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AN EMPIRICAL STUDY ON REVOLUTIONIZING VIRTUALIZATION APPROACH IN CLOUD COMPUTING PARADIGM

R.Sundar Raj,
Research and Development Centre,
Bharathiar University, Coimbatore-641 046.

Dr.V.Murali Bhaskaran,
Dhirajlal Gandhi College of Technology,
Omalur(Tk),Salem-636 309.

Abstract: Cloud computing is one of the recent technologies that gains the attention of developers and researchers due to its emerging features. This technology focuses on the aspect of providing all the needful to the users who are affording it. Many organizations' traditional methods have been migrated to the cloud with their data and functionalities. Still, there are people who are not aware of the features and benefits of cloud computing. Some people even after knowing about it fear to move to clouds due to their feeling of insecurity. This is because of some kind of myths regarding cloud storage. This paper is a survey cum clarification about cloud advantages and its heart like concept Virtualization. The focus will be completely on virtualization, its approaches, and benefits. The main intention is to make the new comers and non-users of clouds to enter into this powerful world without fear. This also tries to educate them that even some issues originates they are manageable.

Keywords: Virtual Machine, Kernel-based Virtual Machine, Network Interface Controller, Virtual Machine Monitor, Operating Systems

1. INTRODUCTION

Cloud Computing is a terminology that illustrates the means of delivering any and all Information Technology to an end user as a service wherever and whenever they need it [40]. By using this technology, Everything (ie) Software, Platform and Infrastructure can be obtained as a service [42][3][40][19][31] as shown in the Figure 1.

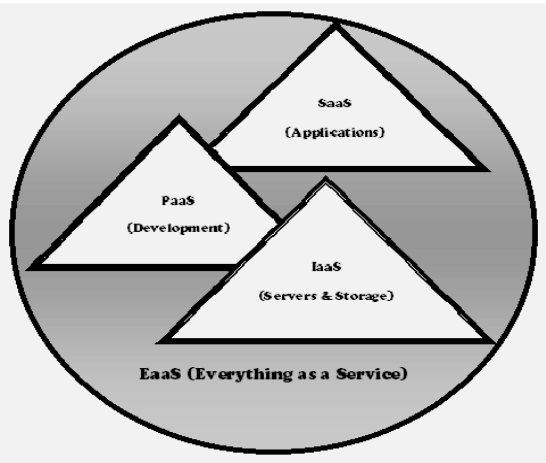

Figure 1: Cloud Services

This allows the users to gain access to the applications and data in a web-based ambience on demand. This provides online scalable environment, noteworthy computing capabilities with minimum level of time and expense, than any other computing solutions of recent times. Instead of the succession of programs and data on an individual desktop computer, everything is hosted in the 'Cloud'—a nebulous assemblage of computers and servers accessed through the internet [3]. It does not require end-user knowledge of the physical location and configuration of the system that delivers the services.

This carry- outs its mission as a front-runner with its data centralization, faster start-up time, extensive logging, reduced management costs, forensics build-up, and improved scalability.

For the people those who develop and manage computer systems, Cloud Computing is all about horizontal scalability in the form of server capability; the technical challenge is developing operating systems and applications to manage this sort of on-the-fly scaling –while

keeping the mechanics of it invisible to the end user. The cyber attack threats are remarkably high when compared to traditional systems [31]. Based on a review of [33], chances are more for a hacker to carryout vulnerable attacks on another Amazon EC2 user who shares hardware resources with the hacker in the cloud. The data of the users are kept stored in the cloud and uses the concept of virtualization.

The chief benefits of cloud computing, such as cost reduction, scalability, agility, increased efficiency and better utilization, are achieved by using virtualization [31]. Thus, Security is an important factor in this virtualization area to not let the unauthorized users to gain access to the confidential data.

Roadmap: The content of the work is organized in the following order: Previous section (Section1) is the introductory portion of cloud computing, virtualization and importance of security. The next section (Section2) surveys related work. Section3 explains the virtualization and its concepts behind, while Section4 categorizes the approaches and benefits of virtualization. Finally, Section5 draw some conclusions of this particular work.

2. RELATED WORK

Various virtualization approaches, security threats in virtualization and its security solutions based on Hypervisor technology are considered in [11][28][31]. The benefits of virtualization are greatly dealt in [37][43]. Important concepts of Intrusion detection systems are dealt in [31][35] and these helps this work while dealing with various approaches of virtualization implementation. Several contributions have been made to secure clouds via virtualization. Architecture has been proposed and has been implemented entirely on Advanced Cloud Protection System (ACPS) have been proposed, tailored and deployed [31].

In [27],[37],[43], the overview of virtualization benefits and security risks are considered and the possibility to consolidate multiple operating systems and applications onto a single server has given rise to significant benefits. Numerous controls, those related to security has been suggested that could be considered for the mitigation of virtualization security risks. Virtualization on server, storage and network has been deeply discussed in [41].

[28],[33]and[41] gives the importance of virtual machines and its implementations.[40] contends that the virtualization and management features of cloud systems make them an ideal design point for exascale OS and runtime. It also illustrates the viability of virtualization technology and the potential for energy savings when proper resource utilization is realized.

In [35] a scalable data center network architecture called SEC2 has been proposed that intends to support secure cloud computing for both enterprise and individual users. The proposed architecture that takes advantage of network virtualization and centralized control has also enabled users to combine cloud-based resources seamlessly with their existing network infrastructure through VPN.

The evaluation environment has been implemented and conducted different tests on Open vSwitch including VLAN test, QoS Test and Overhead evaluation. The fine-grained QoS setup brings additional convenience to network administrators in cloud platform in [42] with the concept of virtualization.

3. VIRTUALIZATION-BACKGROUND

Cloud computing is an uptrend technology that uses the web as well as remote servers to deal with data and applications. It facilitates the consumers and businesses to use applications without installation and access their personal files at any computer with internet access. Cloud computing incorporates virtualization, on-demand deployment, Internet delivery of services, and open source software [43]. Among them virtualization is a most vital technology that empowers cloud computing by separating the infrastructures available in an effective manner.

Virtualization in general is a method of creating a copy in software of a physical machine [40].The user of these machines has an illusion that the total resources are fully available to them. But, the fact is the machine provides only a portion of its total means to the user. The remaining segment is also shared among many users that help them, to run their own copy of the machine. This is a revolutionizing technology that has been most influential in enabling the cloud computing paradigm [42]. Almost all the clouds are virtualized, automated, and standardized to make them to satisfy the customers' expectations on them as scalable services.

Majority of the present interest in virtualization lies on virtual servers in part because virtualizing servers can result in significant cost savings. Added to this, there is a management layer called a Virtual Machine Monitor/Manager (VMM) that generates and manages the all virtual machines' in virtual environment. [11]. the time slice is assigned for each computer for processing. The purpose of Virtualization is to utilize the resource sharing, utilization and distribution to their maximum potential, reduce infrastructure costs in terms of physical resources, hardware, new network setups, system setups, and infrastructure maintenance. Virtualization hides the characteristics of the physical system from the user and instead provides with another abstract computing platform [28].

Virtualization acts as a response to the demands that are posed by IT industry with energy efficiency. As a result of the mentality of single application on a single server, on an average only 15 to 20 percentage of the total computing capacity is used at any time in a cloud based environment. Instead, with the idea of IT departments to run multiple applications on the same server, virtualization provides dramatic gains in server utilization [41]. This when combined with service management greatly improves server utilization and reduces software license costs since fewer machines need licenses [19].

The three chief purpose of the usage of Virtualization are [40]:

(i) Distributing the computer system among several users
(ii) Separating the users from one another and from the control program
(iii) Emulating hardware on different machine

a) Hypervisor

The Hypervisor is software that is able to run all the copies of the VMs and ensures that the users do not share the same resources simultaneously among one another [40]. It is otherwise called as Virtual Machine Monitor (VMM). It is enclosed with Kernel and operating system. Some of the Hypervisors are EMC's VMware, Opensource product of the Linux called KVM and Microsoft's VMware. The three properties of interest for a Virtual Machine Monitor (VMM) also known as a Hypervisor [41] :

- Equivalence,
- Resource control and
- Efficiency

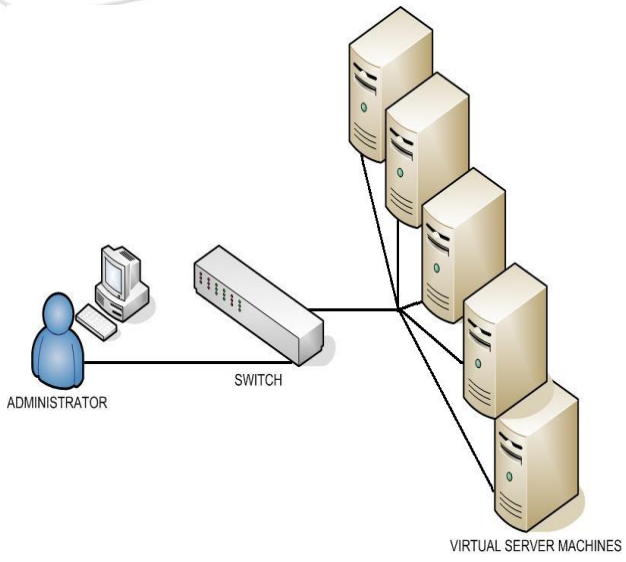

Figure 1.1 Virtual Machine Components

Example: As mentioned in [40], a user may need Windows Vista to run one application, while

Linux may be used in another application. It is easy to set up the server to run both operating systems simultaneously only with the help of Hypervisor. This helps us in providing most controllable environment with additional tools on security like Intrusion Detection Systems (IDSs) [31]. The presence of an IDS in the hypervisor can detect attacks better than the same IDS, running on the guest OS [11][35].

b) Virtual Machines

Virtualization software enables to break the single application server into fractional replicas called Virtual Machines (VMs). In the year 1970, with the development of the system/360 by IBM the technology of virtualization was introduced [43].

The software allows for granular control of processing resources and can again allocate the processing power between virtual machines based on demand [40]. The administrator may easily move within the virtual servers as in the case of traditional systems. A typical VM comprise of a guest Operating System (OS), guest application(s), with shared CPU cores, shared memory, shared NIC and shared disk drives over a physical machine comprising its own layers of hardware and software [28].

Virtual machines can be simply classified as [42][11]

(i) Process virtual machines

(ii) System virtual machines

- Host system virtual machines
- Native system virtual machines

Virtual Machine technology is going main-stream in the IT industry, security of VMs becomes the significant concern [41].

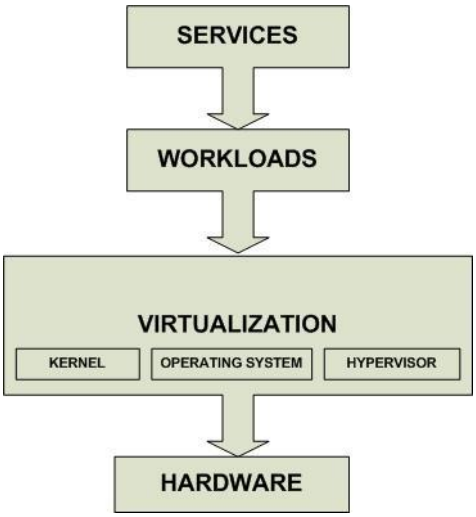

Figure 1.2 Virtual Server Machines

c) Migration Technology

VM Migration is a process that is carried out within two or more physical servers deployed either over a Local Area Network (LAN) or Wide Area Network (WAN) in which a Virtual Machine is moved from one machines to another. With day to day advancements and need for the huge data in application processing and networking, Virtual Machines and their migrations are becoming major needs of any business today[28]. This happens during when there is a need to take backup copies of the data regularly or due to a disaster, share the resources among other users, network and server maintenance along with its management, load balancing.

Virtual machines naturally pave way for migration by encapsulating all of the state of the peripherals and applications running within the virtual machine. The three kinds of state that are to be kept in mind while doing VM migration:

1) The virtual device state
2) External connections
3) The VM's physical memory [24]

The forthcoming virtual machine system mainly presents the architecture, management mode and performance evaluation method is based on the migration technology of virtual machines [27]. While doing a migration the first point to consider is the migration of active operating systems hosting live services to

minimize the downtime. Secondly, the total migration time is to be considered to keep an eye on reliability. Furthermore unnecessary disruptions of active services during VM migration are to be considered [33].

d) Virtual Introspection

When a malicious hacker finds that its destination is in a virtualized environment, it may try to break out that with defenselessness in the VMM. It is able to provide fine-grained isolation among different VMs [42]. Recent approaches leverage isolation of VMM to secure VMs by leveraging various levels of virtual introspection. Virtual introspection is a process that allows observing the state of a VM from the VMM [31]. SecVisor, Lares and KVM-L4, to name a few, leverage virtualization to observe and monitor guest kernel code integrity from a privileged VM or from the VMM [31] [41] [37].

The TCCP allows a client to reliably and remotely attest the platform at the cloud provider's location to verify that it is running trusted VMM implementation and thus make sure that the computation is running in a guest VM is secure [27].[42] propose a design of a trusted cloud computing platform (TCCP) that ensures VMs are running on a secure hardware and software stack with a remote and un-trusted host . The platform is comprised of three trusted components, namely a trusted virtual machine monitor, trusted coordinator (TC) and an external trusted entity (ETE) and an un-trusted cloud manager.

4. VIRTUALIZATION APPROACHES AND BENEFITS

4.1 Approaches of Virtualization

Basically in an environment that supports traditional methods the concept of physical switch is used along by connecting with that of the physical servers. The organizations that use it can receive details about the traffic that goes between the servers and the connected switch. In virtual machines, the virtual switch has links from the physical switch through the physical NIC. The eye is kept away from this and may cause some lag related to the safeguard measures and efficiency in performance. Thus it is essential to keep track on the major approaches related to the virtualization [11][31][31].

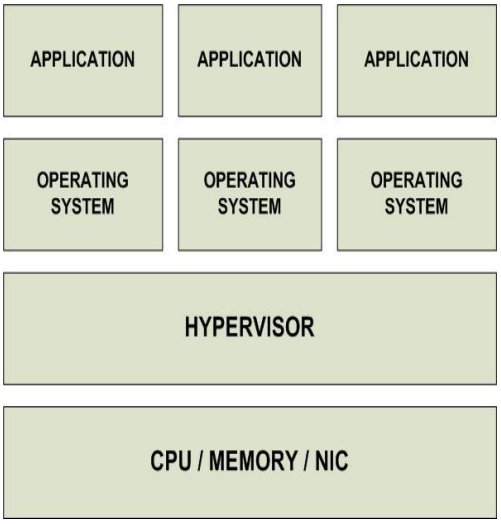

Figure 1.3 Virtual Server Machines

4.1.1 Hypervisor-based Virtualization

Already a detailed discussion has been made in Section 3.1 about the Hypervisor. Simply to summarize the hypervisor is connecting to the system at boot time alone. The user while using this approach should be very cautious, because if failure occurs even at small point chances are high for the intruder to get into the system and may cause attacks. Controlling the attacks after its occurrence is also difficult [35].

4.1.2 Application-based Virtualization

This kind of virtualization follows each VM containing its own guest operating system and related applications. This architecture is not used in commercial environments most commonly.

4.1.3 OS-based Virtualization

This simple method completely rules over the virtualized machines. This approach support the different virtualized guests on a single physical server that has a property that all the individual machines are on the common roof of operating system's central core Kernel only with some external support on the infrastructure of hardware. Security issues of this approach are similar to Application based systems.

These are clearly tabulated with the abstract view as shown below:

Table :1.0 A Comparison on the Approaches of Virtualization

Category	Hypervisor based approach	Applications based approach	Operating system based approach
Common features	1. Web based remote control 2. Migration within hardware nodes 3. Data backup 4. Root access		
Principle behind	Full operating system is running in a virtual machine	Concentrates on the guest OSs that runs its related applications	One kernel installed and runs on the hardware node, with several VMs (as a partial OS)installed on top of it
Operating System	Flexible and allows multiple OS at a time	Can be used in a single OS at a time	Chosen when not more than an OSs are needed
Set-up	Longer set up phase depending on OS (minutes to hours)	Medium level set up (minutes)	Very Quick- Fully automatized by provider (seconds)
Remote access	Available before OS boot - Provides remote console and keyboard functionality	Available after OS boot -Depend on applications	Available after OS boot - Depends on OS- shell access or remote desktop connection
Management of resources	VM needs to get shutted down when new resources are to be allocated.	Consumes application related resources	Provides elasticity- (ie) resources are added whenever necessary Without any shut down or volume resizing
License	Separate license costs for OS and VM	License for applications is enough	All in one included
Pros	Free choice- Full control on OS and parameters- Full control on version and upgrade of Os- Full dedicated resources- QoS is a commitment- Convenient to consolidate physical servers on a single hardware node	Can incorporate changes easily- Runs variety of applications- QoS is moreover essential- Application level updation is allowed	More efficient- Kernel upgraded by provider- Low overhead- Less charged and more economical- QoS is a best try- Provider lends managed service
Cons	More costly- Higher overhead per VM- Full Maintenance is customer's responsibility- Less VM can run on a hardware node	Not used in commercial based environment more commonly- Has some security issues	No control on Kernel- Provider has control on version and upgrades on kernel- Only one kernel can run on hardware node- Mix of OS impossible

4.2 Benefits of Virtualization

4.2.1 Change Management

Migration of services is greatly possible in cloud computing with the concept of virtualization. This pre-planned migration with a determined decision is made possible since it supports the changes. These changes preferred by the users are easily implemented only since change management is effortlessly possible for the user [37]. The necessary clarifications, with cloud providers with virtual machines, are needed to be done by the users in the policies regarding.

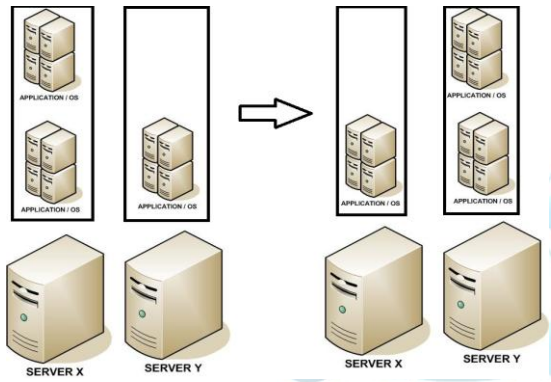

Figure 1.4 Migrations of Services

4.2.2 Catastrophe recovered service

Unexpected disasters may occur at any time due to some network related hurdles. These may occur rarely but may cause adverse effects. Virtualization, by tailoring configuration management will afford the possibility of recovering the lost data and to continue with the service without any huge loss [38]. This will also enable the cloud users and to assist the different disaster recovery service scenarios in order to be attentive before experiencing the difficulties [19].

4.2.3 Portability of services

Standardized or proprietary technology is implemented along with the support of hybrid clouds to achieve the feature of portability [19]. The service of the providers can be easily changed if found that their service is not up to the mark. This change of providers will not affect the concern getting the service, since portability feature is offered. More providers are ready with their resources waiting to render the service competitively. Since the vendors have many other options to get choice, it is very much easy for them to migrate within the services. Also it will not show any adverse effects on the service [37]. This is due to the presence of virtualization.

4.2.4 Security improvisations and convenient administration

Virtualization greatly enhances security and administration with a needed control since VMs are operated in isolation and thereby restrict security vulnerabilities to the compromised unit only. This leads to security policy enforcement being less complex and easily distributed across user interfaces [37]. The servers are reduced to the greater extent, thus makes the administration so easier. During the architecture of the cloud systems the key factor that is to be remembered is the location of management console in order to line up with the control features of the VMs [38].

4.2.5 Resource Consolidation Vs Server Utilization

Today's organizations of IT sectors are in a situation to continuously monitor the virtual and the physical servers [11]. Through this observance the utilization of system resources below or above the saturation level can be easily tracked. The computing resources are consolidated together and bitterly utilized by the systems in cloud only because of the virtualization [37].

These kinds of utilizations are made possible since this allows many varieties of platforms to be connected together. Thus the server utilization is more by reducing the idle time of them.

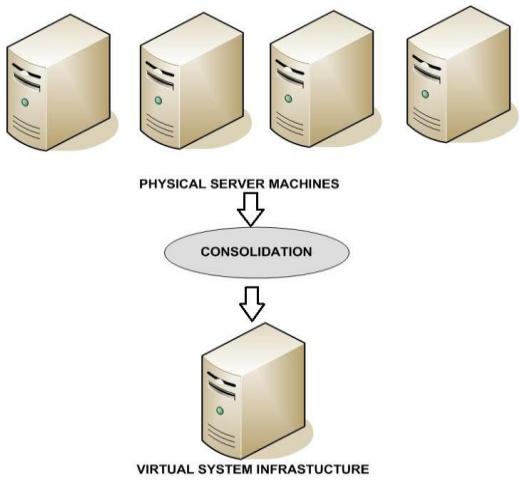

Figure 1.5 Resource Consolidations

4.2.6 Isolation of systems

This process begins at test or development phase, then enters the consolidation phase and ends in the enterprise phase since the virtualization is the building blocks of cloud [37]. This also lends its hands to achieve the improved security [27], by conforming the resources of one user is not shared with the other. This is one of the remarkable features of virtualization since less isolation helps the misbehaving application to affect the other ones [25].

4.2.7 Interoperability and legacy systems

Interoperability refers the link between various systems' cloud and also the link between the cloud and local systems of IT organizations. The flow of data is considered between the cloud systems and local systems [39]. In various levels this feature becomes essential especially in IT aspect optimization, outsourcing of marginal functions etc., Standardization provided by virtualization is the best solution for achieving this interoperability [43]. The chief importance of this lies in the fact that this also involves legacy systems in cloud environment without any maximum deviations.

4.2.8 Cost reduction

The virtual machines and its processes are consolidated together under a single virtual server or a physical server. Through this many applications can be carried out with minimal cost [37]. This also helps in the reduction in the hardware costs and its implementation. It also reduces the replacement costs, since the users may decide at any time whether the processes are to be continued or not [27]. Even this helps in the allocation or acquisition of resources and its maintenance [4].

4.2.9 Scalability

The number of customers that can be supported should be restricted only by the resources
available in the data center, not by design artifacts[35]. The cloud network infrastructure must be capable of scaling a large number of servers and allow for incremental expansion [32]. This feature is achieved with virtualization's load balancing options [26].This also helps in quick addition along with removal of servers and provides instant provisioning [25].

4.2.10 Research area

By covering the entire computing stack and with the implementation of virtualization technologies, cloud computing is offering different variety of services to the end-users. This may greatly reduce the cost that is needed for the incorporation of computing requirements. The applications that are been used are charged on a pay per use basis [3]. By following this method the need for capacity planning is totally neglected and the user has got the full rights and ability to leave the service whenever needed, without any complications.

With the implementation of virtualization, customized execution environment and distributed infrastructures can be settled with perfection for the experiments carried out by the scientists [11]. Even this concept of virtualization has stretched its hands over the appliances that are termed as Hardware virtualization. This feature altogether supports the users in a prominent way to carry out the advancements in the computing world.

4.2.11 Competing performance over usual network

Even before the arrival of the thought of cloud computing, the users were very familiar with the earlier networks. The central theme and idea of this technology with virtualization is not so far from that of the traditional methods. Even though this was the status the performance of virtualization is far forward compared to the traditional networks.

The modified comparison that has resided in [28] is clearly depicted.

Table 1.1: A Comparison of Virtualization on Network and Cloud

S.No	Factors	Impact on	
		Network	Cloud
01	Scalability	By Administrator	Self
02	Flexibility	Limited in VM mobility	Limitless
03	Bandwidth	Wasted	Not Wasted
04	Storage	Does not acts as Database	Acts as a Database
05	Structure	Necessary	Self structured

5. CONCLUSION

This paper focuses on the significance of virtualization and its role cum necessity in the concept of cloud computing. There are some security issues felt in this by the users. The new users travel in the roads of cloud computing with a fear of security and the other users following traditional methods are in a total dilemma to step into the cloud. These all are due to the minor defects that are experienced. These are currently handled by virtualization techniques. Some users think that virtualization is also one of the reasons for these defects. To some extent it seems to be true due to some hurdles like virtualization sprawls, lag in reliability etc., Actually the idea of virtualization is so interesting and remarkable to achieve several tasks in the cloud environment. Thus this survey work presents neatly the importance of virtualization and its need in cloud. This may help in the further empowerments to the pillars of virtualization and may also vanish the fear of users to continue in clouds.

Thus, without virtualization one cannot go conveniently deep into the roots (for researchers) and routes (for developers) of the cloud. This survey will definitely make the new comers to use clouds in beginning level, by knowing the base and benefits of virtualization. The future work will completely focus on some issues occur while using virtualization and algorithms of it. These algorithms will be presented with possible improvisations, in order to help and assist the users and developers in the implementations of virtual machines and processes.

Note: The diagrams used in this paper were drawn with the help of Microsoft Visio.

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