliberation, which are done using virtual machine. In order to obtain the full time slot, online reservation adjustment scheme for enlargement of the sub-deadline on unexecuted task during fault tolerance strategy were constructed. The disadvantage is on-demand resource provisioning and the resources for backups cannot always have the same performance for primary copies, the VRTR of CCRH is greater than two. And the ICFWS reduce the cost of time and resource at the identical time for soft deadline constrained-workflow in Cloud systems.

Then, **Haoran Han Etal(2018)[17]** his study is further extended to hybrid real time task in cloud [17]. A novel algorithm has been designed namely, ARCHER for hybrid task in cloud. The establishment of fault tolerance in task scheduling is intended by using Checkpoint Primary/Backup (CPB) algorithm. It also improved the resource utilization in cloud which guarantees fault tolerance. The experimental result is compared with four algorithms, the projected work, resulted in better task scheduling. According to task scheduling, it divided into two types, namely, makespan and slack time. Task scheduling is done on primary copies of VM, and then it computes the task using the makespan and the Directed Acyclic Graph (DAG) make use of slack time where the data copies are scheduled. The drawback here is the resource utilization of the dynamic data copies is higher. And the idle resources drop down because the execution time taken is longer in scheduling mechanisms. Higher time consumption for completing single task.

In **Zhigang Wang (2019)[18]**, an innovative model is designed for asynchronous iterative computation; the framework is used for recovery of leveraging the surviving data. The approach gives assurances for correction of computation using fault tolerance. Failure Recovery Solution Without Rolling Back (FRWORB) and Failure Recovery Solution Without Asynchronous Checkpoint (FR-WAC) are typically using the maiter by introducing the check pointing in there method to remove the expensive asynchronous barriers. To achieve the most recent checkpoint, the data asynchronously reduce recovery workloads. The optimization technique is load balancing model which are boosting the efficiency of FR-WORB. The experiment

results show the evaluation of real-world graph to validate the effectiveness of fault tolerance and load balancing. They ought to improve the asynchronous models which removes the barriers and allows the vertices to freely update. And cascading failures happen, when node fails before data transmission.

In **Ravi Jhawar etal(2017)** [19], the author has studied about the system-level modular viewpoint for creating and organization of fault tolerance in Clouds. They have clearly delivering the fault tolerance, which deployed in virtual machine. By introducing generic fault tolerance mechanism in cloud, gives an independent modules, with matching user requirement with the available fault tolerance to obtain a desired property. The planned work is combined with the delivery scheme to provide better services. Thus, the component is constructed to extend and improve the overall resilience of cloud infrastructure. The drawback faced here is the maintenance of the replication tree which consumed higher computational cost. When a failure is detected in the system, the planned component, took higher response time to apply masking procedures.

In **Ji Wang etal(2015)** [20], Fault tolerance mechanism using primary backup, is constructed on elastic resource provisioning mechanism to improve resource operation. In order to achieve fault tolerance by allocating set of copies to task in different computing instance.

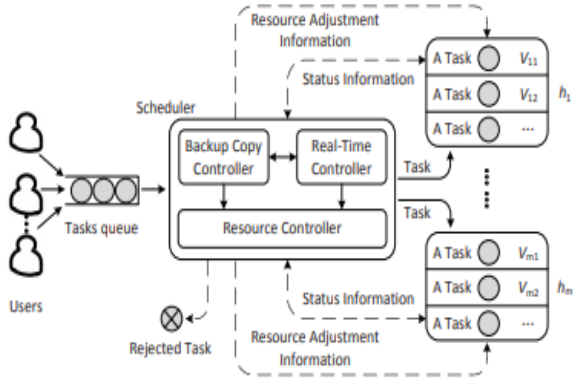


Fig.1 scheduling architecture

Fault-Tolerant Elastic Scheduling Algorithms for Real-Time Tasks in Clouds (FESTAL) is based on novel fault tolerance using virtualization technology on VM migration deployed on data center. Issues like reliability and schedulability in virtualized cloud were still profounding. In term of resource operation, the FESTAL is able to accomplish both the fault tolerance and high performance. Based on the synthetic workloads the real world traces invalidate FESTAL, which increase the performance in virtualization of cloud. The major issues here is elastic resource provisioning mechanism consists of resource scaling-up mechanism and resource scaling-down mechanism. Then, time complexity of the scheduling task requires meta-heuristic search.

From the extension of [20], the authors **Haoran Han(2018)** in [21] have designed a hybrid real-time task and analysis the nuclear physics, emergency response time and computing on-demand resource. This work investigated the scheduling task model on CPB for dynamic scheduling algorithm, namely, ARCHER. By classification of task in virtual machine, the accuracy of the task matches the virtual machine in cloud. The CPB combines the checkpoint technology with the traditional primary backup model for the hybrid tasks. The CPB provide more available time slot for resource utilization of system which are improved. It is analyzed on four baseline algorithms. There ought to improve the existing resources which are not used for scheduling process. And time taken for completing task is higher, when scalability increases.

Proxy based storage system for multiple cloud storage is modeled on NC Cloud for efficient and cost maintains on permanent single cloud failure **Henry C.H.(2014)**[22]. There are two types of operation involved in NC Cloud; they are normal operation where the proxy will be distributed in such a manner without the fault tolerance.

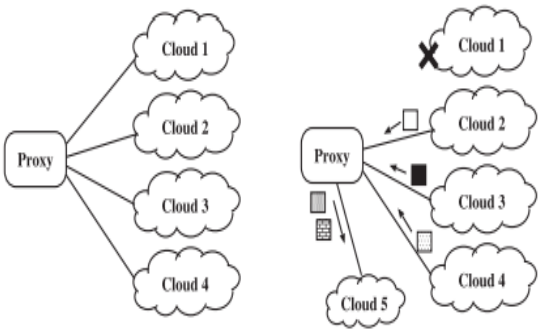


Fig.2 Proxy based design for multiple cloud storage

Second one is the repair operation; here the cloud node fails during this phase so the proxy regenerates the data for new cloud. The implementation of NC Cloud under the version of the FMSR codes during the repair process, it regenerate the new parity chucks to repair subjects which are having the requirement of degree for data redundancy. The presented approach eliminated the encoding requirement for storage node during repair of the new set of chunks which are stored in cloud. The NC Cloud showed the effectiveness of cloud backup usage. The disadvantage is that the security issues arise in regenerating the coded data. The recovery performance of the data is not evaluated.

In **Zibin Zheng(2012)**[23], an innovative method is constructed for component ranking framework, named FT Cloud for the development of fault tolerance in cloud based application.

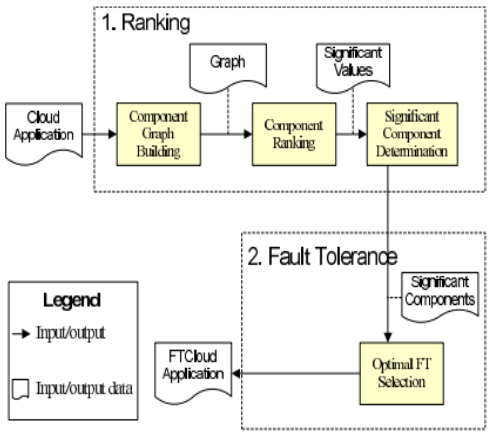


Fig. 3 System architecture of the FT cloud

The numbers of component which are invoked by significant value are been determined. The significant value

of the component is often invoked by the upcoming component and their characteristic. Based on the user constraints, the significant value are been found by the optimal tolerance strategy. Thus, the improvement done on selected components that are failed to achieve the process in cloud applications. And the derivation of prior knowledge is degraded by the impact of whole cloud system.

In **Renyu Yang(2016)** [24], the author has addressed the limitation for user-apparent failover in massive-scale systems. By using method, the soft state inference is accomplished by rapid failure recovery. It avoids the needless restart of resource overhead. By means of rapid user transparent failover, the implemented method is used in large scale cloud datacenters. The effective component are been recovered from the system component achieves the grouping of hard state backup and soft state inference. The drawback is there total requested resources from all jobs surpass the overall cluster capacity. The number of tasks is also not large compared with available resources, making sufficient resources to conduct redundant check pointing.

In **Ao Zhou (2017)**[25], redundant of VM placement optimization approach which enhanced the reliability of cloud services is designed. There are three types of algorithms were used, the first one selects the suitable VM hosting server, the second provide the optimal strategy to select the primary backup VMs and the third one is used for the VM task assignment using the heuristic optimization. To reduce the network computation of resource, a novel topology is designed to recover the backup of tolerance constraints. By embedding the three algorithms, the projected work consumed less network resources. There ought to improve the failure event affect more tasks so the total re-fetched data increase. By taking the bandwidth reservation into consideration, solving the mapping problem consumes higher resources.

In **Weiwei Qiu(2014)** [26], an innovative reliability-based optimization framework, named ROCloud is modeled using two ranking algorithm. First one is to rank the component in the application which migrated in cloud and the second one is by using hybrid application. The modeled work consists of three frameworks, namely, legacy application analysis, automatic rank optimal and automatic optimal fault-tolerant strategy selection. When there is having higher significance value, the component imposes the high impact on the application. After finding the component for optimal fault tolerance, it automatically selected the time and their cost constraints. The ROCloud and fault tolerance are component basis. The disadvantage is the software fault tolerance becomes an infeasible approach to improve the application reliability.

The author **Danilo Ardagna(2013)** [27] stated a service provisioning problem as a generalized Nash game and showed the existence of equilibria for such game. It is constructed for run-time allocation of IaaS resources among SaaS provider. The model here is to class utility function, which includes the performance level and the infrastructure which are associated with cost of IaaS resources. The effectiveness studied by the model approach is the performance and their simulation of the experimental in real protocol environment. The alternative methods provided the result up to 50-60% in the efficiency of the equilibria. The computational time is higher.

In **Xiaoqiang Ma**[28], DALM (Dependency -Aware Locality for Map Reduce) is designed for the real world input with the high dependent of data. The simulation is between the real world implementation and state-of-art, which included the Hadoop system. The efficiency of the presented approach improved the data locality by the Map Reduce framework. Even though the simulations in real world of DALM prototype deploy the superiority, the state of art includes Hadoop system based on Scarlett strategy. The drawback is the DALM degrades the task scheduling algorithm, that shows virtual aware. And there has the potential to improve the finish time for further scheduling jobs in large scale.

III. CONCLUSION

Over past years, cloud computing has became one of the trendy technology in industries. The growth of cloud technologies ensures the data complexity, stability, availability and the reliability. Due to reasons such as, different execution environments, insertion and deletion of components, updates, workloads etc empowers the failures and faults in dynamic environments of cloud systems. Henceforth, fault tolerance is one of the key challenges in cloud computing. This paper states the existing works in the field of fault tolerance and its significance in cloud applications. The main objective of the fault tolerance is to improve the quality of services by enhancing failure recovery, high reliability and the availability in cloud environment. Though, the cloud systems offer advantages, yet it is more prone to the failures\faults. Failures are common while supporting cloud data operations. From the surveys, the issues like availability and reliability of the data have to be concentrated. In specific to, data replication is one of the key challenges of the fault tolerance mechanisms. Since cloud data has been placed in different locations, the uniqueness of the data is to be maintained and the components used for data maintenance should support the recovery mechanism. As a future work, we make attempts on data replication mechanism that simultaneously supports the data recovery process in case of faults/ failures.

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