An Exhaustive Scrutinization & Deployment of Cloud Computing

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Abstract

Cloud Computing is an innovation idea that helps in reducing the computing cost. Cloud Computing offers better Computing through improved utilization and reduced administration and infrastructure costs. Cloud computing is the long-held dream of computing as a utility. Cloud Computing is the combination of Software as a Service and Utility Computing. This paper is the first systematic review of peer-reviewed academic research published in this field, and aims to provide an overview of the swiftly developing advances in the technical foundations of cloud computing and their research efforts. Structured along the technical aspects on the cloud agenda, we discuss lessons from related technologies; advances in the introduction of protocols, interfaces, and standards; techniques for modelling and building clouds; and new use-cases arising through cloud computing. Cloud computing are managed by Cloud Management tools, loaded and tested by various other software testing tools. Cloud computing modelling and simulation is done by CloudSim or SPECI or GroundSim or DCSim on the basis of testing benchmark.

General Terms: Management, Measurement, Performance, Standardization.

Keywords: Cloud computing, cloud technologies and Utility Computing

1. Introduction

Cloud computing describes about different types of computing concepts that involve a large number of computers connected through a real time communication network such as the Internet. Cloud computing is similar like distributed computing over a network which means it has ability to run a program on many connected computers at the same time. Cloud computing has recently reached popularity and developed into a major trend in IT. While industry has been pushing the Cloud research agenda at high pace, academia has only recently joined, as can be seen through the sharp rise in workshops and conferences focussing on Cloud Computing. Lately, these have brought out many peer-reviewed papers on aspects of cloud computing, and made a systematic review necessary, which analyses the research done and explains the resulting research agenda. We performed such a systematic review of all peer reviewed academic research on cloud computing, and explain the technical challenges facing in this paper. Cloud computing is actually an evolutionary approach that completely changes how computing services may produce, priced and delivered. It allows to access services that reside in a distant data centre, other than local computers or other Internet-connected devices. Cloud services are charged based on the amount consumed by worldwide users. Such an idea of computing as a utility is a long-held dream in the computer corporate, but it is still immature until the advent of low-cost data centres that will enable this dream to come true. The advancement of Cloud computing came up due to fast growing usage of internet among the citizenry. The cloud computing is not a totally new technology but it is essentially a journey through distributed, cluster, grid and now cloud computing. In fact, in surge of rapid usage of internet all over the globe, cloud computing has already been steered in the IT industry. In this paper we discuss the advances and research questions in technical aspects of Cloud Computing, such as protocols, interoperability and techniques for building clouds.

The paper contain analogous system, cloud computing basics, open source resource of cloud, cloud computing services, cloud management tools, cloud computing simulations and modelling. Even cloud testing benchmark and application of the cloud is discussed.

2. Definition

There has been much discussion in industry as to what cloud computing actually means. The term cloud computing seems to originate from computer network diagrams that represent the internet as a cloud. Most of the major IT companies and market research firms such as IBM [2], Sun Microsystems [1], Gartner [3] and Forrester Research [4] have produced whitepapers that attempt to define the meaning of this term. These discussions are mostly coming to an end and a common definition is starting to emerge. The US National Institute of Standards and Technology (NIST) has developed a working definition that covers the commonly agreed aspects of cloud computing.

2.1 Analogous System

Cloud computing has related characteristics with:

An autonomic Computing- Computer system which is capable of managing itself means self-management. Client Server model- Client server computing mainly refers to any distributed application that differentiate between service providers (servers) and service requesters (clients).

Mainframe Computer- Powerful computer used mainly by large organizations for critical applications, typically bulk data processing such as census, industry and consumer statics, police and secret intelligence services, enterprise resource planning and financial transaction processing.

Utility Computing-The [17] packaging of computing resources such as computation and storage as a metered service similar to a traditional public utility such as electricity.

Peer-to-peer- Distributed architecture without the need for central coordination, with participants being at the same both suppliers and consumers of resources.

3. Architecture

The fabric layer contains the raw hardware level resources, such as computer resources, memory resources, and network resources. On the unified resource layer, resources have been virtualized so that they can be exposed to upper layer and end users as integrated resources. The platform layer adds to a collection of specialized tools, services and middleware on top of the unified resources to provide a development and deployment platform. The application layer includes the applications that would prevail in the clouds.

3.1 Characteristics of Cloud Computing

The major characteristics of Cloud Computing which explains their relation and difference from the traditional computing are listed below. It gives a clear picture of that how traditional computing is different from the latest one.

- The consumer can provision or un-provision the services when needed, without the human interaction with the service provider
- It has capabilities over the network and access done through standard mechanism.

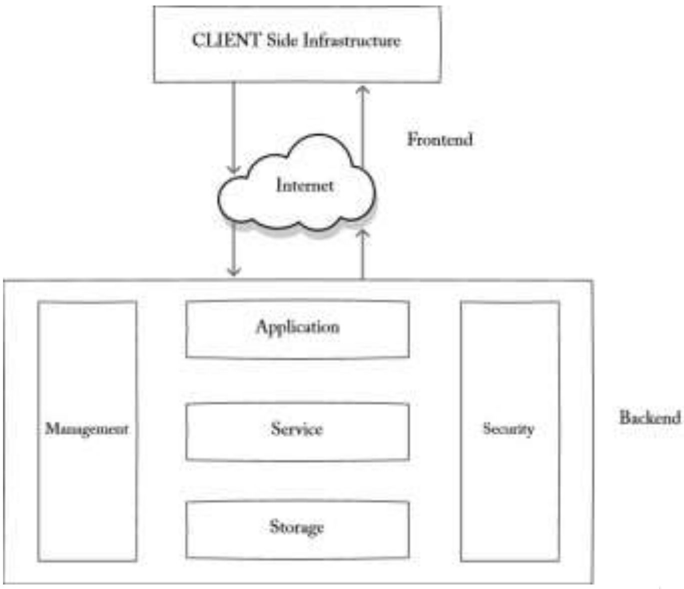

Fig. 1. System Architecture

- The computing resources of the provider are pooled to serve multiple consumers which are using a multi-tenant model, with various physical and virtual resources dynamically assigned, depending on consumer demand.
- Services can be rapidly and elastically provisioned.
- Cloud Computing systems automatically check and optimize resource usage by providing a metering capability to the type of services (e.g. storage, bandwidth, processing, or active user accounts).

3.2 Cloud Deployment Service Model

Erdogmus [5] described Software as a Service as the core concept behind cloud computing, suggesting that it does not matter whether the software being delivered is infrastructure, platform or application, "it's all software in the end" [5]. Although this is true to some extent, it nevertheless helps to distinguish between the types of service being delivered as they have different abstraction levels. The service models described in the NIST definition are deployed in clouds, but there are different types of clouds depending on who owns and uses them. This is referred to as a cloud deployment model in the NIST definition and the four common models are:

- Private cloud: a cloud that is used exclusively by one organisation. The cloud may be operated by the organisation itself or a third party. The St Andrews Cloud Computing Co-laboratory8 and Concur Technologies [6] are example organisations that have private clouds.
- Public cloud: a cloud that can be used (for a fee) by the general public. Public clouds require significant investment and are usually owned by large corporations such as Microsoft, Google or Amazon.
- Community cloud: a cloud that is shared by several organisations and is usually setup for their specific requirements. The Open Cirrus cloud test bed could be regarded as a community cloud that aims to support research in cloud computing [7].
- Hybrid cloud: a cloud that is setup using a mixture of the above three deployment models. Each cloud in a hybrid cloud could be independently managed but applications and data would be allowed to move across the hybrid cloud. Hybrid clouds allow cloud bursting to take place, which is where a private cloud can burst-out to a public cloud when it requires more resources.

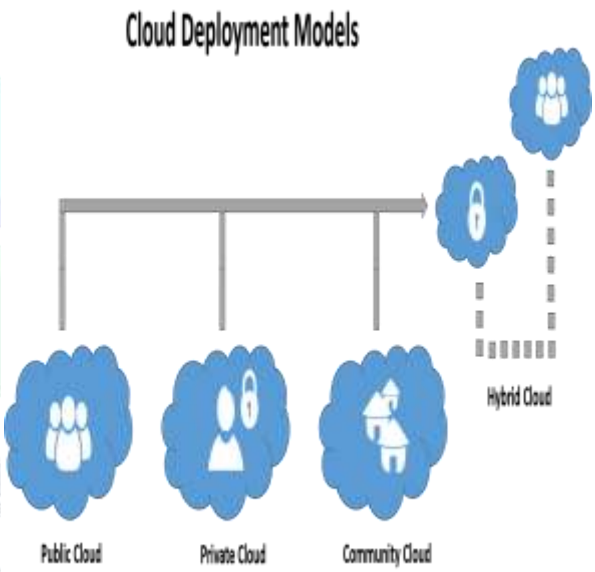

Figure 2: Cloud computing deployment and service models

4. Cloud Service Model

Cloud computing provides services, basically by three models that is software, platform and infrastructure.

a. Software as a Service: Software as a Service (SaaS) is a software delivery model in which applications are accessed by a simple interface such as a web browser over the Internet. The users are not concerned with the underlying cloud infrastructure and even not concern about network, operating systems, servers, platform and storage. This model also eliminates the needs to install and run the application on the local computers. SaaS term is popularized by Salesforce.com that distributes business software on a subscription basis and not on a traditional on-premise basis. This is best known solution for its Customer Relationship Management (CRM). Now SaaS has now become a common delivery model for most business applications, including accounting, collaboration and management. Applications like social media, office software, and online games which enrich the family of SaaS-based services.

b. Platform as a Service:

Platform as a Service (PaaS) offers a high-level integrated environment to build, test, deploy and host customer-created or acquired applications. Generally, developers may accept some restrictions on the type of software that can write in exchange for built-in application scalability. Customers of PaaS does not manage the underlying infrastructure as SaaS users do but control over the deployed applications and their hosting environment configurations. PaaS offerings mainly aim at facilitating application development and related management topics. Some are destined to provide a generalized development environment and some only provide hosting-level services such as security and on-demand scalability.

c. Infrastructure as a Service:

Infrastructure as a Service (IaaS) provides processing, networks, storage and other fundamental computing resources to users. IaaS users can deploy arbitrary applications, software, operating systems on the infrastructure which is capable of scaling up and down dynamically. IaaS user sends programs and related data, while the Scalable, flexible and manageable to meet user requirements.

5. Cloud Management Tools

Cloud computing environments is managed by some form tool mainly called as Cloud Management Tools. This tools monitor, provision and tools that cross the divide between both. The main cloud infrastructure management products offer similar core features.

Provisioning and managing metrics in hybrid environments: RightScale, Zeus, Kaavo, Scalar and Morph. There are also options offered by cloud vendors 72 A Comprehensive Survey on Cloud Computing Copyright © 2015 MECS I.J. Information Technology and Computer Science, 2015, 02, 68-79 themselves that meet the second and third criteria such as Cloud Watch from Amazon Web Services. The large companies known for their traditional data centre monitoring applications have been slow to hit the cloud market. Their products are rehashes of existing applications that do little in the way of providing more than alerting and reporting tools. CA is on an acquisition spree to fix this and just acquired 3Tera, a cloud provisioning player.

6. Software Testing tools to test Cloud.

New Open Source Testing Tools are emerging which can be deployed, managed and tested for the latest Cloud Computing Software applications. With its dynamic scalability, flexibility and virtualized resources are provided as a service, Cloud Computing [4] is seen as the dawn of a new era for application services. With examples of general purpose applications Google Documents, Zoho, Buzzword and Flickr that use Cloud Computing Technology can be seen as the most viable option for application development and deployment. Various IT Giants such as Microsoft, Amazon and Google and they all vying for a spot within the Cloud Computing space for Cloud based Software Applications currently available. Even in the near future software testing appears to be the current favoured use of Cloud environments. A recent survey by Evans Data, an independent research firm that conducts periodic surveys of developers had found that about those who is using cloud facilities to run applications, 49.8% said they were doing so experimentally or for prototyping; 28.6% for non-critical business applications and 21.6% of business critical applications. The question to answer then is what Software testing tools are available to assist developers and Quality Assurance individuals in their application development and testing processes. Software Testing tools that are used for testing of conventional applications are of little use when applied to Cloud Testing as there is a need for tools to allow Software developers and Tester to [4] analyse the network, desktop and implications of changes within the Cloud. A growing variety of Cloud based Open Source Software Testing Tools are being published. Cloud Tools for example is a set of tools for deploying, [4] managing and testing Java EE applications on Amazon's Elastic Computing Cloud (EC2). Containing three main parts, which includes machine images that can be configured to run on Tomcat and Maven & Grails plug-in this is an amazing tool to use for Open source cloud software testing. PushToTest TestMaker is a distributed test environment that can run tests on test equipment, [4] or in a Cloud Computing environment. It introduces specific commands to support automatic Cloud Testing services. Cloud Tools and PushToTest Test Maker represent examples of products that will help shape the future of robust Cloud based Software Testing Applications. Though the technology is in its early stage, various testing tools are emerging that can provide assistance in cloud based software testing.

7. Building Clouds

In this section we describe work that helps building cloud offerings. This requires management software, hardware provision, simulators to evaluate the design, and evaluating management choices.

Sotomayor et al. [8] presents two tools for managing cloud infrastructures: Open Nebula, a virtual infrastructure manager, and Haizea, a resource lease manager. To manage the virtual infrastructure, Open Nebula provides a unified view of virtual resources regardless of the underlying virtualisation platform, manages the full lifecycle of the VMs, and support configurable resource allocation policies including policies for times when the demand exceeds the available resources. Sotomayor et al. argue that in private and hybrid clouds resources will be limited, in the sense that situations will occur where the demand cannot be met, and that requests for resources will have to be prioritised, queued, pre-reserved, deployed to external clouds, or even rejected. They propose advance reservations to have resources available to serve higher prioritised requests that are expected to be shortly arriving. This can be solved with resource lease managers such as the proposed Haizea, something like a futures market for cloud computing resources, which pre-empts resource usage and puts in place advance resource reservations, so that highly prioritised demand can be served promptly. Haizea can act as a scheduling backend for Open Nebula, and together they advance other virtual infrastructure managers by giving the functionality to scale out to external clouds, and providing support for scheduling groups of VMs, such that either the entire group of VMs are provided resources or no member of the group. In combination they can provide resources by best-effort, as done by Amazon EC2, by immediate provision, as done by Eucalyptus, and in addition using advance reservations.

Song et al. [9] have extended IBM data centre management software to be able to deal with cloud-scale data centres, by using a hierarchical set up of management servers instead of a central one. As even simple tasks such as discovering systems or collecting inventory can overwhelm a single management server when the number of managed components or endpoints increases, they partition the endpoints to balance the management workload. Song et al. chose a hierarchical distribution of management components, as a centralised topology will in any possible implementation result in bottlenecks, and because P2P structuring exhibits complexities that are not easy to understand. For resilience, the management components have backup servers which are notified with the changes from the original server. Once this notification no longer arrives, the backup server will replace the original server's task until it comes back to operation. In a case study, Song et al. show that this solution scales "almost linearly" to 2048 managed endpoints with 8 managing servers. However, cloud-scale solutions might need to manage a number of virtual machines that is one or two orders of magnitude larger, and in the future will become even larger. It is left for future work to test if the solution will be feasible and scale for such numbers of managed endpoints.

Vishwanath et al. [10] describe the provision of shipping containers that contain building blocks for data centres. The containers described are not serviced over their lifecycle, but allow for graceful failure of components until performance degrades below a certain threshold and the entire container gets replaced. To achieve this, Vishwanath et al. start with over provisioning the demand at the start, or by putting cold nodes into the container which are not powered on once there is demand due to failure in some of the other components. This work aims at supporting the design of shipping containers with respect to costs, performance, and reliability. For reliability, Markov chains are used to calculate the expected mean time to failure over the lifecycle. For performance and cost, these Markov chains are extended into M Markov reward models. These happen under the assumption of exponential failure times, and need to be evaluated against real data. The shipping containers could be used for selling private clouds in a box.

Sriram [14] discusses some of the issues with scaling the size of data centres used to provide cloud computing services. He presents the development and initial results of a simulation tool for predicting the performance of cloud computing data centres which incorporates normal failures, failures that occur frequently due to the sheer number of components and the expected average lifecycle of each component and that are treated as the normal case rather than as an exception. Sriram shows that for small data centres and small failure rates the middleware protocol does not play a role, but for large data centres distributed middleware protocols scale better. CloudSim, another modelling and simulation toolkit has been proposed by Buyya et al. [12]. CloudSim simulates the performance of consumer applications executed in the cloud. The topology contains a resource broker and the data centres where the application is executed. The simulator can then estimate the performance overhead of the cloud solution. CloudSim is built on top of a grid computing simulator (GridSim) and looks at the scheduling of the execution application, and the impact of virtualisation on the application's performance. AbdelSalam et al. [13] seek to optimise change management strategies, which are necessary for updates and maintenance, for low energy consumption of a could data centre. However, this work simply derives the actual load from the Service Level Agreements (SLA) negotiated with current customers. AbdelSalam then show that the number of servers currently required is proportional to the load, and identifies the number of idle servers as those available after all SLAs are fulfilled on a minimum set of servers. These are suggested as candidates for pending change management requests. One of the key aspects of cloud computing is elasticity, however, which will make it difficult to estimate the load from the SLAs in place. It is a challenge to develop such placement algorithms that the existing load can always be shrunk to a subset of the available servers while still fulfilling all SLAs, and cost factors will seek to minimise idle servers. Further work is necessary that takes these requirements into account and develops guidelines for both saving energy consumption and enabling seamless change management in cloud data centres. In summary, several projects research into the way future clouds can be built. Given the methodology we chose earlier, the papers discussed in this section differ too much to conclude with a single research direction in which academia is heading when looking into building future clouds. In fact, it seems there are many more research directions we will be facing when it comes to building new cloud facilities. All papers in this section for example, looked only at IaaS level clouds. To date, no paper could be found that describes technologies for building clouds at another level.

8. Modelling and Simulation

Cloud simulators are required for cloud system testing to decrease the complexity and separate quality concerns. They enable performance analysts to analyse system behaviour by focusing on quality issues of specific component under different scenarios. Some of the published cloud computing simulators for evaluating cloud computing system performance are described briefly in this section:

8.1 CloudSim

ICloudSim is a simulation application which enables seamless modelling, simulation, and experimentation of cloud computing and the application services, proposed due to the problem that existing distributed system simulators were not applicable to the cloud computing environment. It had been mentioned that users could analyse specific system problems through CloudSim, by not considering the low level details related to the Cloud-based infrastructures and services.

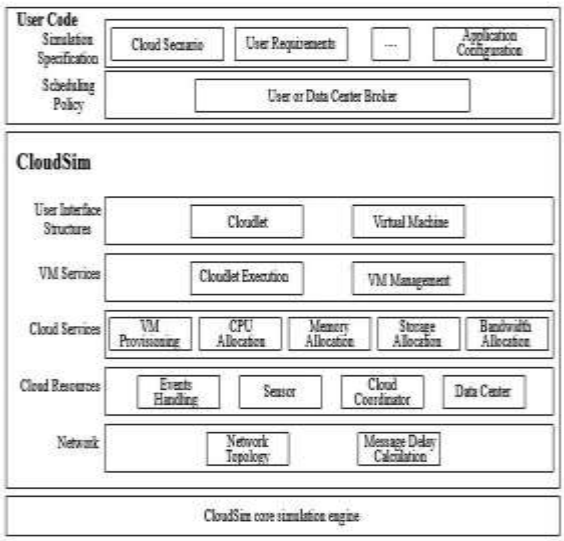

Fig 3: Layered CloudSim Architecture

8.2 SPECI

The size of data centres that provide cloud computing services is increasing and some middleware properties that manage these data centres will not scale linearly with the number of components. Simulation Program for Elastic Cloud Infrastructures (SPECI) is a simulation tool, which allows analysing large data centre behaviour under the size and design policy of the middleware as inputs. It is composed of two packages namely data centre layout and topology and the components for experiment execution and measuring.

8.3 GroundSim

GroundSim is an event-based simulator that needs just one simulation thread for scientific applications on grid and cloud environments. It is mainly concentrated on the IaaS, but it is easily extendable to support additional models like PaaS, or cloud storage. More investigation was carried out in order to allow the user to simulate their experiments from the same environment used for real applications, by integrating GroudSim into the ASKALON environment.

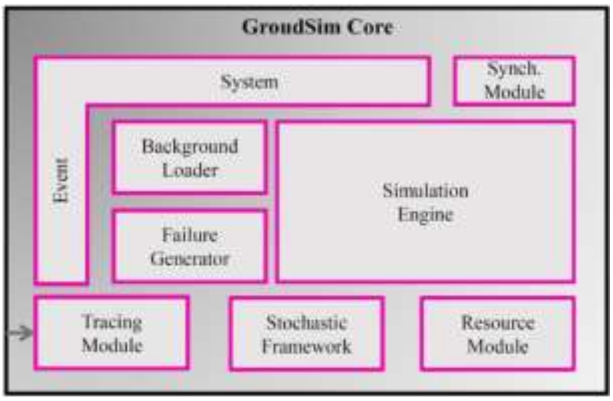

Fig 4: Layered Architecture of GroundSim

8.4 DCSim

Data enter Simulator is concentrated on virtualized data centres, offering IaaS to Multiple tenants, in order to achieve a simulator to evaluate and develop data centre management techniques.

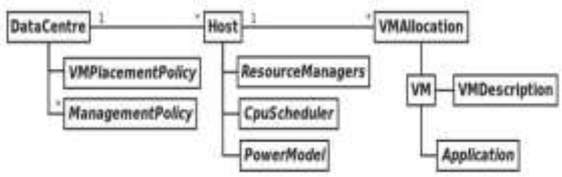

Fig 5: DCSim Architecture

9 Conclusion:

Cloud computing is the use of computing resources that are delivered as a service over a network. It shares characteristics with autonomic computing, grid computing, client server model, mainframe computer, utility computing and peer to peer. The detailed study of cloud computing basics like deployment model, system architecture, cloud services and types of cloud has been done.

Various definitions of cloud computing were discussed and the NIST working definition by Mell and Grance [11] was found to be the most useful as it described cloud computing using a number of characteristics, service models and deployment models. The socio-technical aspects of cloud computing that were reviewed included the costs of using and building clouds, the security, legal and privacy implications that cloud computing raises as well as the effects of cloud computing on the work of IT departments. The technological aspects that were reviewed included standards, cloud interoperability, lessons from related technologies, building clouds, and use-cases that presented new technological possibilities enabled by the cloud. A number of authors have discussed the new research challenges that are raised by cloud computing. Bernstein et al. [15] listed a research agenda and open questions to achieve interoperability, and Birman et al. [16] described a research agenda that seeks to facilitate industry in building successful clouds. To conclude, this paper discussed the research academia has pursued to advance the technological aspects of cloud computing, and highlighted the resulting directions of research facing the academic community. In this way the various projects were set in context, and the research agenda followed by and facing academia was presented. The review showed that there are several ways in which the cloud research community can learn from related communities, and has shown there is interest in academia for describing these similarities

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