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A Study on Resource Pooling, Allocation and Virtualization Tools used for Cloud Computing

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ABSTRACT
In cloud computing various types of resources like CPU, Memory, OS, Application Software etc. are used. A cloud server, which has sufficient resources all the time for its clients as resource pools, efficiently and dynamically allocates or deallocates these resources, is considered good for its clients.

Here, in this paper, we have presented a study on various types of resource pools like physical server pools, virtual server pools, storage pools, network pools etc available in cloud computing, various allocation strategies, and virtualization tools used in cloud computing to manages these resources for client’s request. This study will be useful to understand the underlying technologies of cloud computing.

General Terms
VMM [Virtual Machine Monitor], VM [Virtual Machine], hypervisor, cloud computing, Servers, Pools.

Keywords
Resource pooling, cloud computing, virtualization, hypervisor, virtual machine, allocation, deallocation.

1. INTRODUCTION
Sharing of resources in a network-based environment to its users on pay per use basis is the main goal of cloud computing. Lot of resources are required when network based computing is done, these resources we can hire from the vendors. These resources are available and pooled by many aggregators on network. These pooled resources are dynamically allocated and deallocated to the users on demand. Actually, cloud computing is defined as a pool of virtualized computer resources. Generally, Cloud providers use virtualization technologies combined with self-service abilities for computing resources via network infrastructures, especially the Internet and multiple virtual machines are hosted on the same physical server. Based on virtualization, the cloud computing paradigm allows workloads to be deployed and scaled-out quickly through the rapid provisioning of Virtual Machines or physical machines. A cloud computing platform supports redundant, self-recovering, highly scalable programming models that allow workloads to recover from many inevitable hardware/software failures. Resource pooling is based on aggregating IT resources and sharing these resource pools in such manner that automatically ensures that they remain synchronized.

Some common resource pools are as follows:

a. Physical Server Pools : These are physical servers with operating systems and other necessary programs, may be homogeneous and heterogeneous, connected each other through network and are ready for immediate use over the internet.

b. Virtual Server Pools: The virtual server, also known as virtual machine (VM), is a form of virtualization software that emulates a physical server and is used by cloud providers to share the same physical server with multiple cloud consumers by providing cloud consumers with individual virtual server instances. Figure 1 shows three virtual servers being hosted by two physical servers. The number of instances a given physical server can share is limited by its capacity.

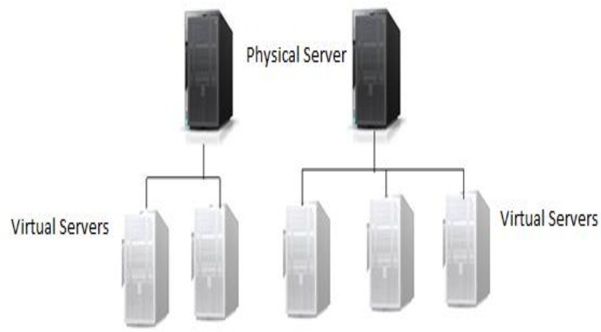

Figure 1: Virtual Server Pools

c. Storage pools or Cloud storage device pools : These pools consists of file-based or block-based storage structures that contain empty and/or filled cloud storage devices.

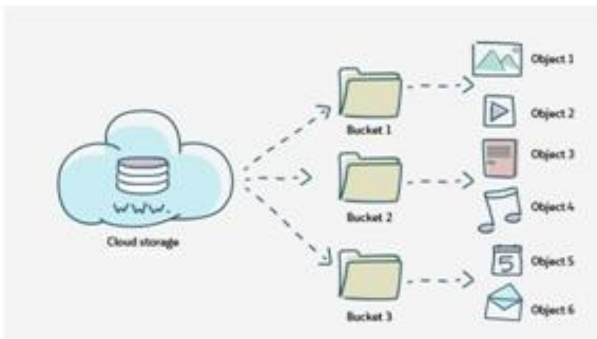

Figure 2: Storage Pools or Cloud storage device pools

d. Network Pools: There are many network pools on internet, which are interconnected to each other. It comprises preconfigured multiple network devices. For example Virtual Private Networks, load balancers etc. This is a group of undifferentiated networks that is available for use.

e. CPU Pools: These may be considered as a large group of CPU connected to each other and are available on internet ready to use through cloud computing on pay per use basis.

f. Memory Pools: This may be considered as a large group of physical memories i.e. RAMs or hard drives provisioned with physical servers or with virtual servers and are scalable & available through cloud computing on pay per use basis.

In addition to these dedicated or individual pools for sharing each type of IT resources, complex structure of pools may be shared on cloud networks. In the nested pool model, larger pools are divided into smaller pools that individually group the same type of IT resources together. Nested pools can be used to assign resource pools to different departments or groups in the same cloud consumer organization.

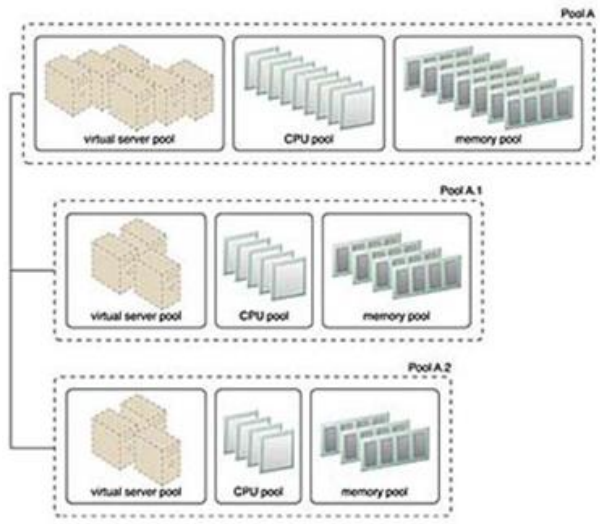

Figure 3: Nested Pools

In Figure 3, Nested Pools A.1 and Pool A.2 are comprised of the same IT resources as Pool A, but in different quantities. Nested pools are typically used to provision cloud services that need to be rapidly instantiated using the same type of IT resources with the same configuration settings.

In addition to cloud storage devices and virtual servers, which are commonly pooled mechanisms, the following mechanisms can also be part of this cloud architecture:

- Audit Monitor – This mechanism monitors resource pool usage to ensure compliance with privacy and regulation requirements, especially when pools contain cloud storage devices or data loaded into memory.
- Cloud Usage Monitor – Various cloud usage monitors are involved in the runtime tracking and synchronization that are required by the pooled IT resources and any underlying management systems.
- Hypervisor – The hypervisor mechanism is responsible for providing virtual servers with access to resource pools, in addition to hosting the virtual servers and sometimes the resource pools themselves.
- Logical Network Perimeter – The logical network perimeter is used to logically organize and isolate resource pools.
- Pay-Per-Use Monitor – The pay-per-use monitor collects usage and billing information on how individual cloud consumers are allocated and use IT resources from various pools.
- Remote Administration System – This mechanism is commonly used to interface with backend systems and programs in order to provide resource pool administration features via a front-end portal.
- Resource Management System – The resource management system mechanism supplies cloud consumers with the tools and permission management options for administering resource pools.
- Resource Replication – This mechanism is used to generate new instances of IT resources for resource pools.

Ultimately, data centre resources can be logically placed into three categories. They are: compute, networks, and storage. For many, this grouping may appear trivial. It is, however, a foundation upon which some cloud computing methodologies are developed, products designed, and solutions formulated.

Compute Pool: This is a collection of all CPU capabilities. Essentially all data center servers, either for supporting or actually running a workload, are all part of this compute group. Compute pool represents the total capacity for executing code and running instances. The process to construct a compute pool is to first inventory all servers and identify virtualization candidates followed by implementing server virtualization.

2. VIRTUALIZATION

Virtualization has proved its value and accelerated the realization of cloud computing. Then, virtualization was mainly server virtualization, which in an over-simplified statement means hosting multiple server instances with the same hardware while each instance runs transparently and in isolation, as if each consumes the entire hardware and is the only instance running.

3. HYPERVISOR

A hypervisor or virtual machine monitor (VMM) is computer software, firmware, or hardware, that creates and runs virtual machines. A computer on which a hypervisor runs one or more virtual machines is called a host machine, and each virtual machine is called a guest machine. The hypervisor presents the guest operating systems with a virtual operating platform and manages the execution of the guest operating systems. Multiple instances of a variety of operating systems may share the virtualized hardware resources: for example, Linux, Windows, and OS X instances can all run on a single physical x86 machine. This contrasts with operating-system-level virtualization, where all instances (usually called containers) must share a single kernel, though the guest operating systems can differ in user space, such as different Linux distributions with the same kernel.

The term hypervisor is a variant of supervisor, a traditional term for the kernel of an operating system: the hypervisor is the supervisor of the supervisor with hyper- used as a stronger variant of super.

A hypervisor is a function which abstracts -- isolates -- operating systems and applications from the underlying computer hardware. This abstraction allows the underlying host machine hardware to independently operate one or more virtual machines as guests, allowing multiple guest VMs to effectively share the system's physical compute resources, such as processor cycles, memory space, network bandwidth and so on. A hypervisor is sometimes also called a virtual machine monitor.

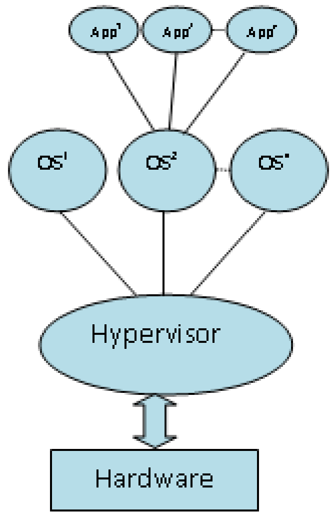

Figure 4 : Native or Bare-Metal Hypervisors

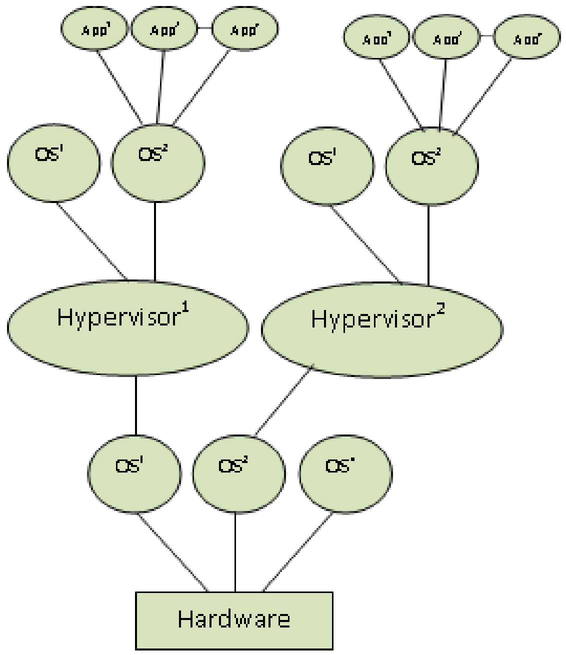

Figure 5 : Hosted Hypervisor

3.1. Native or Bare-Metal Hypervisors:

These hypervisors run directly on the host's hardware to control the hardware and to manage guest operating systems. For this reason, they are sometimes called bare metal hypervisors. The first hypervisors, which IBM developed in the 1960s, were native hypervisors.[4] These included the test software SIMMON and the CP/CMS operating system (the predecessor of IBM's z/VM). Modern equivalents include Xen, Oracle VM Server for SPARC, Oracle VM Server for x86, Microsoft Hyper-V and VMware ESX/ESXi.

3.2. Hosted Hypervisors:

These hypervisors run on a conventional operating system (OS) just as other computer programs do. A guest operating system runs as a process on the host. Type-2 hypervisors abstract guest operating systems from the host operating system. VMware Workstation, VMware Player, VirtualBox, Parallels Desktop for Mac and QEMU are examples of type-2 hypervisors.

However, the distinction between these two types is not necessarily clear. Linux's Kernel-based Virtual Machine (KVM) and FreeBSD's bhyve are kernel modules[5] that effectively convert the host operating system to a type-1 hypervisor.[6] At the same time, since Linux distributions and FreeBSD are still general-purpose operating systems, with other applications competing for VM resources, KVM and bhyve can also be categorized as type-2 hypervisors.

3.3 Virtual Machine Monitors:

Following are the description of two Virtual Machine Monitors used in many cloud based applications:

- **ManageEngine:** VMWare provides the most comprehensive solution for server virtualization today. ManageEngine Applications Manager provides comprehensive performance metrics to monitor your VMware ESX/ESXi servers and their guest virtual machines, and helps you ensure they are performing well at all times. Applications Manager connects with VMware ESX/ESXi servers through APIs and determines the health status as well as the performance of host servers and their corresponding virtual machines.

  With out-of-the-box reports, graphical views, alarms, thresholds and comprehensive fault management capabilities, administrators can maximize ESX server uptime and ensure that the guest virtual machines of the ESX/ESXi servers are running at peak performance.
- **VM Manager Plus:** It is free virtualization monitoring software that monitors unlimited VMs, hosts, and data stores across VMware, Hyper-V and XenServer platforms. It proactively monitors critical performance metrics such as CPU, memory, and disk utilization, network usage, memory swap, datastore read/write latency, memory ready, and much more. VM Manager Plus also monitors live migration of VMs and updates the VM-host relationship map automatically.

Specifically, the monitor sits between one or more operating systems and the hardware and gives the illusion to each running OS that it controls the machine. Behind the scenes, however, the monitor actually is in control of the hardware, and must multiplex running OSes across the physical resources of the machine. Indeed, the VMM serves as an operating system for operating systems, but at a much lower level; the OS must still think it is interacting with the physical hardware. Thus, transparency is a major goal of VMMs.

Today, VMMs have become popular again for a multitude of reasons. Server consolidation is one such reason. In many settings, people run services on different machines which run different operating systems (or even OS versions), and yet each machine is lightly utilized. In this case, virtualization enables an administrator to consolidate multiple OSes onto fewer hardware platforms, and thus lower costs and ease administration.

Another reason is testing and debugging. While developers write code on one main platform, they often want to debug and test it on the many different platforms that they deploy the software to in the field. Thus, virtualization makes it easy to do so, by enabling a developer to run many operating.

Platform virtualization software, specifically emulators and hypervisors, are software packages that emulate the whole physical computer machine, often providing multiple virtual machines on one physical platform. Some of the Platform virtualization softwares examples are DOSBox, FreeBSD Jail, Hercules, Hyper-V, INTEGRITY etc.

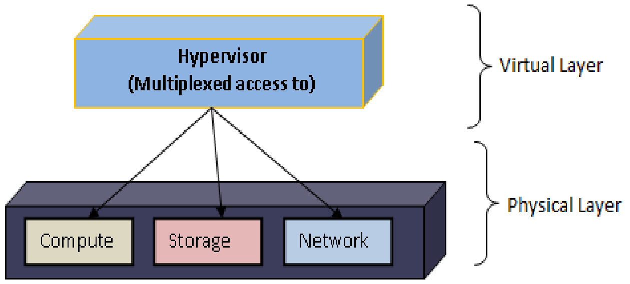

Figure 5: Role of Hypervisor in virtual computing

A hypervisor has an inherent knowledge of application's requirements. It also has a global view of architecture and is also hardware agnostic.

Resource Allocation

Dynamic allocation and deallocation process of Resources in cloud computing is shown in figure 4 below is based on dynamic allocation and deallocation of resources of multi-tenant cloud enviornment. The model is consisting of different units they are:-

A. Client
B. Request and Response Module\
C. Hypervisor
D. Virtual Machine
E. Operating System
F. Virtual Machine Resources like CPU, Memory, Disk, etc.

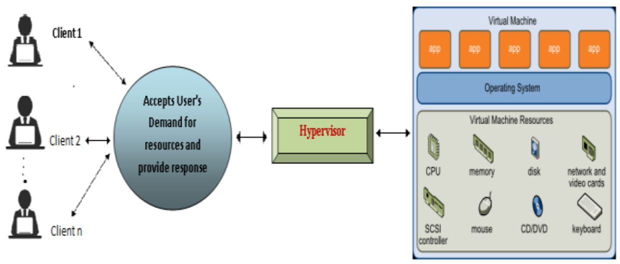

Figure 4 : Dynamic allocation and deallocation process of Resources in Cloud Computing

4. CONCLUSION

Virtualization has rapidly attained mainstream status in enterprise IT by delivering transformative cost savings as well as increased operational efficiency, flexibility and IT service levels. While a full virtual service-oriented infrastructure is composed of a wide array of technologies that provide resource aggregation, management, availability and mobility, the foundational core of virtual infrastructure is the hypervisor.

In this paper, we have analyzed and presented some common resource pools, nested pools, the advantages of virtualization, hypervisor and its types. Hypervisor may be treated as the kernel of Virtualization system.

Future researchers are working on making hypervisor more robust and dynamic for managing the allocation and deallocation or resources in cloud environment.

5. ACKNOWLEDGMENTS

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