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Supercloud – Need, Issues and Challenges

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Abstract -Cloud Services are offered and used more as a utility, but in many cases a user may require the services of more than one cloud service provider. Here lies the problem, there is no uniform standard for data storage and retrieval across different providers, this is where the Supercloud comes into the picture. TheSupercloud acts as a distributor consuming resources from multiple providers and providing an amalgamation to the users giving them a feeling of having their own homogenous cloud.

Virtualization and Cloud computing go hand in hand because of its unique characteristic of delivering resources in a cost effective manner. This distribution layer makes use of nested paravirtualization to obtain the above. The guest operating system is modified in order to adapt to virtual environment in paravirtualizationfor efficiency.The Supercloud can include different hypervisors, hardware architectures, storage subsystems and connection fabrics.

The Supercloudbrings in benefits along with certain concerns. This paperdiscuses the need for the Supercloud along with the issues and challenges that can be faced in implementing the same.

1. INTRODUCTION

The concept of virtualization was developed by IBM in 1960's to concurrently access resources without any delays. Virtualization is the buzz word everywhere nowadays. Absence of this technology couldcause co-operations to investhuge amounts on physical hardware and resources unnecessarily. Virtual Machines (VM) are used for the virtualization. A Virtual Machine is a replica of a real physical machine which is strongly protected and isolated. It enables multiple operating systems to runsimultaneously as if they were running on their own physical hardware. Virtualization reduces power consumption ultimately dropping overall costs by cutting down the need for physical hardware. It also increases the ease at which multiple tasks can be done simultaneously and hence provide extracted resources to the respective users when required. Infrastructure as a Service(IaaS) is a service model through which users can acquire computing resources such as network, storage, hardware and memory from an IaaS provider. The users have no control over the underlying hardware. The provider ensuresthat its resources are utilized thoroughly.

A virtual environment consists of Virtual Machine Monitor (VMM) or the hypervisor. It is an abstraction layer whose purpose is assign computing resources such as the CPU, memory, network and storage to the virtual machines (VMs). The location of the hypervisor or VMM creates two forms of virtualization. Figure 1ilustrates the first form known as bare metal. In this the hypervisor lies between virtual machines(VMs) and the physical hardware resource and acts as an interface between the two[7]. The second form isknown as hosted virtualization depicted in Figure2.

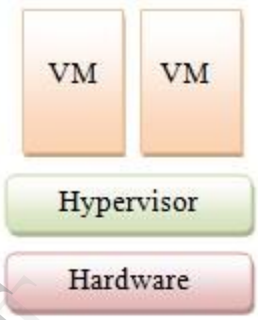

Figure 1: Bare Metal

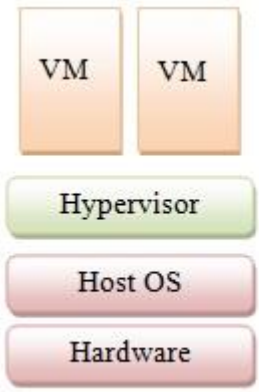

Figure 2: Hosted

We can also run one virtual machine inside another. This is known as nested virtualization. In 1973 and 1975 initial research was published about properties of recursive virtual machine architectures [1, 2]. Thus recursive virtualization could be another term to describe nested virtualization. This has played a major role in building of Supercloud[3]. It is through the use of nested paravirtualization that Dan Williams, Hani Jamjoom and Hakim Weatherspoon in their publication "Plug into the Supercloud" came up with the concept of designing a layer that would be of great importance to the users. Paravirtualization refers to the communication between the guest OS and the hypervisor to attain improved performance and efficiency[10]. Here, the guest OS acts as a gateway between applications and the execution on host hardware. Figure 3[10] shows that the modification of the guest OS replaces non-virtualized instructions by Hypercalls. Hypercalls ensure smooth communication with the hypervisor.

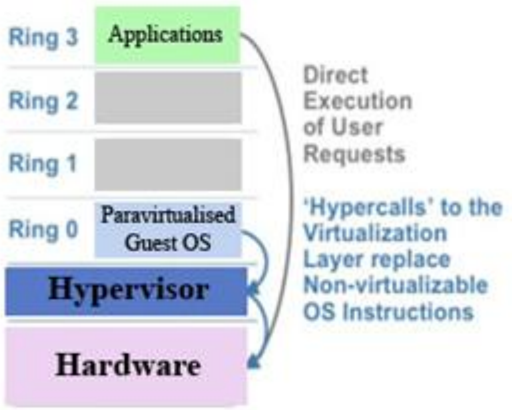

Figure 3: Paravirtualization

"Plug into Supercloud"publicationhavedevised a way to homogenize multi-cloud environments. It enables cross provider live migration, oversubscription and page sharing. Live migration is the ability to move guestsacross physical machines with minimal or no interference to theguest or its users.Oversubscription utilizes the underutilized capacity.Memory can be utilized in virtual environment sharing pages thathave identical and/or similar contents [13].These features are not found in native cloud environment.

2. SUPERCLOUD

The intricate details of the clouds remain concealed beneath the hardware. Users forced to rely on the provider to expose everything from I/Ointerfaces to physical data information sharing. Moreover, they are in a vendor lock-in[8] situation. Vendor lock-in is a situation where the cloud provider monopolizes over the users and restrict them to their services and additional features. It is difficult to move toanother provider if your data is more[8] and would directly increase costs. Therefore the users can't implement strategies to extract maximum performance from the rented virtual machines. The existence of Supercloud was solely a result of the inability of cloud providers to provide standard distributor defined image formats[4]. A virtual machine image is a single file which contains a virtual disk that has a bootable operating system installed on it [9].Cloud providers like Amazon and VMware use AMI image formats and VMDKformats for images respectively[9].Standardization would take years to come into existence. Even though a common standard might be accepted across all providers, attempts could be made to tempt users with features different from the others. Hence this would in any way lead to competition among providers causing users to benefit with the services provided on one hand whereas on the other hand they would be restricted to services pertaining to a specific provider.Also Supercloud ensures users some level of hypervisor level flexibility.

Supercloud uses Xen-Blanketmechanism to provide homogeneity to the cloud users as shown in Figure 4 [4]. The Xen-Blanket has two main activities through its top half and bottom half. The top half exposes a homogeneous virtual machines interface to the respective users. The bottom half of the blanket layer ensures that it is available to all to access various cloud platforms. The Xen Blanket supports nonstandard interfaces by modifying the bottom half to contain cloud-specific Blanket drivers [3]. Here, the device I/O is not emulated thus the Blanket hypervisor must know about the interface beneath it [3].

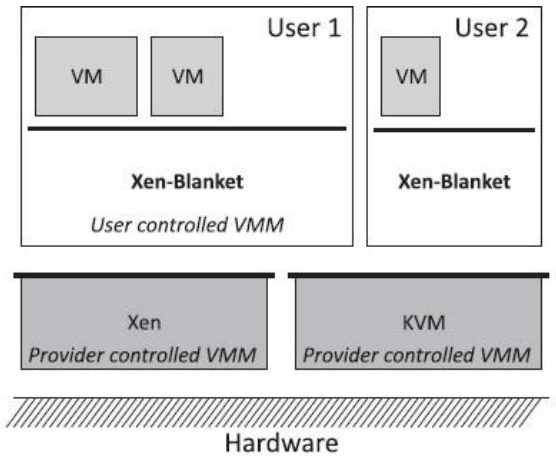

Figure 4: Xen-Blanket controlled by users

Xen-Blanket contains blanket drivers for each of cloud providers interface. The components of blanket drivers are shown in Figure 5[4]. These Blanket drivers exist in the bottom half of the Xen-Blanket due to which they are bound to interact with the underlying hardware. These hardware devices are eventually exposed to the virtual environment through a consistent paravirtualized device interface.The Blanket layer contains both a Xen hypervisor as well as a privileged Blanket Domain 0. Guest VMs are run on top of the Blanket layer, each containing standard paravirtualized front-end device drivers and corresponding backend device drivers. The back-enddrivers combine into Blanket drivers and therefore act as front-end drivers for the underlying hypervisors [4].

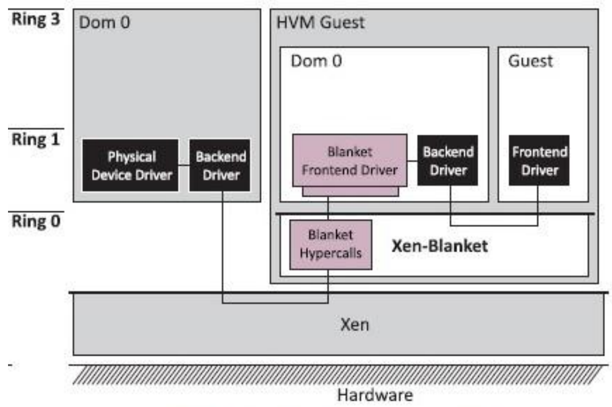

Figure 5: Blanket Driver Components

3. OPPORTUNITIES

This approach of implementing Supercloud is independent of the provider. For example, no cloud currently exists with a hypervisor that allows users to maximally utilize their leased VMs through techniques like page sharing or aggressive oversubscription [4]. Live VM migration between multiple clouds is completely out of question in virtual environment.This is due to the lack of open standards which involve a common standard image format to be used by all cloud providers. Original ideas for enabling hypervisor level flexibility which could provide users control is impossible. This prototype arises because the hypervisor is a software layer coded by the providers and the code prohibits any access to its users. This allows the providers to sole controller of their resources.

If clouds support the ability to virtualize a hypervisor on top of another hypervisor, then the VM format becomes irrelevant to the cloud. The only dependence is the format of the guest hypervisor itself.

In Supercloud using nested virtualization it is easy and efficient to debug and monitor guest OS upon a VMMelaborate VMM when first used, and even VMM itself [5].

Different providers can exist together in Supercloud environment.

4. CHALLENGES AND SUGGESTIONS

1. The users might gain several benefits using Supercloud but the mechanism which Supercloud uses is Xen-Blanket. Xen-Blanket works only on Xen based and KVMbased hypervisors. KVM is an open source hypervisor software that runs unmodified Linux or Windows images[11].If a situation arises where users want to access resources or services from other hypervisor environment, we need to have another blanket layer. For example VMware's hypervisor uses binary translation which will restrict Xen-Blanket from consuming resources from them. Moreover Xen-Blanket revolves around nested paravirtualization approach.Nested virtualization uses paravirtualization technique for two hypervisors layers. First hypervisor layer(L0) is just above the hardware and the second hypervisor layer (L1) is introduced by nesting. L1 resides in the guest of L0[12]. In nested paravirtualization the paravirtualized guest is knowledgeable of the virtual environment and uses hypercalls to interact with the hypervisor directly. In order to use hypercall the guest's OS should be modified. For bare-metal type of virtualization this indicates that the code of Ring 0 is modified whereas for hosted type of virtualization it means the host OS is changed to adapt to the virtual environment[12]. Hence there is a need for an interface between hypervisor and Xen-Blanket which would ensure the flexibility of accessing resources from different environment using different virtualization techniques.

2. Another issue is security.The providers definitely would find a way to ensure that their hypervisor source code becomes more secure and efficient in the sense, impenetrable. Xen-Blanket would be considered more of an intrusion trying to dictate their services. This would lead to more innovation from their providers. Enabling complete access to the users might prove cumbersome as there won't be control over resources being utilized. It is essential to provide isolation control to providers.

5. CONCLUSION

Virtualization technology provides a way to share computingresources among virtual machines by using hardware and softwaredivision, emulation, time-sharing and dynamic resourcesharing[6].It is suggestedthat in this distribution layer before the blanket interacts with its drivers there should be an additional activity taking place which will ensure drivers are compatible with all hypervisors using different virtualization techniques. The bottom half would ensure it to accept IaaS providers'image formats. The top half of this interface would interact with the respective drivers associated with the paravirtualization and binary translation technique and form a unified gateway where image formats can be decoupled.This kindof hypervisor diversity causes new challenges but it also promisesnew opportunities if applications can be carefully matched tothe best hypervisor[6].

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