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A Review of Cloud Network Virtualization and Evolution

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Abstract: Cloud computing and virtualization are the fastest growing emerging technologies that presents modern computing paradigm. It provides individuals and organizations to reach a network of computing resources with free or minimum cost. In this paper, a review of cloud computing evolution and its network virtualization is presented. Cloud computing provides its popular service models Software as a Service (SaaS), Infrastructure as a Service (IaaS) and Platform as a Service (PaaS). Cloud computing provides a transparent access to its services such that the location and attributes of the relevant resources are not required to know for its users. However, cloud computing technologies are not affordable solution without virtualization technique. Therefore, on top of it cloud computing, virtualization technology should be required to built. This paper presents the insights of both cloud computing and its virtualization besides their impact on the modern society.

Keywords: Cloud Computing, Virtualization, IaaS, PaaS, SaaS, Wireless Virtualization.

I Introduction

Cloud computing is an emerging technology which helps users to access to immense network of computing resources. The individuals and organizations are avoiding high investments and simply use the cloud computing resources as if they are available in their machine [1]. The services are available as free or pay per use manner. The advantages of cloud computing and virtualization include education, disaster recovery, product evaluations, testing, training, quality assurance, software development, scientific computation, improved security, server consolidation, server migration, low provisioning times, high hardware utilization and easy administration [2].

In cloud computing, virtualization is the process of abstracting computing resources such that multiple applications can share a single physical hardware. Put differently, virtualization refers to the creation of a virtual, rather than actual, version of a resource [3, 4]. The canonical example of virtualization is "server virtualization", in which certain attributes of a physical server are decoupled (abstracted) and reproduced in a hypervisor (virtualization software) as vCPU, vRAM, vNIC, etc.; these are then assembled arbitrarily to produce a virtual server, in few seconds [5–7].

Computing resources are not the only resources that are virtualized; storage can be virtualized too. Through virtualization either one resource is shared among multiple users or multiple resources, e.g., storages, are aggregated and presented as one or more high capacity resource that can be used by one or multiple users [7–9].

II Service Model of Cloud Computing

Broadly speaking, public cloud services are divided into three categories: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). In general, X as a Service (XaaS) is a collective term used to refer to any services that are delivered over the Internet, rather than locally. XaaS presents the essence of cloud computing and new variants of XaaS emerge regularly.

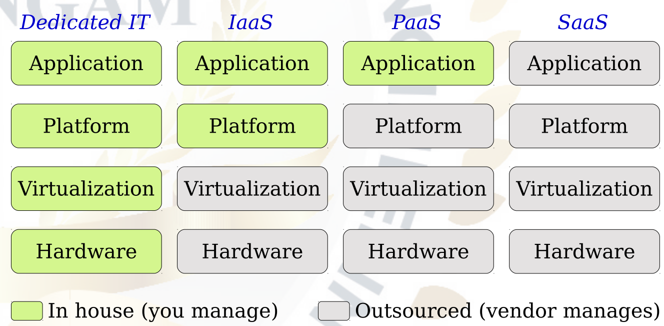

Figure 1: Dedicated Hosting *vs* Cloud Computing (purchasing IaaS, PaaS and SaaS)

Yet, the three basic models (IaaS, PaaS, and SaaS) suffice for a proper understanding of cloud computing. This three service models form a service growth model, from IaaS through Paas to SaaS, as illustrated in Figure 1, in which the following layers can be identified:

- **Application:** It denotes the software for the customer.
- **Platform:** It includes runtime environment (JVM, .NET, PHP, Apache), middleware, and operating system in which software is run.
- **Virtualization:** It refers to the virtualization software (hypervisor) which creates multiple virtual environments based on the physical hardware.
- **Hardware:** It is the equipment (servers, storage and network resources).

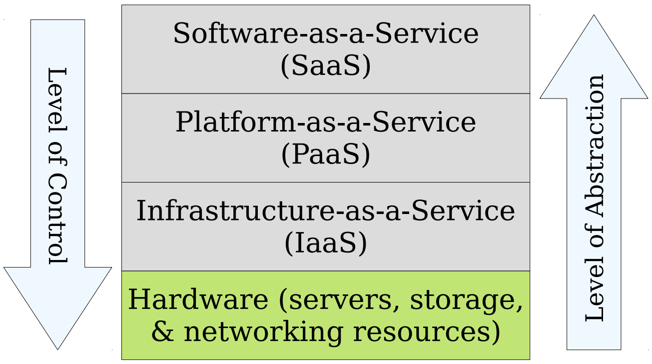

Figure 2: Cloud Computing Service Layers

As can be seen in Figure 1 and more clearly in Figure 2, the first growth phase is the use of IaaS. IaaS, PaaS, and SaaS are different logical layers in the stack, as visualized inFigure 2. The level of abstraction/control increases as we move up/down the stack. Here is a brief explanation of each service model.

2.1 Infrastructure as a Service (IaaS)

In this case, computing resources (compute, storage, and network) are exposed as a capability and the clients put together their own infrastructure. For example, they decide on the operating system, the amount of storage, and the configuration of network components such as firewalls. The clients do not own, manage, or control the underlying infrastructure; instead, they rent it, as a service. As can be seen in Figure 1, the hardware and virtualization move to the cloud. This eliminates the need for customers to set up and maintain their own physical resources. Service provider supplies virtual hardware resources (e.g., CPU, memory, storage, load balancer, virtual LANs, etc.). An example is Amazon elastic cloud compute (EC2), which provides resizable compute capacity along with the needs of the customers. The pay-per-use model makes it possible to not have to make more expenditure than is strictly necessary [10].

2.2 Platform as a Service (PaaS)

In this solution, programming platforms and developing tools (such as Java, .NET, or Python) and/or building blocks and APIs for building and running applications in the cloud are provided as a capability. The customer has control over the applications and some of the configuration of the platform environment but not over the infrastructure; this is the main difference between PaaS and IaaS. Hence, unlike IaaS where users select their operating system, application software, server size, etc., and maintain complete responsibility for the maintenance of the system, with PaaS operating system updates, versions, and patches are controlled and implemented by the vendor [11].

Facebook is probably the most well-known PaaS. Web hosting is another example of PaaS, where web hosting provider provides an environment with a programming language such as PHP and database options in addition to hypertext transfer protocol (HTTP) which allow a personal website to be developed. Some of the biggest names in PaaS include Amazon Elastic Cloud Computing, Microsoft Azure, and Google App Engine, and Force.com [12].

2.3 Software as a Service (SaaS)

With SaaS, the customer uses applications, both general (such as word processing, email, and spreadsheet) and specialized (such as customer relationship management and enterprise resource management) that are running on cloud infrastructure. The applications are accessible to the customers, at any time, from any location, and with any device, through a simple interface such as a web browser. As it is shown in Figure 1, all layers are outsourced in SaaS. This is the ultimate level of abstraction and the consumer only needs to focus on administering users to the system. Then again, the users can influence configuration only in a limited manner, e.g., the language setups and look-and-feel settings [13].

III Related Work

Ananth *et al.* [14] implemented a prototype of the network function virtualization (NFV) based cloud network system. An network function virtualization (NFV) based cloud network system virtualizes the network functions and other internetwork system devices such as servers, firewalls etc., as per the user requirement. From obtained results it is observed that network function virtualization (NFV) based system thereby reduces the capital expenditure of an organization, while providing flexibility and ease of management. From the analysis of the performance of a web server, it was observed that the performance and behavior of the web server on two environments was similar. This research can be extended to service function chaining (SFC) in future. Load on CPU can be refined further and analyzed by introducing Load Balancing mechanism and using dynamic web pages. Analysis of the performance of RAM can also be incorporated. Another field of future work is to enhance the Cloud security. As the number of functions increases on the cloud, the cloud provider should have a strong protection for the cloud. network function virtualization (NFV) can also be tried on the scientific computing platform. A scientific functionality running on a dedicated hardware can be virtualized using network function virtualization (NFV).

Baroncelli *et al.* [15] discussed the abstraction of "Network as a Service" NaaS, a novel class of cloud computing services that enables cloud users to request on-demand connectivity without any knowledge of the complexity and the technology details of the network. NaaS is enabled by a network virtualization platform (NVP). The NVP has principally two roles: it collects network status at the boundary of the network and maintains a distributed network resource database, and it performs the mapping between the perceived QoS parameters of the NaaS to the transport technology-dependent QoS parameters needed by the network for the provisioning of that NaaS. The mechanism that allows the NVP to collect network topology and technology information has been presented. It is based on a signaling among the network virtualization platform (NVP), distributed entities (DEs) and allows to achieve scalability in terms of network dimension and service delivering latency. An NVP can control more than one network domain. In particular, an NVP implementation is provided with functionalities in order to communicate with other NVP for the provisioning of inter-domain NaaS.

Wan [16] presented an approach using processor core to control all network interfaces and dispatch packets to others cores OSs/applications run on. Also gave the implementation of network virtualization on Cavium CN3860 multi-core processor platform. The theoretical analysis and tentative benchmark showed overall system performance got solid improvement. This approach replaced the hypervisor layer in current widely deployed full virtualization. One of the key component as the basis to guarantee the overall performance is the Schedule/Synchronization/Order (SSO), a dedicated hardware for fast packet scheduling. In fact, lots of current many-core processor vendors, e.g., Netlogic, Tilera and so on introduce different hardware implementation to assist fast packet processing and passing among cores. This approach is also applicable for those chips. Meanwhile, the major limitation of this approach is th dedicated hardware unit dependency. For those dedicated packet processing unit absent multi-core processors the packet rescheduling should be elaborated redesigned basing on other inter-core communication mechanism.

IV Proposed Virtualization Approach

The basic motivation for virtualization is to efficiently share resources among multiple users. This is similar to multitasking operating systems where, rather than doing one task at a time, unused computing power is used to run another task [17]. Migration is another big advantage of virtualization. It comes in handy if an upgrade is required or when the hardware is faulty because it is fairly simple to migrate a virtual machine from one physical machine to another. Therefore, increasing backup capability is another compelling reason for virtualization.

Network virtualization refers to the technology that enables partitioning or aggregating a collection of network resources and presenting them to various users in a way that each user experiences an isolated and unique view of the physical network. This technology may virtualize a network device (e.g., a router or network interface card (NIC)) a link (physical channel, data path, etc.), or a network.

As a natural extension of wired network virtualization, wireless networks virtualization is motivated by the observed benefits of that in wired networks. However, while virtualization of wired networks and computing systems has become a trend, much less virtualization has occurred in infrastructure based wireless networks. Yet, the idea of virtualizing wireless access has recently attracted substantial attention in both academia and industry.

Wireless virtualization may refer to wireless access virtualization, wireless infrastructure virtualization, wireless network virtualization, or even mobile network virtualization. It is about the abstraction and sharing of wireless resources and wireless network devices among multiple users while keeping them isolated.

V Conclusion

This paper studied the virtualization on which cloud computing is based. It throws light into both cloud computing and virtualization. Virtualization improves the efficiency of cloud computing. Virtualization is done with many resources like I/O, OS, network, storage and so on. Virtualization improves scalability besides making the cloud solutions cost effective. These two technologies go hand in hand in providing state of the art services to end users. Individuals and organizations can access to various kinds of clouds in pay per use fashion and obtain services pertaining to infrastructure, platform and software. Scientific and high computing tasks can take advantage of cloud computing.

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