Reliability Analysis of Cloud Computing Service System

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Abstract. Cloud computing represents the rapid intensive, large-scale and specialized development of the IT field. However, the ceaseless occurrence of security incidents also urges people to improve the reliability and safety of cloud computing systems. This study presents the definition of cloud computing and expounds the basic characteristics of reliability risks. It also introduces the key technology of cloud computing - the virtualization technology, and its reliable deployment.

Introduction

Cloud computing is the third innovation wave in the field of IT following personal computer (PC) and the Internet. The concept of "cloud computing" first appeared in the 2006 "Google 101" plan. US National Institute of Standards and Technology (NIST) defines cloud computing as a universal, convenient and on-demand mode for online access to configurable shared computing resource pools (e.g. networks, servers, memory, applications and services) \cite{1}. The computing resources can be rapidly provided and released with the least amount of management cost and the lowest interference from service providers \cite{1}.

As a network-based novel computing mode that permits the on-demand acquisition of computing resources or services, cloud computing embodies the multi-technology integration involving grid computing, distributed computing, parallel computing and utility computing. It also represents the idea of "the network is the computer". Specifically, a large amount of computing resources, memory resources and software resources are linked together to form a huge-scale shared virtual IT resource pool. Then this pool provides remote computer users with IT services "at one's beck and call" and with nearly "infinite capacity". Owing to its convenience, economy and high extensibility, cloud computing attracts a growing number of enterprises and liberates them from the cumbersome burden of IT infrastructure management and maintenance. As a result, enterprises can devote more effects into the development of core business.

Cloud services have become the major basic type of services on the Internet and are recognized as the core of the IT industry in the future. However, the development of cloud computing is faced with many key problems, especially the safety problem. Moreover, with the gradual popularization of cloud computing, the safety problem becomes increasingly important and restricts its further growth. In recent years, cloud computing sponsors including Amazon and Google have run into successive safety accidents, which aggravate user concern. Thus, all the safety problems encountered by cloud computing should be completely analyzed and resolved. Only in this way, will more enterprises and organizations be willing to widely use the cloud computing technology and platforms and trustfully hand over their own data to cloud service providers. Cloud service providers would run into safety incidents to varying degrees such as business interruption and data leakage. The ceaseless emergence of safety incidents urges cloud computing developers to improve the reliability and safety of cloud computing systems.\).

Reliability Risks of Basic Characteristics of Cloud Computing

Cloud computing is a new mode of providing information services to end users. Compared with the conventional IS/IT deployment mode, cloud computing is superior because it can push services to the
market in a more economic and time-saving way. NIST offers the five basic characteristics of cloud computing: on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service. Cloud service providers have many choices of service modes, including Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). Moreover, the cloud deployment options include private cloud, community cloud, public cloud and hybrid cloud. By using the services of cloud computing providers, end users expect to be guaranteed with the same reliability and safety as the traditional service mode. Then we analyze the reliability risk for each key characteristic of cloud computing [2].

**On-demand Self-service**

On-demand self-service is a key function that changes the service provision from a rare case to a cloud-based application. Moreover, as the key of rapid elasticity, it allows cloud users to order more resource capacity when the existing network load is intensified. On-demand self-service is so important for users that the loss of this function would lead to partial service interruption and disproportion. Thus, the reliability of on-demand self-service becomes the key index reflecting the quality of cloud computing.

**Broad Network Access**

The combination of wireless/wired network access with wide area networks (WANs) is able to link the users of cloud computing services to the cloud data center. This data center is mounted with the servers that run the cloud user applications. Thus, the reliability of IP network services directly affects the quality of user experience.

**Resource Pooling**

Resource pooling allows service providers to improve resource utilization rate and thereby reduce costs. Meanwhile, the appearance of a resource pool brings some potent service risks. The first, Risk of virtualization of service reliability and usability. The virtualization technology makes viable the resource pool, shared computing, memory, network and memory resources. This technology brings about the risk of system unreliability and alters the risks of software reliability and hardware reliability. The second, The resource scheduling and competition would induce the delay and fluctuation of services. The third, Services would be interrupted by real-time (on-line) virtual machine (VM) migration.

**Rapid Elasticity**

With rapid elasticity, the extra resources can be allocated as per the demand of applications and be recovered when not needed. This is a customized service of cloud computing. It guarantees that a user only has to pay for the resources s/he has used. As for on-line services, rapid elasticity allows to rapidly expand or shrink the service capacity. However, rapid elasticity would also introduce some risks, such as the impacts of expansion/shrinkage on services, the impacts on reliability and delay, and failure of elasticity.

**Measured Service**

The rapid elasticity plus the "pay-as-you-go" charge mode implies that it is very important for the cloud support system to carefully track the real-time resource usage of each application. Compared with resource growth, the resource reduction would cause a different reliability risk. The basis of measured service is data. Thus, besides the data unavailability or missing, other risks include data inaccuracy, data integrity, and low timestamp precision.

**Reliability Analysis of Virtualization Technology**

The virtualization technology is the key and core for realization of cloud computing. To use the virtualization technology, cloud architecture providers on the cloud computing platform should
guarantee their users with safety and isolation. This technology separates the applications and OS software from the low-level layer of software. As a result, guest OS as well as the applications running on the guest OS is offered with a "virtual" machine. The virtualization technology would improve the utilization rate of modern server hardware and allows the multiple VM-operated application cases to be integrated to a small amount of physical machine, thereby largely reducing the demand for physical systems. Then the reliability block diagram (RBD) is used to investigate the reliability of full virtualization, OS virtualization and Paravirtualization.

**Reliability Analysis of Full Virtualization**

Figure 1 shows how the "full virtualization" alters the system reliability by inserting a virtualization management program and host OS in between the OS and the bottom-layer hardware. It should be noted that for full virtualization, the "host" OS may differ from the guest OS. This application together with its software platform and OS constitutes a VM. Each VM is isolated from other VMs running on the server and does not know it is running under a virtual environment. Thus, the failure of each VM is independent: the breakdown and recovery of a VM do not affect other VMs running on the same VM management program. Since all VMs need a VM management program as the interface with the hardware, the VM management program and the hardware all become single point of failure for virtual systems.

![Figure 1. Reliability Block Diagram of Full Virtualization.](image)

**Reliability Analysis of OS Virtualization**

Figure 2 shows how the system RBD is changed when a VM management program is inserted into OS virtualization. The RBDs of full virtualization and OS virtualization are the same, but the guest OS and the host OS are different for full virtualization, while they must be the same in OS virtualization. It should be noted though the guest and host OS cases should have the same type and version of OS, the guest OS cases are independent, and the failure (collapse) and repair events are independent from the OS cases of the host or other guests.

OS virtualization can also segment the application cases, software platforms and guest OS into several independent parts, or namely the so-called virtual environment or vessel. Such isolation guarantees that the failure in the virtual environment would not affect another virtual environment that shares the same OS virtualization management program. It also ensures that each virtual environment would be contained in an independent recovery group.

![Figure 2. Reliability Block Diagram of OS Virtualization.](image)
Reliability Analysis of Para virtualization

Like full virtualization, the Para virtualization aims to insert a VM management program and host OS in between the hardware and software platforms. As a result, the application has an illusion that it shares a special system hardware case with the software platform. The difference is that the user OS also includes the integrative equipment driver, which is used to provide more-direct access to the space between the application cases and hardware resources. The Para virtualization has to divide the applications into several VMs: each VM can run on the OS different from the host OS. The failure of each VM is isolated and is independently running on other VMs under the VM management program and can recover in its own repair group.

Para virtualization integrates the merits of both full virtualization and OS virtualization. Since all applications run on the same OS, the applications on the OS virtualization can directly transfer the OS without conversion. This is a major limitation of OS virtualization: the host and all guests should run on the same type and version of OS. Compared with full virtualization, Para virtualization allows the applications to more directly visit the hardware resources, but not as directly as OS virtualization. The Para virtualization integrates the best characteristics of full virtualization and OS virtualization, such as the ability of direct access to hardware resources, and support of OS VMs different from the host VMs.

The most commonly-used way of the virtualization technology is to allow multiple VM cases to share the hardware resources and thereby to improve the hardware utilization rate and efficiency.

Conclusions and Prospects

Cloud computing is an extremely attractive business mode that provides information services. The deployment and development of many new applications are definitely based on cloud computing. Moreover, many existing applications will be updated to cloud-based deployment. Owing to the complexity and flexibility of cloud computing, the virtualization, rapid elasticity, promoted resource sharing, and relevant IT service management risks would all slightly aggravate the risks of severe failures. Nevertheless, cloud computing brings about new opportunities. Highly-reliable and highly usable services can be deployed and created by appropriate reliability efforts or by alleviating the existent or new reliability risks.

References


