A SURVEY OF OPEN SOURCE CLOUD COMPUTING SOFTWARE

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Abstract - Cloud computing is a service-oriented architecture that offers a high level of flexibility and on-demand self-service, powered by existing technologies like virtualization and the internet. Open source software (OSS) is a type of computer software in which the source code is made publicly available under a license that allows users to review, modify, and distribute [1]. Open Source Cloud Computing is, therefore, any cloud solution developed with open-source software. This paper examines current trends in cloud computing and open-source software and serves as a road map for future research. This research aims to provide a detailed overview of the two open cloud computing solutions, Xen Cloud Platform (XCP) and OpenStack.

Keywords- Cloud Computing, Open Source Software, Virtualization, Xen Cloud Platform, OpenStack

1. INTRODUCTION

The recent growth in technology use in many sectors has led to the need for cost-effective, scalable, highly available software and hardware infrastructure. Millions of individuals, organizations, and governments have used cloud computing technology to reduce costs, ensure security while delivering scalable computing power, storage, databases, and more. According to the National Institute of Standards and Technology (NIST), Cloud Computing is: "is a model for enabling ubiquitous, 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" [2]
The internet is a core component that cloud providers leverage to provide computing capacity to client's cloud services using the internet. The cloud offers these computing capacities by leveraging virtualization technologies throughout the datacentre's infrastructure including, storage, memory, and processors.

This paper outlines the study of open-source cloud computing software, including virtualization, hypervisors, virtual machines, the features and benefit of open-source software, and the assessment of two open-source cloud managers.

2. VIRTUALIZATION

Virtualization is a vital concept in cloud architecture. Virtualization is the abstraction of computing resources such as processors, memory, programs, and network resources [6]. Virtualization provides the ability to allow a single physical resource to serve as multiple virtual resources, and many physical resources work as a single virtual resource. Virtualization is helpful since it is rare to find dedicated servers and costly to maintain several physical servers running

different operating systems. Virtualization is also known as Hypervisor. A hypervisor is a software that enables multiple host or virtual machines to run on single hardware [16]. In the hardware virtualization architecture, the virtualization layer is positioned between the hardware and the virtual machine running an operating system, as shown in *figure 1.0*

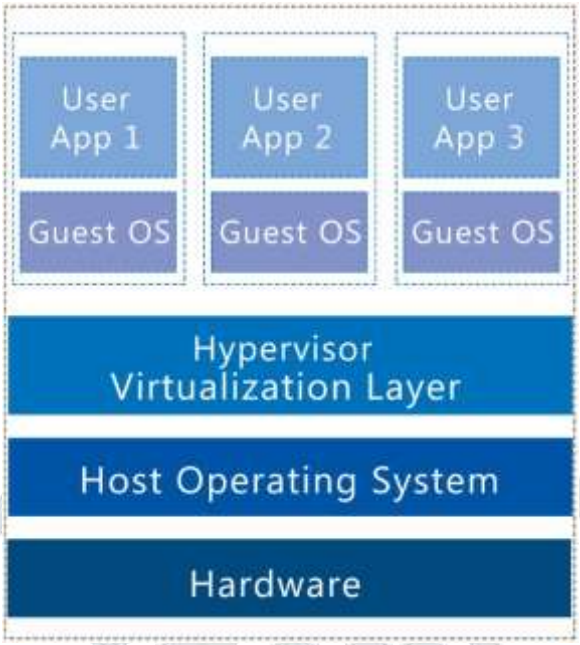

figure 1.0 the architecuture of hardware virtualization

3. OPEN -SOURCE CLOUD COMPUTING ARCHITECTURE

According to Zhang, Cheng, and Boutaba, cloud computing architecture can be divided into three main layers [4]. They are hardware, infrastructure, platforms, and application layers, as shown in Figure 2.0

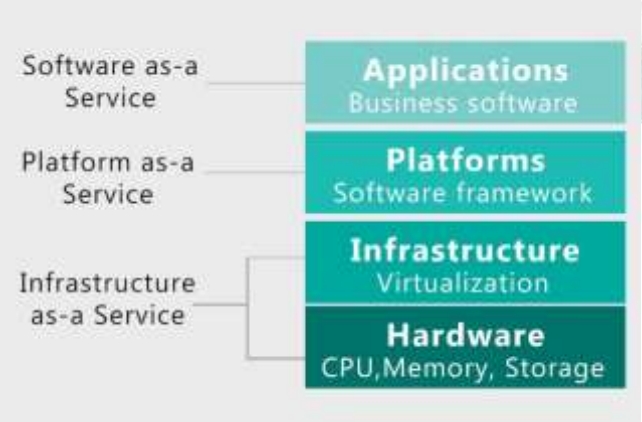

figure 2.0 the architecture of hardware virtualization

3.1 Infrastructure as a service (IaaS)

The Infrastructure as a Service model is a low level of abstraction primarily responsible for managing the physical cloud computing resources such as servers, network devices, network and electric cables, and cooling systems [5]. The physical cloud computing resources are made available through data centers with thousands of servers. The Infrastructure layer provides a pool of resources for processing, storage, and allocating the physical resources through open-source virtualization technologies such as Xen, Kernel-based Virtualization Machine (KVM), Virtualization Machine Software (VMware). IaaS offers users more flexibility and enables the users to deploy any software stack on top of the operating system. Examples are; Amazon Web Services Elastic Cloud Compute (EC2) and Simple Storage Service (S3) are examples of IaaS [8].

3.2 Platform as a service (PaaS)

Platform as a Service is a cloud-based computing platform. PaaS services come pre-installed with applications that a client might need. Therefore, the client does not need to purchase, install and configure the required software and hardware environment. The PaaS service makes it easier for software and application developers to access the systems and environment needed for software design, development, testing, and deployment. Google App Engine (GAE) and Microsoft Azure are good examples. This approach, as compared to conventional application development, can reduce development time, provide hundreds of readily available tools and services, and scale efficiently [13].

3.3 Software as a service (SaaS)

Software-as-a-Service is a modern software distribution model in which software is delivered as a service over the internet [7]. SaaS is becoming a more popular software delivery model, with numerous benefits for customers. The benefits of SaaS include automated updates and patch management by the service provider, global accessibility, lower costs due to a pay-per-use policy, and scalability. The SaaS services can be accessed from numerous devices using a thin client, such as a web browser [5]. Examples of SaaS providers are Salesforce.com Rackspace [9]. The key features of Software as a Service are shown in figure 3.0

Figure 3: Features of Software as a Service

4. OPEN SOURCE SOFTWARE IN CLOUD COMPUTING

Open-Source Software (OSS) can be freely accessed, used, changed, and shared in modified or unmodified form by anyone. Many people make open-source software and distribute it under licenses that comply with the Open-Source definition [3]. Open-Source Software results from a collaborative effort by highly skilled individuals to create software and applications freely available to the public. The open-source projects include source code, software documentation, and test results [10]. Many OSS projects publish their products under an open license, allowing anyone to access them for free, enabling anyone to contribute to the design, coding, testing, and documentation processes. Examples of OSS projects are Operating Systems, libraries, frameworks, and application programs [3].

4.1 The Advantages of Open Source Software Applications

Open-source software is now more widely used in the cloud computing industry. Some of the advantages of open source software are discussed below [11].

A) Cost-Effective:

A user no longer has to pay for proprietary software when using OSS; unrestricted access to the source code allows customization.

B) Global Community Support:

Open-source software has a global community that works with a common goal to support and develop software that benefits both businesses and the community by improving software performance, patches, security, and introducing new concepts.

C) Better Security:

The source code of open source software is publicly accessible for the community to review. As a result, any software flaw can easily be detected and a fix published on time by the community.

4.2 Characteristics of Open Source Computing

A) Open Source Cloud Computing supports the integration of the enterprise applications, products, and systems developed by different organizations and vendors

B) Open Source Cloud Computing is available for the users to study, modify and redistribute.

C) Supports the use of free and open standards, allowing data to be exchanged and integrated across platforms.

4.3 Solutions for Deploying Open Source Cloud

There are various solutions for deploying open source clouds. This paper will present these three solutions; Xen Cloud Platform(XCP) and OpenStack.

4.3.1 Xen Cloud Platform

The Xen Cloud Platform (XCP) is an enterprise-level open source virtualization technology that supports cloud computing. Xen Cloud Platform manages Storage, Virtual Machines (VM), and networks on the cloud. XCP is an infrastructure virtualization solution that acts as an abstraction layer between the server's hardware and the operating system. A Xen hypervisor enables each physical server to run several virtual servers while hiding the operating system and applications from the underlying physical server [13]. Many cloud providers, including Amazon EC2, Oracle VM Server, IBM Cloud, use the Xen Cloud Platform solution [14]. Xen Cloud Platform does not have the complete cloud architecture because it does not have a front-end interface for end-users to connect with cloud services. The fundamental components of a Xen Cloud Platform are the hypervisor, Operating Systems, and user applications. The Xen hypervisor is in charge of low-level functions, such as hardware virtualization [17]. Domain 0 of the Xen architecture is a privileged Xen guest OS that can control and perform input and output (I/O) operations. Domain 0 can use the administrator's interface to provide direct hardware access, device management, and assignment of hardware resources for the various guest domains, also known as the U Domains[18]. *The architecture of the Xen Cloud Platform is shown in Fig. 4.0*

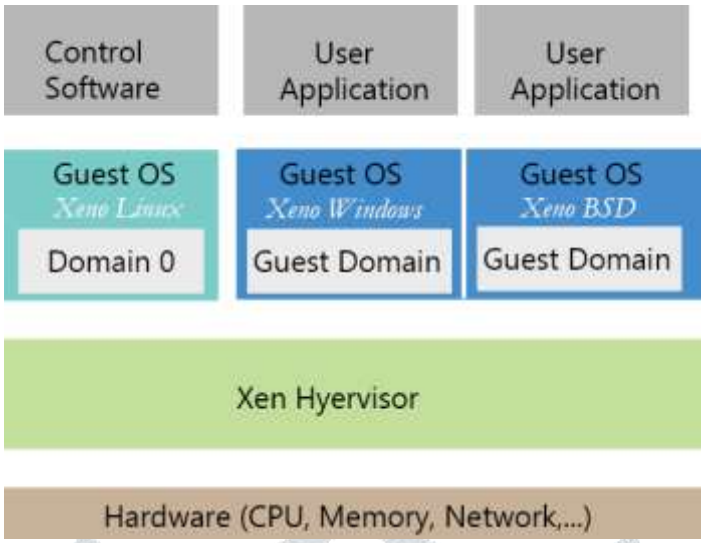

figure 4.0 architecture of xen cloud platform

4.3.2 OpenStack Cloud Software

It is a cloud operating system that manages cloud resources such as servers, computing power, storage, and networking services throughout a data center. The OpenStack comes with a dashboard that gives administrators control to provision resources through a web interface. It is a platform that can meet the needs of the four cloud deployment models, public, private, community, and hybrid cloud. OpenStack is a NASA-developed platform that can manage petabytes of distributed data and can massively scalable up to million physical machines. The architecture of OpenStack has three key components: compute, image, and object storage [12]. OpenStack Compute is a management framework for managing resources such as virtual servers, bare metal, and containers [15]. It controls the infrastructure for handling the Infrastructure-as-a-Service (IaaS) of the cloud. The OpenStack Image Service is a search engine and a retrieval system for Virtual Machine images configured to use any available storage. It offers storage facilities, including recording and distribution of images to virtual machine discs. OpenStack Storage provides a distributed and scalable storage space for storing petabytes of data. It employs a distributed architecture with multiple access points to help prevent single points of failure [12]. *The architecture of the OpenStack cloud is shown in Fig. 4.1*.

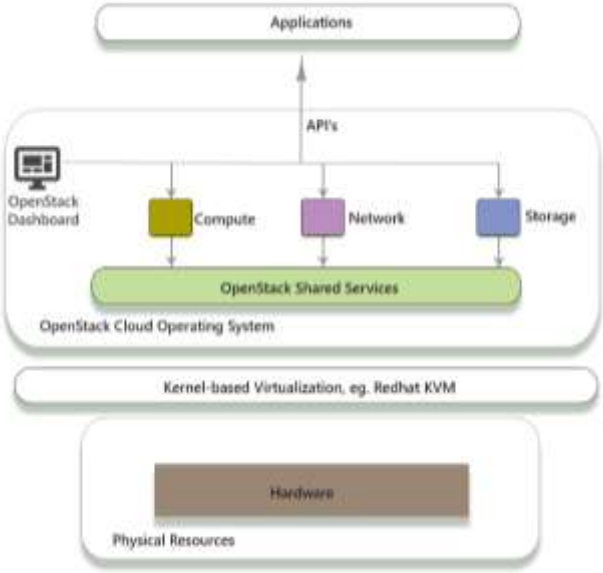

Figure 4.1 Architecture of OpenStack Cloud Software

5. CONCLUSION

Cloud Computing has developed in recent years as a new computing model that offers IT infrastructure and can meet the ever-growing needs for storage and processing applications. Open source cloud software is significant because it provides end-users with enhanced portability, versatility, and scalability of the cloud platform. This paper discussed the architecture and features of two standard Open Source cloud software, Xen Cloud and OpenStack's software. As most businesses move their in-house services to the cloud, cloud computing is becoming increasingly popular. We believe this paper will contribute to a deeper understanding of cloud computing and its underlying architecture, software and support future research in this field.

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