International Journal of Advance and Applied Research
www.ijaar.co.in
ISSN – 2347-7075 Impact Factor – 7.328
Peer Reviewed Bi-Monthly
Vol.10 No.6 July – August 2023

A Comprehensive Review Of Cloud Computing: Advancements, Challenges, And Future Perspectives In Distributed Systems

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DOI - 10.5281/zenodo.10032639

Abstract:

Computing in the cloud is a relatively new and developing technique that provides information technology via the use of the internet. Customers make use of the services they need when they require them and at a location of their choosing, and they pay only for the services they have actually used. Therefore, cloud computing provides a great deal of benefits, particularly for companies. An in-depth investigation and comprehension of this developing system and the components that are intrinsic to it are very helpful in determining what steps should be taken in order to enhance its performance. In this work, we will first introduce cloud computing and its constituent parts, and then we will propose an approach that seeks to improve the administration of cloud computing systems that are made up of several data centres.

Keywords: Cloud Computing, Distributed System, Cloud Technologies, Data Center, Multi Agent System, System Management.

Introduction:

Users are unaware of the processes that go into the generation of the energy they use. The implementation of this idea inside the Information Technology (IT) industry is what's meant to be understood by the keyword "cloud computing." The cloud computing model is a kind of business model in which information technology services are provided to end users. The easiest provision of computer services, comparable in importance to the provision of other utilities such as water, electricity, gas, and telephone, is the primary goal of this system. Therefore, customers make use of the resource and/or the service when they demand it according to the quantities of their requirements, and as a result, their payments are determined by the rate at which they utilise it. In point of fact, cloud computing has emerged as the dominant model for the consumption of information technology. It is a paradigm of computing in which a resource—

whether it be software or hardware—is hosted, operated, managed, and administered through the internet in huge data centres. This informational resource is made available to users as a courtesy. Therefore, cloud computing provides an IT architecture that is both adaptable and dynamic.

Computing in the cloud is the answer to a new need in the information technology industry. In point of fact, "grid computing" might be thought of as the conceptual ancestor of what is now known as "cloud computing." The way in which each one is managed is the single most significant distinction between the two [8]. The user is responsible for managing the whole of the system in grid computing, including the server, network elements, operating system, and applications. However, with cloud computing, the system itself is provided as a service to the user. Therefore, the user is only concerned with the services and problems that directly pertain to his wants, and none of the others. It indicates that cloud computing may be utilised in an environmentally responsible manner [10]. In point of fact, cloud computing is an implementation of the utility computing paradigm. Therefore, it is usable by the vast majority of people without the need for them to have any special understanding of how the system functions or to manage anything. Computing on a grid is often geared for academic academics who have a significant amount of experience in the field of computer science.

In order to meet the ever-increasing demand, a large number of projects have been planned or are now under development. Amazon's Elastic Compute Cloud (EC2) was the most advanced offering in this sector. Then, each major participant in the IT industry, such as Microsoft with her system Azure, Google with App Engine, and IBM with Blue Cloud, follows suit and provides their own respective cloud computing platforms.

This piece is composed of two distinct sections. The first one explains the concept of cloud computing, as well as the architecture that goes along with it and the many applications that may make use of it. In the second section, we will go through a notion that describes an approach to improving the efficiency of the administration of cloud computing systems that include more than one data centre.

Definition:

The concept of using information technology over the internet has now been referred to using the word "cloud," which has been used several times in the past. Computing on the cloud is not exactly a novel technological concept. It is more of an innovative approach to use

than it is a whole novel piece of technology. This explains why there are now several definitions being offered. Everyone is looking for a definition, yet the ones that have been proposed only address particular facets of the technology. The piece of writing [2] makes an attempt to summarise them. In conclusion, it suggests the definition which is as follows: Clouds are vast pools of virtual resources (hardware and/or software) that are simple to use and may be accessed from anywhere. These resources have the capability of being dynamically altered in response to any and every demand. We just have to pay for what we use according to this approach.

The National Institute of Standards and Technology (NIST) in the United States proposes the following definition [3] for the term "cloud computing": "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."

The majority of academics have chosen to adhere to this definition, which seems to have caught the elements of cloud computing that are generally acknowledged. It is essential to get a consensus on a single definition in order to restrict the scope of the study and place more emphasis on the possible advantages for business.

Cloud computing is not really a new technology; rather, it is a new adoption of already existing technologies to run businesses in a different way. This is the primary reason for the existence of these various definitions, and it can be summed up in the fact that cloud computing is not really a new technology. In other words, the main reason for the existence of these different definitions can be summed up in the fact that. The technology known as cloud computing is built on multiple older ideas, such as [1 and 4]: service-oriented architecture (SOA), distributed and grid computing (also known as utility computing), and virtualization.

Cloud Computing Architecture:

Cloud computing is discussed in this section, with an emphasis on the composition model, the business model, and the deployment model.

Cloud Computing Composition Model:

In general, cloud computing may be broken down into the following four layers: the hardware layer, the infrastructure layer, the platform layer, and lastly the application layer [7]. The simplicity of this layer-based design makes system development possible. In

point of fact, any layer may have its contents updated or altered independently of the other levels, which need not be modified in any way. A comparison is made between this layer classification and the OSI model [5] of the network protocol. As a result, the implementation of new software or the installation of a new component of hardware does not have an effect on any other part of the system when the architecture is designed in this way.

The Following Elements Make Up The Layer Architecture:

The hardware layer is the part of the cloud computing system that brings together all of the different hardware components. It pertains to the administration of the actual server, as well as the network component, the power, and the controlling system. Inside this layer, we discuss the administration that takes place within the data centre. In most cases, a cloud computing provider will be responsible for the management of many data centres.

The infrastructure layer, which consists of: It is the layer that symbolises the virtualization. It makes it possible to create the virtual resource that the higher layer will use in its operations. Xen1, KVM2, and VMware3 are the three virtualization technologies that are used the most.

The platform layer is the part of the stack that is responsible for hosting the application frameworks and operating system. It is determined by the virtual machine that is produced in the layer below it.

The application layer: At here, the very top of the structure, we find the application layer. This layer incorporates all of the cloud apps into a single whole. It acts as the front desk for the computing platform that is hosted in the cloud.

This layer-based design serves as the foundation for the cloud computing business model. There is a one-to-one correspondence between each offer in the business model and one or two levels in the architectural model [10].

Cloud Computing Business Model:

As was discussed in the introduction, cloud computing is a reaction to a new need that has arisen in the information technology industry. Cloud computing is offered to customers as part of the business model, which also includes other components. In [11], the writers make an attempt to outline the many offers that may be made. They come to the conclusion that everything is a service, which is denoted by the acronym XaaS. Examples of XaaS include: SaaS (Software as a Service), PaaS (Platform as a Service), HaaS (Hardware as a Service), DaaS ([Development, Database, Desktop] as a Service), IaaS (Infrastructure as a

Service), etc. There are many more instances provided in [12]. IaaS, PaaS, and SaaS are the three types of services that are used the most in this architecture [6, 7, 13, 14 and 15]. (figure 1).

IaaS stands for "Infrastructure as a Service," and it allows customers to make direct use of the underlying information technology infrastructure (computing power, networks, storage, etc.). These resources are made available via the use of technologies related to virtualization. In order to satisfy the requirements of the customers, the physical resources are either consolidated or broken down. The virtualization approach includes the creation of as many virtual machines as are required to meet the requirements. Therefore, with this kind of service, the provider is only responsible for managing the resources, and it is up to the customers to choose both the operating system and the application that will be used.

PaaS stands for "platform as a service," which refers to the fact that this service makes available various software resources, such as an operating system and frameworks for... Consequently, the customer is solely responsible for the development and management of his application while using this sort of service. The customer can successfully execute his application since the service provider provides him with all of the tools that are required to do so.

The term "Software as a service" (SaaS) refers to the act of making a programme available on demand over the internet. Therefore, the service provider administers and controls the whole system, from the lowest level (the hardware layer) all the way up to the highest level (the final application). The consumer will only utilise the programme when he has a need to fulfil that requires neither management nor the creation of anything.

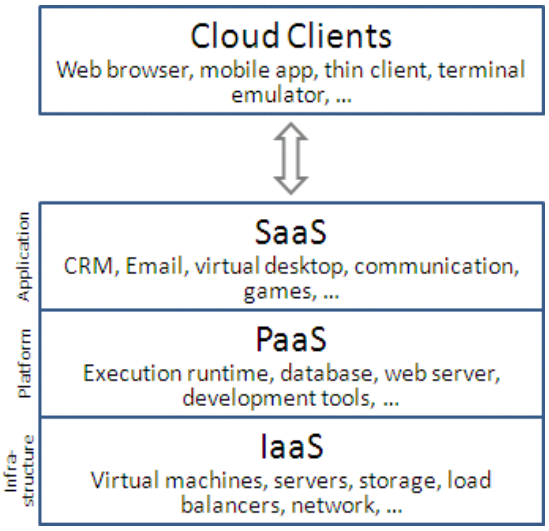

Figure 1. Business model of cloud computing

Cloud Computing Deployment Model:

The deployment model is mainly made up of four different kinds that have been specified by members of the cloud community [6, 7 and 16]:

Infrastructure hosted in the public cloud: The supplier of this kind of system makes available to members of the general public a collection of resources, which may include either

hardware or software. The public clouds provide a number of benefits, one of which is the absence of an initial financial investment in the infrastructure. Because of the nature of this infrastructure, users have less control over the system, which reduces their level of productivity in a variety of different types of commercial settings.

Infrastructure based on a private cloud: One individual is served by this kind of deployment at a time (organization). This system's administration may be handled by the organisation itself or by a third party at the organization's discretion. When using a private cloud, the end user has a greater degree of control over the underlying infrastructure. Because of this, the deployment of this kind is favoured in commercial settings, particularly during the first phase of cloud technology integration.

Infrastructure based on hybrid clouds: We have a hybrid deployment of cloud computing in this system, which means that both types of cloud computing are present. It makes use of both the private cloud for basic operations and the public cloud if there is a need for more storage space than the private cloud can provide. Therefore, hybrid cloud computing may be used to optimise the utilisation of users' resources in accordance with the activities that are really being performed (figure 2).

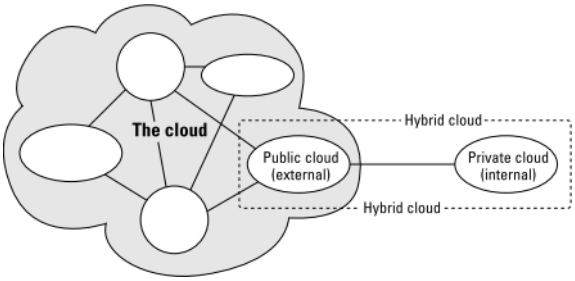

Figure 2. Example of hybrid cloud deployment

Community Cloud infrastructure refers to a system that provides support for a particular community that has a function or purpose in common. It may be developed by a single organisation or by many organisations working together to address shared problems, such as those organisations' missions, policies, or security. It is possible for the community cloud to be maintained either by the organisations that make up the community or by a third party.

Integration Of An Agent System In Cloud Computing:

In this part of the article, we will discuss an optimization concept for management. The acronym "Infrastructure as a Service," or IaaS, refers to the provision of resources in the form of a service. In most cases, these resources are outlined using terms related to virtual machines (VM). The consumers make a request for a service, which the supplier of infrastructure as a service (IaaS) attempts to fulfil by providing the required resources (such as storage, processing power, and

bandwidth). In most cases, the resources offered by the provider will be housed in many distinct data centres. A data centre typically consists of a number of different physical servers that are linked to one another and virtualized in order to maximise the utilisation of those servers. It's possible that the consumers are situated in a variety of different areas. Therefore, it is in the best interest of the service provider to establish data centres in a number of different places (figure 3).

Our plan is to implement a multi-agent system that will operate the many data centres. This will allow us to improve the efficiency of system administration and better meet the needs of as many users as possible.

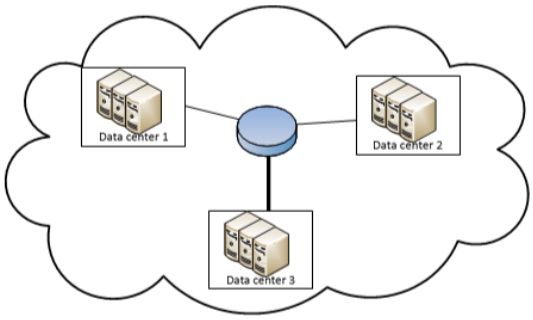

Figure 3. Example of Cloud Computing System

Related Work:

The practise of computing on the cloud is still in its infant stages. In [8,] Foster discusses the present status of distributed systems as well as the best practises for managing them. In addition, we are able to use the technologies that have been utilised in grid computing in cloud computing as well. An agent-based paradigm for achieving scalability in cloud computing was presented in the study [17]. It centred on the communication between the agents in order to fulfil the user's requirements and supply the service, regardless of whether or not a complimentary service from another provider was employed to do so. As a result, they endeavour to improve the efficiency of the consumer task by using the agent technology. There is no prior work that we are aware of that tried to deal with several data centres that belong to the same provider, to the best of our knowledge. As a consequence of this, we will discuss our suggestion in the next part, which strives to maximise the efficiency with which resources are used in the event that a single provider operates numerous data centres.

Proposed Work:

The goal of this effort is to figure out how to make effective use of the resources available in the various data centre locations. The goal here is to devise a method that satisfies the needs of the greatest number of customers without compromising the level of service provided to those customers. When a client makes a request for a certain collection of resources, the normal practise is to send this request to

the data centre that is geographically located the closest to the customer. However, this strategy is not always going to be the ideal option, particularly when there is network delay or when the data centre is already operating at capacity. Therefore, the provider requires a technique to effect the client request in such a way that it is sent to the data centre that is the best match. In this scenario, the knowledge of the global state (forecast state) of the cloud computing system is crucial information that impacts the decision of which data centre is the best to employ based on the criteria that have been set. In point of fact, in order to accomplish this objective, an autonomous communication system that guarantees the proper administration of the cloud system is required. It is going to be in charge of all of the contacts and agreements that take place between the various data centres so that we can choose the best one. Therefore, a multi-agent system may be a solution to the problem of controlling the cloud computing system and selecting the most appropriate data centre for each individual customer's needs. We introduce two distinct kinds of agents: the Local Agent (LA) and the Global Cloud Agent (GCA) (figure 4).

We develop a Local Agent specific to each data centre that makes up the cloud infrastructure. This agent is in charge of controlling and administering the system that is located in the local data centre. At any given time, it provides whatever information that the Global Cloud Agent requires, such as the status of the network, the available resources, etc. In addition to this, LA maintains a record of the previous states of the data centre. Therefore, with this knowledge, it is able to make predictions and provide the GCA with additional data that may assist in the management of the cloud computing system. In the context of this particular cloud computing system, the local agent's function is more analogous to that of an overseer than a manager or controller.

We were only able to locate a single instance of the Global Cloud Agent inside the cloud computing system. This agent will be in charge of directing and supervising the operation of the whole system. When a customer makes a request, GCA first obtains information from the LA, and then selects which data centre will serve that customer's needs most effectively. This choice may be made in accordance with the policy that has been established by the supplier of cloud computing services.

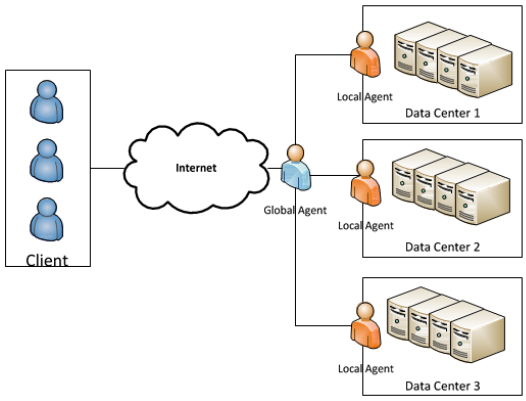

Figure 4. Integration of agent in cloud computing system

For instance, we have the option of choosing to load balance between the data centres or to utilise a data centre only when the one we are currently using is at capacity. Utilizing the data centre with the lowest costs from the beginning is yet another tactic that may be used.

Conclusion:

This study was broken up into two parts: the first portion focused on introducing the concept of cloud computing as well as its underlying architecture. After that, we presented the concept of making use of a Multi-agent System in order to maximise the potential of a cloud computing system. In subsequent works, we will make an effort to establish the way of communication between agents, and we will then put this approach into practise in order to evaluate his actual potential.

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