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DETECTION AND PREVENTION OF FAULTS IN CLOUD COMPUTING BY FAULT TOLERANCE TECHNIQUES

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ABSTRACT

To use the capabilities of Information technology as a service, Cloud computing is one of the most useful methods. Cloud computing allows the users to access the services available on Internet without understanding or controlling the infrastructure. Nowadays, Cloud computing is getting used massively, hence the need of Fault tolerance in the cloud is a matter of inspection because of its reliability. Fault tolerance has a lot of benefits such as Fault Recovery, economical, better performance when we use them in Cloud Computing. The main purpose of utilizing Fault tolerance techniques in cloud computing has encouraged the capability of researchers to participate in the development of efficient algorithms. As a result, we can find out the advantages and disadvantages of Fault tolerance in cloud computing. In my paper, I introduced various fault-tolerance methods recently used in cloud computing and a relevant study is presented of various techniques and methods in the field of bug tolerance in cloud computing. With the help of studying and reviewing fault-tolerant techniques, according to the requirements of the user, these techniques can be used for error tolerance capability measurement in cloudcomputing.

KEYWORDS: *Information, Cloud Computing, Error*

Article History

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INTRODUCTION

On a distributed network, there are several application and services that gets run with the help of resource available on Internet and Cloud computing is one of those concepts. It provides an abstract representation of physical system. There are a lot of advantages of Cloud computing such as Reliability, economical, high availability, flexibility, adaptability and scalability for the users that appears a new computing platform for the users. Quality of service also plays an

Important aspect in Cloud computing, high efficiency means how fast the system is responding on a user’s request for any service. Reliability means that the requested service has been handled successfully or not. High, efficient performance and Reliability play an important role in Cloud computing. More reliable means less crashes in the cloud service that will balance the number of users and reduce the loss of the server. The efficiency should remain high so that the user does not need to wait for a long time. So it can be related directly to error tolerance. High tolerance to fault is used to improve the reliability in cloud computing. Hence Fault tolerance is one of the most important issues in Cloud computing, related to all the necessary techniques to enable the system to tolerate the fault if its occur in the remaining software system after its development. The Key stimulation for this study is to identify different methods of fault tolerance in cloud computing that shall help researchers for designing more efficient algorithm. So this article is categorized into the following sections:

Faulttolerance

Error Tolerance is one of the important features of the system that helps the computer system or network device from failing due to any failure in system execution. This includes effective steps to stop such errors or failures in the system. Hence,a fault-tolerant system[2] is capable enough of providing the services in an efficient manner if a fault or failures occur in system components as a result the availability and reliability of the system will not be lost. A bug system should be tolerable in such a way that if a bug occurs, the system can tolerate it and continue to work. We should understand the proper definition of error at first, because with this word, two words arises in the mind that is the fault and the failure, however there are three major differences between them.

Failure: A failure occurs when the system is not giving the expected result or performance. If the system misconduct affords the system to fail at least one of its capabilities properly.

Fault: The fault is a physical malfunction or a failure of a hardware or software component.

Bug: The reason of an error is a bug in the system. Not all bugs would lead to faults. Failure, faults and bugs can occur in applications, servers, virtual machines even hardware. The system must be capable [1] of handling fault and continue to work. Fig 1 shows the path of a fault:

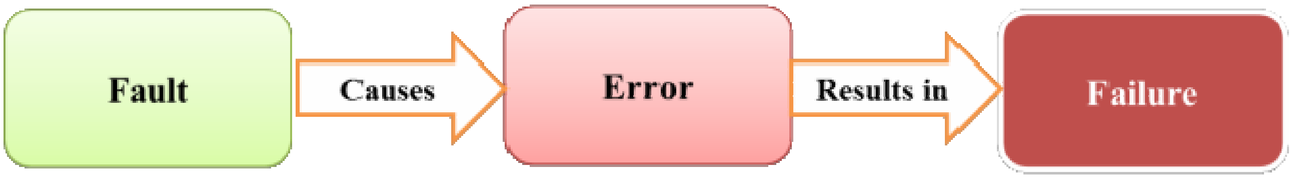

Figure 1: The Path to Failure

Below are the Solutions to the Problems

Fault Detection: To get the best result, the first step that a system must perform is identifying the functions that can lead to Faults.

Fault Repair: After detecting the fault, the next step is to rectify, a void the fault or to improve it.

Fault Types

The cloud platform comprises of three layers:

- Hardware
- Virtual machines
- Applications

Each of them has a malfunction. These failures can be present on any hardware or virtual machine layer during program execution. Therefore, as per the nature of the failure, appropriate action should be carry out, faults can be split in several categories:

Network Faults

Faults related to networks are known as network faults. This fault occurs when the data is destined to a particular network, however it does not get deliver there for various reasons such as packet loss, closed date, destination failure, link failure. [5]

Physical Fault

Faults that occur in hardware, CPU crashes, crash failures and memory crashes.

Media Fault

Due to the lack of communication media.

Processor Fault

Fault occurred on the processor due to failure in operating system.

Service Termination Fault

If the service life of the resource is over, however the application still requires the use of resources.

Transient

This fault stays for a long time and appears onlyonce, however after taking properactions it disappears. For example, at first the network message displays that the signal cannot reach its destination, but after a while it reaches its destination prosperity.

Alternate

Alternate faults are those that repeatedly and alternately distributed. These failures are not good, mainly due to the failure of each component or function inappropriately [4] between the components, for example a faultyconnection.

Stable

These kind of failures do exist, after defective systems are repaired or replaced in some cases completely.

Types of Faulttolerance

Fault tolerance are of two types: Hardware fault tolerance and software fault tolerance.

Hardware Faulttolerance

One of the main aspects of fault tolerance is to make a computer system which can automatically recover if multiple random faults occur in hardware components. The best methods for this work generally include the division of a computational system in multiple modules. Each module in the system is unique. Therefore, if one of the failure occurs in one of the modules, the backup module will continue to work. Fault tolerant methods include two types of error handling and dynamic recovery.

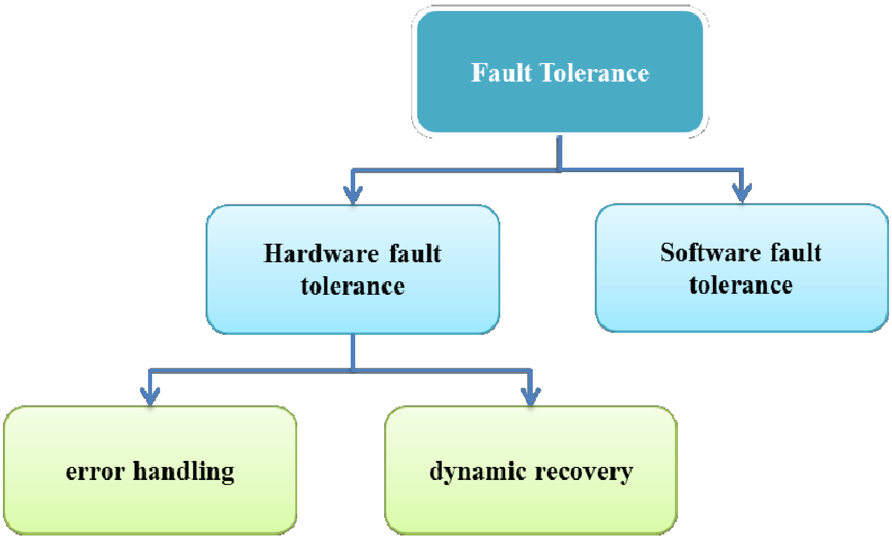

Figure 2: Types of Fault Tolerance

Fault Coating

Fault coating eliminates faults in a set of mixed components. A number of identical components execute same functions and their output is voted on to remove faults afforded by a defective module.

Dynamic Retrieval

A dynamic retrieval technique is only used when a copy of the work or calculations is made to run at a time. This technique is a self-repair. Like a fault-coating technique, additional spare components are used to perform to remove redundancy.[3]

Software Faulttolerance

Programming faults can be exploited using static and dynamic methods similar to those used for hardware fault handling. One of the methods is n-version programming, which uses static redundancy in the form of independent programs. All of these methods perform the same function. Another method known as design variation, which incorporated software and hardware fault tolerance by applying a fault-tolerant computer system? The main goal of the design diversity technique is to tolerate hardware and software faults, however it’s very expensive.

Fault-Tolerant Requirements

The important goal in designing distributed systems is to generate a system that can automatically repair minor defects without affecting the system performance. In other words, a distributed system is expected to tolerate the fault. To realize the role of tolerable fault, there should be covered a number of useful requirements [6] for distributed systems including the following:

Average Failover Time (MTTF)

The waiting time for failure bearing in mind that the system has been utilizable.

Average Repair Time (MTTR)

The expected time to repair the system after a failure.

Average Breakdown Time (MTBF)

This denotes the average time for the next failure and is calculated as follows:

MTBF=MTTF+MTTR

Reliability

Points to the point that a system can run continuously and without fail.

$$Reliability = \frac{MTTF}{1{+}MTTF}$$

Availability: The system operates at any one time and is available to perform tasks.

$$Availability = \frac{MTBF}{1{+}MTBF}$$

Safety: refers to a situation when nothing works temporarily, nothing happens.

Maintenance: **R**efers to how to repair a failed system. A superb maintenance system may also have a high degree of availability.

$$Maintainability = \frac{1}{1{+}MTTR}$$

Reasons for Accurate Analysis of Several Techniques of Fault Tolerance in Cloud Computing

Implementation of fault tolerance in cloud computing due to its complexity, reliability, and the following reasons are confronting challenges which requires detailed analysis.

- There is a need to implement a self-governed fault tolerance technique for several instances of an application running on multiple virtual machines.
- Different technologies from cloud computing providers and vendors will require a formidable integrated system
- With new approaches in the cloud, should also be expand fault tolerance techniques and scheduling algorithms[8]
- Self-governed fault tolerance techniques must be aligned with differentclouds.
- To ensure maximum reliability and availability must be operational several providers of these services.

Criteria for Fault Tolerance in Cloud Computing

Fault tolerance methods in cloud computing considers various parameters:

Adaptive: The entire process changes automatically according to the work requirements in real time.

Efficiency: To measure the efficiency at an acceptable cost, such as it will give the result to the users in minimum response time and improve the latency in response**.**[7]

Response Time: The amount of time spent to give the output by the particular algorithm. This should be minimum.

Scalability: The capability of an algorithm to perform error tolerance for a system with a finite number of nodes.

Operating Capacity: To keep a track of the work that has been completed. This aspect must be maximize to improve system performance.

Reliability: The purpose of this criteria is to give a true result in a limited environment.

Availability: The availability of a system is typically measured as a reliability factor, as it increases the reliability of access.

Usability: The percentage of a product that can be exploited by a user to achieve his/her goals with effectiveness, maximum efficiency and product satisfaction.

Related Overhead: The tolerance of the fault distinguished the amount of overhead captive in the execution of an algorithm. This overhead is performed due to overhead to work, processor inside, and communication between the processes, it should be reduced so that an error-tolerant technique can work more effectively. [11]

Effect on Cost: The cost here is defined as a warning cost here.

Fault Tolerance Methods

Based on fault tolerance, different techniques and strategies are divided as shown below.

Tolerable Preventive Fault

The policy of tolerance is the action-oriented fault, it prevents the faults and failure by their prediction and the actions performed to replace the detected component. There are a number of methods based on this policy that contain preventive migration, software rejuvenation and self-protection. [2]

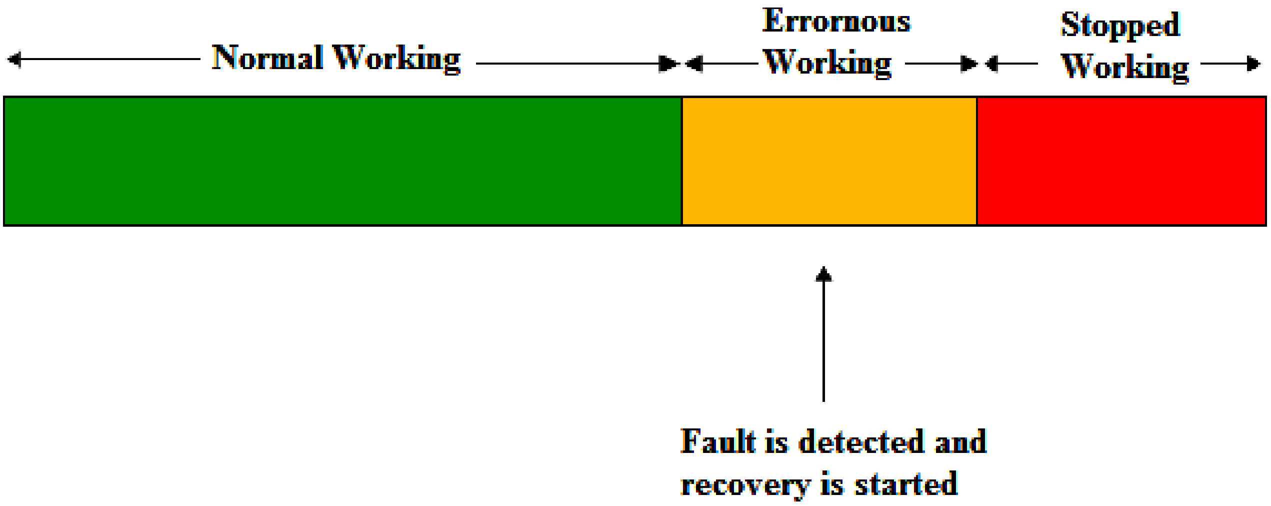

Figure 3: Timetable for a Precautionary Fault Detection System

Software Rejuvenation: It is a technique that designs the system for periodic reload and returns the system to its original state and helps to make a new start.

Preventive Migration: Preventive Migration works on the feedback loop control mechanism. This application is continuously monitored andmeasured.

Self-Protection: This method is used to improve performance. When different instances of an application are running virtually on different devices, it automatically manages application sampledefects.

Tolerable Reaction Fault

When failure happens effectively attempt to reduce failures, this technique is used this method gives morepower to the system. Different techniques are based on this policy; Inspection, re-assignment of function, release of workflow, handling of user's specific behavior, retrial S-Guard, etc. [9]

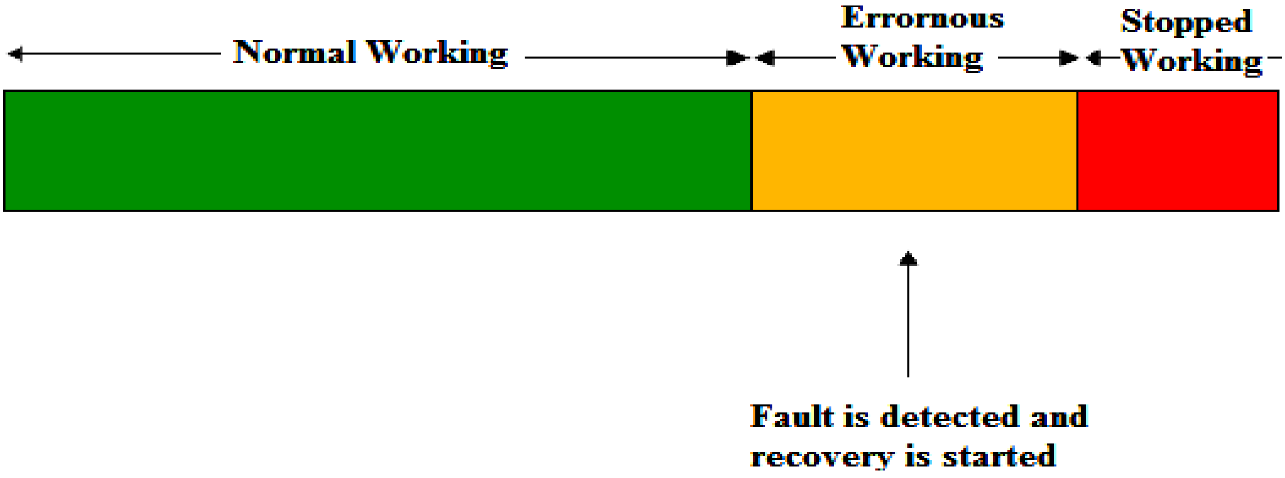

Figure 4: Timeline for a Reactive Fault Detection System

Inspection: One of the fault handling Technique for large tasks. It examines the system after a huge change in the system.

Work Migration: If a machine is not responding as per the requirements or not giving the desired result. So that work can be transferred to a different machine. [17]

Duplication: If a method is giving an efficient result on a particular software system, the same method can be used on the software systems having same characteristics. It helps to get the favorable result on different resources.

Examining safety packages: Blocking of commands that do not have safety properties.

Retry: A task will re-implement and retrieve. This is one of the easiest techniques to re-work in one source.

Task Resubmission: In this method, at runtime, the task is re-sent to run to the samesource. [13]

S-Guard: Fewer disturbances to normal execution flow. On the basis of work retrieval and rollback.

Adaptive Faulttolerance

The tolerance of an application fault requires the change depending on the range of control inputs. Adaptive tolerance automatically adjusts the instructions to the status control, also ensures the credibility of critical modules under any resources and time constraints. Provides as much redirection resources and modules as possible to give the best result. [10]

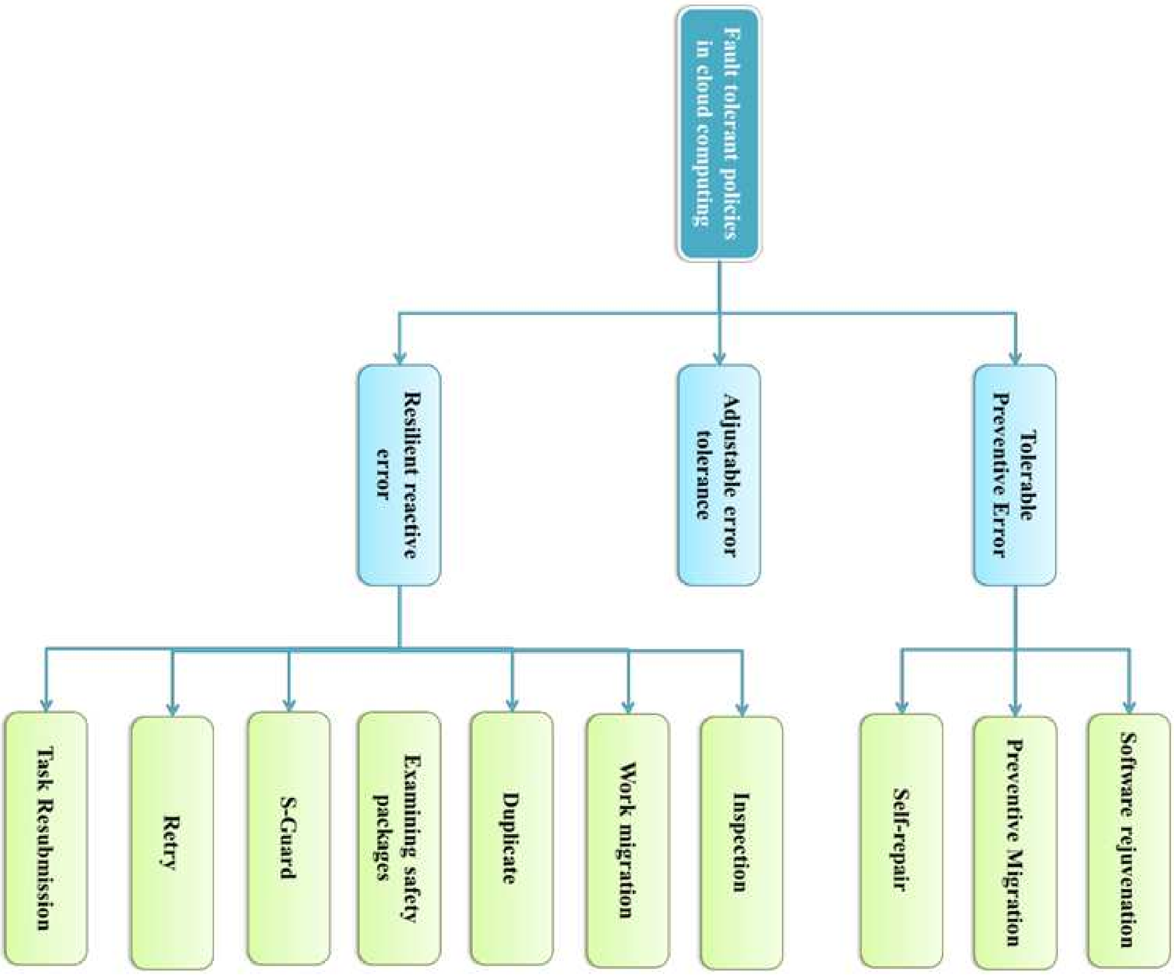

Figure 5: Classification of Fault Tolerance Policies in Cloud Computing

Table 1: Comparison of Different Tolerance Techniques

Politics	System	Programming Framework	Environment	Fault Detection	Application Type	Techniques
Preventive / Reactionary	HAProxy	Java	Virtual machine	Node failure or processing	Fault tolerance and load balancing	**Self-healing, job migration, replication**
Preventive	SHelp	SQL,JAVA	Virtual machine	Application Crash	Fault tolerance	**Check Pointing**
Preventive / Reactionary	Assure	JAVA	Virtual machine	Network / host failure	Fault tolerance	**Check Pointing, retry, self-healing**
Preventive / Reactionary	Hadoop	Java,HTML, CSS	Cloudy environment	Node downtime and application های programs یدربراک	Volume of data	**Job Migration, Replication, S-Guard**
Preventive / Reactionary	Amazon EC2	Amazon Machine Image, Amazon Map	Cloudy environment	Node downtime and application programs	Fault tolerance and load balancing	**Replication, S-Guard, Task Resubmission**

Fault Tolerant Models

Most of them are based on these techniques:

FT-Cloud: Cloud computing applications are more complex and provided on a large scale. However, they are not reliable enough so we cannot consider them ideal. There is a chart-based ranking component which uses its architecture to build cloud applications. [11] A two-stage framework of operational algorithms that includes ranking and fault tolerance. FT-Cloud provides applications to Cloud computing to deal with faults. Also helps, Cloud computing against collision faults and amounts.

BFT-Cloud: This model can be categorized as a reactive model. When a request is located in the cloud computing system, the request must be performed in different nodes. One of the nodes is selected as the main node and the other nodes are selected as backup nodes. In the application, all applications run on the device locally. If the results on the backup nodes are the same, the output is correct and correctly requests the module. If on the back up nodemajor editions failed, [15] they will give a different outputs than other outputs. Hence this node is knownas a defective node and in the upgrade phase, shouldbe done the recovery operation. If the node is a defective node, it will change it to the original new version at the initial stage and if the defective node is one of the backup nodes, then it should be replaced with convenient nodes at the replacement update stage.

FTM Model: Another architecture that deals with cloud computing fault tolerance is FTM, which is used to manage fault tolerance. The FTM model is one of the reaction techniques that use three techniques (job migration, checkpoint / retrieval, repeat). This model guaranteed reliability and flexibility by using creative methods that the user can identify and enforce to achieve a satisfactory level of fault without having to know about its accomplishment. [12]

LLFT Model: The model which is called LLFT, delivers fault tolerance with a low postponement. This model has provided F.T the capacity to develop distributed programs or data centers. LLFT uses the leader / follower duplication approach. In this structure, copies of a process form the group. In each group, a process is selected as the main process, and the rest are selected as the backup. These groups are a process that provides services for users in the form of a server group. Communication between groups happened through a virtual connection. The original version of the source group sends messages to the original version in the destination group through multicast via virtual communication. [18]

Candy Model: It has been introduced a component-based distributed modeling framework which is a comprehensive semi-automatic model and is described by the language of the system model. This model indicates that cloud services and cloud computing providers should guaranteed availability, which is one of the highlights of cloudservices.

AFTRC Model: A fault tolerance model for cloud computing is based on a real-time system can benefit from computing capacity and cloud-scalable virtual environment for better real-time use. In this model, the fault system is tolerant of action. Based on the reliability of the processor nodes; it exports an executable command.

FTWS Model: The FTWS model stated in, fault tolerance is presented using startup and propagation techniques according to the priority of tasks. This model plans the workflow with a deadline in the presence of faults. This model is also based on the fact that the workflow is a set of processed tasks with a segregated order based on data and affiliation. [16]

Magi-Cube Model: In the Magi-Cube architecture is introduced which a very reliable storage structure for cloud computing. They use this system on top of HDFS and handle it as a storage system for reading / writing files and managing cloud data. They also create a startup file and modify the component to work independently in the background. In fact this model is based on the three contradictory components of the storage system that they are reliability and high efficiency and low cost (space).

Table 2: Comparison between Different Models Based on Error Tolerance Criteria in Cloud Computing

BFT-Cloud	Magi-Cube	FT-CLOUD	CANDY	FTM	FTWS	LLFT	AFTRC	Model Criterion
Yes	Yes	Yes	Yes	No	No	No	Yes	**Adaptive**
High	High	High	Average	Average	Average	High	High	**Performance**
Average	Average	Average	Average	Average	Average	Average	Average	**Response time**
High	High	High	High	Low	Low	High	High	**Scalability**
High	High	Average	High	Average	Low	Average	High	**Throughput**
High	High	High	High	Average	Average	High	High	**Reliability**
High	Average	Average	High	High	Average	High	High	**Availability**
Average	High	High	Average	Average	Average	Average	High	**Usability**
Average	Average	High	Low	Low	High	Low	Average	**overhead**
High	High	High	Low	Low	High	Low	Average	**Impact on cost**

CONCLUSIONS

Cloud computing has become a commonly used computing technology. There must be reliability and availability for users. This requires utilization of tested tolerance methods which can manage any kindof fault. The fault tolerance is required when a fault enters the system borderline, Therefore, fault tolerance techniques are used to predict these failures and take the necessary actions before it damages the system completely. Therefore, we need a fault tolerance method that will prepare the services provided in cloud computing against the resulting faults and failures.in this paper, we discussed the need for fault tolerance, covering various techniques for implementing fault tolerance. There are a number of fault-tolerant techniques in the cloud, which prepare various fault tolerance mechanisms by increasing the reliability of the system. Also, these techniques represent a major role in providing service availability to the user. However there are still some issues and deficiencies that must be considered for each framework. There are debility that none of them can complete all aspects of the faults. Therefore, it is possible to dominate the inability of all previous models and try to create a proper and efficient model that covers the most aspects of fault tolerance. In the future, it is also expected to better understandthe types of faults in hardware, software, and cloud infrastructure by providing other models of architecture with higher fault tolerance, higher reliability, availability, and better performance.

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