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Review Article

System and Failure Analysis on the Various Reliability Issues in Cloud Service

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Abstract: Cloud computing is a recently developed new technology that provides a model for resource sharing over the internet, which is different from the resource sharing of the grid computing systems. Cloud computing is designed to deliver computing resources as a service to consumers over the internet from large-scale data centers – or "clouds". Reliability is one of the major issue in the cloud computing. Cloud reliability analysis and modelling are not easy tasks because of the complexity and large scale of the system. This research paper is the systematic review on the cloud computing basic concepts. This research paper also analyzes the key research challenges present on reliability of cloud service.

Keywords: Cloud Architecture, Cloud Computing, Cloud Management System (CMS), Reliability, FTCloudSim, Monte Carlo Simulation.

1. INRODUCTION

This section gives an introduction to Cloud computing basic concepts and models. Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction [1].

Cloud computing is a combination of various previous technologies like "grid computing", "distributed computing", "utility computing" or "autonomous computing". Cloud computing provides easy and cheap access to all resources. Cloud computing has the ability to scale up or down their service requirements. With the help of virtualization different computational needs are accomplished on the same physical infrastructure. Usually Cloud Computing services are delivered by a third party provider.

Cloud computing is a general term that provides resources as a service over the internet. A bird's eye view of Cloud computing is shown in Fig. 1 [3].

1.1 Basic Concepts

There are working models that make the cloud computing feasible and accessible to end users. Following are the working models for cloud computing:

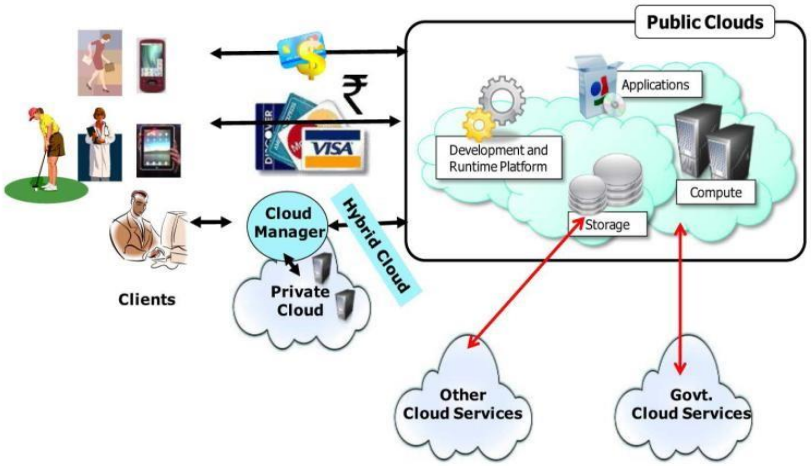

Fig. 1: A bird's eye view of cloud computing [3]

1.1.1 Deployment Models

Deployment models are defined on the type of access to the cloud, i.e., how the cloud is located? Cloud can have any of the four types of access: Public, Private, Hybrid and Community.

- *Public Cloud* are developed, deployed and maintained by a third part service. The services within the public cloud have been developed for the general public. Public clouds have lack of security due to its openness to public, e.g., e-mail.
- *Private Cloud* services are developed, deployed, maintained and maintained for single enterprises. The private cloud provides more security and greater control than public clouds.
- *Community Cloud* a cloud that is developed for sharing of resources by the several organizations. These clouds are designed for specific purpose like for security requirements.
- *Hybrid Cloud* a cloud that is built by combining the above of three deployment models. This cloud provides the features of that clouds from whom that it is made.

1.1.2 Service Models

Service Models defines the main models for cloud computing on which computing is based. These are three basic service models as listed below:

- ***Software as a Service (SaaS):*** In SaaS pre made software is provided to consumers on pay-per-use manner. The SaaS is the software that is developed by a hosted service and accessed through the internet.
- ***Platform as a Service (PaaS):*** PaaS gives the platform to develop programs and application without the need of software. Applications are developed by using a set of programming languages and tools that are supported by the PaaS provider. It also provides an infrastructure to test cloud applications.
- ***Infrastructure as a Service (IaaS):*** IaaS provides the environment for sharing of resources like servers, networks and storage. IaaS helps users to use that shared resources to deploy and run their applications.

Figure 2 provides an overview of the common deployment and service models in cloud computing, in which the three service models could be deployed on top of any of the four deployment models.

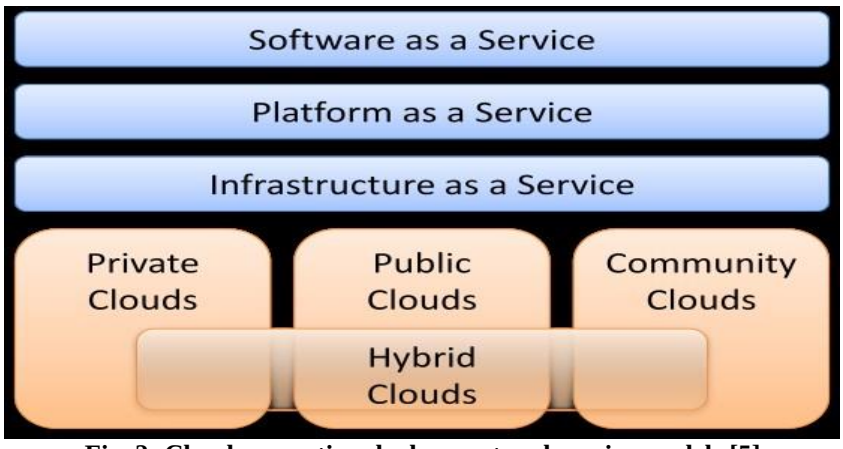

Fig. 2: Cloud computing deployment and service models [5]

2. CLOUD SERVICE RELIABILTY

This section gives an overview about the architecture and various failures of cloud service system. Reliability is one of the key factors to be considered in cloud computing environment. Reliability is defined as the probability that a given item will perform its intended function for a given period of time under a given set of conditions.

Cloud reliability means how the cloud is available to provide the services even when several of its components fail. A cloud will be more reliable if it is more fault-tolerant and more adaptable to changing situations. It is impossible to have a cloud that is completely free from failures or failure resistant. Various types of failures are interleaved in the cloud computing environment such as overflow failure, timeout failure and resource missing failure, network failure, hardware failure, software failure, and database failure [6].

The reliability of the cloud computing is very critical but hard to analyze because cloud is made up by the combination of various factors like wide-area networks, heterogeneous software/hardware components. There are many complicated interactions among the various components of the clouds. Hence, the reliability models that are defined for pure software/hardware or conventional networks cannot be simply applied to study and evaluating the cloud reliability.

2.1 Cloud Computing System and Failure Analysis

Cloud computing is different from distributed computing by its focus on high massive-scale service sharing than the distributed computing.

2.1.1 Cloud Service System Architecture

The architecture of our cloud service system is described in Fig. 3. There is a cloud management system (CMS) which define by a set of servers (either centralized or distributed). The CMS mainly fulfills four different functions as shown in Fig. 3.

The four different functions managed in cloud service system are given below [6]:

- To manage a request queue that receives job requests from different users for cloud services;
- To manage computing resources (such as PCs, Clusters, Supercomputers, etc.) all over the Internet;
- To manage data resources (such as Databases, Publicized Information, URL contents, etc.) all over the Internet; and
- To schedule a request and divide it into different subtasks and assign the subtasks to different computing resources that may access different data resources over the Internet.

2.1.2 Failure Analysis of Cloud Service

There are a various types of failures that may affect the success/reliability of a cloud service, including Overflow, Timeout, Data resource missing, Computing resource missing, Software failure, database failure, Hardware failure, and Network failure [6].

- ***Overflow:*** this failure occur if the job request is greater than the maximum number of the requests set in the request queue. After the maximum number all the new request are discarded and the users are unable to get the service that they want, and the overflow failure occurs. If the new request has to wait for too much time then that leads to more timeout failures.
- ***Timeout*****:** The time is set by the users or service provider for the result of the requested job in cloud service that is called due time. If the waiting time of the job/request is greater than due time the timeout failure occurs.
- ***Data Resource Missing*****:** In CMS, all the data resource is registered on the data resource manager (DRM). If the data resources that are registered on DRM are removed but the DRM is not updated. As a result, if so when those data resources are assigned in a certain job request, they will cause the data resource missing failure.
- ***Computing Resource Missing:*** The computing resources in cloud are any physical or virtual component. Similarly to the data resource miss, the computing resource missing may also occur, such as PC turns off without notifying the CMS.
- ***Software Failure*****:** The software failures that are due fault or unexpected results in programs running on same or different computing resources.
- ***Database Failure:*** The database that stores the required data resources may also fail due to mistake in the design of the database fail to connect with the database and database crashes that causing that the subtasks when running cannot access the required data.
- ***Hardware Failure:*** The computing resources and data resources have both hardware (such as computers or servers) which may also encounter hardware failures e.g. crashes in the storage devices.
- ***Network Failure:*** The network problems arise due to the bad design of the communication channels and broken of the communication channels when subtasks access remote data.

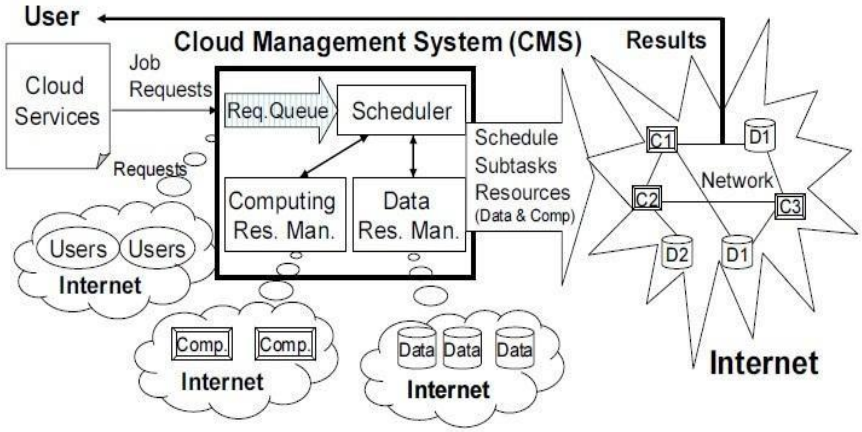

Fig. 3: Cloud Service System [6]

We classify the above failures in two groups [6]:
1) Request Stage Failures: □ Overflow

- Timeout.

2) *Execution Stage Failures:*

- Data resource missing,
- Computing resource missing,
- Software failure,
- Database failure,
- Hardware failure and Network failure.

Therefore, the two groups of failures could be considered as independent. But failures within each group are strongly correlated.

3. CLOUD SERVICE RELIABILITY ENHANCEMENT MECHANISM

The downtime of the cloud data center has the negative affect on the cloud service reliability. Evaluating and enhancing reliability in cloud computing is not so much easy task. However, there are some tools that are used to evaluate and enhance the cloud service reliability. This section gives the introduction about the tools that help to enhance the reliability of cloud service.

3.1 FTCloudSim

FTCloudSim is developed by extending the basic functionality of CloudSim. FTCloudSim, a CloudSim-based tool provides an extensible mechanism to enhance the cloud service relaibility. FTCloudSim can handle the failure events with the help of check-pointing mechanism.

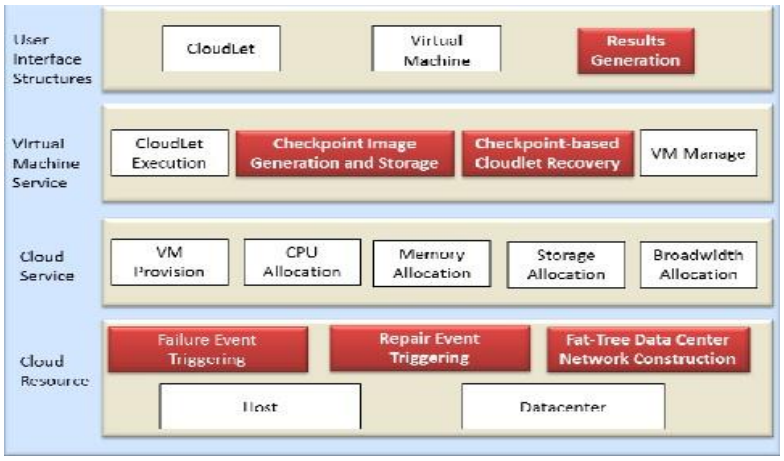

Fig. 4: FTCloudSim Framework [9]

3.1.1 Design of FTCloudSim

As shown in Fig. 4, FTCloudSim is developed by adding 6 modules to CloudSim: (fat-tree data center network construction, failure and repair event triggering, checkpoint image generation and storage, checkpoint based cloudlet recovery and results generation) [9] which will be described in this section.

- ***Fat-Tree Data Center Network Construction:*** FTCloudSim automatically constructs a fat-tree data center network. With the help of fat-tree construction the networks can be used with any bandwidth and with any communication technology. This feature helps the cloud service providers and consumers to reliable communication of the data resources.
- ***Failure and Repair Event Triggering:*** With the help of FTCloudSim all the failure and repair events are saved on a file so that the experiments can be repeated for improving the reliability of the cloud.
- ***Checkpoint Image Generation and Storage:*** A checkpoint image is generated and stored for the purpose of resume the task from that stored point in the event of failure.
- ***Checkpoint-Based Cloudlet Recovery:*** A task is resumed from the latest checkpoint image stored in the event of host failure. If there is no accessible checkpoint image, it will fetch the necessary data from the central database and restart the interrupted task from the beginning.
- ***Results Generation:*** This module generates all the failure, repair and checkpoint results to the user.

3.2 MCS (Monte Carlo Simulation)

MCS is a computer based mathematical technique that deals with the quantitative analysis of the risks occurred in the system. MCS also analyzes the behavior of the component that causes the uncertainty. MCS is a stochastic simulation tool which comes in two varieties: non-sequential and sequential. The general non-sequential MCS algorithm used for evaluating reliability [10].

All four steps of the MCS algorithm (sampling, classification, calculation, and convergence) are dependent on an efficient representation of individual states [10]. Non-sequential Monte Carlo Simulation (MCS) is used for evaluating cloud service reliability.

4. CONCLUSION

The cloud computing provides high reliability from the previous technologies (grid computing, distributed computing etc) but still reliability is primary component to be considered in cloud computing environment. The challenge of reliability comes when cloud service provider delivers on-demand software as a service i.e. accessible through any network conditions (slow connections). The main purpose of discussing reliability in this paper is to highlight the failures in cloud service. From failure characteristics in cloud we can identify the availability of cloud service when several of its components fail. A cloud is more reliable and available if it is more faults tolerant. Fault-tolerance mechanism like FTCloudSim and MCS are used for recovering and evaluating the failures in cloud computing environment.

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