

Cloud Computing Issues at Design and Implementation Levels – A Survey

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ABSTRACT

Cloud Computing is an emerging paradigm in the advanced network arena that facilitates the users to access shared computing resources through internet-on-demand. Cloud Computing has been widely used since it brings tremendous improvements in business. Cloud users are expected to grow exponentially in the future. In order to meet the demands of future cloud users, a full-fledged survey analyzing the various issues is the need of the hour. The different classifications presently available do not present the issues at micro levels. Amongst the various issues, the ones at design and implementation levels are of utmost importance since they directly affect the performance of the applications. Hence the cloud issues at those levels are presented in this paper from the available literature. This paper also attempts to outline a few possible solutions for some of the issues.

Keywords - Cloud Computing, Design, Implementation, Performance, Research Issues, Security

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1. INTRODUCTION

Cloud Computing (CC) has become one of the frontier research areas of this decade. The National Institute of Standards and Technology (NIST) defines the cloud computing as,

“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”.

CC has emerged as a novel technology, in the paradigm shift from the traditional “desktop-as-a-platform” to “internet- as-a-platform” model. Users can access shared IT resources through internet-on-demand and they will be charged only based on their amount of consumption and this enables them to use the cloud according at their own convenience. At the same time, the users will be unaware of where the services are hosted and how they are delivered in the cloud environment [1]. Since the growth of CC is very fast, people can acquire the necessary software and computing facility at a faster rate. This helps to bring tremendous improvements in the IT business infrastructure and has become the modern trend in computing environment.

CC has evolved from Grid computing. The on-domain resource provisioning is a distinguishable feature that gives improved environment over Grid Computing. Zhang et al. in [2] provides a comparative study between CC and Grid Computing and discuss the advantages of Cloud over the Grid. Hence, CC will be the most preferred choice in computing world.

Many research areas including technologies and infrastructure for CC are being explored by academicians and researchers [3]. One such anthology has been provided by Rajkumar Buyya et. al [4], in which a few noticeable outcomes of the above are Abicloud (a CC platform developed by Abiquo, a company in Barcelona Spain), OpenNebula (an open source cloud service framework) and Nimbus (an open tool set and also a CC solution providing Infrastructure as a Service). Similarly, industrial organizations have contributed several cloud computing platforms such as EC2 (Elastic Compute Cloud, enables users to run Linux-based applications) from Amazon, Azure (aims to provide an integrated development, host and control CC environment) from Microsoft, AppEngine (allows a user to run web applications written using the Python programming language) from Google, Sun network.com (enables the user to run Solaris OS, Java, C, C++ and FORTRAN based applications). Since each platform has its own characteristics and advantages, it is a real challenge for the users to make an unbiased choice.

Junjie Peng et al. in [1], analyze several platforms and provide a comparative study between them. This enables the users to get a better understanding of the different platforms available and provide guidelines to choose the most appropriate one. In short, it will be suitable to identify the various platforms for CC and also the advanced features of cloud over Grid, so that, this will benefit the upcoming cloud users.

The proposed survey presents a classification of CC with the present state of the art of research from the academic and industrial perspective. The survey also discusses the different issues connected with design and implementation levels. In order to benefit the research community, the above issues are even discussed at micro level.

This paper is organized as follows: Few similar surveys have been provided in Section 2, while Section 3 discusses the proposed survey and Section 4 highlights the future directions.

Some of the cutting edge technologies including virtualization, security management, programming model and data management are widely discussed in the work. A framework namely simulator-cloudsim has been implemented that allows cloud customers to test their services free of cost. But the authors have not analyzed the problems associated with the unfriendly interface when implementing the simulator with new types of codes rather than java codes. Since many source codes might be involved, it is not easy for the users to learn the implementation aspect of the framework.

From the above literature, it is evident that a survey that analyzes different challenges relating to CC is presently unavailable. This fact becomes the motivation for the proposed survey that discusses various issues and challenges in CC which is presented in the next section. It discusses the issues at design and implementation levels which it is believed will benefit the CC user community and researchers.

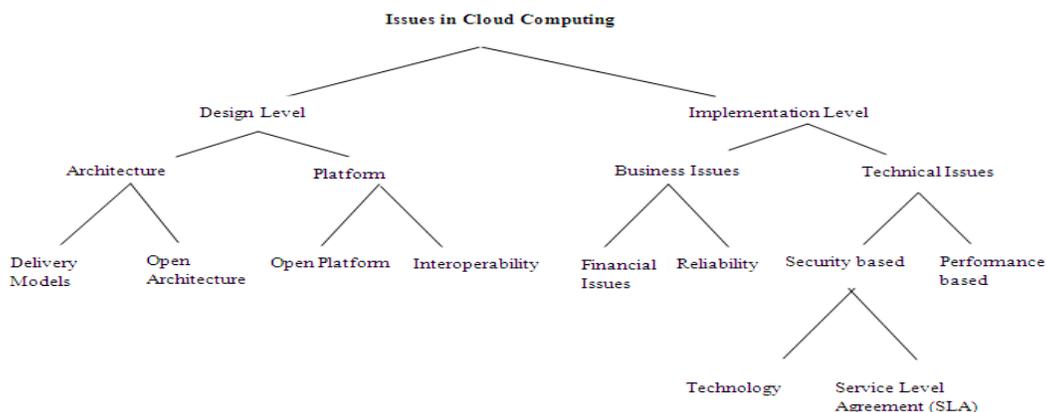


Fig. 1 Classification of Cloud Computing highlighting design and implementation level issues

2. RELATED WORK

A few related works exist that deal with the categorization of the cloud, the challenges faced, the benefits accrued and the shortcomings yet to be conquered.

Yang et al. have classified the issues relating to cloud applications into the four categories namely, Technological Issues, Business Issues, Applications and General. The articles are presented in chronological order but the categorization of research presented does not cover the issues related to cloud at micro levels [5].

Tharam Dillon et al. [6] have identified a few challenges of CC such as security, costing model, charging model (for the profitability and sustainability of cloud providers) and Service Level Agreement (SLA).

The concept and background of CC provided by Peeyush Mathur et al. [7] also discusses the benefits and the shortcomings. They have concluded that developing applications for CC need more time and sizeable resources.

Juefu Liu et al. [8] have discussed the emerging cloud platforms from the industrial and academic perspectives.

3. DESIGN AND IMPLEMENTATION LEVEL ISSUES

The schematic diagram shown in Fig.1 provides the classification of CC. The issues are depicted in two levels namely Design and Implementation.

3.1. Design Level Issues

In this level of research, the key issues in creating an open architecture and in the development of heterogeneous platforms have been discussed.

3.1.1 Architectural Issues

It is essential to construct a CC architecture with the important features such as unification, scalability and reusability. But the development of such architecture may face additional challenges because of the emerging technologies and industry practices.

Irena Bojanova et al. [9] have discussed the cloud service model architectures of SaaS (Software as a Service), PaaS (Platform as a Service) and IaaS (Infrastructure as a Service) which have been implemented in a few familiar applications including Google, Microsoft and Oracle

fusion middleware. In their work, a few set of metrics like hardware cost, software cost, system administration cost and real-time provisioning cost are dealt with in order to determine the efficiency of different CC models.

Zhang et al. [10] have proposed an open architecture based on seven principles including management of ecosystem, extensible service provisioning and cloud quality. Cloud computing Open Architecture (CCOA) could be the architectural foundation in the cloud value chain. It helps the users in designing and deploying the cloud applications. Authors have discussed the two case studies for the cloud offerings based on CCOA. The first case discusses the infrastructure cloud for IaaS and the latter discusses business cloud for business process as a service.

3.1.2 Platform Related Issues

Numerous platforms have emerged as an outcome of the increased demand in CC. Some literatures have addressed issues related to heterogeneous platforms.

Eucalyptus is an open source software framework for CC proposed by Daniel et al. [11]. It implements IaaS in order to support infrastructure development. The framework is specifically designed to motivate CC research.

Endo et al. discussed several open source solutions of CC. This work highlights the significance of various platforms as follows: Xen Cloud platform (XCP) provides a tool to support automatic configuration and maintenance of cloud platforms. Nimbus is an open source solution for scientific applications. OpenNebula toolkit is used to build private, public and hybrid clouds and TPlatform is a cloud solution that provides a development platform for web mining applications [12].

Though a number of cloud platforms are available, each one provides its own interface for customers to interact with underlying infrastructures. But it becomes a great challenge for one cloud user to access the services when interacting with other clouds, because of heterogeneous software and incompatible interfaces.

Jie Tao and Holger Marten et al. [13] have addressed the problem with user interface that varies from one cloud to another and have presented a framework that combines all into a single platform enabling inter-cloud communications. The authors have analyzed the framework with respect to Amazon EC2 and Eucalyptus only and work may be extended in future to include other clouds.

Tharam Dillon et al. [6] have highlighted the interoperability issue among heterogeneous platforms and have suggested solutions connected with it for various cloud service deployment models. Further research could be raised to tackle the interoperability issue for PaaS as it has not been handled.

3.2 Implementation Level Issues

The second level of this survey discusses on the various implementation issues in the CC environment. Under the implementation level, several business and technical issues in CC are discussed. The business issues are further

divided into financial and reliability and security and performance issues are dealt under technical branch.

International Data Corporation (IDC) expects IT cloud services spending to grow from about \$16 billion in 2008 to about \$42 billion by 2012. Garner Inc. predicts that CC revenue will exceed \$150 billion by 2013 [14]. The business market has been established around CC is growing rapidly to fulfill the users' demands in the near future. From the business perspective, the financial issues and the reliability concerns of the cloud providers are to be addressed.

3.2.1 Business Related Issues

IT industry has recognized the impact of increasing concern over the growing datacenter energy cost and is taking necessary initiatives to curtail these costs and maximize energy efficiency and thereby protect the environment. Smart metering helps to mitigate power related costs and risks in the longer run [15][16]. Energy efficiency and demand response play a vital role in meeting future energy needs. Since the approach aims at providing a globally concentrated effort to reduce energy consumption and uphold sustainability, certainly the contributions will be well recognized in the future. Sheikh et al. [14] have shown a clearer direction for a promising future for CC by considering the customer's perspective, by facilitating them to select a reliable cloud provider using some trust and reputation models. It has been identified that the existing models are not sufficient to meet the present and future challenges.

3.2.2 Technical Issues

In the cloud environment, there are several technical issues to be solved. The proposed survey paper addresses the two major technical issues in CC related to security and performance based issues.

CC has to effectively manage the security aspects of the cloud applications. Security consciousness and concerns arise as soon as one begins to run applications beyond the designated firewall and move closer towards the public domains. Survey is made on security perspective of CC. The aim is to highlight the security concerns that should be properly addressed and managed to realize the full potential of CC.

Based on the research by Gartner, various security issues are discussed by Ramgovind S et al. [17]. The authors have identified the information security requirements for the organizations and the key decision-makers. It helps the executives to understand and measure the feasibility of implementing CC solutions to match their cloud strategy in the best possible manner. The information security requirements provided by each cloud delivery model having ISO standards are also explored. This gives confidence for selecting a highly protected and suitable cloud framework. Several distinct technologies are combined and used to build CC systems. Due to this, issues relating to technical security arise from the usage of cloud services. Meiko Jenson et al. [19] have discussed issues like XML signature and browser security. To overcome those issues, appropriate counter-measures are

suggested in their work. Every service provider assures the customer on security of data in CC through service level agreements (SLA). Hence, SLA by itself needs standardization to satisfy the customer to make him trust the chosen service provider. The existing SLAs only discuss the services provided and also the waivers given. But they do not meet the customers' expectations in terms of adequate services. Hence the waivers have to be made according to the nature of business carried out by the customers. Above all, the SLAs have to discuss many more issues like security policies, methods and their implementations [19]. This gives the scope for the research from security perspective in the near future.

Nezih et al. [20] presented C-Meter, a framework for performance analysis of CC environment. It is implemented in python and it can be extended to interact with many CC environments. The authors have also analyzed the future work involving different resource scheduling algorithms.

According to Xing et al [21], applications running on one VM (Virtual Machine) may affect the performance of applications running on its neighboring VMs. In their work, the experimental study on the performance interference among VMs is implemented in Xen Virtual Machine Monitors (VMMs). The authors have presented their findings from the experiments. Research on virtualization is highly complex by nature. Further, it becomes more challenging when it involves effective management of cloud environment for service providers as well as customers.

In a virtualized cloud environment, cloud providers implement server consolidation by slicing each physical machine into multiple virtual machines (VMs) based on the capacity of the server. Cloud consumers may reserve computing resources through renting VMs from cloud providers. Yiduo et al. [22] have proposed a measurement analysis to identify the impact of idle instances and the concurrent I/O applications running in a virtualized cloud. The performance gains and losses are analyzed in their work. The authors have explained how applications should be arranged properly in order to minimize the performance degradations and maximize the throughput.

The consolidated view of the various issues and the challenges faced are provided in Table 1 and 2 of Appendix A.

4. CONCLUSIONS & FUTURE WORK

The cloud would become the predominant technology of the future. Keeping this view in mind, the survey presented in this paper has attempted to consolidate the issues connected with design and implementation levels. It is believed that this survey would definitely benefit the developers to have complete knowledge about the impact of using Cloud Computing before utilizing them for their applications. The future work will be to identify a suitable model to address some of the key issues highlighted in this paper.

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APPENDIX A

TABLE 1. DESIGN LEVEL ISSUES

Issues	Context						Challenges faced	Suggested Solution
	Service Models			Deployment Models				
	SaaS	PaaS	IaaS	Private	Public	Hybrid		
Open Architecture	√	√	√	√	√		Creating suitable and configurable provisioning platform to support all types of resources	Cloud Computing Open Architecture (CCOA) is a platform available to provide cloud offerings to its enterprise consumer users.
Delivery Models	√	√	√	√	√		Efficient and appropriate delivery architecture models required to be implemented for different applications	CC delivery architecture models for different applications (e.g. SaaS for GoogleApps, IaaS for Microsoft Azure) are available. Further, the efficiency are determined by applying suitable metrics
Open Platform			√		√	√	Unified environment is widely preferred by many users in order to deploy and develop large-scale applications	Some open source platforms (e.g. Eucalyptus) exist for the research community for further exploration.
Inter-operability	√		√	√	√		Unified method to interact with heterogeneous clouds	A generic interface (e.g. g-Eclipse, a framework for Grid computing) enables the users to access the heterogeneous clouds

TABLE 2. IMPLEMENTATION LEVEL ISSUES

Issues	Context						Challenges faced	Suggested Solution
	Service Models			Deployment Models				
	SaaS	PaaS	IaaS	Private	Public	Hybrid		
Financial	√	√	√		√		Increase in data center energy costs may lead to poor energy utilization	Smart metering approach is preferred to reduce energy consumption and promote sustainability
Reliability	√	√	√		√		Selection of appropriate service provider	Trust and Reputation models facilitate the customer to choose a provider
Security	√	√	√		√		Security will be the main concern across distinct technologies	It is the need of the hour to invent proper tools and protocols for the purpose
Performance			√	√	√		Interferences and idle instances contribute to poor performance.	Measurement analysis can be carried in order to optimize the performance.

Authors Biography



A. P. Nirmala received her MCA and M. Phil., degree in Computer Science from Bharathiar University, Coimbatore in 2000 and 2006 respectively. She is pursuing her Ph.D at Karpagam University, Coimbatore, India. She is presently working as

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designed and delivered various training programs in the areas of IT & Management. He has published 12 research papers in leading Journals and Conferences and presently guiding four research scholars. He has got 15 years of experience and he is presently designated as Dean, Faculty of Computer Application, Marwadi Education Foundation's Group of Institutions, Rajkot, India.