FTCloudSim: A Simulation Tool for Cloud Service Reliability Enhancement Mechanisms

Ao Zhou, Shangguang Wang*, Qibo Sun, Hua Zou, Fangchun Yang
State Key Laboratory of Networking and Switching Technology
Beijing University of Posts and Telecommunications, Beijing, China
hellozhouao@gmail.com, {sgwang, qbsun, zouhua, fcyang}@bupt.edu.cn

ABSTRACT
Recently, an increasing number of companies have deployed their application services on in the cloud. However, the cloud data center downtime has negative affected the quality of cloud service quality. Many researchers have studied the problem of cloud service reliability assurance. However, there is a shortage of tools that enable researchers to evaluate their new proposed cloud service reliability enhancement mechanisms. To fill this gap, we extend the basic functionalities of CloudSim and present FTCloudSim in this paper. FTCloudSim provides an extensible interface to help researchers implement new cloud service reliability enhancement mechanisms. In addition, FTCloudSim can also study the behavior of the new proposed mechanisms. We demonstrate the capabilities of FTCloudSim by using four reliability enhancement mechanisms. The results can indicate the benefits of our tool.

Categories and Subject Descriptors
I.6.7 [**Simulation Support Systems**]: Environments

I.6.8 [**Types of Simulation**]: Distributed

General Terms
Algorithms, Performance, Reliability, Experimentation

Keywords
Cloud computing, CloudSim, Cloud Service, Reliability, fault-tolerance

1. INTRODUCTION
Recently, because of its ability to allocate resources dynamically and instantaneously as needed, cloud computing has become a popular computing model nowadays. As cloud computing allows the physical resources to be shared by a vast number of cloud service providers, companies and other organizations have begun deploy their application services in the cloud to save on the costs of maintaining their own infrastructure. However, there are hundreds or thousands of host servers in a cloud data center, failures are the norm, rather than the exception. Therefore, this problem is being thoroughly studied [1-2]. Researchers have begun to study the problem and propose many fault-tolerant mechanisms to enhance the reliability of cloud services.

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Unfortunately, current cloud simulation tools are not able to aid researchers in evaluating their new proposed mechanisms. In this work, we present FTCloudSim, a CloudSim-based tool which can model and simulate the cloud service reliability enhancement mechanisms. An extensible interface is provided in FTCloudSim to aid researchers in easily implementing new mechanisms easily. In addition, FTCloudSim can trigger failure events to test the performance of each mechanism. After execution, it will generate information on the necessary metrics to highlight the advantages and shortcomings of the mechanism.

CloudSim [1] is a cloud simulation toolkit developed by the CLOUDS Laboratory of University of Melbourne. CloudSim, supports the simulation of a virtualized cloud data center. It enables researchers to experiment on cloud computing infrastructures.

As shown in Fig 1, CloudSim consists of four layers. In CloudSim simulation, a data center is composed of host servers and storage servers. A host server can host one or more virtual machines. A data center assigns virtual machines to host servers based on its policy. Virtual machines process the cloudlets according to the policy of the Cloudlet Scheduler. All policies can be re-defined by the user.

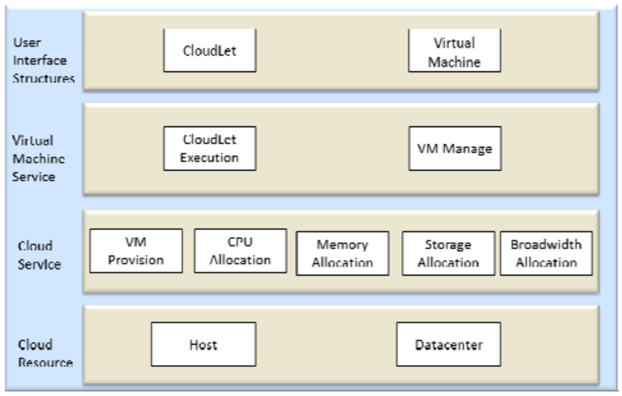

Figure 1. CloudSim Framework.

CloudSim is an extensible simulation tool. Researchers can extend the existing functionalities provided by CloudSim, and add new features to CloudSim, including CloudAnalyst, CloudAuction, CloudSimEx, WorkflowSim, and DynamicCloudSim, among others. Although DynamicCloudSim [2] can support fault -tolerance in some ways, it can currently only determines whether a task succeeds or fails. None of the available

[1] http://www.cloudbus.org/cloudsim/
[2] https://code.google.com/p/dynamiccloudsim/

current tools can properly simulate Cloud Service Reliability Enhancement Mechanisms.

2. DESIGN of FTCLOUDSIM

Almost all the reliability enhancement methods are based on the exploitation of redundancy. Replication and checkpointing are two widely used basic mechanisms. FTCloudSim can support checkpointing-based fault-tolerant mechanism currently. As shown in Fig. 2, FTCloudSim has added 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, which will be described in this section.

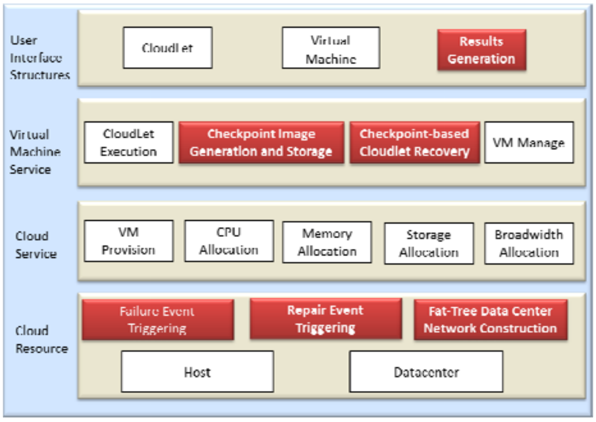

Figure 2. FTCloudSim Framework.

(1) *Fat-tree data center network construction.* Although CloudSim supports the simulation of data center network topologies, the user needs to construct the network by himself. The process is troublesome if the network is complex. The fat-Tree data center network is a typical architecture of a current commodity data center. Hence we provide the functionality to construct a fat-tree data center network automatically. The user only needs to set the port number in the configuration file.

(2) *Failure and repair event triggering.* Host failure events and repair events are triggered. The failure events can be generated according to some special distribution [3-4], Weibull distribution, or exponential distribution, etc. The failure event data and the repair event data can be saved to a file so the experiment can be repeated.

(3) *Checkpoint image generation and storage.* A checkpoint image is generated, transferred and stored periodically based on the checkpoint mechanism. This module is extensible. The user can design its own checkpoint schedule policy by extending the default policy, including when to generate a image, the content of the image and where to store the image.

(4) *Checkpoint-based cloudlet recovery.* A task is resumed from the host failure based on the latest available checkpoint image. 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.

(5) *Results generation.* This module outputs the simulation results to the user. In cloud computing environments, all resources are commercialized. Therefore, in addition to ensuring reliability, the method should reduce resource consumption based on data center characteristics. Therefore, FTCloudSim will provide three types of metrics to highlight the advantages and shortcomings of each mechanism. The first metric type is the ability to enhance the reliability of cloud service. The metrics includes the total execution time (total time the method takes to complete all tasks) and the average lost time (all time lost because of host failure). The second metric is network resource usage. In addition to the total checkpoint image data transferred by all switches, the metric includes the total checkpoint image data that is transferred by the core switches, the aggregation switches and the edge switches. The third metric is storage resource usage. The metric includes the total disk usage (the disk usage for the storage of checkpoint image).

3. DEMONSTRATION

In our live demonstration, we will construct a 16-port fat-tree data center network. The capacity of the core link and aggregation link is set as 10Gps, and the capacity of edge link is set as 1 Gps. There are 16 host servers in each subnet. Each host servers can host 4 virtual machines at most. The transfer delay of the core switch, aggregation switch and edge switch are 1 s, 2 s, 3 s respectively. The failure events of host servers arrive in a Weibull distribution. The parameter shape is uniformly distributed between 0.7 and 0.8, and the parameter scale is uniformly distributed between 15 and 20. The base system is 769 M. The ram disk is 5.3 M. The kernel is 1.6 M, and the disk size is 500 M. For the demonstration, 3000 tasks are randomly assigned to the virtual machines. The task size is uniformly distributed between 10 and 20 hours. The checkpoint image size grows with the increase of checkpoint interval, and the convex function is set as (143*logT – 254) MB. The checkpoint interval is set as 3600 s [5].

We will demonstrate the capabilities of FTCloudSim by using the following four reliability enhancement mechanisms. First, no reliability enhancement method is employed. Second, a normal checkpoint method is used. All images are stored in a central database. Third, an incremental checkpoint method is used. All images are stored in a central database. Four, an incremental checkpoint method is used. All images are stored on host servers. The image storage node is selected randomly. More information can be found on http://sguangwang.com/

4. ACKNOWLEDGMENTS

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5. REFERENCES

[1] E. Bauer, and R. Adams. Reliability and availability of cloud computing. John Wiley & Sons. 2012.

[2] T. Do, and H.S. Gunawi. The Case for Limping-Hardware Tolerant Clouds. In *USENIX HotCloud' 2013*.

[3] K.V. Vishwanath, and N. Nagappan. Characterizing cloud computing hardware reliability. In *SOCC' 2010*.

[4] B. Schroeder, and G.A. Gibson. A large-scale study of failures in high-performance computing systems. *IEEE Trans. On Dependable and Secure Computing*, 7(4): 337-350, 2010.

[5] Í. Goiri, F. Julia, J. Guitart, and J. Torres. Checkpoint-based fault-tolerant infrastructure for virtualized service providers. In *NOMS'2010*, pages 455-462.